

# **Sustainable Cities – Infrastructure and Technologies for Water**

A select annotated bibliography on water related  
resources

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# Introduction

The demand for clean water is a challenge worldwide. Population growth, along with rapid urbanisation, changing lifestyles and economic development has led to increasing pressure on water resources everywhere, and especially in developing countries. Today, more than 1 billion people do not have access to safe drinking water.

As countries continue to grow and urbanise, the search for cost-effective and sustainable water solutions becomes more important. In recent years, a full-blown technology race has emerged in pursuit of more affordable and energy-efficient ways to produce clean drinking water for the community.

While good infrastructure facilitates accessibility to clean water, it is often the mismanagement and lack of planning that has resulted in a dwindling supply of clean water worldwide. It is therefore important for water agencies to focus on the proper planning and management of water resources.

Providing high quality potable water is also becoming a challenge due to increasing pollution and higher standards of potable water required by World Health Organisation (WHO) and USEPA\*. It is hence imperative that good water safety management plans, and new analytical methods are used to tackle these concerns.

To ensure good, clean drinking water for Singapore, PUB, the national water agency has adopted an integrated water management approach to put in place a long-term water supply strategy known as the Four National Taps, comprising water from local catchments, imported water, reclaimed water (branded NEWater in Singapore) and desalinated water. By leveraging on technology, PUB was able to successfully harness NEWater and desalinated water as alternative sources of water. Further boosting Singapore's water supply is the Marina Barrage which was officially opened last year. With its completion, Singapore's 15th reservoir and its first in the city centre is formed, meeting 10% of Singapore's water needs. Besides water supply, the Marina Barrage is also a flood control mechanism and provides a venue for lifestyle activities. Both the Marina Barrage and the development of NEWater exemplify how the use of infrastructure and technology are critical in ensuring a sustainable water supply for cities.

This bibliography introduces resources focusing on the themes of 'Sustainable Cities: Infrastructure and Technologies for Water'. It covers a spread of resources including books, journal articles (from databases), web articles, websites and patents. The work represents a current scan of known available resources and should be taken as an introduction to the topic and is not meant to be an exhaustive coverage.

\* USEPA. Retrieved March 09 2009 from <http://www.epa.gov/waterinfrastructure/>

# 1.0 Water Technology Solutions for Today's Application

There is a continuous drive throughout the world to invest in R&D and improve water treatment processes to find more cost-efficient ways of producing water for both domestic and industrial use. The use of such treatment processes and technologies need to be efficient without compromising other resources, such as the depletion of energy in the operation of hi-tech treatment processes.

The paradigm shift in the use of non-conventional water sources have been made possible with advances in technologies. Not only are new technologies being explored, existing processes and technologies are also constantly being improved on. In the face of these technological drives, however, it is important not to lose sight of the importance of more conventional water treatment if they can do the job at lower operations and environmental cost, particularly for developing countries.

This compilation of resources on the latest water technology solutions includes methods that have the potential to become green water treatment alternatives while adhering to the required standards for water quality. The compilation is divided into 3 parts.

- Part 1 introduces various drinking water treatment and wastewater treatment technologies, including advanced membrane technology and applications, membrane bioreactors for anaerobic treatment of wastewaters, reverse osmosis, coagulation and flocculation, ultraviolet and chlorine disinfection,
- Part 2 introduces desalination technologies, including nanofiltration, solar desalination, membrane desalination, thermodesalination desalination and reverse osmosis desalination.
- Part 3 introduces sludge management and odour control management technologies, including radiation processing, industrial wastewater treatment, hydrothermal treatment, vermifiltration, biosolids management, sludge minimisation technologies, and anaerobic treatment.

# 1.1 Water and Wastewater Treatment

## Books

### **Industrial water quality**

Eckenfelder, W. W., Ford, D. L. and Englande, A. J.  
New York: McGraw-Hill, c2009  
R 628.3 ECK

Describes the range of processes involved in industrial water treatment, including ion exchange, reverse osmosis, and oxidation, and provides guidelines on how to select the most appropriate process, depending on the nature of the wastewater.

### **Membrane bioreactors for anaerobic treatment of wastewaters: Phase II**

Hall, E. R.  
Alexandria, Va.: London: Water Environment Research Foundation; IWA Pub., 2006  
R 628.162 HAL

Presents a study of anaerobic membrane bioreactors and membrane filtration under different conditions.

### **Advanced membrane technology and applications**

Li, N. N.  
Hoboken, N.J.: John Wiley, c2008  
R 660.28424 ADV

Describes the basic principles and theories of separation and purification by membranes, the important membrane processes and systems, and major industrial applications. There are 13 chapters dealing with the application of membranes in water and wastewater treatment.

### **Radiation processing: Environmental applications**

International Atomic Energy Agency  
Vienna: International Atomic Energy Agency, 2007  
R 628.162 RAD

This guidebook launched by the International Atomic Energy Agency, provides information on radiation processing for environmental applications, including wastewater purification and treatment of sewage sludge.

### **Industrial wastewater treatment**

Ng, W. J.  
London: Imperial College Press, c2006  
RSING 628.4 NG

Targeted at senior undergraduate and postgraduate environmental engineering students, and practitioners of the field, this book introduces the practice of industrial wastewater treatment, including sludge management.

### **Membrane systems for wastewater treatment**

Water Environment Federation  
New York: London: McGraw-Hill Professional, 2006  
R 628.1622 MEM

Describes the applications of various technologies in the field of wastewater treatment. The three primary wastewater membrane applications covered are membrane bioreactors, low pressure membranes (microfiltration/ultrafiltration) for effluent filtration, and nanofiltration/reverse osmosis for advanced post treatment.

## **Databases**

### **ProQuest central**

#### **More, larger membrane bioreactors begin to dot the horizon**

Bishop, J.

2006, March

Water Environment & Technology, 18(3), 90-91

Discusses the technology limits of the membrane bioreactor (MBR) and the associated costs factors of the process, which combines the biological step of the conventional wastewater treatment process with the secondary clarification step via submersion of fine-pore-membrane modules in the aeration tank to separate clean water from the sludge.

#### **Ultraviolet and chlorine disinfection of Mycobacterium in wastewater**

Bohrerova, Z. and Linden, K. G.

2006, June

Water Environment Research, 78(6), 565-571

Describes a research which studies ultraviolet (UV) and chlorine inactivation on *Mycobacterium terrae* (*M. terrae*), a species of Nontuberculous Mycobacteria (NTM) previously isolated from a water distribution network. Results show the presence of NTM aggregates which negatively affect the disinfection efficacy of both UV and chlorine disinfectants. Filtration of the effluent results in improved disinfection, suggesting that effluent filtration should precede the disinfection process to ensure adequate inactivation of Mycobacteria..

#### **Enhanced removal of heavy metals in primary treatment using coagulation and flocculation**

Johnson, P. D., Girinathannair, P., Ohlinger, K. N., and Ritchie, S., et al.

2008, May

Water Environment Research, 80(5), 472

Describes a study to determine the removal efficiencies of chromium, copper, lead, nickel, and zinc from raw wastewater by chemically enhanced primary treatment (CEPT) and to attain a total suspended solids removal goal of 80%.

#### **A modeling study of fouling development in membrane bioreactors for wastewater treatment**

Liang, S., Song, L., Tao, G., Kekre, K. A. and Seah, H.

2006, August

Water Environment Research, 78(8), 857-863

Describes a research utilising a mathematical model to study membrane fouling in submerged membrane bioreactor systems for wastewater treatment, in which both reversible and irreversible fouling were quantified.

#### **Anaerobic membrane bioreactors: Applications and research directions**

Liao, B.-Q., Kraemer, J. T. and Bagley, D. M.

2006

Critical Reviews in Environmental Science and Technology, 36(6), 489-530

Summarises the state of the art anaerobic membrane bioreactors (AnMBRs), determines the types of wastewaters for which AnMBRs would be best suited, and identifies the research required to increase implementation.

**Ultraviolet disinfection of Fecal Coliform in municipal wastewater: Effects of particle size**

Madge, B. A. and Jensen, J. N.

2006, March

Water Environment Research, 78(3), 294-304

Describes a research which shows that the degree to which particles interfere with UV disinfection efficiency is dependent on particle size. The small size fraction (<5 µm) consistently produced a statistically significant faster disinfection rate than the large fraction (>20 µm), with the unfiltered sample and the medium fraction (particles >5 µm, but <20 µm) between the two extremes.

**Water disinfection enhanced with ultraviolet light**

McClellan, J.

2008, October

Water & Wastewater International, 23(5), 18-19

Discusses ultraviolet (UV) light use as an effective barrier against *Legionella pneumophila*, and highlights successful applications in indoor and outdoor water systems and features.

**Influence of source characteristics, chemicals, and flocculation on chemically enhanced primary treatment**

Neupane, D. R., Riffat, R., Murthy, S. N., Peric, M. R. and Wilson, T. E.

2008, April

Water Environment Research, 80(4), 331

Describes a research that investigates various methods and parameters to increase the efficiency of chemically enhanced primary treatment (CEPT). The performance of CEPT was evaluated based on its efficiency in removing non-settleable solids (NSS).

**Increasing significance of advanced physical/chemical processes in the development and application of sustainable wastewater treatment systems**

Rulkens, W.

2008, December

Frontiers of Environmental Science & Engineering in China, 2(4)

Describes the specific future roles and aims of the various physical/ chemical treatment processes in the development and application of sustainable wastewater treatment systems. These include improving the performance of microbiological treatment processes, achieving high quality standards for effluent reuse, recovering valuable components and energy from wastewater for beneficial reuse, desalinating brackish water and seawater, and treating concentrated liquid or solid waste residues produced in a wastewater treatment process.

**Sewage treatment by vermifiltration with synchronous treatment of sludge by earthworms: A Low-cost sustainable technology over conventional systems with potential for decentralization**

Sinha, R. K., Bharambe, G. and Chaudhari, U.

2008, December

The Environmentalist, 28(4)

Describes a research that uses the earthworms' body as a 'biofilter'. Findings show that earthworms are able to remove 5 days of biological oxygen demand (BOD) by over 90%, chemical oxygen demand (COD) by 80–90%, total dissolved solids (TDS) by 90–92%, and total suspended solids (TSS) by 90–95% from wastewater by the general mechanism of 'ingestion' and biodegradation of organic wastes, heavy metals, and solids from wastewater and also by their 'absorption' through body walls.

**Use of membranes for heavy metal cationic wastewater treatment: Flotation and membrane filtration**

Sudilovskiy, P. S., Kagramanov, G. G., Trushin, A. M. and Kolesnikov, V. A.

