Wastewater Management Systems

A Review of Sewage Systems for Denman Island
Including an Analysis of Greywater Reuse and Rainwater Collection

Report prepared for H. Holm,
Denman Community Land Trust Association.

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Abbreviations

CMHC	Canada Mortgage and Housing Corporation
CSA	Canadian Standards Association
ITF	Islands Trust Fund
ROWP	Registered Onsite Wastewater Professional
SPM	**Standard Practice Manual (for sewerage systems in BC)**
SSR	**Sewerage System Regulation in BC**
USEPA	United States Environmental Protection Agency

Foreword

The Wastewater Management Systems report provides basic information about approved domestic sewage, greywater and rainwater systems for landowners on Denman Island and in other rural areas in BC, as available to February 2014. The report is compiled from the literature listed in the bibliography and from conversations with the contributors noted in Appendix 1.

NOTES: This report uses sewage system, sewerage system and septic system interchangeably. Also, the near future is likely to bring about changes and advances in handling "wastewater". Lastly, this review does not include a discussion of composting toilets.

Decision Tree for Planning a Sewage System

The following is a list of questions to answer when considering the installation of a sewage system. For the details of possible options at each question/decision stage, see the respective sections of this report as indicated in the boxes.

Question/decision stage

1. **What are the priority goals of the landowner?**

   Landowner Goals
   See 3.3

2. **What financial resources can be committed to these goals?**

   $ Dollars
   Up to the individual

3. **What Authorized persons are available, affordable?**
   1. For a "Type 1 or 2 treatment system", see section 3.1, use **ROWP** or **Professional**.
   2. For a "Type 3 system", see section 3.1 use a **Professional**.

   Authorized Persons
   Choice of 2 types, see 2 & Appendix 3

4. **What are the household septic system needs?**
   Calculated by the Authorized person from household requirements.

   Household Requirements
   Calculated, see 3.4

5. **What are the conditions and constraints of the site?**
   Determined onsite by the Authorized person from soil conditions and aspects of location.

   Site Conditions & Constraints
   Determined on site, see 3.4

6. **What possible septic system types are appropriate for this site?** Outlined by the Authorized person, based on all of the above.

   Sewage System Options
   See 4

7. **What could be the schedule of construction /installation /maintenance and who will be involved in each task?**
   e.g. How much involvement is desired by the landowner?

   Construction Schedule & Input
   Individual choices & see 2.

Based on the decisions and information obtained above, landowners can make the best choice of an appropriate system and who is going to be involved in its design, construction and continuing maintenance.

1 Sewage System Definitions

Definitions for terms relating to sewage systems are included here to assist readers in wading through the detailed terminology. The list covers both BC Public Health Act terms as well as other words commonly used when discussing sewage systems. **BC Public Health Act definitions are in bold type and are contained in quotes.**

Authorized Person **"Either a Registered onsite wastewater practitioner (ROWP) or a Professional."** See Section 2 and Appendix 3.

Baffles/Chambers / Vaults As part of septic field distribution systems, are inverted U-shaped porous plastic covers, one to three feet in diameter, used over pressurized septic field pipes.

Biomat Mixed layer of biological growth with their related organic products and inorganic compounds that forms where the wastewater (effluent) meets the soil and tends to clog the effluent path and prevent further infiltration of the soil. Black colour usually due to a precipitate of iron sulphide.

Black water Untreated water with domestic toilet/human excreta effluent.

BOD Biochemical Oxygen Demand Amount of oxygen used by bacteria to "treat" organic matter in wastewater. Gross measure used to represent the amount of biodegradable organic impurities or the 'loading of the field'. Expressed as mg/L.

Discharge area Also known as septic, drain, leach or disposal field. **"Area used to receive effluent discharged from a sewage treatment method."** *NOTE:* an area of unsaturated soil into which the wastewater infiltrates through porous components. The field is considered a major part of effluent treatment, as the soil's micro-organisms further breakdown or take up effluent contaminants before the liquid reaches other water sources. Aerobic (oxygen-using) organisms in the soil play an important role. The field accepts, treats and disperses the effluent.

Domestic sewage **"Human excreta & *[greywater]* waterborne waste from preparation & consumption of food & drink, dish washing, bathing, showering and general household cleaning and laundry except from self-service laundromat."**

Drainfield See Discharge area.

Effluent **"Domestic sewage treated by a treatment method and discharged into a discharge area."**

Fecal coliforms Coliform bacteria primarily inhabit the intestines of warm-blooded animals and fecal coliforms are defined as the particular species of coliform bacteria that have the ability to ferment lactose at 44.5ºC. Fecal coliforms are used as more specific indicators of fecal contamination that other coliforms. Examples are *Escherichia coli* and some *Klebsiella pneumoniae* strains.

Greywater Water that has already been "lightly-used": untreated-water from sinks and showers/baths (not water from toilets or urinals)
NOTE:Health Canada "greywater" does not include water from the kitchen sink.

Hydraulic loading rate Rate of transmission of the effluent through the soil, depends on soil characteristics, measured crudely by percolation testing.

Packaged Treatment Plants Advanced treatment systems for home use that are in addition to the septic tank and field, and that are similar but smaller versions of those used in large sewage treatment facilities.

Percolation Test Measures the rate a known volume of water permeates the subsoil through a hole of known surface area. Used to determine the absorption rate of soil in a proposed septic field. (Permeameter test –tests the permeability of soil).

Potable Water Drinking water, safe for human consumption.

Professional Professional under BC Sewerage System Regulations:

- has the required training and
- is a registered practicing member of BC professional association regulating persons engaged in supervision of sewerage system construction and maintenance (*e.g*. engineer or geoscientist).

Rainwater harvesting Collecting rainwater for various domestic uses.

ROWP Registered Onsite Wastewater Professional, under BC Sewerage System Regulations:

- has successfully completed training authorized program or demonstrated competence to Applied Science Technologists and Technicians of British Columbia and
- holds a registration certificate.

Septic field See Discharge area.

Septic Tank **"Watertight container for receiving, treating and settling domestic sewage."**

Sewage Waste carried in water, or wastewater. In this report, sewage is distinguished by containing human excreta, from rainwater and greywater.

Sewage treatment Process of removing contaminants from sewage, including physical, chemical and biological contaminants.

Sewerage Can be used interchangeably with sewage. Also, can be used for the infrastructure that conveys sewage.

Surface Water **"Natural watercourse or source of fresh water whether usually containing water or not and includes lake, river, creek, spring, ravine, stream, swamp, gulch and brook, and ditch into which a natural watercourse or source of fresh water has been diverted (but not a culvert used to prevent watercourse contamination by sewage)."**

Treatment Method **"Health Act designates sewage systems by effluent treatment methods:**

Type 1 treatment by septic tank only.

