WERF

Water Environment Research Foundation

Collaboration. Innovation. Results.

A Review of Advanced Sewer System Designs and Technologies

Co-published by

IWA Publishing

INFR4SG09d

A REVIEW OF ADVANCED SEWER SYSTEM DESIGNS AND TECHNOLOGIES

by:

Simon Lauwo
Dr. Sybil Sharvelle (PI)
Dr. Larry Roesner (Co-PI)

Colorado State University

2012

WERF

The Water Environment Research Foundation, a not-for-profit organization, funds and manages water quality research for its subscribers through a diverse public-private partnership between municipal utilities, corporations, academia, industry, and the federal government. WERF subscribers include municipal and regional water and wastewater utilities, industrial corporations, environmental engineering firms, and others that share a commitment to cost-effective water quality solutions. WERF is dedicated to advancing science and technology addressing water quality issues as they impact water resources, the atmosphere, the lands, and quality of life.

For more information, contact:
Water Environment Research Foundation
635 Slaters Lane, Suite G-110
Alexandria, VA 22314-1177
Tel: (571) 384-2100
Fax: (703) 299-0742
www.werf.org
werf@werf.org

This report was co-published by the following organization.

IWA Publishing
Alliance House, 12 Caxton Street
London SW1H 0QS, United Kingdom
Tel: +44 (0) 20 7654 5500
Fax: +44 (0) 20 7654 5555
www.iwapublishing.com
publications@iwap.co.uk

Library of Congress Catalog Card Number: 2011931423
Printed in the United States of America
IWAP ISBN: 978-1-78040-025-9/1-78040-025-X

Colorado State University

The research on which this report is based was developed, in part, by the United States Environmental Protection Agency (EPA) through Cooperative Agreement No. CR-83419201-0 with the Water Environment Research Foundation (WERF). However, the views expressed in this document are not necessarily those of the EPA and EPA does not endorse any products or commercial services mentioned in this publication. This report is a publication of WERF, not EPA. Funds awarded under the Cooperative Agreement cited above were not used for editorial services, reproduction, printing, or distribution.

This document was reviewed by a panel of independent experts selected by WERF. Mention of trade names or commercial products or services does not constitute endorsement or recommendations for use. Similarly, omission of products or trade names indicates nothing concerning WERF's or EPA's positions regarding product effectiveness or applicability.

CHAPTER 2.0

SUMMARY OF ADVANCED SEWER SYSTEM DESIGN AND TECHNOLOGIES

2.1 Sewer Conveyance System Design and Technologies Literature Selection and Classification Criteria

Literature on advanced sewer system design and technologies was collected from a plethora of sources, the principal sources of which were the United State Environmental Protection Agency (U.S. EPA), Water and Environmental Research Foundation (WERF), Elsevier, America Society of Civil Engineers (ASCE), Australia Water Association, Hunter Water Corporation of Australia, and National Small Flows Clearinghouse.

The information gathered from the literature review is summarized in Table 2-1 below. The literature is grouped under the following subject headings:

- Onsite Technologies
- Pressure and Vacuum Sewer Technologies
- Small Diameter Gravity Sewers
- Gravity Sewer System Design
- Techniques for Infiltration Detection and Control
- Sewer Construction/Rehabilitation Technologies to Control I&I and SSO
- Pipe Material and Joints for Sewer Systems Designs

Within each of these subject areas the information is further categorized as *Established Technologies* and *Innovative/New Technologies*. *Innovative/New Technologies* are further subdivided into *Proven Technologies*, and *Experimental & Foreign Technologies.*

The *Established Designs and Technologies* subgroup identifies sewer design and technologies that are fully adopted in the United States and are commonly used by many municipalities and sewer utilities. Selection of a design or technology to be listed in the table was based on whether the particular innovation has been introduced into the existing sewer systems for the purpose of improving performance, or reducing the cost of sewer operations. Literature was collected from a variety of publication years.

The *Proven Designs and Technologies* subgroup comprises sewer design and technologies that have been introduced into the sewer industry but have only been adopted on a limited scale in the U.S. These technologies have been proven to work in some areas around the U.S, but their application in other areas around the country is not widespread. Most of the literature used for proven technologies was published between the years 1999 and 2010.

The *Experimental and Foreign Technologies* subgroup summarizes sewer designs and technologies that are either at the experimental stage in the U.S. or outside U.S, and/or are

proven to work in other countries but have not been used much in the U.S. More focus was given to technologies and designs used in Australia, Germany, UK and Canada. Most of the literature used for this group was published between 2000 and 2010.

A number of these designs and technologies identified in Table 2-1 were selected, based on their potential for application in the near future, for detailed discussed in Chapters 3.0 through 8.0. These chapters are organized in the same fashion as Table 2-1.

NOTE: In order to make Chapters 3.0 through 8.0 more readable, most of the references from which the discussion is developed have been omitted; but the reader can easily find the references by looking back at the appropriate section of Table 2-1.

Enviro-Septic Treatment System is another innovative septic treatment system that has been introduced to the market by Make-Way Environmental Technologies, Inc. of Ontario, Canada. However, Presby Environmental, the inventor of this technology, is a U.S. based company. This system was designed to optimize both aerobic and anaerobic bacterial treatment of septic tank effluent prior to discharging to the surrounding soil. Optimizing treatment prior to dispersal into the natural soils reduces the size requirement and increases longevity of the system. The Enviro-Septic treatment system consists of a distribution box, offset adaptor, Enviro-Septic pipes and bio-accelerator™ fabric, pipe couplings, ventilation pipes, piezometers, and system sand (Figure 3-20).