2007, August

Clean Technologies and Environmental Policy, 9(3)

Describes a research studying the hydrodynamics of air sparging with the use of microporous membranes as well as the membrane flotation efficacy for cationic wastewater treatment. The performance of membrane filtration processes was evaluated. Ways of integrating flotation and membrane filtration in cationic wastewater treatment practice are also discussed.

## Websites

### **Applied Membrane Inc.**

**(Technical database for the water treatment industry)**

Retrieved on Mar 3, 2009

**[www.watertreatmentguide.com/membrane\\_fouling\\_solutions.htm](http://www.watertreatmentguide.com/membrane_fouling_solutions.htm)**

A very useful website that provides information on membrane fouling solutions.

### **Bio-Bubble Ltd**

Retrieved on Mar 3, 2009

**[http://www.bio-bubble.com/products.php?content\\_id=62](http://www.bio-bubble.com/products.php?content_id=62)**

This is the website of Bio-Bubble Ltd, which does full-scale municipal, commercial, industrial wastewater, sludge and domestic sewage treatment, using 'advanced aeration' which combines wastewater and sludge treatment within a single reactor. More information about their products and technologies applied can be downloaded from the website.

### **International Water Association**

Retrieved on Mar 3, 2009

**[www.iwahq.org](http://www.iwahq.org)**

This website provides a platform to globally connect water professions around the world. It also provides very useful articles and information on the latest water technologies, such as membrane technologies.

### **Koch Membrane Systems**

Retrieved on Mar 3, 2009

**<http://www.kochmembrane.com/ps.html>**

A corporate website that specialises in membrane technologies used in industrial applications for water and wastewater treatment. There are also many useful articles and literature papers on the website.

### **Lenntech Water Treatment & Air Purification Holding B.V.**

Retrieved on Mar 3, 2009

**[www.lenntech.com/membrane-technology.htm](http://www.lenntech.com/membrane-technology.htm)**

This corporate website provides theoretical concepts on membrane technology, membrane system management, and membrane cleaning.

### **Lettinga Associates Foundation (LeAF)**

Retrieved on Mar 3, 2009

**<http://www.lettinga-associates.wur.nl/?page=10>**

LeAF is a not-for-profit firm that actively promotes the implementation of sustainable environmental protection technologies, such as anaerobic treatment in sludge management. The website provides information on their services (including water treatment courses), publications, and anaerobic wastewater treatment technology.

### **Water Technology**

Retrieved on Mar 3, 2009

**<http://www.water-technology.net/>**

This website is a procurement and reference resource providing a one-stop-shop for professionals and decision makers within the water and wastewater industries. It provides a comprehensive breakdown of water equipment manufacturers, suppliers and services, up-to-date news and press releases, white papers and detailed information on current industry projects and trends.

## 1.2 Desalination

### Books

#### **Desalination of seawater and brackish water**

Lauer, W. C. (Ed.)

Denver, C.O.: American Water Works Association, c2006

R 628.167 DES

Contains articles taken from AWWA conference proceedings and periodicals and includes some updated materials not previously published. Major topics covered are seawater and brackish desalination, membrane softening, disposal, costs and delivery.

#### **A novel approach to seawater desalination using dual-staged nanofiltration**

Le Gouellec, Y. A., et al.

Denver, Colo.: [London]: AWWA Research Foundation: American Water Works Association; IWA Pub., c2006

R 628.167 NOV

Describes a new approach of desalting seawater by using a dual-staged nanofiltration (NF<sup>2</sup>) process developed by the Long Beach Water Department (LBWD), which is able to desalt seawater by treating the first-stage permeate through a second stage to produce water with salinity levels that meet drinking water standards.

#### **Solar desalination for the 21st century: A Review of modern technologies and researches on desalination coupled to renewable energies: [Proceedings of the NATO Advanced Research Workshop on Solar Desalination for the 21st Century, held in Hammamet, Tunisia, 23-25 February 2006]**

Rizzuti, L., Ettouney, H. M. and Cipollina, A.

Dordrecht: Springer, c2007

R 628.167 NAT

Presents the state of the art desalination technologies and contains topics on modelling tools and optimisation and solar desalination potential and local applications.

## Databases

### SpringerLink

#### **Membrane desalination driven by solar energy**

Banat, F. and Qiblawey, H.

2007

Solar desalination for the 21<sup>st</sup> Century, 271

This study reviews the current status of a number of solar thermal and PV (spell out in full) technologies that are coupled with water membrane desalination processes.

#### **Thermodistillation desalination of seawater with direct heating in the first stage**

Evzel'man I. B.

2007, April

Coke and Chemistry, 50(4)

Describes a research that reduces fuel consumption in the desalination of seawater, by the replacement of steam heating by direct heating in the first stage of desalination. In this way, the heat liberated during fuel combustion is transferred to the desalination unit without any intermediary, increasing the thermal efficiency of the process by a factor of 2–2.5.

#### **Deep desalination of water by evaporation through polymeric membranes**

Lazarev, S. I., Gorbachev, A. S., Shaposhnik, V. A. and Stamov, V. M.

2007, May

Russian Journal of Applied Chemistry, 80(5)

Describes a research that studies the transport properties and structural features of known and new types of polymeric membranes in the desalination of aqueous salt solutions by membrane distillation and *pervaporation*. It also studies the possibility of obtaining distilled water in a single stage by *pervaporation* from diluted or concentrated aqueous salt solutions, using membranes fabricated from celluloses of varied origin (wood, cotton, bacterial).

#### **Kinetics of reverse osmosis desalination of aqueous sodium sulfanilate**

Lazarev, S. I., Gorbachev, A. S., Shaposhnik, V. A. and Stamov, V. M.

2006, May

Russian Journal of Applied Chemistry, 79(5)

Describes a research studying the kinetics of reverse osmosis desalination of aqueous sodium sulfanilate on a laboratory pressure filter unit, in relation to the solution concentration, temperature, and pressure in the inter-membrane channel.

#### **Experimental study of the performance of multi-effect solar thermal water desalination system**

Mahkamov, K. and Akhatov, J. S.

2008, February

Applied Solar Energy, 44(1)

Describes the development of a pilot project on a multistage solar thermal water desalination system, and presents the results of the system testing under laboratory conditions. The results show that the productivity of the developed system is two times higher than that of conventional solar distillers installed on greenhouses.

#### **Impact of desalination plants brine injection wells on coastal aquifers**

Nassar, M. K. K., El-Damak, R. M. and Ghanem, A. H. M.

2008, April

Environmental Geology, 54(3)

Describes a new methodology to assess the environmental impacts of desalination plants discharging brine into the ground, by using laboratory and computational methods to simulate the unsteady three-dimensional (3D) phenomena of subsurface brine disposal.

## Websites

### **Ashkelon Desalination Plant, Seawater Reverse Osmosis (SWRO) Plant, Israel**

Retrieved on Mar 3, 2009

**<http://israel-institute.com/media/Askelon%20Desalinazation%20Center.pdf>**

Describes the plant design and technology used in the Ashkelon seawater reverse osmosis (SWRO) plant, one of the largest in the world, and which was voted 'Desalination Plant of the Year' in the 2006 Global Water Awards.

### **Desalination: A National Perspective**

Retrieved on Mar 3, 2009

**[http://dels.nas.edu/dels/rpt\\_briefs/desal\\_final.pdf](http://dels.nas.edu/dels/rpt_briefs/desal_final.pdf)**

Describes the current state of desalination technology, the costs involved, and further areas of research necessary to make desalination a competitive option among water supply alternatives.

### **Desalination, With A Grain Of Salt: A California Perspective**

Retrieved on Mar 3, 2009

**[http://www.pacinst.org/reports/desalination/desalination\\_report.pdf](http://www.pacinst.org/reports/desalination/desalination_report.pdf)**

Provides a comprehensive overview of the history, benefits, and risks of ocean desalination, and the barriers that hinder more widespread use of this technology. It also offers a set of recommendations for water users and planners interested in making desalination a more significant part of international, national, and local water policy.

### **Tampa Bay Seawater Desalination**

Retrieved on Mar 3, 2009

**<http://www.tampabaywater.org/watersupply/tbdesal.aspx>**

Describes the Tampa Bay Seawater Desalination Plant, the largest in the United States, and the desalination process used.

### **World's first full-scale large-diameter SWRO desalination plant**

Retrieved on Mar 3, 2009

**[http://www.waterwastewaterasia.com/WWA\\_archive/JanFeb08/22t24.pdf](http://www.waterwastewaterasia.com/WWA_archive/JanFeb08/22t24.pdf)**

Describes the new 10,000-m<sup>3</sup>/day seawater reverse osmosis (SWRO) desalination plant at PowerSeraya's Pulau Seraya Power Station on Jurong Island, Singapore, which is the first in the world to use the highly advanced 16-inch (400 mm) large diameter membrane SWRO technology. The current industry standard is an 8-inch (200 mm) diameter membrane.

## 1.3 Sludge Management

### Databases

#### SpringerLink

##### **Sludge minimisation technologies**

Pérez-Elvira, S. I., Nieto Diez, P. and Fdz-Polanco, F.

2006, November

Reviews in Environmental Science and Biotechnology, 5(4)

Describes the minimisation techniques for reducing sludge production in biological wastewater treatment processes, and provides an overview of the main technologies used.

##### **Sewage sludge hydrothermal treatment by microwave irradiation combined with alkali addition**

Qiao, W., Wang, W. Xun, R., Lu, W. and Yin, K.

2008, April

Journal of Materials Science, 43(7)

Describes the effects of microwave treatment on sewage sludge with alkali addition, the solubilisation of organic matters and the settleability of sludge. This alternative method to treat sludge was found to provide a fast and effective sludge hydrolysis process.

##### **Sludge reduction by predatory activity of aquatic oligochaetes in wastewater treatment plants: Science or fiction? A review**

Ratsak, C. H. and Verkuijden, J.

2006, July

Hydrobiologia, 564(1)

Reviews the feasibility for reducing activated sludge in wastewater treatment plants (WWTPs) by means of aquatic oligochaetes, and also discusses the current techniques used in sludge reduction.

##### **A new, pellet-forming fungal strain: Its Isolation, molecular identification, and performance for simultaneous sludge-solids reduction, flocculation, and dewatering**

Subramanian, S. B., Yan, S., Tyagi, R. D. and Surampalli, R. Y.

2008, September

Water Environment Research, 80(9), 840

Describes a study to isolate a new fungal strain from municipal sludge that could simultaneously reduce sludge, flocculate, and dewater. The fungal strain was identified, and its role in sludge degradation and dewatering was established in this research.