Type 2 treatment produces effluent consistently containing:

- **< 45mg/L of total suspended solids and**
- **5 day biochemical oxygen demand of < 45 mg/L.**

Type 3 treatment produces an effluent consistently containing:

- **< 10 mg/L total suspended solids and a 5 day biochemical oxygen demand of less than 10 mg/L and**
- **Median fecal coliform density of < 400 Colony Forming Units /100ml."**

Type 1,2 or 3 System See Treatment method and Section 3.1.

TSS Total Suspended Solids Weight of the residue after a sample liquid is filtered through a standard glass-fibre filter and then dried, divided by the original volume of the liquid. Expressed as mg/L.

2 Introduction to Sewage System Regulation - BC

Sewage systems regulations and their components are intricately linked, as the one often directly relates to, or dictates the requirements of the other. For clarity in this report, this brief regulatory introduction is included before the components of sewage systems are explained. The aim is to create an awareness of the regulations, to indicate the importance of reviewing Section, 6.2, which briefly explains the regulations in more detail, and also to point out the need to keep abreast of possible regulatory amendments.

Two important documents, cover domestic household sewage system requirements in BC. These documents undergo revision and are amended as considered necessary.

Two Important Documents in BC about Domestic Sewage Systems

1. The construction and maintenance of domestic household sewage systems is regulated under the BC Public Health Act by the '**Sewerage System Regulation**" (**SSR**):
http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/22_326_2004#part1
The latest amendments as of January 2014 were added in 2010:
http://www.health.gov.bc.ca/protect/pdf/Sewerage-System-Regulation-Amendments-OIC476.pdf.

2. All plans and specifications for domestic sewage systems must be consistent with the BC Sewerage Systems **Standard Practices Manual** (**SPM**). **Note** New version SPM (3) coming out soon. http://www.health.gov.bc.ca/protect/lup_standards.html.

Authorized Persons: ROWP or Professional

An Authorized person is required for the process of putting in a sewage system. Two types of Authorized persons can be contracted: an ROWP or a professional. Qualified ROWPs are listed on the website of the Applied Science Technologists and Technicians of BC http://owrp.asttbc.org/c/finder.php and professionals are listed by the Professional Engineers and Geoscientists of BC https://www.apeg.bc.ca/Member-Directories/Professionals-for-Sewerage-System-Regulation. Several local Authorized persons are listed in Appendix 1. Professionals are able to take on more responsibilities than ROWPs, but most sewage systems can be done by either type of Authorized person. The possbile responsibilities, as well as descriptions of the required training of Authorized persons are covered in section 1 and Appendix 3. Of note, an amendment to the Sewerage Regulations in 2010 made it possible for homeowners to participate in the installation of sewage systems on their own property, under the supervision of their Authorized person.

Maintenance Plan & Record Keeping

Regular maintainance of sewage systems, including record keeping, is required of landowners under the Sewage System Regulation BC (SSR). Maintenance must be in accordance with the maintainance plan written and provided to the landowners by the Authorized persons certifying the system. Owners must complete and keep records of this maintenance. Sewage system maintenance is discussed in section 5 and a useful maintenance fact sheet can be found at http://www.healthlinkbc.ca/healthfiles/pdf/hfile21.pdf.

Responsibility resides with the owners of land parcels on Denman and other rural areas in BC, on which a structure is constructed or located, to ensure that all domestic sewage originating from the structure:

- is discharged into a sewage system that is constructed & maintained as stated in the plans attached to the certification letter.
- does not cause a health hazard.

3 Introduction to Sewage Systems

A sewage system first collects wastewater, then allows the light, usually grease elements to float and the solids to settle out and begin decomposition. Next, extra parts may be added to further remove or sterilize various contaminants, including physical, chemical and biological elements. Finally the system allows for the absorption and natural breakdown of the remaining effluent components within a drain field, resulting in an environmentally safe liquid. The decomposing solid sludge layer in the first portion of the system, the septic tank, is then removed periodically. Specific factors place demands on a sewage system and thus affect the system's design. As sewage systems are technically complex, all stages of the design (site evaluation, selection of components) and installation are critical.

Sewage Disposal Factors

- the amount of fluid (volume),
- how fast the fluid flows through the system and
- possible contaminating physical, chemical and biological (bacteria, viruses, protozoa etc) components that require removal.

3.1 Regulated Types of Sewage Treatment Systems

Three types of sewage treatment systems are described in the BC SSR and Standard Practice Manual (SPM). Formal definitions are covered in section 1, but a simplified explanation may be of assistance.

Type I Sewage Treatment Systems are the simplest and usually consist of a septic tank, often concrete, and a gravity-fed, pumped or pressurized effluent distribution system in the septic field. If the site is suitable for a Type 1 system, these are usually the most economical.

Types 2 and 3 Sewage Treatment Systems involve additional treatment of effluent beyond the basic septic tank and field. Section 4.2 includes a description of some of the possible additional treatment options and the reasons for using them. In general, these systems release an effluent that has fewer contaminants to the disposal area. Type 2 systems include most of the packaged treatment plants and filter treatments. Type 3 systems involve additional sterilization/disinfection, usually by UV light. Chlorination of effluent is less desirable due to the presence of residual chlorine affecting the septic field. Disinfection is also called "effluent polishing". The specific requirements in terms of acceptable designs, performance, installation and monitoring for sewage systems with additional treatments are covered in the BC SPM.

3.2 Progress in Sewage System Design

Progress in sewage system design is occurring due to a burgeoning interest in individual domestic sewage system management and technology. Currently, a daunting array of treatment plants and design combinations are possible due to advances in alternative systems. At the same time protocols are continually being up-graded. Wikipedia lists over 50 wastewater treatment technologies that can form all or part of sewage systems, see Appendix 5. Wikipedia's general discussion of sewage treatment gives an overview of the development of the various sewage treatment techniques.

One major reason for the interest in wastewater treatment is the growing global awareness of the need for water conservation. Also, individual domestic sewage systems are actually common, even in North America – we are not alone! For example, in the USA, the Environmental Protection Agency (US EPA) noted that in 2007, approximately 20% or 26.1 million housing units in the USA were served by septic systems and this was up from 1985. The EPA estimates that about 10-20%

per year of these systems malfunction and could cause environmental pollution and health risks. There are an estimated 250,000 onsite (domestic) sewage treatment systems in BC (British Columbia Ministry of Environment 2013).

Although describing even a portion of the possible sewage system options is well beyond the scope of this report, landowners are encouraged to press their Authorized person for information and to explore many possible alternatives. Siting sewage systems in forests is perhaps the most advantageous development for rural areas on the BC coast. For cleansing effluent, assisting with septic field siting, protecting fields, as well as conserving forests, forest sewage distribution is considered an excellent effluent treatment choice, as discussed in section 4.3.3. As researchers, industrial interests and regulators are all examining sewage system possibilities, the future may hold the key to much more improved and practical systems than those presented in this report.

3.3 Process of Choosing a Sewage System

The 'decision tree' shown on the first page of this report, indicates the six steps to go through when considering the installation of a septic system. As with most projects, that first step, for the landowner to identify their personal goals, will influence the entire project.

Landowner goals can vary widely and must be prioritized.

