

Low-cost sewerage

—Duncan Mara¹

Research and development undertaken by the World Bank during 1976–1986 (1, 2, 3) has shown clearly that possession, proper use and maintenance of a sanitation facility are more important, in terms of improving health, than the actual sanitation technology employed, provided that it is affordable and socioculturally acceptable. Nevertheless, sanitation technology choices have to be made, and the principal choice is between on-site and off-site systems, as follows:

- On-site technologies:**
 - VIP latrines (or other types of pit latrine)
 - pour-flush toilets
 - septic tanks
- Off-site technologies:**
 - conventional sewerage
 - low-cost (unconventional) sewerage
 - settled sewerage
 - simplified sewerage

These technologies are described in the literature (see, for example, Mara (4, 5), Mara and Sinnatamby (6), Otis and Mara (7), Sinnatamby (8), Bakalian et al. (9) and, more generally, Mara (10)). The two low-cost sewerage technologies are less well known. Yet, in low-income areas with an adequate water supply these are viable sanitation options—often, depending on housing density, they are the only feasible options. This article reviews these low-cost sewerage options, their potential and their limitations. It also provides guidance on how to choose the most appropriate option, and gives examples of their successful application (see also (16)).

Nomenclature of low-cost sewerage

Both settled sewerage and simplified sewerage use small-diameter sewers laid at shallow depths and in which the flow is, ideally, due to gravity. Other terms, such as small-bore sewerage, small-diameter gravity sewerage or shallow sewerage are unclear. The definitions used in this article follow the Portuguese terminology developed in Brazil (see (11)) and are outlined below.

Settled sewerage: a system in which wastewater from one or more households is discharged into a single-compartment septic tank (usually called a solids interceptor tank). The settled (or solids-free) effluent from the septic tank is then discharged into shallow, small-bore gravity sewers. Settled sewerage is thus the same as small-bore sewerage as described by Otis and Mara (7), small-diameter gravity sewerage (12) and common effluent drainage (13). (In Portuguese it is called *redes de esgotos decantados*; in French, *réseaux d'eaux usées décantées*; and in Spanish (17), *alcantarillado sin arrastre de sólidos*.)

Simplified sewerage describes shallow sewerage as used by Sinnatamby (8) and its in-block variant called backyard or condominium sewerage (15). This system does not

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Low Cost Sewerage

Duncan Mara



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Low-Cost Sewerage Duncan Mara,1996-10-07 Low cost sewerage provides practical solutions to the sanitation needs of low income areas As a result of the currently very rapid urban population growth the demand for sewerage exceeds the resources of most high density urban areas in developing countries Low cost alternatives to conventional sewerage such as settled sewerage and simplified sewerage therefore need to be developed This book is the result of contributions by both academics and practitioners who attended the International Conference on Low cost Sewerage which was held at the University of Leeds England in July 1995 Low cost sewerage technologies are described and their applications in both developed and developing countries are detailed

Low Cost Urban Sanitation Duncan Mara,1996-12-23 This book covers the public health technical socioeconomic sociocultural and institutional aspects of sanitation in towns and cities of developing countries The text features excreta related diseases and the use of sanitation to reduce their transmission The sanitation technologies covered in detail are VIP latrines pour flush toilets septic tanks settled sewerage and simplified sewerage with additional chapters on sullage disposal pit emptying and sewage treatment and reuse Sociocultural constraints on sanitation systems and their socioeconomic costing are described together with hygiene education which is essential in order to achieve maximum benefits to health The text also explains how to choose the most appropriate sanitation option for a given low income community Finally institutional aspects are reviewed including effective sanitation programme planning monitoring and evaluation

Hand Book of Low Cost Housing A. K. Lal,1996 In Recent Years There Is A Growing Emphasis On Low Cost Housing To Meet The Housing Requirements Of The Millions In The Country This Book Makes An Attempt To Bring Various Issues Related To Low Cost Housing Under One Umbrella Viz Innovative Cost Effective Construction Techniques And Materials Availability Of Funds For Undertaking Housing Programmes Hindrances In The Availability Of Land Due To Several Legal Complications Upgradation Of Slums And Squatter Settlements Low Cost Infrastructure Services Rural Housing Scenario And Measures To Be Adopted For Making Safe And Durable Houses In Areas Prone To Natural Disasters The Information Contained In The Book Might Prove Beneficial To The Engineering And Architectural Students Professionals Architects And Engineers Both In Private And Public Sectors Academicians Including Economists And Sociologists And Entrepreneurs In Building Industry The Book Might Also Serve As A Useful Reference For B Tech B Arch M Tech M Arch Courses And Ph D Programmes Offered By Several Indian And Foreign Universities