##### **Technological options for the management of biosolids**

Wang, H.

2008, June

Environmental Science and Pollution Research, 15(4)

Provides a review of the technologies used in biosolids management, and recommends further research in the following areas: achieving a higher degree of public understanding and acceptance for the beneficial use of biosolids, developing cost-efficient and effective thermal conversions for direct energy recovery from biosolids, advancing technology for phosphorus recovery, and selecting or breeding crops for efficient biofuel production.

## Websites

### **Sludge Treatment, Reuse And Disposal**

Retrieved on Mar 3, 2009

**[http://www.unep.or.jp/ietc/publications/freshwater/sb\\_summary/10.asp](http://www.unep.or.jp/ietc/publications/freshwater/sb_summary/10.asp)**

Describes the nature of sludge and the treatment options available, such as stabilisation, thickening, dewatering, drying and incineration.

### **Sludge Water Treatment: DEWA**

Retrieved on Mar 3, 2009

**<http://www.dwteng.com/sub/Products.php>**

This is the website of DEWACO LTD, one of the leading players in sludge treatment, both in municipal and industrial water and wastewater applications. The website provides information on their products and technologies related to sludge water treatment, such as sludge thickening & dewatering.

### **WWDMag.com and Water & Wastes Digest magazine: Water and Wastewater Treatment**

Retrieved on Mar 3, 2009

**<http://www.wwdmag.com/Sludge-Treatment-Made-Easy-article8491>**

Provides information on the topic of water waste management, including articles on sludge management which are searchable from their website.

## 2.0 Managing Water Infrastructure

Sustainable water management is a key environmental challenge of the 21<sup>st</sup> century. Developing countries have huge water supply and sanitation challenges to meet, whereas developed countries struggle to keep their water spending constant to maintain the existing service level.

A recent OECD study\* shows that Japan and Korea may have to increase their water spending by more than 40% to maintain existing levels of service. The United States' Environmental Protection Agency estimates that annual investment of USD 23 billion will be needed over the next 20 years to maintain water infrastructure at current service levels given stricter standards. In the face of such challenges, it is fundamental to have good water management practices.

Asset management is a form of systematic integration of advanced and sustainable management techniques, which has been introduced as a management paradigm with a primary focus on the long-term life cycle of the asset. The use of asset management in conjunction with reliable water distribution networks and water and wastewater plants with efficient treatment processes would make it possible to create a turning point for water sustainability.

This chapter on managing water infrastructure will highlight resources that cover the topics of water asset management, operations and maintenance of water and wastewater plants, and water distribution networks.

\* Organisation for economic co-operation and development (OECD). Retrieved February 17, 2009 from [http://www.oecd.org/document/47/0,3343,en\\_2649\\_37465\\_36146415\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/47/0,3343,en_2649_37465_36146415_1_1_1_1,00.html)

## 2.1 Water Asset Management

### Books

**Water-works: The Architecture and engineering of the New York City water supply**

Kevin, B. (Ed).

New York: Monacelli Press Inc, c2006

R 628.1097471 WAT

This book is the culmination of an archival rescue mission that took place from 1994 to 2003. The goal was to create a permanent, fully functioning archive dedicated to the care and preservation of New York City's essential water supply records.

**Adaptive and integrated water management: Coping with complexity and uncertainty**

Pahl-Wostl, C., Kabat, P. and Moltgen, J.

Berlin; New York: Springer, c2008

R 333.912 INT

This book provides contributions by leading scientists, and water makers at the 2007 international conference on adaptive and integrative water management. Chapter topics range from adaptive steps towards groundwater protection, to regional water management regimes, managing flood risks, improvement of water use and conceptual considerations.

**Taming the anarchy: Groundwater governance in South Asia**

Tushaar, S.

Washington, D.C: Colombo, Sri Lanka: Resources for the future, c2009

R 333.9130954 SHA

This title investigates the forces behind the transformation of South Asian irrigation and considers its social, economic, and ecological impacts.

## **Databases**

### **EBSCOhost**

#### **Asset management streamlines water district operations**

Blackman, M.

2007, April

Waterworld, 12

This newsletter highlights the benefits of using a centralised automated asset management system that is designed to help water distribution agencies and departments optimise their assets and resources.

#### **Implementation of pressure and leakage management strategies on the Gold Coast, Australia: Case Study**

Girard, M. and Stewart, R.A.

2007, May/June

Journal of water resources planning and management, 133(3)

This paper quantifies the benefits derived from a pressure and leakage management (PLM) strategy in a trial area located on the Gold Coast. The results support claims that PLM can reduce water consumption and the frequency of infrastructure failures.

#### **Development of rehabilitation plans for water mains replacement considering risk and cost-benefit assessment**

Giustolisi, O., et al.

2006, September

Civil Engineering and Environmental Systems, 23(3), 175

The article introduces a processing step by which pipes are prioritised for rehabilitation. Using the model and management theory proposed, it has significantly reduced the economic and social costs of pipe bursts in the water distribution networks (WDN).

## **SpringerLink**

### **Evaluation of biological stability and corrosion potential in drinking water distribution systems: A Case study**

Chien, C. C., et al.

2008, May

Environment Monitoring Assessment

This paper highlights the water distribution system of Cheng-Ching Lake water treatment plant. It evaluates the fate and transport of organic based indicators in the selected distribution system, correlates the organic indicators to major water quality parameters, and illustrates asset management issues caused by corrosion in water pipes systems.

### **Development of a moisture-content system for monitoring leaks in VVER pipelines**

Gonor, V. K., et al.

2007, November

Atomic Energy, 103(5), 858

This paper shows the technical decisions adopted in developing a moisture-content system for monitoring leaks in the pipeline.

## Websites

### **American Society of Civil Engineers – Water infrastructure security enhancement (WISE)**

Retrieved on February 10, 2009

**[www.asce.org/static/1/wise.cfm](http://www.asce.org/static/1/wise.cfm)**

The American Society of Civil Engineers (ASCE), American Water Works Association (AWWA), and Water Environment Federation (WEF) teamed up in 2003 to produce guidance documents for the physical security of water and wastewater utilities under the Water Infrastructure Security Enhancements (WISE) project.

### **AWWA Research foundation – Asset Management Research**

Retrieved on February 10, 2009

**[www.waterassetmanagement.com](http://www.waterassetmanagement.com)**

AWWA Research Foundation (AwwaRF) has established the Asset Management Research Needs Roadmap project for the water and wastewater industry. The project identifies the industry's most pressing research needs in relation to asset management and defines a set of comprehensive, cohesive and prioritised research initiatives.

### **CH2MHILL**

Retrieved on February 10, 2009

**[www.ch2m.com/corporate/](http://www.ch2m.com/corporate/)**

CH2MHILL is a global leader in full service engineering, consulting, construction, and operations. This webpage provides a list of useful updates on water asset management.

### **USEPA – Sustainable infrastructure for water and wastewater**

Retrieved on February 10, 2009

**[www.epa.gov/waterinfrastructure/](http://www.epa.gov/waterinfrastructure/)**

A website provided by The United States Environmental Protection Agency, dedicated to promoting sustainable practices in water management.

## 2.2 Operations & Maintenance of Water and Wastewater Plants

### Books

#### **Pumping station design**

Garr, M. J., et al.

Burlington, MA: Butterworth-Heinemann, c2006

R 628.29 PUM

This book written by water consultants provides expert information on water pumping station design, operation and maintenance.

#### **Radiation processing: Environmental applications**

International Atomic Energy Agency

Vienna: International Atomic Energy Agency, 2007

R 628.162 RAD

This publication provides information relevant to radiation processing for environmental applications. Chapters 3 and 4 are of particular interest to this water publication, as it discusses issues pertaining to radiation processing and operations of wastewater and sewage sludge.

#### **Membrane bioreactors: Operation and results of a MBR wastewater treatment plant**

Van Bentem, A. G. N., et al.

London: IWA Publishing, c2007

R 628.3 MEM

This book highlights a municipal wastewater demonstration plant that shows the technical feasibility of scaling up.

## **Databases**

### **EBSCOhost**

#### **Singapore plans two more reuse plants, increasing its reliance on reclaimed water**

Landers, J.

2008, August

Civil Engineering, 33-35

This paper highlights Singapore's growing reliance on reclaimed water, as it embarks on building two more reuse plants.

#### **Wastewater treatment in Brazil: Institutional framework, recent initiatives and actual plant performance**

Oliveira, S. M. A. C.

2006

International Journal of Technology Management and Sustainable Development, 5(3), 241

The paper discusses an innovative program which aims to encourage public and private companies to implement new treatment plants and to improve the performance of existing wastewater treatment systems.

#### **Cost and land functions for wastewater treatment projects: Typical simple linear regression versus fuzzy linear regression**

Papadopoulos, B., et al.

2007, June

Journal of environmental engineering, 133(6), 581

This paper analyses cost data pertinent to the municipal wastewater treatment plants (MWTP) in Greece. Data have been collected with onsite visits, such as the land size necessary for a MWTP, the construction costs, and the operations and maintenance cost of existing wastewater treatment facilities.

#### **Permeate flux optimisation of a pilot microfiltration plant for cost-effectiveness of water reclamation reuse**

Xie, R. J., et al.

2006, July

Journal of Environmental Science and Health Part A, 41, 1171

This paper discusses the results of permeate flux optimisation of a pilot microfiltration plant that helps reduce the cost of water reclamation reuse.

#### **Case study: Design and operation of sustainable urban infiltration ponds treating storm runoff**

Zheng, J., et al.

2006, March

Journal of urban planning and development, 132:1(36)

This case study assesses the constraints associated with the planning, design and operation of wetlands ponds as well as the influence of aquatic plants on infiltration rates and water treatment potential.

## **SpringerLink**

### **State water corporation total asset management plan**

Barrie, R., et al.

2006, July

WCEAM, 121, 1

This paper contains the organisational background, asset management framework, and benefits of a total asset management plan for a state water corporation in Australia.

### **Life cycle assessment of water from the pumping station to the wastewater treatment plant**

Lassaux, S., et al.

2007, March

International Journal of Life Cycle Assessment, 12(2), 118-126

This paper discusses the environmental impact of using one cubic metre of water in the Walloon region.. The processes analysed are, water catchment, water treatment, water supply, sewer system, collective and individual wastewater treatment plant, waste sludge treatment, and water discharge.

## Websites

### **Asia Water Technology Ltd**

Retrieved on February 11, 2009

**[www.asiawatertech.com](http://www.asiawatertech.com)**

Asia Water Technology Ltd is a Singapore company that carries out businesses related to water purification treatment, wastewater treatment, automated control systems and other projects.