Landowner goals

- Comprehensive and evolving uses of the property may constrain the area of the property that is available for the sewage system.
- Potential for increased home occupancy or water consumption may need to be factored in.
- Conservation of as much as possible of the natural vegetation and habitat on the property may need to be considered.
- Low water availability or a general interest in conserving water may be major factors

Industry-based Onsite Sewage System organizations in BC may be able to supply the additional information throughout the sewage system selection process. These organizations provide educational material for landowners as well as training programs for those who wish to become more involved in this industry.

- WCOWMA On Site Wastewater Management Association of BC, part of the western Canada association. This is an industry association, which interacts with government at all levels to improve and train the wastewater industry. WCOWMA is proactive in contacting regional districts and municipalities as to available programs for training the public regarding wastewater issues.
- BCOSSA BC On Site Sewage Association.

The final choice of the system will be the sum of the various factors in the decision tree. For example, for one property in Minnesota

- The landowners' over-riding goals were to use most of their property for garden, pasture and to protect some mature trees.
- The landowners had the ability to meet the cost of an appropriate system for their goals.
- The site had restrictions with thin soils, a nearby well and slightly sloping topography.
- Those involved were aware of all the options and knew that the regulations allowed a drip-distribution septic field system in this situation.
- The sewage system installer had the skills and experience to correctly install a drip system.

All of the above contributed to the particular sewage system decision (Gustafson *et al* 2000).

3.4 Site Evaluation

Both the landowner and the Authorized person contribute to evaluating the site for the sewage system, so that the system addresses both the landowners' needs and the physical restrictions of the property.

1 **Household Requirements** of the landowner indicate the effluent flow requirements for the system. The SPM contains a chart that uses the number of bedrooms to predict daily effluent flow rates and other the factors suggest additional household activities that may influence the amount or frequency of the flows.

Household Requirements

- number of bedrooms
- number of bathrooms
- square footage of home
- number of people

2 **Soil conditions** of the site are determined by an Authorized person using onsite percolation or permeameter tests and inspection holes.

Soil Conditions

- natural soil depths
- soil type
- water table / saturation
- rate of absorption

Soil consistency/quality relates to the need to hold the effluent within the field for enough time to allow any contaminants to be exposed, broken-down and/or absorbed primarily by aerobic (oxygen-using) microorganisms. There must be soil of sufficient depth and suitable porosity over a given field area, to absorb and diffuse all the effluent, without the field becoming saturated and thus drowning the aerobic microorganisms and potentially creating pathways in the soil that would short-circuit the uniform distribution and treatment of effluent. The soil data will determine the ability of the soil to accommodate the various types of septic fields.

3 **Location** of the septic system must take into account all of the factors that affect first, the ability of the system to function, including coping with the cumulative effects of nutrients such as nitrogen and phosphorus, and draining liquid away from the source. Second, the location must fulfill all of the necessary regulations and set backs protecting structures and the environment from possible damage or health hazards. The amount of space available and the characteristics of the topography may constrain the options for positioning septic fields.

Location

- topography e.g. slope, aspect, shape/form etc.
- distance necessary for set-backs e.g. to wells, property lines, water courses (creeks, ditches), water bodies (lakes, ponds and wetlands), driveways, buildings.

4 Components of Sewage Systems

In-home collection and transport system or sewage conveyance consists of outflow pipes from various sinks, baths, toilets, drains and pipes that receive and transport the sewage to a treatment location.

- Each outflow from sinks or drains will have a U-shaped "p-trap" in the outflow system that holds a solid reservoir of water and prevents the return of sewage gases into the home.

- Also, the sewage collection system requires venting in order to allow the sewage to flow, thus vents are piped to the outside of the house.

4.1 Septic Tank

The first stage of the effluent treatment process occurs in the septic tank. The sewage settles out within the first chamber. The scum layer made up of grease and light constituents, floats to the surface and forms a crust, while the sludge layer, consisting of solids, sinks to the bottom and begins to decompose in this anaerobic (lacking oxygen) environment. A relatively clear liquid is formed between the scum and sludge layers. This clearer liquid, flows through a T-shaped pipe from the first chamber to the second one. The process is repeated and the clearer liquid goes through to another chamber or the next part of the sewage system. Thus the functions of the septic tank include settling solid components, floating grease components, anaerobic decomposition of solids and storage of sludge.

Septic tanks in BC are commonly made of concrete, plastic or fibreglass; are of various shapes and capacities from a minimum of 2727 litres; and are usually buried in the ground. Since 1975, at least two chambers are required within the tanks.

Advantages of different types of tanks:

Concrete: strong, less breakable, withstand considerable weight, will rarely float.

Plastic: light, easily moved, durable, resilient, ribs can be added to somewhat strengthen tank, but will collapse under weight. May float, unless in very well drained area. Packaged treatment plants are often included in plastic tanks.

Fibreglass: also light and easily moved, brittle and like plastic also will collapse under weight and may float.

Options for septic tanks that may be necessary include additional chambers, forced-sedimentation chamber, baffles, filter ports, risers and effluent pumps.

Risers and Effluent Pumps

- Risers are tubes attached to the access ports that extend up from the septic tank to the surface and often have green plastic lids. Risers allow easy access as well as the addition of more soil to the tank's surface. Surface access to the septic tank components has been required since 2005 and risers facilitate access for annual inspection.
- Effluent pumps, if required, move sewage out of the tank to the septic field and are installed in an additional tank chamber or in a separate pump chamber.

The location of the septic tank is best recorded on a map or drawing that shows the entire sewage system. The map needs to show the relative distances to structures and relevant features, such as the house, well, drive and pathways, property borders, immediate neighbour's wells if they are close to the property border, etc. The BC government has produced a brochure on 'How to find a septic tank', which may be of assistance http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/septic_tank.pdf.

4.2 Additional Sewage Treatment

After the septic tank, additional treatment of the effluent may be necessary. Reasons for further treatment include inadequate soil depth, poor soil quality, not enough space, high/shallow water table, nearby sensitive ground water or to address landowners' goals. Additional treatment systems can have multiple components to remove different contaminants depending on the site conditions.

Treatments may involve two processes, (1) filtering to collect the contaminants, especially particulates and (2) microorganisms (e.g. bacteria, protozoa, fungi) to biodegrade the soluble organic elements and bind other elements. Treatment systems can be relatively straightforward such as sand or other specific porous media collected into containers or built into mounds. On the other hand, a host of manufactured treatment systems or 'packaged treatment plants' are now produced that in many ways mimic large-scale sewage treatment facilities. Ecological plant-based systems are also used. With the additional treatment, the required size of the septic field may be reduced, and the field itself may have a longer life expectancy. Only a few systems are discussed here, while Appendix 5 lists many possible treatment options that could be investigated.

4.2.1 Additional Treatment Components

Filtering materials may be part of the additional treatment systems, but many septic tanks also have a basic filter on the outlet to prevent the passage of solids. Single pass (filter) systems involve one passage of the effluent through the system.