Sanitation & Water Supply in Low-income Countries , **National Conference on Less Costly Wastewater Treatment Systems for Small Communities** ,1978 Urban Drainage David Butler,John Davies,1999-12-09 This textbook covers the environmental and engineering aspects involved in the drainage of rainwater and wastewater from areas of human development Extensive examples are used to support and demonstrate the key issues explained **Sewerage** Amory Prescott Folwell,1918 WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater World Health

Organization, 2006 The third edition of the WHO Guidelines for the safe use of wastewater excreta and greywater has been extensively updated to take account of new scientific evidence and contemporary approaches to risk management The revised Guidelines reflect a strong focus on disease prevention and public health principles This new edition responds to a growing demand from WHO Member States for guidance on the safe use of wastewater excreta and greywater in agriculture and aquaculture Its target audience includes environmental and public health scientists researchers engineers policy makers and those responsible for developing standards and regulations The Guidelines are presented in four separate volumes Volume 1 Policy and regulatory aspects Volume 2 Wastewater use in agriculture Volume 3 Wastewater and excreta use in aquaculture Volume 4 Excreta and greywater use in agriculture Volume 1 of the Guidelines presents policy issues and regulatory measures distilled from the technical detail found in volumes 2 3 and 4 Those faced with the need to expedite the development of policies procedures and regulatory frameworks at national and local government levels will find the essential information in this volume It also includes summaries of the other volumes in the series Volume 2 of the Guidelines explains requirements to promote safe use concepts and practices including health based targets and minimum procedures It also covers a substantive revision of approaches to ensuring the microbial safety of wastewater used in agriculture It introduces health impact assessment of new wastewater projects Volume 3 of the Guidelines informs readers on the assessment of microbial hazards and toxic chemicals and the management of the associated risks when using wastewater and excreta in aquaculture It explains requirements to promote safe use practices including minimum procedures and specific health based targets It puts trade offs between potential risks and nutritional benefits in a wider development context Volume 4 of the Guidelines focuses exclusively on the safe use of excreta and greywater in agriculture Recent trends in sanitation including ecological sanitation are driven by rapid urbanization The momentum created by the Millennium Development Goals is resulting in dramatic changes in human waste handling and processing New opportunities enable the use of human waste as a resource for pro poor agricultural development particularly in periurban areas Best practice to minimize associated health risks is at the heart of this volume

National Conference on Less Costly Wastewater Treatment Systems for Small Communities, U.S. Environmental Protection Agency, Date: April 12, 13, and 14, 1977, Location: Reston, Virginia, 1977

Meeting Development Goals in Small Urban Centres United Nations Human Settlements Programme, 2006

Published by Earthscan for and on behalf of the United Nations Human Settlements Programme UN HABITAT Meeting Development Goals in Small Urban Centres Un-Habitat, 2012-05-04 Half of the world's people live in urban areas and roughly a third of these live in desperate poverty without access to basic amenities Taking on the themes of UN HABITAT's Water and Sanitation in the World's Cities 2003 this new volume focuses on the deficiencies in the provision of water and sanitation where most of the populations of the developing world live in towns and small cities Drawing on extensive unpublished research and 15 commissioned papers from experts involved in designing and implementing innovative projects around the

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Tees,1992 Urban Waste and Sanitation Services for Sustainable Development Bas van Vliet,Joost van Buuren,Shaaban Mgana,2013-11-12 Urban sanitation and solid waste sectors are under significant pressure in East Africa due to the lack of competent institutional capacity and the growth of the region s urban population This book presents and applies an original analytical approach to assess the existing socio technical mixtures of waste and sanitation systems and to ensure wider access increase flexibility and ecological sustainability It shows how the problem is not the current diversity in waste and sanitation infrastructures and services and variety of types and scales of technology of formal and informal sector involvement and of management and ownership modes The book focuses instead on the lack of an integrative approach to managing and upgrading of the various waste and sanitation configurations and services so as to ensure wider access flexibility and sustainability for the low income populations who happen to be the main stakeholders This approach coined Modernized Mixtures serves as a nexus throughout the book The empirical core addresses the waste and sanitation challenges and debates at each scale from the micro level households to the macro level international support and is based on the results of a five year long interdisciplinary empirical research program It assesses the socio technical diversity in waste and sanitation and provides viable solutions to sanitation and waste management in East Africa This book provides students researchers and professional in environmental technology sociology management and urban planning with an integrated analytical perspective on centralized and decentralized waste and sanitation configurations and tools for improvement in the technology policy and management of sanitation and solid waste sectors **Maintenance Engineering**