### **EUWA Water Treatment Plants**

Retrieved on February 11, 2009

**[www.euwa.com/en/index.php](http://www.euwa.com/en/index.php)**

EUWA water treatment plants are used around the world with a guarantee of stable and good quality water supply. . A Singapore subsidiary was open in 1965 to offer water treatment solutions in Asia. Its website provides a useful list of product descriptions, explaining the concepts and principles behind each application.

### **GE Water & Process Technologies**

Retrieved on February 11, 2009

**[www.gewater.com](http://www.gewater.com)**

GE Water and Process technologies, a unit of GE infrastructure, is a leading global supplier and operator of water treatment, wastewater treatment and process systems solutions. This website provides a constant update of some of the current solutions and technologies available on plant operations and maintenance.

### **International Water Association: Design, operations and maintenance of drinking water treatment plants**

Retrieved on February 11, 2009

**[www.iwahq.org/templates/ld\\_templates/layout\\_633184.aspx?ObjectId=633920](http://www.iwahq.org/templates/ld_templates/layout_633184.aspx?ObjectId=633920)**

The Specialist Group at IWA on Design, Operation and Maintenance of Drinking Water Treatment Plants is a forum for the exchange of theoretical, practical and operational experiences for those involved in the design and operation of drinking water treatment plants.

### **Keppel Seghers**

Retrieved on February 11, 2009

**[www.keppelseghers.com/home](http://www.keppelseghers.com/home)**

Keppel Seghers is a leading provider of comprehensive environmental solutions ranging from consultancy, design and engineering, technology and construction to operations and maintenance of facilities. The website covers interesting publications and past examples of water and wastewater treatment. A useful list of water solutions is also provided.

## 2.3 Water Distribution Networks

### Books

**Hydrometry: A Comprehensive introduction to the measurement of flow**

Boiten, W.

Boca Raton: CRC Press, c2008

R 627.042 BOI

This book provides a thorough introduction to the science of hydrometry. Dealing with both traditional techniques and innovative new methods and instruments in line with the latest ISO standards, this book addresses the main themes of hydrometry: the measurement of water levels and bed levels, the amount of discharge and flow of sediment transport. It also discusses the use of flow measurement structures, hydrological networks and the organisation of river surveys.

**Process piping design handbook: The Fundamentals of piping design**

Smith, P.

Houston, Texas: Gulf Pub, c2007

R 621.8672 SMI

This handbook covers the broad spectrum of information relevant for piping engineers, such as piping codes, standards and specifications, piping components, and includes examples covering project developments and construction.

## **Databases**

### **EBSCOhost**

#### **Solution for water distribution systems under pressure-deficient conditions**

Ang, W. K., et al.

2006, May/Jun

Journal of Water Resources Planning and Management, 132(3), 175

The paper suggests a proposed model which progressively introduces a set of artificial reservoirs into the network to initiate nodal flows. The results show that the behaviour of a water distribution system under pressure-deficient conditions is complex and nonintuitive.

#### **Improve control of pressure reducing valves in water distribution networks**

Prescott, S. L., et al.

2008, January

Journal of Hydraulic Engineering, 134(1), 56

The paper presents work done on the influence of modulating control valves on the behaviour in a water pipe network. Results from modelling studies shows the interactions between pressure reducing valves in response to changes to pressure variations.

#### **Water quality failures in distribution networks – risk analysis using fuzzy logic and evidential reasoning**

Sadiq, R., et al.

2007

Risk Analysis, 27(5), 1381

The evaluation on the risk of water quality failures in a distribution network is investigated in this paper. Five general pathways through which a water quality failure can occur in the network are also identified.

#### **Optimal cost design of water distribution networks using harmony search**

Zong, W. G.

2006, April

Engineering Optimization, 38(3), 259

This study presents a cost minimisation model for the design of water distribution networks. The model uses a recently developed harmony search optimisation algorithm to find better design solutions for pipe diameters in a water distribution network.

## **ProQuest central**

### **How not to calibrate a hydraulic network model**

Hirrel, T. D.

2008, August

American Water Works Association, Journal, 100(8), 70

This article challenges the notion that hydraulic network models should be calibrated by input parameters such as roughness and demand so that the model results and field data match.

### **Comparative study of three types of controllers for water distribution networks**

Kumar, M. P., et al.

2009, January

American Water Works Association. Journal, 101(1), 74

The paper discusses proportional derivative (PD) and proportional integral derivative (PID) controllers in terms of water distribution networks. Controller performance is evaluated for sequential supply to multiple reservoirs for level and flow control.

### **Using aggregation/skeletonization networks models for water quality simulations in epidemiologic studies**

Perelman, L., et al.

2008, June

American Water Works Association Journal, 100(6), 122

In this study, a network aggregation methodology based on both hydraulic and water quality aggregation of an all-pipes network was applied to a complex all-pipes network.

## **SpringerLink**

### **An integrated model to evaluate losses in water distribution systems**

Tabesh, M., et al.

2008, June

Water Resource Management, 23, 477-492

Using the capabilities of the model proposed, the network map and attribute data are linked and factors affecting network leakage are identified. Illustrated by a real case study, the results show that the suggested model has overcome the shortcomings of the existing methodologies by accounting for water leakage in the distribution networks.

### **Conjunction management of large-scale pressurized water distribution and groundwater systems in semi-arid area with parallel genetic algorithm**

Tsai, F. T-C., et al.

2007, May

Water Resource Management

This study develops a production well management model for the conjunctive management of water resources in semi-arid areas. The management model integrates a large-scale pressurised water distribution system and a three dimensional groundwater model under an optimisation framework.

## Websites

### **BOSS International**

Retrieved on February 11, 2009

**[www.bossintl.com/waternet-overview.html](http://www.bossintl.com/waternet-overview.html)**

BOSS international is a leading software provider for water distribution. A live demonstration on water quality modelling and analysis is also available on its website. .

### **C.R. Hutchison & Co PTY. LTD. (CRH)**

Retrieved on February 11, 2009

**[www.hutchisonandco.com.au/index.php](http://www.hutchisonandco.com.au/index.php)**

CRH was established in 1970 and provides surveying services. They have completed numerous projects related to sewer reticulation systems, water supply and pipelines.

### **Free patents online: Non-destructive testing of pipes**

Retrieved on February 11, 2009

**[www.freepatentsonline.com/7475596.html](http://www.freepatentsonline.com/7475596.html)**

This patent on non-destructive testing of pipes (USPTO number: 7475596) is available online.

### **VEOLIA Water Network Services (VWNS)**

Retrieved on February 11, 2009

**[www.veoliawaterns.com.au/en/](http://www.veoliawaterns.com.au/en/)**

VWNS is a world leading construction specialist in water distribution networks and wastewater collection systems. A useful list of case studies on water network solutions can also be found on its website.

### **Water Integrity Network (WIN)**

Retrieved on February 11, 2009

**[www.waterintegritynetwork.net/](http://www.waterintegritynetwork.net/)**

WIN was formed to support anti-corruption activities in the water sector worldwide by forging coalitions that can take action in ways that individuals or single organisations cannot. The complexity of multiple geographical and institutional levels typical of water sub-sectors makes such coalitions essential.

## 3.0 Water and Health

Water quality plays an essential role towards human growth and civilisation. In the second half of the 20<sup>th</sup> century, rapid population growth and increasing urbanisation resulted in a three-fold increase in global clean water demand. Human activities and wastes threaten the stability of the quality of water supplies; and polluted water sources have been linked to the spread of water-borne diseases and chemical poisoning. It is of utmost importance to protect water sources from contamination, so that we can extract clean raw water to be treated for the drinking water supply. As globalisation and industrialisation takes place, there is a need to set worldwide standards and regulations for clean water.

The World Health Organisation (WHO) is one such organisation that addresses the above need. It produces international norms on water quality and human health in the form of guidelines that are used as the basis for regulation and standard setting in countries worldwide. The main aims of such regulations are to ensure that water is protected within respective countries and to minimise the threat to human health and society.

This chapter on water and health will highlight resources on drinking water guidelines and regulations.

## 3.1 Safe Drinking Water Quality and Regulations

### Books

#### **Water quality control handbook**

Alley, R.  
Maidenhead: McGraw-Hill Professional, 2007  
R 628.168 ALL

This book explores design innovations, equipment selection, treatment processes and new regulations for achieving peak performance in all kinds of wastewater treatment facilities. Chapter 4 touches on water quality, Chapter 5 on water quality management and Chapter 6 on water pollution standards.

#### **Our waters: Joining hands across borders: First assessment of transboundary rivers, lakes and groundwaters**

Economic Commission for Europe  
New York: United Nations, 2007  
R 333.910095 OUR

This is the first ever in-depth report produced on transboundary rivers, lakes and groundwaters in the UNECE (should be spelled out in full) region.

#### **Fluoride in drinking water**

Fawell, J. K., et al.  
London: IWA Pub: WHO, c2006  
R 628.166 FLU

The primary focus of this book is on the prevention of adverse health effects from excessive levels of fluoride in drinking water. Chapter 4 contains the WHO water quality guidelines and standards that are applicable to local conditions.

#### **Hydrodynamics and water quality: Modelling rivers, lakes, and estuaries**

Ji, Z.  
Hoboken, N. J.: Wiley-Interscience, c2008  
R 627 JI

This book provides the principles, basic processes, mathematical descriptions, and practical applications of modelling surface waters. It discusses hydrodynamics, sediment processes, toxic fate and transport, and water quality. It also shows the progress made in mathematical models for water distribution. Chapter 5 covers water quality and eutrophication.

#### **Drinking water: Principles and practices**

Moel, P., van Dijk, J. and Verberk, J.  
Singapore; Hackensack, N. J.: World Scientific, c2006  
R 363.61 MOE

This book gives an overview of all the major aspects of modern drinking water systems from a Western European context. There is an addendum on water quality legislation in the Netherlands.

**Advances in water quality & management**

Rao, S. M., et al. (Eds).

Singapore: Research Publishing Services, c2008

R 628.1 ADV

The book is presented in four sections: section 1 deals with ground and surface water quality; section 2 deals with sanitation and wastewater treatment; section 3 deals with water management; and section 4 provides summary recommendations on issues, R&D challenges, institutional and societal gaps in sustainable water quality management.

**Statistical framework for recreational water quality criteria and monitoring**

Wymer, L. (Ed.)

Chichester: John Wiley & Sons, c2007

R 628.161015195 STA

This book offers a practical guide to the statistical methods used for assessing health effects and for monitoring and modelling water quality. Chapters 1, 2 and 10 cover water quality standards and monitoring.