Sand as a specifically engineered mixture can be used both to filter and as a support medium for contaminant-digesting microorganisms. Sand can be used in mounds, trenches or constructed-enclosures.

Geotextiles or manufactured fabric-materials can be used like sand as a filter and these synthetic fabrics are able to hold a much denser microbe capacity for the digestion of contaminants. Thus, the geotextiles can function as well as sand in a much smaller space. These textiles and other filters also may be part of packaged treatment plants.

Activated carbon filters could be used to remove residual toxins, in special circumstances.

Microorganisms are usually part of additional treatments and require oxygen for growth while they aerobically breakdown contaminants in effluent. Organic compounds are broken down, oxidized and the by-products released. By-products include carbon dioxide and often nitrogen compounds such as nitrites (NO_2^-). Nitrites may then be broken down to nitrates (NO_3^-) by the further oxidation of ammonia, also called the nitrification of the liquid. In some systems there is added breakdown to nitrogen gas (N_2), also called the denitrification of the liquid. Denitrification requires an anaerobic environment, which may occur in the inner thickened layers of microorganisms (biofilm) growing on media in some systems.

Where the microbial growth is exposed to the open air, such as in basic sand filters, the systems are passively aerobic. Microbial growth in packaged treatment systems may require added oxygen. Of note, the term Aerobic Treatment Unit or ATU seems to be being used specifically for packaged treatment plants that require added oxygen, although the passively air-exposed systems are also 'aerobic'.

4.2.2 Packaged Treatment Plants

Packaged septic treatment plants usually involve complete aerobic treatment units for the effluent after going through the septic tank. After a specific microbial treatment, there is often an additional settling chamber and then the effluent is pumped to the septic field. Many variations of packaged systems have been developed. Those that are confined within tanks have air actively added to the system. These packages often have moving parts, air and effluent pumps that require electricity and thus have a continual operating cost. Usually they are equipped with alarm systems, both visual and auditory, in case of failure. There are many manufacturers producing these aerobic treatment plants and often a maintenance contract with a service provider authorized by the manufacturer may be required.

A basic difference between types of packaged treatment plants is in the way microorganisms are used. Systems are usually either fixed-film systems that develop 'biofilm' growths, or suspended-growth systems with the growth elements or 'biofloc' floating throughout the effluent.

Fixed Film or Suspended Growth Packaged Treatment Systems

Fixed-film (attached-growth) systems include trickling filters, towers and rotating units.
In fixed-film systems, microorganisms grow on specific media under aerobic conditions as the effluent passes over/through the media.
Trickling filters are often of simple design and are usually one of the most trouble-free of the secondary treatments. Effluent passes through highly permeable media colonized by microorganisms, though no actual physical straining or filtering occurs in this process.

Some fixed-film packaged treatment systems are passively exposed to the air in-between intermittent applications of effluent to the biofilm media. Other fixed-film systems are like suspended-growth systems and are submerged in effluent and thus require added oxygen.

Fixed-film systems can better cope with changes in nutrient-content in the effluent flow and can more quickly remove organic material and suspended solids than the suspended-growth types. In open trickling filters the microorganism biofilm that develops may be grazed by insect larvae, snails and worms and this process keeps the film down to an optimal aerobic thickness.

Suspended-growth systems involve microorganisms that are suspended in the effluent that is actively supplied with oxygen. Air is added either by bubbles from an external air compressor, or by suction during the agitation or stirring of the effluent. These systems, such as activated sludge treatment plants, tend to take up less space than fixed-film systems.

Notes:

- The microbial growth in both of these types of systems consumes nutrients and gradually builds up and falls off the media, or settles out of the suspended systems. This material may be directly recycled into the flow, or may go into a sedimentation tank and then back to the septic tank.
- Also, these living systems may become ill, overgrown by problematic organisms or killed by changing inhospitable conditions or damaging chemicals.
- Membrane micro or ultra filters have also been added to some systems that are called *Membrane bioreactors* or MBR.

Least complicated systems The advantages of single pass filters and less complicated treatment plants include significantly reduced electricity costs, simple technology not requiring as complicated or difficult to repair parts, pumps that activate for a short time and will last much longer and clarification of the effluent to significantly reduce the size of the septic field (personal communication, Ron McMurtrie, Engineer, Hornby Island).

4.2.4 Examples of Packaged Treatment Plants

Common examples, often used locally, are listed and other examples are noted in section 9.

Ecoflo Biofilter http://www.ecoflobiofilter.com/ is a trickling filter with passive aeration. The medium for biological digestion is peat that is laid in a fibreglass shell. The peat is underlain with 2 layers: 200mm of clear stone and 300mm of clean sand. The peat is changed approximately every 8 years and a yearly maintenance contract is required.

Bionest System http://www.bionest-tech.com/MR-en/product/335-336/bionest-system.html is contained in an underground tank and is actively aerated through linear air pumps and fine bubble diffusers. The system has ribbon-shaped polymer media for microbial growth.

AdvanTex Treatment System http://www.orenco.com/systems/advantex_wastewater_treatment.cfm is an enclosed geotextile filter bed system that performs like a sand filter but in a much smaller space.

Waterloo Biofilter http://www.waterloo-biofilter.com/ developed in Ontario. This trickle filter system is passively aerobic with intermittent exposure of the absorbent synthetic filter media /material to effluent. This system can cost more than $10,000, but has one of the lowest electricity uses of the treatment plants (United States Environmental Protection Agency 2004).

4.2.4 Ecological Treatment Systems

Ecological treatment systems or Constructed wetlands pass effluent through a living ecosystem, where the waste is consumed as nutrient, up the food chain. Flows can be on or below the surface and can be vertical or horizontal. Various organisms may be included from microorganisms to various aquatic plants and small animals such as snails. These are aerobic systems deriving oxygen passively from the air.

The ecological treatment systems usually consist of basins filled with a treatment medium and growing plants through which wastewater is passed. Usually the treatment capacity of these systems improves with age. Some vegetated systems include physical filtration, such as the ghost-vegetated units produced on Hornby Island, which are vegetated soil/sand filters in a box. The containers in these ghost-vegetated units are strings of six foot-diameter well rings.

Some sources of ecological treatment systems include:

- **Ed Hoepner Aquarian Systems** http://www.aquariansystems.ca/about.htm ROWP Hornby Island / **Ron McMurtrie and Associates Blue Island Onsite** jasbreez@island.net Professional Hornby Island. see Appendix 1.
- **S. Colbert-Kerns / S. Brydges WetlandsPacific Corp**. http://www.wetlandspacific.com/ 921 Maughan Road, Nanaimo, Vancouver Island, B.C. V9X 1J2 Phone: (250) 722-7117 Toll Free: 1 (800) 617-9972
- **Solar Aquatics Systems** http://www.ecological-engineering.com/solaraquatics.html Ecological engineering Group info@ecological-engineering.com 508 Boston Post Rd., PO Box 415 Weston, Massachusetts 02493-0003 USA
- **Living Machine Systems**, http://www.livingmachines.com/Home.aspx L3C 1180 Seminole Trail, Suite 155 Charlottesville, VA 22901 USA t 00+1+434 973 6365
- **Eco-Machines** http://toddecological.com/about_us/ John Todd Ecological **Design** Post Office Box 497 Woods Hole, MA 02543

  Also see Appendix 4 for website descriptions of some of these companies' systems.