(Principles, Practices and Management) Srivastava, Sushil Kumar,2006 This book is highly useful for the students of B E B Tech of Punjab Technological University Jalandhar and aslo for the other Technological Universities of India as per New Syllabus Accordingly few sample question are given at the end of each chapter The chapter and topics covered in this book are expected to encompass the syllabus that may be needed by various colleges institutions in maintenance field It also serves as a reference book for students of all other engineering disciplines in universities colleges institutions and also vast numbers of engineer managers supervisors technologists and other persons working in or associated with maintenance and upkeep of machines equipments and systems in any shop plant or industry Advances in Civil Engineering and Infrastructural Development Laxmikant Madanmanohar Gupta,Maya Rajnarayan Ray,Pawan Kumar Labhasetwar,2020-11-13 This book comprises selected proceedings of the International Conference on Recent Advancements in Civil Engineering and

Infrastructural Developments ICRACEID 2019 The contents are broadly divided into five areas i smart transportation with urban planning ii clean energy and environment iii water distribution and waste management iv smart materials and structures and v disaster management The book aims to provide solutions to global challenges using innovative and emerging technologies covering various fields of civil engineering The major topics covered include urban planning transportation water distribution waste management disaster management environmental pollution and control environmental impact assessment application of GIS and remote sensing and structural analysis and design Given the range of topics discussed the book will be beneficial for students researchers as well industry professionals

Water and Sanitation in the World's Cities Un-Habitat,2013-06-17 This is surely the most impressive and important publication to come out of the UN system for many years Peter Adamson founder New Internationalist and author and researcher of UNICEF s The State of the World s Children from 1980 to 1995 The world s governments agreed at the Millennium Summit to halve by 2015 the number of people who lack access to safe water With rapidly growing urban populations the challenge is immense Water and Sanitation in the World s Cities is a comprehensive and authoritative assessment of the problems and how they can be addressed This influential publication by the United Nations Human Settlements Programme UN HABITAT sets out in detail the scale of inadequate provision of water and sanitation It describes the impacts on health and economic performance showing the potential gains of remedial action it analyses the proximate and underlying causes of poor provision and identifies information gaps affecting resource allocation it outlines the consequences of further deterioration and it explains how resources and institutional capacities public private and community can be used to deliver proper services through integrated water resource management

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(Sackler NAS Colloquium) The Role of Science in Solving the Earth Emerging Water Problems Proceedings of the National Academy of Sciences, Henry Vaux, William Jury, National Academy of Sciences, 2005-09-15 Earth is about 70% water the human body is about 53% water plants use water s unique properties to transport food and aquatic organisms can survive during the winter due to water s thermal properties However as life continues to evolve on Earth new problems with water emerge The Sackler NAS Colloquium The Role of Science in Solving the Earth Emerging Water Problems provides a look into these problems ranging from water s agricultural use and importance in society to its scarcity and use in technology

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Municipal and County Engineering ,1927

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jan 27 2015 yuma yu gi oh zexal anime serisi nin ana karakteridir kişisel Özellikler yuma hırslı enerjik genç bir çocuk olarak rekabet içine girmeyi ve zor işlerde başarılı olmayı denemeyi seviyor genellikle gözünde büyüttüğü şeyleri yapmaya çalışırken başarısız olmasına rağmen

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zexal power yu gi oh wiki fandom - Jul 05 2022

zexal 𐄂𐄂𐄂 zearu is a miraculous force from the astral world in the yu gi oh zexal anime that is called upon by yuma tsukumo

and astral combining them into a single being while being utilized the wielder is capable of performing the shining draw which allows them to create and draw cards

iv d team yu gi oh wiki fandom - Jan 31 2022

iv IV 四四 fō is a alternate incarnation of quattro a character from the yu gi oh zexal anime appearing in the yu gi oh d team zexal spin off manga he is currently the asian champion iv challenged team zexal as they were the winners of the team duel tournament where he easily managed to defeat tetsuo and takashi after winning he made fun of them

yu gi oh go rush wikipedia - Apr 02 2022

on december 17 2021 tv tokyo announced that yu gi oh go rush would premiere on april 3 2022 on tv tokyo and bs tv tokyo with key staff members from yu gi oh sevens returning for their respective positions nobuhiro kondo is directing the series at bridge toshimitsu takeuchi is in charge of series scripts and kazuko tadano and hiromi matsushita