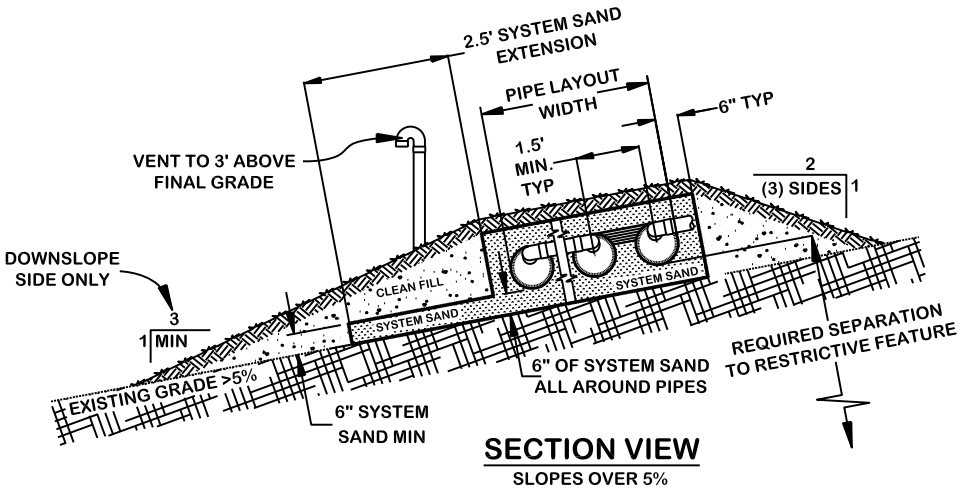

Figure 3-20. Advanced Enviro Septic® System Treatment Components.
Reprinted with permission from Presby Environmental[290]

The Enviro-Septic pipe is the notable design component for this treatment system. The pipe contains a 30cm diameter high density plastic pipe which is corrugated and perforated with skimmer tabs that extend into the pipe at the point of each perforation. Warm effluent enters the pipe and is cooled to ground temperature. Suspended solids and grease that remain in the effluent separate from the liquid effluent as it cools. The skimmer tabs assist in separation of solids and scum from the liquid layer in the corrugated pipe. A bio-accelerator™ fabric layer sits below each pipe, partially covering a layer of coarse fibers (Figure 3-21). The bio-accelerator fabric screens solids from the effluent and develops a biomat. The layer of coarse fibers, which extends around the circumference of the pipe, further assists in removing solids. A non-woven geo-textile layer holds all the components in place and provides a protected surface on which another layer of biomat develops. Liquid exiting the geo-textile fabric is wicked away from the piping by the surrounding system sand. This assists in cooling the effluent and enables air to transfer to the bacterial surfaces. Anaerobic bacteria utilize the effluent to form biomat layers on the provided surfaces during high flows and during low flows, aerobic bacteria consume the biomat. Bacterial efficiency is increased by the large air supply and fluctuating liquid levels which provide large food supplies. [26][290]

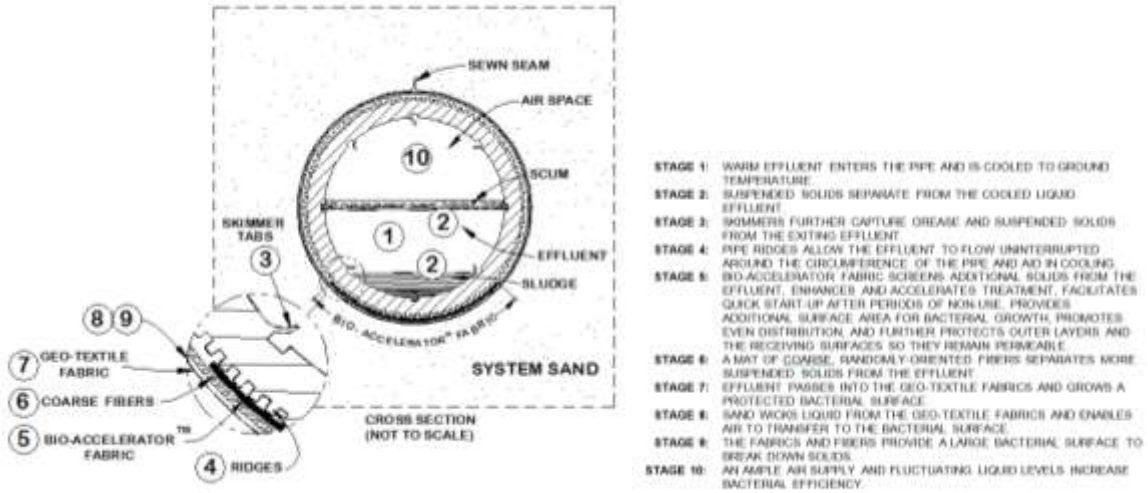

Figure 3-21. Advanced Enviro-Septic Pipe Design: 10 Steps of Treatment.
Reprinted with permission from Presby Environmental[290]

Advantages: It is a natural, non-mechanical system, does not require an input of electricity, adapts to difficult sites by way of a smaller treatment field and easy blending on sloping terrain, it requires less fill and is easier to install compared to traditional septic systems, there is no need for expensive washed stone, it adapts easily to both commercial and residential sites, provides a stable pH and protected surface for bacterial growth which increases septic system performance and longevity by facilitating a naturally balanced, secondary treatment that utilizes both aerobic and anaerobic bacteria, it more effectively reduces CBOD5, fecal coliforms and TSS when compared with conventional drain field technology and recharges the groundwater with better quality effluent than conventional septic systems. [26] All of these advantages contribute to a cost-effective system.

Performance: Effluent quality after treatment with Enviro-Septic is expected to meet U.S. EPA Tertiary Treatment guidelines, NSF Standard 40 Class 1 requirements and BNQ Secondary and Advanced Secondary requirements (Quebec).