## Databases

### EBSCOhost

#### **Effect of water source pollution on the water quality of Shanghai water supply system**

Bai, X., et al.

2006, July

Journal of Environmental Science & Health, Part A: Toxic/Hazardous Substances & Environmental Engineering, 41(7), 1271-1280

The paper describes the quality of water sources in Shanghai, China and its water supply system. The effect of purification by traditional water treatment process and the effluent biological stability were evaluated by measuring quality parameters in the water supply system. The data shows that the main pollutants in the water source of Huangpu River were organics and ammonia.

#### **Estimating water quality pollution impacts based on economic loss models in urbanization process in Xi'an, China**

He, H., et al.

2007, September

Journal of Urban Planning & Development, 133(3), 151-160

This study investigates water quality pollution impacts on urbanisation by analysing temporal and spatial characteristics of different water quality parameters, and by simulating economic losses from water quality pollution in Xi'an, China from 1996 to 2003.

#### **Water quality index: A Fuzzy river-pollution decision support expert system**

Nasiri, F., Maqsood, I., et al.

2007, March

Journal of Water Resources Planning & Management, 133(2), 95-105

In this study, the authors propose a fuzzy multiple-attribute decision support expert system to compute the water quality index (WQI) and provide an outline for the prioritisation of alternative plans based on the amount of improvements in WQI.

#### **Comparison of Different Biological Indices for the Assessment of River Quality: Application to the Upper River Moselle (France)**

Thiébaud, G., Tixier, G., et al.

2006, October

Hydrobiologia, Vol. 570 Issue 1, p159-164, 6p

The aim of this study is to assess the water quality of the upper Moselle river in France by using biological indices. A biological monitoring combining both macroinvertebrates and macrophytes was performed.

## SpringerLink

### **Analysis of groundwater quality using water quality index and conventional graphical methods: The Volta region, Ghana**

Banoeng-Yakubo, B., et al.

2009, 13 February

Environmental Earth Sciences (Vol/ issue/ pg nos?)

Conventional graphical and statistical methods were used with water quality indices to characterise the hydrochemistry of groundwater from the northern part of the Volta region of Ghana.

### **Desorption of arsenic from drinking water distribution system solids**

Copeland, R. C.

2006, May

Environment Monitoring Assessment, 127, May 2006, 523

This paper discusses the impact of pH and orthophosphate on the chemical release of arsenic from nine drinking water distribution systems solids.

### **Comparative analysis of regional water quality in Canada using the Water Quality Index**

De Rosemond, S., Duro, D. and Dubé, M.

2008, 22 August

Environmental Monitoring and Assessment (Vol/ issue/ pg nos?) The Canadian Council of Ministers for the Environment (CCME) has developed a Water Quality Index (WQI) to simplify the reporting of complex water quality data. This science-based communication tool tests multi-variable water data against numeric water quality guidelines and/ or objectives to produce a single unit-less number that represents overall water quality.

### **Integration of metrological principles and performance evaluation in a proficiency testing scheme in support of the Council Directive 98/83/EC**

Drolc, A. and Cotman, M.

2009, 21 February

Accreditation and Quality Assurance: Journal for Quality, Comparability and Reliability in Chemical Measurement (Vol/ issue/ pg nos?)

Proficiency testing is a means of external quality assessment of laboratories' performance. It was designed specifically to support the Drinking Water Directive (98/83/EC).

### **Development and sensitivity analysis of a global drinking water quality index**

Rickwood, C. and Carr, G.

2008, 12 September

Environmental Monitoring and Assessment

The UNEP GEMS/Water Programme is responsible for the development of water quality indicators and it maintains the only global database of water quality for inland waters (GEMStat). A composite index was developed to assess source water quality across a range of inland water types, both globally, and temporally.

## Websites

### **Drinking Water Inspectorate (DWI)**

Retrieved on March 13, 2009

<http://www.dwi.gov.uk/index.shtm>

The Drinking Water Inspectorate (DWI) regulates public water supplies in England and Wales. DWI is responsible for assessing the quality of drinking water, taking appropriate enforcement actions when standards are not met.

### **Surface Water Quality Regulation In EECCA Countries: Directions for Reform**

Retrieved on February 25, 2009

<http://www.oecd.org/dataoecd/62/26/41832129.pdf>

The paper presents a brief overview of the main features of the existing Eastern Europe, Caucasus and Central Asia (EECCA) systems of surface water quality standards. It describes the key conceptual directions for reform based on OECD and EECCA country experience, and summarises the main issues discussed at the expert meeting.

### **United Nations Economic Commission for Europe (UNECE)**

Retrieved on March 13, 2009

[http://www.unece.org/env/water/text/text\\_protocol.htm](http://www.unece.org/env/water/text/text_protocol.htm)

The UNECE provides a set of water protocols to protect human health. The Protocol is the first international agreement of its kind adopted specifically to attain an adequate supply of safe drinking water and adequate sanitation for everyone.

### **United States Environment Protection Agency (USEPA)**

Retrieved on March 13, 2009

<http://www.epa.gov/safewater/standards.html>

This website provides detailed information on the kinds of substances allowed in drinking water, as well as the different kinds of regulatory infrastructure that control drinking water standards.

### **Water Quality for Ecosystem and Human Health**

Retrieved on February 25, 2009

[http://www.gemswater.org/publications/pdfs/water\\_quality\\_human\\_health.pdf](http://www.gemswater.org/publications/pdfs/water_quality_human_health.pdf)

The United Nations GEMS/ Water Programme provides scientifically-sound data and information on the state and trends of global inland water quality required as a basis for the sustainable management of the world's freshwater to support global environmental assessments and decision-making processes.

### **WHO Guidelines for drinking-water quality**

Retrieved on February 25, 2009

[http://www.who.int/water\\_sanitation\\_health/dwq/gdwq3rev/en/index.html](http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en/index.html)

The first and second editions of the Guidelines for Drinking-water Quality were used by developing and developed countries worldwide as the basis for regulation and standard setting to ensure the safety of drinking water. The third edition of the Guidelines has been comprehensively updated to take account of developments in risk assessment and risk management since the second edition.

# 4.0 Planning for Sustainable Water Solutions

One of the most pressing concerns of governments around the world in the 21<sup>st</sup> century is ensuring access to freshwater supplies. With increased urbanisation, demographic changes and increasing domestic consumption patterns, many developed and developing countries are on the brink of a water crisis, particularly in vast continents of Africa and Asia.

Global climate changes has exacerbated the situation and placed tremendous pressures on the environment and in particular, on precious water resources. Besides building up the nation's water and sewerage infrastructure, enforcing laws and regulations to protect against the degradation of water sources and developing and implementing various technologies to treat and clean wastewater, proper water management practices have often been cited as the key to ameliorating the water shortage exigency.

The collective cooperation of international, national and local authorities and the consultation and engagement of the private sector and the community are also essential for a successful and sustainable water governance structure. Finally, policies need to be flexible and adaptive to meet future uncertainties that can threaten the world's water resources.

This section of the bibliography on "Planning for Sustainable Water Solutions" highlights books and digital resources on different aspects of strategies and policies to ensure a continuous and adequate supply of good, clean and freshwater to meet the needs of the community.

- Part 1 introduces various ways of ensuring the efficient and prudent usage of water, through water conservation campaigns, water recycling programmes and improving water resource management;
- Part 2 introduces sustainable solutions for water resource management, such as stormwater and watershed management; and
- Part 3 introduces water source protection strategies in response to climate changes.

## 4.1 Cities of the Future & Water Reuse

### Books

#### **Eau Canada: The Future of Canada's water**

Bakker, K.

Vancouver: UBC Press, c2007

R 333.9100971 EAU

This book presents perspectives from a panel of water and environmental experts on the threats confronting Canada's supply of freshwater. It examines the current governance of Canada's water resources, in terms of its jurisdictional fragmentation, cultural heritage, business decisions, legal framework and water politics. The contributors have also proposed several solutions to better manage Canada's water resources, such as conservation-led management strategies, a revamped water policy and a more efficient water pricing strata.

#### **Water: The Looming crisis in India**

Binayak, R.

Lanham, MD: Lexington Books, c2008

R 333.9100954 RAY

The author presents a grave scenario of India facing a severe shortage of freshwater and gives a critique of India's national water policy, with its unsustainable supply-side solution. He advocates that the five South Asian countries sharing common sources of freshwater from the Himalayan Rivers should work together to develop cooperative water policies to ensure that their socio-economic growth and development are not impeded.

#### **The world water crisis: The Failures of resource management**

Brichieri-Colombi, S.

London: I. B. Tauris, 2009

R 333.91 BRI

With over 50% of the world's surface covered with water, the author posits that the global water crisis is due to the poor management by water resource planners. He proposes a new paradigm – Water In the National Economy (WINE), which addresses factors impacting society's demands for water, such as policies to reduce population, encourage urbanisation and produce food by alternative methods.

#### **China's water warriors: Citizen action and policy change**

Mertha, A. C.

Ithaca: Cornell University Press, 2008

R 333.9100951 MER

Mertha examines the hydropower politics in China, which has been subject of ugly political tussles and widespread protests. The scrutiny of the policy processes and agents involved in the control and management of water, from national bureaucracies, local governments, NGOs, policy entrepreneurs, activist groups and the media, reveals the increasing democratisation and political pluralism in China. Three cases of public oppositions to dams in the Sichuan and Yunnan provinces are also highlighted.

## Databases

### ProQuest central

#### **Drought relief in South East, Queensland, Australia, provided by membrane-reclaimed water**

Freeman, S., et al.

2008, February

American Water Works Association Journal, 100(2), 40

This article describes a multi-pronged approach that Queensland has adopted to tackle water shortages due to drought and increased usage. These initiatives include: using membrane-based advanced water treatment plants to reclaim water from the municipal wastewater treatment plant; launching emergency water projects and organising public outreach programmes.

#### **Role of water-saving devices in reducing urban water consumption in the mega-city of Tehran, case study: A Residential complex**

Gholamreza N. B., et al.

2008, April

Journal of Environmental Health, 70(8), 44

This article reports on the outcomes from a case study done on a residential complex in Tehran, to investigate the effects of installing subcounters, single handle faucets and reducers on household water consumption. Results showed a total reduction in water consumption of about 20 percent.

#### **The role of water conservation in drought planning**

Knutson, C. L.

2008, September/October

Journal of Soil and Water Conservation, 63(5), 154A

This article focuses on the role that behavioral and technological water conservation measures play in increasing resilience to drought and responding to drought crisis, in the context of the US. Knutson advocates a risk over a crisis management approach to reduce impacts on the community and economy. He also highlights new water conservation strategies such as installing rainwater harvesting systems in Arizona homes, the development of an aquifer storage and recovery system in North Carolina and dryland farming in Nebraska.