4.3 Septic Fields

Septic fields perform physical, chemical and biological treatment of effluent. Larger particles in the effluent are physically filtered through soil layers. Chemical reactions, such as 'ion-exchange', the binding of charged particles, occur between soil material and effluent nutrients. These reactions can tie up simple acids and bases and also more complex organic charged molecules. For example, soil particles may bind phosphorous through cation exchange. In addition, aerobic organisms in the soil, particularly in the biomat, can feed on and breakdown nutrients in the effluent. For organisms to function, the field must have air and thus cannot be waterlogged. Significantly, septic fields achieve 80-90% of the overall effluent treatment in a Type 1 system (Ontario Rural Wastewater Centre).

Accurate design and installation is critical to constructing a functional septic field. For some clarity with terminology, 'underground dispersal systems' for effluent are the buried piping systems in septic fields. The BC SPM refers to these systems of septic field pipes as 'subsurface wastewater infiltration systems' or 'SWIS'. The BC SPM outlines the factors to be considered in planning the many different types of fields, but some factors for the landowners' initial consideration are:

- **Where?** The field needs to be located in a protected area of the property, with little or no other human use. Possible plants for the surface of conventional fields need to be shallow-rooted. Forested areas are ideal for certain types of fields. Septic fields also need to be monitored, so while situated 'out of the way', they need to be accessible.
- **Well drained** is an important criterion for sighting a septic field. Septic fields must not be saturated or subject to any surface or ground water flows. A safe precaution is to provide a drainage system or tiling around the prospective septic field area, particularly on the side subjected to any surface or ground water flows.
- **Access ports** allow for monitoring the condition of the field and for flushing buried lines if necessary. Ports are usually placed at the end of the lateral lines of buried pipes, using a 90 degree junction and the port-pipe coming to the surface. While possibly un-aesthetic, ports greatly assist with field maintenance and prolonging the life of the field.
- **Length of distribution pipes / size of field** is calculated from charts in the SPM including the previously determined, expected-effluent flow rate, together with the available soil depth and the hydraulic loading rate of the particular soil, for which percolation test is crude measure.

4.3.1 Septic Field – Effluent Distribution Systems

Common types of discharge systems that distribute effluent in the septic field are:

Types of Discharge Systems

- Gravity or Trickle
- Pumping, Dosing
- Pressure or Uniform
- Drip
- Alberta at Grade

Gravity or **Trickle flow** into a discharge field is the simplest. Sewage flows both, from the dwelling to the septic tank and from the tank to the discharge area, by the force of gravity or 'downhill'. These systems usually consist of pipes in trenches.
Lengths of 4" diameter perforated-PVC-pipe are put into 16" wide trenches that are 5 ft apart and about 30" below the surface. The trenches are filled with 0.75" to 1.5" drain rock. In gravity systems, the effluent flow runs out before reaching the end of the pipes and thus the field is unevenly used.

Pumping of the sewage flow is needed when the septic tank is located below the septic field, or at a distance from the disposal field, and thus gravity flow is not possible. Sewage is pumped into the distribution box and then goes into the standard four-inch-perforated-pipes that distribute the flow in the septic field. Despite pumping the effluent to the field, the distribution in the large pipes still tends to be uneven and dependent on volume and pump pressure. These pumps are contained within screens to prevent larger particles from being pumped to the field.

Dosing is intermittent trickling or pumping to the field so that the field has intermittent rest periods. Doses are measured by the volume of a septic pump chamber, so that a specific volume is delivered regularly to the field. Dose chambers and pumps, if used, must be maintained, although an overflow system can be designed to over-ride if there is a dosing-equipment failure.

Septic pump chambers are separate tanks that hold the effluent until a float switch is triggered at a specified effluent level. The switch allows effluent to flow into the field or activates a pump, which then pumps effluent into the field.

Pressure or **Uniform distribution** is commonly installed now, in order to try to use as much of the field as uniformly as possible. This system may be required if space is limited or if soils are poor or shallow, to ensure that the entire area of the field is in use. An electric pump in the septic tank or in a pump chamber forces effluent from the septic tank to the field. Pressurized distribution fields can have pipes in trenches, on beds of gravel or in mounds of sand and gravel. Pipes used are smaller in diameter, usually 1 or 1.25" PVC with 3/16" holes drilled every 2 to 3 ft. The pipes often have raised plastic baffles or vaults/chambers above and along them to add an open area within the soil to receive, aerate and help retain the effluent excreted by the pipes. The system is calibrated and tested to disperse effluent relatively uniformly throughout the absorption area of the field. For these systems, the particular type of pump is chosen to suit the required pressure and volumes. This system also provides field dosing and resting cycles.

Drip distribution systems for effluent resemble garden drip systems. Effluent in these systems usually receives additional treatment prior to the septic field (Type 2 system), although a Type 1 system may be used with considerable care. Drip systems can be used in sites with shallow or lower quality soils or reduced space. They also offer the possibility of excellent effluent treatment. Drip systems are pressurized systems. The tiny ½ inch drip lines, can sit in small native soil trenches that are about 4 inches wide and 6 to 8 inches deep. These lines can be placed 1 foot apart. Drip lines can also be placed on the surface, after trimming back the vegetation, and then covering the lines with 6 to 8 inches of native soil. The fluid emitters are formed plastic units, embedded in the drip lines that release precise volumes at a rate of about ½ to 1 gallon/hr. So as not to clog the fine bore-emitters or thin lines, additional filters, either disc or spin, are used and in addition, the system incorporates a return line that is used for back-flushing to remove any accumulated slime or soil particles. Drip lines cost more than standard fields, have special pumps, gauges and filters and require maintenance, but they offer distinct opportunities for many situations, see forest use in section 4.3.3.

Alberta at Grade systems consist of pressurized pipes, hung within inverted-U-Shaped plastic baffles or chambers that sit directly on the soil surface. These baffles can be one or three feet in diameter. Openings in the pipes spray upward into the baffles that cover them. These lines of baffles are placed six feet apart. The baffles are then covered with very coarse bark mulch and the neighbouring vegetation is allowed to grow in over this material. Depending on the site vegetation, the bark mulch may have to be renewed periodically. These systems also offer excellent effluent treatment potential and are ideally suited to certain situations, see forest use in section 4.3.3.

4.3.2 Use of Sand

Sand Filters can pre-treat the effluent before it reaches the rest of the main field. This can be used where the field-characteristics, *e.g* soil volume, are insufficient to achieve complete effluent treatment. Usually the effluent moves from the pump chamber to a sand layer, either above or below ground.