yu gi oh zexal 4 bölüm türkçe altyazılı Çizgi film - Aug 18 2023

jan 27 2015 kabul ediyorum yuma yu gi oh zexal anime serisi nin ana karakteridir kişisel Özellikler yuma hırslı enerjik genç bir çocuk olarak rekabet içine girmeyi ve zor işlerde b

yu gi oh zexal 34 bölüm part 1 türkçe altyazılı Çizgi film - Sep 07 2022

jan 27 2015 yuma yu gi oh zexal anime serisi nin ana karakteridir kişisel Özellikler yuma hırslı enerjik genç bir çocuk olarak rekabet içine girmeyi ve zor işlerde b

yu gi oh zexal vikipe di - May 15 2023

yu gi oh zexal japonca 四四 zexal romanize yūgiō zearu shin yoshida tarafından yazılan bir manga serisidir seri aralık 2010 haziran 2015 tarihleri arasında shueisha nın v jump dergisinde dokuz tankōbon cilt halinde yayınlandı

yu gi oh zexal wikipedia - Jan 11 2023

the first yu gi oh zexal sound duel 1 was released on september 28 2011 the second yu gi oh zexal sound duel 2 was released on september 19 2012 the third yu gi oh zexal sound duel 3 was released on may 15 2013 the fourth yu gi oh zexal sound duel 4 was released on november 13 2013 the fifth yu gi oh

yu gi oh zexal izle türkçe anime izle anizle - Sep 19 2023

yu gi oh serisinin 4 sezonuna karşılık gelen yapımdır yeni serimizin kahramanı yuma tsukumo her zaman meydan okumaya açık olan bir orta birinci sınıf öğrencisidir başına gelen bazı olaylar sebebiyle kendini okulun çete liderlerinin en büyüğü shark ile düelloda bulur

yu gi oh vikipe di - Dec 10 2022

yu gi oh zexal 2011 2014 dördüncü anime serisidir 148 bölümden oluşur xyz canavarları oyuna tanıtılır bkncz yu gi oh zexal yu gi oh arc v 2014 2018 beşinci anime serisidir 220 bölümden oluşur pendulum canavarları ve pendulum kartı bölgelerini

oyuna tanıtır

quattro yu gi oh wiki fandom - Mar 13 2023

quattro known as iv in the japanese version four in the italian version and born thomas arclight is a character appearing in the yu gi oh zexal anime he is a number hunter of the vetrix family and the current asian duel champion

zexal nyaa - Jul 17 2023

uraharashop yu gi oh zexal ii 31 104 mkv 463 4 mib 2013 07 04 14 57 0 0 0 ygo yu gi oh zexal ii 022 95 b654558b mkv 499 1 mib 2013 03 17 15 13 0 0 0 ozcc yu gi oh zexal 06 h264 480 720p 584 0 mib 2011 05 29 05 04 0 0 0 yu gi oh zexal 136 sub latino znf 180 1 mib 2014 02 09 14 50 0 0 0

official yu gi oh site watch full length yu gi oh episodes online - Aug 06 2022

the official site for all things yu gi oh watch full episodes from all four animated series get the latest news and find everything you would want to know about the characters cards and monsters of yu gi oh

yu gi oh zexal tv series 2011 2014 imdb - Jun 04 2022

rate animation action comedy yuma tsukumo must team up with an ethereal being connected to an ancient relic left to him by his parents in order to collect 99 number cards doing so will restore the lost memories of this being giving them the

yu gi oh zexal yu gi oh wiki fandom - Apr 14 2023

yu gi oh zexal sound duel 1 was released on september 28 2011 yu gi oh zexal sound duel 2 was released on september 19 2012 yu gi oh zexal sound duel 3 was released on may 15 2013 yu gi oh zexal sound duel 4 was released on november 13 2013 yu gi oh zexal sound duel 5 was released on november 19 2014 episodes

yu gi oh zexal tv series 2011 2014 episode list imdb - Oct 08 2022

s4 e4 rule duel october 28 2012 ray nominates yuma to run against caswell for the position of class representative but when the ray way takes a turn for the worse yuma finds himself facing off against a student council president who s been corrupted by the barians 6 6 10

list of yu gi oh zexal episodes wikipedia - Jun 16 2023

zexal ㊦ ㊦ ㊦ zexal ㊦㊦㊦ yūgiō zearu is the fourth spin off anime series in the yu gi oh franchise and the sixth anime series overall by nihon ad systems and tv tokyo it is directed by satoshi kuwahara and produced by studio gallop the series aired in japan on tv tokyo between april 11 2011 and september 24 2012 a second series yu gi oh