#### **Water in the 21<sup>st</sup> century: Defining the elements of global crisis and potential solutions**

Lall, U., et al.

2008, Spring

Journal of International Affairs, 61(2), 1

This article identifies the three types of crisis that together make up the global water crisis faced by countries around the world today: 1. crisis of access to safe drinking water, 2. crisis of pollution, and 3. crisis of scarcity. One of the main causes of water scarcity, the most pressing concern, is agricultural water use and finding solutions to improve the situation, such as making changes to the agricultural supply-chain and using innovative technologies to reclaim water require a synergy among local, national and international authorities.

#### **Water reuse and conservation in the CPI**

Schultz, T.

2008, September

Chemical Engineering, 115(9), 44

This article examines water reuse in the chemical process industries, with examples from the petroleum refining and petrochemical sectors. Some examples of water reuse include stripped sour water, coke-drum cutting water and using water from steam-assisted gravity drainage (SAGD). Some of the challenges faced by these industries in reusing wastewater include the cost of wastewater treatment and the lack of adequate technology to remove substances that adversely impact the membrane systems.

## Websites

### **The Chartered Institution of Water and Environmental Management (CIWEM)**

Retrieved on February 19, 2009

<http://www.ciwem.org/resources/water/>

CIWEM supports the government and other organisations in promoting and creating awareness of sustainable water and environmental management practices. A wealth of information is provided on this website, such as the implementation of the water framework directive in Europe, an overview of water reuse, an introduction to catchment management in England and Wales, reed bed wastewater treatment and recommendations for a sustainable water future.

### **Florida Department of Environmental Protection - Florida's Reuse Program**

Retrieved on February 19, 2009

<http://www.dep.state.fl.us/water/reuse/flprog.htm>

Describes the key features of Florida's reuse programme and provides a downloadable link to its Reuse Strategy Report, which lists 16 strategies aimed to encourage Florida residents to use reclaimed water. The Florida Department of Environmental Protection and various agencies have also come together to issue a Statement of Support for Water Reuse, reflecting their commitments to promote water reuse in Florida.

### **Ministry of the Environment and Water Resources – Water Conservation**

Retrieved on February 19, 2009

<http://app.mewr.gov.sg/web/Contents/ContentsSSS.aspx?ContId=1206>

This website describes the water conservation initiatives implemented to reduce domestic consumption of water in Singapore. These programmes include the 10-litre challenge, Efficient Homes programme, Water Volunteer Groups programme, a labelling scheme for water-efficient appliances, and promoting the use of dual-flush low-capacity flushing cisterns.

### **Water Recycling and Reuse: The Environmental Benefits**

Retrieved on February 19, 2009

<http://www.epa.gov/region09/water/recycling/>

Provides an introduction to water recycling and details the environmental benefits of using recycled water such as reducing and preventing pollution to water bodies and creating and enhancing wetlands. It also provides links to water quality standards and information on water sustainable infrastructure.

### **WaterReuse Association (WRA)**

Retrieved on February 19, 2009

<http://www.watereuse.org/?assoc&wra>

WRA is a non-profit organisation that promotes the "efficient use of water resources through education, sound science, and technology". Besides quick facts and glossaries on water reuse and desalination, links to guidelines, technical reports, local and international resources, associations, foundations and institutes are provided. It also provides access to The National Database of Water Reuse Facilities in U.S. that allows searches by Utilities, Facilities, Treatment Technologies, and End Use.

## 4.2 Sustainable Solutions for Water Resource Management

### Books

#### **Health impact assessment for sustainable water management**

Fewtrell, L. and Kay, D.  
London: IWA Pub., c2008  
R 333.91 HEA

The focus of this book is applying health impact assessment (HIA) to gauge the strengths and shortcomings of water management approaches in different countries. Case studies are drawn from developed and developing countries, such as rainwater harvesting in UK, the hydroelectric project in Laos and the irrigation project in Zimbabwe. In each study, the risk assessments and health impacts such as infection and contamination levels are detailed.

#### **Design for water: Rainwater harvesting, stormwater catchment, and alternate water reuse**

Heather, K-L.  
Gabriola, B. C.: New Society Publishers, c2007  
R 631.7 KIN

This book provides updates on alternate water reuse. There are also numerous case studies outlining the process of water collection from landscape, residential, commercial, industrial, school, park, and municipal systems.

#### **Strategic planning for water**

Howes, H.  
London; New York: Taylor & Francis, 2008  
R 333.9100941 HOW

Howes describes how sustainable water management practices can be incorporated into London's planning system and proposes a Water Framework Directive that provides implementation and funding guidelines for city planners, water companies and the Environment Agency. He also discusses the impact that the water environment can have on the quality of life of city dwellers and the importance of balancing between economic pursuits and community wellbeing.

**Making the most of scarcity: Accountability for better water management results in the Middle East and North Africa**

Washington, D. C.: World Bank, 2007

R 363.610956 MAK

This report highlights the water scarcity challenges in the Middle East and North Africa (MENA) region. The problem is exacerbated by climate changes, which have led to rising temperatures, floods and desertification. Region-wide water reform is crucial to alleviate water shortages and hold off economic and social instability but these have been forestalled by the scarcity of physical resources, accountability and organisational scarcity. The report proposes that engaging non-water policy makers and improving external accountability in the water sector are strategies that can help MENA countries meet water demands in the 21<sup>st</sup> century.

**Integrated evaluation for sustainable river basin governance**

Videira, N., et al.

London, UK: IWA, 2007

R 333.911 INT

Divided into three main sections, part 1 of this report describes the problems of past evaluation practices in five European Union states and proposes an integrated evaluation process of river basin governance under the Water Framework Directive. Part 2 shows how the principles and tools for Integrated Deliberative Decision Processes (IDDP) are put in practice, with experimental case studies from Greece, Portugal and Spain. Part 3 proposes ways to tackle future challenges of integrative evaluation.

**Water resources sustainability**

Mays, L. W.

New York: Alexandria, Va.: McGraw-Hill; WEF Press, c2007

R 363.61 WAT

This book provides an extensive coverage of the critical issues surrounding water resource sustainability. May extrapolates water management practices from ancient civilisations and compares them with current approaches in the American Southwest. Other chapters discuss the impact of climate changes on water sustainability, models for managing sustainable groundwater, water resource sustainability in South Korea, water supply security pre- and post 9/11, community management of rural water systems in Ghana and the privatisation of water utilities in Europe.

**Adaptive and integrated water management: Coping with complexity and uncertainty**

Pahl-Wostl, C., Kabat, P. and Möltgen, J.

Berlin; New York: Springer, c2008

R 333.912 INT

Targeted at industry professionals, scientists and policy makers, this book is a select compilation of papers for the 2007 international Conference on Adaptive and Integrative Water Management. The papers focus on how water management policies have to change and adapt to manage for example, flood risks, improve water usage and protect groundwater as a result of global climate changes. It includes case studies such as the impact of climate change on river runoff in Central Asian river basins, management of wastewater and storm water drainage in Kolkata and the governance of water resources in the Mekong region.

**Managing water resources: Policies, institutions, and technologies**

Reddy, V. R., and Dev, S. M.

New Delhi: Oxford University Press, c2006

R 333.910954 MAN

This is a transcript of selected papers presented at a two-day national seminar on water organised by the Centre of Economics and Social Studies in collaboration with the Indian Council for Social Science Research.

**Clean, green and blue: Singapore's journey towards environmental and water sustainability**

Tan, Y. S., Lee, T. J. and Tan, K.

Singapore: ISEAS Pub., 2009

RSING 363.70095957 TAN

This book documents Singapore's success in managing its environmental resources, achieving clean air quality, adequate water supply and effective wastewater management. The joint corporation between multi-national agencies, the private sector and the community have enabled Singapore to achieve environmental sustainability while being ranked 6<sup>th</sup> among the world's best economies in terms of GDP per capita.

## **Databases**

### **EBSCOhost**

#### **Integrated water resource management and water sharing**

Davis, M. D.

2007, September

Journal of Water Resources Planning & Management, 133(5), 427-445

This article provides a broad overview of Integrated Water Resource Management (IWRM), which can assume various institutional forms and is best implemented at national, regional, river basin, and/ or sub-basin levels. Case studies highlighting California's water management governance and France's river basin management are also highlighted.

#### **Tourism destination water management strategies: An Eco-efficiency modelling approach**

Kelly, J. and Williams, P.

2007

Leisure/ Loisir: Journal of the Canadian Association for Leisure Studies, 31(2), 427-452

This article identifies the key features of water management in tourist destinations and proposes a forecasting model for assessing the relative eco-efficiency of various strategies. This model is applied to the mountain resort destination in Whistler, British Columbia as a practical application case study.

#### **Community governance for sustainability: Exploring benefits of Community water schemes?**

Marquardt, M. and Russell, S.

2007, August

Local Environment, 12(4), 437-445

The authors examine two solutions to New Zealand's water scarcity problem: local operation water storage and water sharing schemes. Studies show that these two schemes have had positive economical, social and environmental effects, such as increase in job opportunities, higher water security, added economic value to the region, a less interrupted irrigation season and a mechanism put in place to ensure that the river stays above minimum flow level.

#### **Politics, plurality and problemsheds: A Strategic approach for reform of agricultural water resources management**

Mollinga, P. P., Meinzen-Dick, R. S. and Merrey, D. J.

2007, November

Development Policy Review, 25(6), 699-719

This paper begins with a critique of the planning and implementation of the irrigation infrastructure over the past three decades, which has failed to take into account the political complexities of the reform process. The authors propose a three-step strategic action and identify three operational aspects critical to the success of institutional and policy reform: 1. Modesty and realism about feasible options; 2. Out-of-the-sector policy entrepreneurship for better co-ordination, and 3. Reflective practitioners.

#### **Challenges and realities of water management of megacities: The Case of Mexico City metropolitan area**

Tortajada, C.

2008, Spring/Summer

Journal of International Affairs, 61(2), 147-166

This article addresses the challenges of managing water resources in huge urban metropolis cities and focuses on the 22m inhabited Metropolitan Area of Mexico City (ZMCM), which is facing a water crisis. Causes of water shortage problems in ZMCM include damages to water supply and sewerage infrastructure and degradation of groundwater supply. Comparisons are made against other megacities such as Dhaka, São Paulo and Bangkok. The author concludes that the solution to ZMCM's predicament is to improve its water governance.