Mound Construction can be used where there is insufficient soil or other field restrictions. Specific additional filtration-material may be added to the ground surface as a mound for pre-filtration of the effluent before it reaches the existing soil. Usually mound-systems pump the effluent into a network of pressurized pipes in a gravel bed on top of the mound and then the effluent drains through a layer of a particular type of sand before reaching the original soil surface. Raised or aboveground distribution systems of various forms and combinations of systems are possible, depending on the site conditions.

4.3.3 Sewage Distribution in Forested Areas of Properties

Disposal of effluent from sewage systems within forests offers many advantages to landowners.

Advantages of Sewage Dispersal in Forests

- Effluent treatment is enhanced by:
  - The increased biological activity in the top 16" of the soil
  - The forest soils' fungal mycorrhizal and mycelial elements are normally able to digest woody-plant cell wall polymers (lignin) and thus would be very capable of digesting complex organic compounds found in sewage, such as antibiotics, etc. Breaking the bonds in these chemicals involves a similar process.
- Septic fields are protected from surface water loading as less rainfall directly impacts the ground level within forests.
- Fields can fit aesthetically into landscape and be out of sight.
- Fields, amongst trees, are protected from landowner usage and possible damage.
- Trees benefit from nutrients in the effluent.
- Forested areas and ecosystems on properties can be conserved while septic systems can be accommodated.

Two possible dispersal systems are practical for use in forests.

Drip systems are ideal for use in forested areas. The four inches wide, six to eight inches deep trenches for normal drip lines are narrow and shallow enough that their installation would have a relatively low impact on the main roots of trees. In addition, in some cases drip systems could be placed on the surface and native soil added on top.

Alberta at Grade systems are also applicable for forested areas and for cleared areas that are intended to be allowed to grow up and return to forests. The system's baffles / chambers go in at the ground's surface after merely trimming the surface vegetation. Coarse wood chips, added over the baffles, will support the growth of vegetation.

5 Maintenance of Sewage Systems

A healthy sewage system is essential to a healthy house and property, as well as being an extremely valuable asset. Thus, the statement to landowners, on the Pacific Group Developments' website, "read the owner's manual", is good advice! To assist landovers, the BC government has produced a maintenance guide for domestic sewage systems (British Columbia Government HealthLink 2013).

5.1 Key Factors in Sewage System Maintenance

Addressing key factors in maintenance can prolong the life of sewage systems and avoid field failures.

Basic Sewage System Maintenance

- Identifying and protecting the sewage system site.
- Inspecting the system annually and keeping records.
- Avoiding the disposal of harmful materials in wastewater.
- Pumping and emptying the septic tank at regular intervals.

1. **Identifying the sewage system site** is the first essential step towards being a good septic system steward. To identify the site, to prevent any regular use that causes soil

compaction and also to provide enhanced evaporation and nutrient uptake, mark the boundaries in some manner or plant shallow-rooted, valued herbaceous beds on the site. As noted in the septic tank section, draw a map of the property indicating the septic system features in relationship to the home and other buildings and indicate the distances of the septic field to structures, driveways, wells, water bodies etc. Keep this map with the maintenance records.

Stewarding the sewage system involves looking after the health and consistency of the soil in the field and protecting the stability of the various introduced parts of the system.

Careful Stewardship Actions to Protect the Sewage System

- Do not allow heavy weights, such as vehicles on top of any part of the system.
- If the use of the house changes, *e.g.* additional persons, bedrooms or bathrooms, the septic system may need to be up-graded.
- Watch for changing water flows on the property and do not allow flooding of the field, which would drown the field's necessary aerobic organisms.
- Do not allow water from surfaces such as roofs, driveways or patios to run onto the septic field or the replacement area.
- To facilitate water runoff from the septic system area, soil laid over the system can be mounded, or slightly raised.
- In general, use water wisely!

2. **Inspection of the septic system** regularly, at least once a year, enables landowners to assess any changes. The risers that can be added to septic tank ports are easily accessed from the surface and the tank material may be viewed. In this way the landowner may become familiar with the tank's location, as well as the normal appearance of the contents.

   Regulation! Currently in BC, the SSR require that the landowner must maintain the septic system in accordance with the plan from the Authorized person and that the landowner must keep records of having done so. For Type 1 or Type 2 systems maintenance must be under the supervision of at least an ROWP. If packaged treatment plants are used, the companies often require maintenance contracts with their own approved representatives. For Type III systems or systems with a daily flow of >9100 L, a Professional must supervise the maintenance. Often landowners set up a maintenance contract with the Authorized person, particularly for Type 3 systems.

3. **Avoiding the disposal of harmful materials in wastewater.** The following list includes items that are generally recommended **NEVER** to be disposed of in septic tanks:
   - Grease, fats, oils.
   - Household cleaning or other strong chemicals, such as Lysol, Pine Sol, Tidy Bowl, Drano and Murphy's Oil.
   - Paints, solvents, automobile fluids.
   - Pesticides, herbicides, or any toxins.
   - Chemical or biological septic tank additives.
   - Non-biodegradable items such as cigarette butts, disposable diapers, baby wipes, toilet cleaning wipes, feminine hygiene products, condoms, hair, coffee grounds, rags, paper towels, bandaids and other bandages.
   - Home brewery waste.
   - Antibacterial soaps (avoid as much as possible) and wipes.

- Strong medicines (especially antibiotics).
- Fabric softener liquids in the wash.
- Supposedly septic safe towels and rags.

Other common ways to control wastewater and protect your valuable septic system:

- Spread out laundry loads so as not to overwhelm the system. Remember high water levels in the field can drown the bacteria.
- Limit the use of bleach by using small quantities infrequently to allow recovery.

4. **Pumping** to empty the septic tank at regular intervals. Sludge normally builds up on the bottom and gradually fills the tank. Pumping is recommended if the total depth of the sludge/solids at the bottom of the tank, exceeds more than 1/3 of the tank's working depth. Generally, pumping every 3-5 years is recommended, but the maintenance plan filed by the Authorized person will indicate the best schedule recommended for the particular sewage system.

5.2 Sewage System Warnings

Some very important warnings were noted on the Pacific Group Developments' website:

Warning! Make sure the power supply is turned off at the circuit breaker and unplug all power chords before handling the pump or floats of a sewage system.

Warning! Do not enter the septic tank or pump chamber. The gases contained inside are poisonous and the lack of oxygen can be **rapidly fatal**.

Alarm ON: If the sewage system has an alarm and either the light or sound is noticed:

- Use water sparingly.
- The reset button will silence the alarm.
- Go through the specific alarm checklist for your system (problems could include overloaded circuit breaker due to using other devices on the dedicated septic line; tangling or debris on floats in the alarm chamber).
- Call your Authorized person for assistance if unable to resolve the problem.

5.3 Signs the Sewage System is Failing

Septic System Needs Examination If

- An unusual green, spongy grass layer develops over the septic field.
- Toilets, showers and sinks back up, are slow to drain, or produce a gurgling sound.
- Sewage material surfaces in the yard or nearby ditch.
- Sewage smells occur, especially after the rain.
- A high sludge layer is apparent in the septic tank, e.g. over the baffles (junction device between the chambers).