## Websites

### **Bureau of Watershed Management**

Retrieved on March 3, 2009

<http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1425&q=482310&watershedmgmtNav=|>

The Bureau is responsible for planning and managing Pennsylvania's water resources. It carries this out by enforcing legislation to limit human activities that pollute water resources, implementing erosion and sediment control to protect the state's drinking and water sources, and educating the community about watershed management.

### **The Stormwater Manager's Resource Center**

Retrieved on March 3, 2009

<http://www.stormwatercenter.net/>

This is a one-stop information hub on all aspects pertaining to stormwater and urban watershed management, targeted at industry practitioners and policy makers. Besides downloadable fact sheets on topics such as land planning, stream restoration and conservation, research articles, a customisable manual, model ordinances, assessment methods and programme resources are also available.

### **Water Resource Management in the Petroleum Industry**

Retrieved on March 3, 2009

[http://www.ipieca.org/activities/social/downloads/publications/water\\_mngt.pdf](http://www.ipieca.org/activities/social/downloads/publications/water_mngt.pdf)

This report provides an insight to water resource management in the petroleum industry, which has adopted two key practice guidelines: Operating Responsibly and Building Capacity. Examples of good practices at various petroleum companies are also highlighted.

### **The WETLANDS II Project**

Retrieved on March 3, 2009

<http://www.wetlandsmanagement.org/>

This follows from a previous WETLANDS project, which provided guidelines for the successful integrated management of wetlands in Europe. WETLANDS II aims to improve the operative management of wetlands through these activities: 1. Participatory planning and management; 2. Certification of products and services; 3. Sustainable development in wetlands; 4. Communication and awareness raising; 5. Environmental monitoring, and 6. Training for Wetlands Managers.

### **World Bank – Water Resources Management**

Retrieved on March 3, 2009

<http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTWAT/0,,contentMDK:21630583~menuPK:4602445~pagePK:148956~piPK:216618~theSitePK:4602123,00.html>

The World Bank website provides an overview of water resources management and identifies the challenges and obstacles that affect the provision of water. Water management projects in Lesotho, Mexico and Tunisia are featured, as well as water strategies implemented in countries such as Brazil, Pakistan and Ethiopia. Information resources are also provided for basin management, groundwater, droughts and floods and water quality measurements. Current statistics such as total water productivity and water pollution by industry are also available on a global scale.

## 4.3 Water Resource Protection and Climate Change

### Books

#### **Water policy for sustainable development**

Feldman, D. L.

Baltimore: Johns Hopkins University Press, 2007

R 333.91150973 FEL

Feldman identifies three main critical factors impacting water disputes today: economic growth versus environmental protection; climate change and meteorological uncertainty; and control and ownership of water. He analyses successful river basin and watershed initiatives to illustrate how improvements to water management can be made in different countries, through adaptive management, environmental and natural resource policy innovations together with an organisational setting that allows mistakes to be made, lessons to be learnt from them and learning points to be applied to future challenges.

#### **Water: The Final resource: How the Politics of water will impact on the world**

Houston, W. and Griffiths, R.

Petersfield: Harriman House, 2008

R 333.91 HOU

The authors begin by examining how climatic changes and shifting weather patterns in the last 500 years have impacted rainfalls and water levels around the world. They then put forward various scenarios that these impacts have on food supply, migration patterns and water conflicts in the politically volatile Middle East and water deficient countries in Asia. They propose how technological innovations can relieve water scarcity and suggest how water can be a profitable investment commodity in the future.

#### **Climate variability and water resources degradation in Kenya: Improving water resources development and management**

Mogaka, H., et al.

Washington, D. C.: World Bank, 2006

R 333.910096762 CLI

This report paints a gloomy picture of Kenya's water resources development and management and describes the physical and economic impacts of its rainfall variability and water resources degradation in the light of the El Nino-La Nina phenomenon (1997-2000), which has caused floods and destroyed crop and livestock. Recommendations from the report include: "building political commitment, increasing water storage capacity, improving water management through decentralization, greater transparency and increased community participation, and increasing the knowledge base for management".

#### **The solution to global warming and climate change: Water storage economies for all countries**

Ong, Y. K.

Singapore: Ong Yew Khoon, 2008

RSING 628.13 ONG

Ong proposes a secured underground water storage system (System) that can help improve the efficiency of water management and storage, to complement other natural and man-made water storage sources such as lakes, dams, reservoirs, wells and aquifers. He describes how this System can help to achieve water security and reap positive economic returns through the charging of fees for water storage and using water as a commodity for international trading. He includes revenue-generating proposals for how Singapore and other countries around the world can benefit with the development of this System.

## **Databases**

### **ProQuest central**

#### **Warming up to water markets**

Adler, J. H.

2008, Winter

Regulation, 31(4), 14-17

To combat the pressures placed on water resources by climate changes, Adler suggests that water marketing and water pricing can improve the management of water supplies and provide greater assurance against climate-induced uncertainties. Making property rights to water transferable ensures a more efficient allocation of resources and encourages cost effective conservation measures, while market pricing of water will encourage more efficient usage.

#### **Flood protection: Netherlands makes way for rising waters**

Brown, J. L.

2008, June

Civil Engineering, 78(6), 19-21

This article describes how The Netherlands are now accommodating flood waters in The Meuse River, the Rhine River, and the Rhine's major distributaries in a plan approved by the Dutch parliament in 2006, called, "Room for the River". The plan aims to increase the capacity of the Rhine and its branches to safely accommodate flows of up to 16,000 m<sup>3</sup>/s by 2015 and is designed to improve the environmental quality of the river basin. The manifold benefits include lowering water levels and cost savings of between EUR\$10m – EUR\$50m.

#### **Impact of climate change on transboundary water sharing**

Draper, S. E. and Kundell, J. E.

2007, September

Journal of Water Resources Planning & Management 133(5), 405-415

This article discusses the risks imposed by climate change to transboundary water sharing agreements. Depending on the geographical region where the source water is located, sharing water agreements may be at higher risk and may need to be significantly adapted or replaced. Particularly vulnerable areas are highlighted in Africa, Asia, Australia and New Zealand, Europe, Latin America and North America.

#### **Climate change and water resources: The Challenges ahead**

Miller, K. A.

2008, Spring/Summer

Journal of International Affairs, 61(2), 35-50

Miller outlines the current known impacts of climate change on global water resources, such as increase in greenhouse gas concentrations leading to the simultaneous increase in rainfall and droughts and impacting water availability and quality. He also discusses the implications of climate change for water governance adaptations and policy negotiations.

#### **The forgotten infrastructure: Safeguarding freshwater ecosystems**

Postel, S.

2008, Spring/Summer

Journal of International Affairs, 61(2), 75-90

Postel notes that water management policies have often neglected to take into account the health of freshwater ecosystems. She cites various places in Australia, the European Union, South Africa and the Great Lakes that are establishing policies to reduce human activities that have adverse effect on these ecosystems, in an effort to protect and preserve the ecological infrastructure.

## Websites

### **Center for Watershed Protection**

Retrieved on March 3, 2009

<http://www.cwp.org/>

This website provides abundant information on watershed management, stormwater management and wetlands protection, with resources to aid industry practitioners to plan, implement and analyse various strategies to maintain and restore water resources. It also provides free downloads of publications such as The Practice of Watershed Protection articles, local site planning roundtable documents and a 11-parts manual set that provides guidelines on urban watershed restoration.

### **Climate Change - Health and Environmental Effects - Coastal Zones and Sea Level Rise**

Retrieved on March 3, 2009

<http://www.epa.gov/climatechange/effects/coastal/index.html>

This website provides information on the impact of climate change to coastal zones, resulting in rise in sea levels and increase in land loss, storms and flooding. It also provides links to reports such as the *Pew Center Report: Coastal and Marine Ecosystems & Global Climate Change: Potential Effects on U.S. Resources* and Climate Change studies commissioned under the U.S. Climate Change Science Program.

### **Climate Change and Freshwater**

Retrieved on March 3, 2009

<http://www.climate-and-freshwater.info/>

This website offers an overview of how climate change affects freshwater ecosystems in Europe generally and in particular, focuses on these areas: presently used assessment systems; indicators to detect the effects of climate change on European aquatic ecosystems; and types of aquatic species impacted upon. Case studies are also provided for each major freshwater ecosystem.

### **International Rivers – Dams, Rivers and People Reports**

Retrieved on March 3, 2009

<http://www.internationalrivers.org/en/node/486>

International Rivers aims to protect rivers and promote sustainable natural resource management through collaborations with a global network of communities, NGOs and activist groups. Its 2008 report offers a harsh appraisal of the Kyoto-created Clean Development Mechanism programme and proposes an alternative Greenhouse Development Rights framework. It also provides an analytical review of the current state of rivers and dams on a global level and advocates policies and practices to ensure that basic needs for water and energy are met, while protecting and preserving the earth's natural resources.

### **UK Rainwater Harvesting Association (UK-RHA)**

Retrieved on March 3, 2009

<http://www.ukrha.org/>

This association facilitates organisations in the rainwater harvesting industry by providing information on standards, updates on legislation and news on technological innovations. The FAQ section provides useful facts presented in an easily digestible format, while the Resources for Manufacturers section provides information on the Enhanced Capital Allowance Scheme that encourages businesses to invest in water saving technologies. Several publications are also available for download free, such as the Code for Sustainable Homes, an introductory guide to rainwater harvesting systems and their installation and various industry fact sheets.

# 5.0 Patents

Patents are the official records of inventions registered with national authorities or bodies responsible for protecting intellectual property. There are various such agencies around the world, such as the World Intellectual Property Office (or more commonly referred to as WIPO<sup>1</sup>), the European Patent Office (EPO<sup>2</sup>) and the United States Patent Office (USPTO<sup>3</sup>).

It is always useful to be kept updated on the state of the art of technological developments in any industry. For the water industry, it may help parties with vested interest to be able to find out if solutions have been proffered or are available in the market before they embark on their own research and developmental efforts.

The section here highlights some recent patents that may be of interest to people working within the water industry. It is not meant to be a comprehensive analysis or review of the current situation but as a sample and overview of resources available that are available for open-access. The USPTO is featured mostly as it is the main resource to-date that offers full-text access without limitations, other IP bodies generally have limited access to all their documents.

<sup>1</sup> WIPO <http://www.wipo.int/portal/index.html.en> as of 11 Mar 09, WIPO's Patentscope searches 1,545,277 international patents.

<sup>2</sup> EPO <http://www.epo.org/> as of 11 Mar 09, EPO's esp@cenet service offers patent searches in multiple European languages, and claims to have a search coverage of approximately 60 million patents worldwide with a timeframe from 1998 to 2008.

<sup>3</sup> USPTO <http://www.uspto.gov/> as of 11 Mar 09, USPTO's PATFT offers full-text access to patents registered with the USPTO. The search engine is able to search the full-text of patents registered since 1976, whilst patents registered prior to 1790 can be accessed via the USPTO numbers.

## 5.1 Samples of Recent Patents

### **Water and Wastewater Treatment, Desalination and Sludge Management**

Bader, Mansour S. (2006, May 8). U. S. Patent No. 7,501,065.

**Methods for treating agricultural drainage water and the like**

Washington, DC: U. S. Patent and Trademark Office.

Several zero-discharge processing methods are proposed that tackle the selective removal of sulphate scale-prone species and toxic species; produce usable water that meets quality standards for irrigation; and recover sodium sulphate and sodium chloride as valuable by-products from agricultural drainage water.

Dart, Frederick James and Richmond, John Owen. (2004, June 28). U. S. Patent No. 7,497,953.

**Water treatment apparatus and method**

Washington, DC: U. S. Patent and Trademark Office.

The inventors claim to have created an automatic, self-regulating water treatment method that can be used in water circulating towers. A water-conditioning unit is devised to prevent the adherence of scale deposits due to evaporation and to prevent the formation of bio-fouling nutrients on the flooded surfaces of the tower and flow circuits. Trace levels of iodine are introduced to enhance the disinfection of nutrient-deprived surfaces and combat chance pathogen contaminations. Zinc ions at trace levels are proposed to combat iodine-resistant strains of algae and bacteria.

Knighton, David R. and Fiegel, Vance D. (2005, April 14). U. S. Patent No. 7,497,947

**Devices for water treatment**

Washington, DC: U. S. Patent and Trademark Office.

The inventors propose the use of Sphagnum moss contained within a device to treat water.

Plantikow, Ulrich. (2003, April 4). U. S. Patent No. 7,494,573.

**Evaporator tube for a sea water desalination system**

Washington, DC: U. S. Patent and Trademark Office.

An evaporator tube design is proposed to extract usable water from sea water that has both sea water and acid resistance characteristics for an intermittent desalination system like wind energy-powered systems.

Tepper, Frederick and Kaledin, Leonid A. (2007, March 1). U. S. Patent No. 7,390,343.

**Drinking water filtration device**

Washington, DC: U. S. Patent and Trademark Office.

A fibrous structure consisting of a mixture of nano alumina fibers and second fibers arranged in a matrix to create asymmetric pores is proposed. The inventors claim that with this structure, there is more efficient removal of soluble contaminants like halogens from a fluid stream and an improved ability to retain turbidity, bacteria and viruses.

Cassassuce, Florence Valerie; Arce, Itzcoatl Bareno and Zamudio, Oscar Rodriguez. (2006, May 5). U. S. Patent No. 7,361,904.

**UV water purification system**

Washington, DC: U. S. Patent and Trademark Office.

A UV water purifier that can be run on a 12-volt battery or solar powered battery is proposed and the inventors claim an ability to remove substantially all viruses, bacteria and mould spores from untreated water in a short time of exposure to UV radiation.

Kotsaridou, Maria; Vogelwohl, Alfons and Hamouda, Hasan. (2002, November 15). U. S. Patent No. 7,247,239.

**Method for biological treatment of water by adding macromolecular carbohydrates**

Washington, DC: U. S. Patent and Trademark Office.

A biological treatment method for sludge water is proposed using macromolecular carbohydrates with vitamins and other additives to achieve a reduction in residues.

Land, Glenn E. (2004, September 28). U. S. Patent No. 7,217,343.

**Point of use water purification method and apparatus**

Washington, DC: U. S. Patent and Trademark Office.

The inventor proposes a compact and energy efficient device that can boil filtered water and channel the steam via condensation in to a separate storage container for ready use. The proposed system is equipped with sensors to maintain water levels in both the boiler and storage containers.

## **Water Management, Operations and Distribution**

Frank, Bernard. (2006, September 21). U. S. Patent No. 7,497,957.

### **System, method and apparatus for end-to-end control of water quality**

Washington, DC: U. S. Patent and Trademark Office.

A method is described that covers the treating and delivery of water to consumers at the point of delivery with filtering, purifying and the monitoring and reporting of quality over a network.

Taylor, Thomas M. and Goslin, David. (2004, May 28). U. S. Patent No. 7,497,228.

### **Freeze and backflow protection for a subterranean water flushing system**

Washington, DC: U. S. Patent and Trademark Office.

A freeze and backflow protection design is proposed for subterranean water flushing systems that includes freeze-protection assembly, a detachable coupling system, a de-chlorination system, and a backflow prevention system.

Dussich, I. and George Victor Anthony. (2006, March 21). U. S. Patent No. 7,485,218.

### **Storm water filtration system**

Washington, DC: U. S. Patent and Trademark Office.

A storm water filtering system is proposed that includes a plurality of filter assemblies mounted within corresponding ones that are targeted at matching the outflow rate of a catch basin so as to maximize the effective filtering rate of the filter assemblies.

Kent, Greg B. (2007, October 30). U. S. Patent No. 7,470,362.

### **In line wetland water treatment system and method**

Washington, DC: U. S. Patent and Trademark Office.

This patent proposes a storm water management system and process that incorporates a wetland water treatment system allowing for multi-level and multi-stage flow control. Both aerobic and anaerobic processes are used when water is flowed through the wetlands chamber for filtration and decontamination.

Wu, Zheng Yi; Walski, Thomas M.; Gurrieri, Robert A.; Herrin, Gregg A. and Mankowski, Robert F. (2002, January 17). U. S. Patent No. 7,457,735.

### **Method and system for automatic water distribution model calibration**

Washington, DC: U. S. Patent and Trademark Office.

A model calibration technique is proposed that allows an engineer to collect sample data that can represent the overall water distribution system conditions. Further modelling can be tested by setting up simulated trials involving changes in parameter settings within the whole system by comparing the calculated evaluations to actual observed data.

## **Drinking Water Quality**

Merrick, William F.; Zesking, Julie E.; Krebs, Melissa D. and Davis, Christina E. (2006, May 4). U. S. Patent No. 7,470,898.

### **Monitoring drinking water quality using differential mobility spectrometry**

Washington, DC: U. S. Patent and Trademark Office.

The pyrolysis-differential mobility spectrometric method is proposed for the continuous monitoring of drinking water supply. The inventors claim that this method improved detection sensitivity and selectivity of contaminations.

Joyce, Patrick C.; Lynch, Toni L. and Rinker, Edward B. (2006, July 27). U. S. Patent No. 7,309,418.

### **Water contaminant indicators**

Washington, DC: U. S. Patent and Trademark Office.

A device is proposed that has the ability to display a visual change, for example, by colours, to indicate the presence of contaminants for both gravity-driven and pressure-driven systems.

## **Water reuse and Sustainability**

Nomura, Hiroyuki. (2004, August 5). U. S. Patent No. 7,493,784.

### **Washing machine with water treatment unit**

Washington, DC: U. S. Patent and Trademark Office.

The inventor claims that a cartridge type water treatment unit that can be mounted in a washing machine is able to clear metal ions in water by the process of energisation using an electrode.

Markham, Gary W.; Kirkpatrick, Harmon L.; Guercio, Rick; Mast, Douglas E.; Gustas, Jr. and Stanley, C. (2006, November 1). U. S. Patent No. 7,491,336.

### **Process for treating industrial water with activated media**

Washington, DC: U. S. Patent and Trademark Office.

This patent describes the use of activated media (pellets of porous ceramic materials) in vertical stacks or horizontal chains to treat effluent water that can absorb or oxidize organic and inorganic impurities, resulting in an effluent water stream that is suitable for recycling or for direct discharge to the sea.

Luke, Donald A. and Astley, Vaughn V. (2007, April 17). U. S. Patent No. 7,491,333.

### **Industrial waste water treatment process**

Washington, DC: U. S. Patent and Trademark Office.

The patent describes a treatment process involving flocculation, sedimentation and pH precipitation of impurities in wastewater. The inventors claim that this process enables water reuse in an operating phosphoric acid facility or the release of the treated water directly to the environment, in compliance with the Federal Clean Water Act.

Schmidt, Ernst; Sferrazza, Alois F. and Williams, Michael E. (2005, January 6). U. S. Patent No. 7,501,064.

### **Integrated electro-pressure membrane deionisation system**

Washington, DC: U. S. Patent and Trademark Office.

This patent describes an integrated treatment system utilising electro-dialysis and pressure-driven membranes to deionise and decontaminate liquids to a quality suitable for industrial or municipal use or reuse. The system includes the steps of pre-filtering, nano-filtration or reverse osmosis, followed by electrodialysis.

Olivier, Laurent. (2004, October 4). U. S. Patent No. 7,481,935.

### **Waste water treatment process**

Washington, DC: U. S. Patent and Trademark Office.

A method to improve the treatment of wastewater and solid waste is described with the addition of catholytes and anolytes. The inventor claims that anolytes are useful as a disinfectant against bacteria, viruses and algae, while the catholytes are described as useful for flocculation, coagulation, washing and extraction of heavy metals.

## **Access Information**

### Books

The books cited in this bibliography are available from the National Library Singapore.

### Journals

The journal articles cited in this bibliography are retrieved from databases that are available from the National Library Digital Library at <http://eresources.nlb.gov.sg/index.aspx>. You will need to be a registered member of the Digital Library to access these databases.

A description of the databases used to locate the journal articles in this bibliography are listed on the following page.

### Patents

The patents cited in this bibliography are available from the United States Patents Office at <http://www.uspto.gov>.

### Reference Point

In addition to the on-site reference enquiry service, Reference Point also satisfies your reference needs from the comfort of your home or office. You can email, SMS, fax or call Reference Point whenever you have an enquiry.

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## **Databases**

### **EBSCOhost**

This database provides full-text articles from over 4,500 publications, including full-text for more than 3,600 peer-reviewed journals in subject areas such as biology, chemistry, engineering, physics, religion, arts and sociology.

### **ProQuest central**

This database provides a wide offering of datasets. Prominent datasets include ABI/INFORM and Wilson's Social Sciences Index. Subject coverage includes Business, Accounting and Tax, Applied Science and Technology, Banking, Health, General Science, Computing, Education, Pharmaceuticals, Medicine, Religion and Social Science

### **SpringerLink**

This database offers access to over 1,250 peer-reviewed journals covering subjects such as biomedical and life sciences, business and economics, chemistry and materials science, computer science and more. Includes access to more than 8,500 eBooks (those published in the last 3 years) in English covering all areas of science.

## **Acknowledgement**

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