If these signs develop, examination by an Authorized person is recommended.

6 Sewage System Costs, Regulation and Guides

6.1 Sewage System Costs

Every sewage system provider contacted, stated that the cost is completely dependent on the conditions at the particular site. Providers are generally very reluctant to quote any figures. Costs quoted for other areas of the country have to be considered in the context of available labour and materials. Also, the need to ferry over materials to Denman may add to the relative costs of different systems. For example, where properties are situated near commercial sand pits on Vancouver Island, sand filters in beds or mounds may be quite inexpensive.

One quote for the potential price range of sewage systems for single family homes with non-problematc Denman properties was:

Type 1 system	$8500 - $12,000
Type 2 system	$14,000 to $23,000,
Type 3 system	$22,000 to $30,000.

Canadian Sewage Solutions notes a cost of $1000-3000 for site assessment and design.
http://www.sewagesolutions.com/site-assessment2.htm
Landowner labour, directed by the Authorized person, can reduce the cost to some extent, although much of the overall cost is materials.

6.2 Sewage System Regulation Details - BC

Two documents are important with regard to sewage system regulation and construction in BC. These documents undergo revision and amendments are added as considered necessary. The regulation of the construction and maintenance of domestic household sewage systems is dictated by the BC Public Health Act under the "Sewerage System Regulation" (SSR) (British Columbia Government 2005). The actual design and construction of sewage systems are prescribed by the BC Sewerage Systems Standard Practices Manual (SPM), currently undergoing revision (British Columbia Onsite Sewage Association 2007).

The SSR lays out the BC government's sewage system definitions, rules and processes for designing, installing and using a septic system. Amendments have already been included and will continue to be added to this document. Thus, notes concerning regulatory information need to be continually updated. The latest amendments as of January 2014 were added in 2010 (British Columbia Government 2010).

Fortunately, for those practical landowners who wish to save some of the costs involved in this process, one of the 2010 amendments made it possible for homeowners to participate in the installation of sewage systems on their own property, under the supervision of a Registered Onsite Wastewater Practitioner (ROWP) or a professional as regulated by the BC Sewerage system Regulations. Qualified ROWPs are listed by the Applied Science Technologists and Technicians of BC http://owrp.asttbc.org/c/finder.php. The ROWPs or professionals still assume responsibility for the system, must oversee the process and certify the completed system.

Thus, under the supervision of an Authorized person (ROWP or qualified Professional), landowners may construct and maintain, on their own land, a sewage system that uses a Type 1 or Type 2 treatment method. Treatment methods are described in the definitions; for example, a Type 1 is a simple system with a septic tank and discharge/septic field. Supervision of a professional is required to construct or maintain a Type 3 system, or for systems with an estimated minimum domestic sewage flow of more than 9100 litres/day. Professionals providing this service are listed by the Professional Engineers and Geoscientists of BC https://www.apeg.bc.ca/Member-Directories/Professionals-for-Sewerage-System-Regulation.

Another of the 2010 amendments stipulates, the set back distance for sewage systems built as of 2010, including septic tanks, from a domestic water well must be 30m, unless a reduction is authorized by a qualified professional. In addition, a holding tank (watertight tank for holding domestic sewage) must be no less than 15m from a well.

Most domestic household sewage systems are covered under these BC Sewerage System Regulations which apply to holding tanks for sewage effluent or onsite sewerage systems that:

- Serve single-family systems or duplexes.
- Process a total sewage flow of less than 22,700 litres per day, whether as a single sewage system or combination of sewage systems on a single parcel, or strata lots or on a shared interest.

All other domestic sewage discharges are covered by the Municipal Wastewater Regulation http://www.env.gov.bc.ca/epd/mun-waste/regs/mwr/.

In order to install a septic system, the regulations require either an ROWP or a qualified professional (see definitions) to file initial information prior to the system's construction and then this filed information is valid for up to two years pending construction. Within 30 days of the completion of the septic system, the ROWP or professional must submit a certification letter to the health authority, in Denman's case, "Island Health" http://www.viha.ca/. All plans and specifications must be consistent with the SPM.

Landowners are required to ensure that their septic systems are maintained in accordance with the maintainance plan written and provided to the landowners by the Authorized persons certifying the system. Owners are also required to keep records of this maintenance. Enforcement of these regulations is by the Health Officer and offences, such as un-supervised construction, health hazards and failure of maintenance, are stipulated in the regulations. A useful maintenance fact sheet can be found at http://www.healthlinkbc.ca/healthfiles/pdf/hfile21.pdf and also, maintenance tips are included in Section 5.

The responsibility resides with the owners of land parcels, where a structure is constructed or located, to ensure that all domestic sewage originating from the structure:

- is discharged into a sewerage system that is constructed & maintained as stated in the plans attached to the certification letter.
- does not cause a health hazard.

A flow chart of the regulatory process has been copied in Appendix 3.

6.3 Useful, Easy References Explaining Sewage Systems Available OnLine

Alberta Department of Agriculture**:** Environmental Manual for Alberta Farmsteads Chapter 9: Household Wastewater Management
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11162/$file/Chapter9.pdf?OpenElement

InspectAPedia Free Encyclopedia of Building & Environmental Inspection, Testing, Diagnosis, Repair http://inspectapedia.com/septic/Septic_Systems.htm

Pacific Group Developments Website http://www.pacificgroupdevelopments.com/ Also see Appendix 6.

United States Environmental Protection Agency website:
http://water.epa.gov/infrastructure/septic/index.cfm
Including SepticSmart http://water.epa.gov/infrastructure/septic/septicsmart.cfm

Yukon Health and Social Services. 2010. Design Specification for Sewage Disposal systems. A guide to their design and maintenance. Available at:
http://www.hss.gov.yk.ca/pdf/septic_guide.pdf. Accessed January 2014.

7 Water Conservation Considerations

BC has among the highest per-capita water consumption in the world! The estimated average daily per-person-use of municipal water in BC in 2004 was 426 litres (BC Ministry of Environment 2007). The average daily use for all Canada is 343 L, while in France the amount is 150 L. (Cyganiak 2011). While large quantities of water are 'used', the actual per-person drinking-water consumption is considered by Health Canada to be only 1.5 L per day, including the water in drinks such as juices, tea or coffee (In: BC Government 2008). The Canadian Mortgage and Housing Corporation noted that only approximately 3% of municipal water provides for potable water uses (CMHC 2013).

Gulf Island residents often face restricted water supplies in the summer months. Today, low flush toilets (<4.8 l in BC) are required in new construction and low-water use washing machines and other water-saving devices are available. In addition to these helpful steps, further water conservation strategies are being explored. The 2008 BC Government's Water Plan, "Living water smart" states

> "Household purple pipes are a second set of plumbing that captures rainwater and recycles leftover water from the dishes, washing and showers. This 'extra' water can be used for flushing toilets and watering gardens, this means we can save the best water for drinking and take less from the environment." "By 2010, government will mandate purple pipes in new construction for water collection and reuse." (BC Government 2008).

The two issues, which are coming under increasing scrutiny with regard to both efficiency and safety, are greywater reuse and rainwater collection. These topics were included in this sewage system report as both rain and greywater can contribute to wastewater management. These sources could provide household water either as a treated potable supply or as non-potable water for toilet flushing. In addition, removing the greywater from the initial wastewater stream, reduces the overall demands on the sewage treatment and disposal system.

7.1 Greywater Reuse

7.1.1 What is Greywater?

Greywater is water that has already been "lightly-used" and is the untreated-water from sinks, washing machines and showers/baths. In some cases, kitchen sink or dishwasher water is excluded from greywater collection, as these sources tend to yield the most contaminated water. In Canada, greywater currently is being collected and re-used in some large projects particularly for flushing toilets or for irrigation, as discussed below. The advantages of greywater re-use over rainwater harvesting include the constant and predictable supply, which also results in reduced storage requirements and lowered costs.

7.1.2 Greywater Regulation in Canada

In Canada, two perceived barriers to the initial adoption of reclaimed-water strategies were the lack of plumbing standards for non-potable water systems and the lack of national standards for the quality of this water. The Standards Council of Canada now has draft standards for residential or light commercial non-potable water reuse systems: CSA B128.3 (Standards Council of Canada 2012). In these standards, greywater does not include kitchen wastewater. The standards cover greywater volumes of less than 10,000L/day that is treated and then used for toilets or subsurface-irrigation. In developing the standards, Health Canada examined the management and safety issues involved in re-using domestic wastewater not including that from toilets, urinals or kitchen sinks (Health Canada 2010).

The standards cover the necessary components of packaged commercial non-potable water reuse systems but they are not intended for custom-engineered systems. Custom systems need to be referred to the "authority having jurisdiction". The standards include a protocol for testing the systems over a 46 week period and evaluating the product. The methods to test the performance of systems and the overall minimum requirements are set out in a document that can be purchased from the Council for $140.00.

BC was the first province to begin addressing "reclaimed water" regulation under the Municipal Wastewater Regulation (British Columbia Government 2012). Revision and amendments of the regulation are in progress. The first stage focused on reclaimed water and registration requirements. The National Plumbing Code and the BC Provincial Plumbing Code both have approved systems for non-potable water use for flush toilets and subsurface irrigation.

To date, no greywater treatment technology has been tested under the new CSA standards and thus, as yet, there is no certified greywater system in Canada. (personal communication C. Soroczan, Central Mortgage and Housing Corporation, CMHC, Jan. 2014). In BC, a system can be installed under the supervision of an Authorized Professional.

7.1.3 Re-Using Greywater - Concerns

Greywater, due to the added household biological and chemical components, may have unpleasant odours, chemical contaminants or health hazards. In individual homes, the constituents in greywater and the possibility for contamination will depend on what is flushed down sinks or used in laundry by the landowner or water-user. Thus caring about what goes down the sink at all times, can make a difference. To avoid unpleasant or hazardous water problems, greywater should be treated immediately upon collection, prior to storage or re-use. The Health Canada guidelines for domestic reclaimed wastewater, not including water from toilets or kitchen sinks, provide a detailed overview of the specific hazards and the related degree of risk of exposure to greywater (Health Canada. 2010). Exposure hazards are anticipated to be principally microbial as chemical hazards are expected to be minimal. The Health Canada Guidelines for reclaimed wastewater also outline the water quality parameters to use in evaluating greywater and possible treatment processes.

In addition to health concerns, re-claimed water must be kept separate from potable water. Thus, greywater systems also require additional separate and specially marked plumbing. Also, re-pressurization is needed to move the greywater through treatment to the site of re-use. Overflow systems are used to direct excess greywater from storage systems to the black water /septic system.

Greywater for irrigation, especially if untreated, also has to be used with care. As noted by Greywater Action (2014), speaking for California locations and not the acid Denman soils:

> "Greywater isn't too salty for the vast majority of plants if you switch from powdered laundry products to liquids. Powdered laundry products are full of salts; they rely on salt's negative ions to loosen debris from fabrics, whereas liquids rely on enzymes to loosen debris. It doesn't really matter which liquid you switch to, as any are better than every powder. For acid-loving plants (that probably should be grown in the tropics and not the arid West), you will either need to add gypsum to the soil or "liquid gypsum" to the greywater itself."

They recommend that greywater only be discharge onto mulch as greywater can clog the soil, also that a space should be left between the pipe and the resting surface, and that the pooling of greywater should be avoided. The California code states that discharges should be 2 inches under the mulch. Additional information is available on the Greywater Action website (Greywater Action California 2014).

7.1.4 Greywater Treatment

Treatment systems formally used at large wastewater facilities have been adapted, and technologies have advanced, so that sophisticated treatment systems are available for smaller on-site uses. Simple, septic tank/primary treatment is not considered sufficient for reclaimed greywater. Additional treatment elements include biologic processes either aerobic or anaerobic, filtration, nutrient-removal (phosphorus and nitrogen) and sterilization, followed by monitoring of the effluent.

Greywater Treatment System Elements

- settling tank and large mesh screen filter
- multi-media filter / biofilter / sand filter systems
- suspended growth biological activated sludge / chemical precipitates or adsorption filters
- sterilization (chlorination with chlorine, calcium hypochlorite, chloramines); ultraviolet light – requires direct exposure and has no residual effect), ozonation.

A number of companies offer treatment systems for greywater or rainwater and have websites with further information:

Water Tiger Purification Systems Inc. Victoria http://www.watertiger.net/
#186-5489 Byrne Rd, Burnaby, BC V5J 3J1 (604) 630-1114
524 William St, Victoria, BC V9A 3Y9 (250) 412-1110
#212-2459 Cousins Ave, Courtenay, BC V9N 3N6 (250) 331-0888

Water Harvesting Solutions WAHASO http://wahaso.com/ 304 South Lincoln St., Suite 100 Hinsdale, IL 60521 Call Toll Free: 800-580-5350, has a detailed website with many services for water treatment for both greywater and rainwater.

ReWater Systems http://rewater.com/ California.

7.1.5 Greywater Reuse Examples

Greywater (not including kitchen wastewater) is approved for various irrigation uses in some jurisdictions, despite only being considered for subsurface irrigation in BC (unless the system is set up by an Authorized Professional). For example, in Arizona, residential use of greywater, on the same private premises, is possible for irrigation using flood or drip systems, although it must be less than 400 gallons per day. There is no formal notification system and residents are asked to adhere to specific best management practices (Arizona Department of Environmental Quality 2011). Arizona is now examining the re-use of greywater from kitchen sinks.

In California, greywater regulations cover wastewater not from toilets, kitchen sinks or dishwashers. The new code for non-potable water reuse systems, adopted in 2009, made the management of greywater for use in non-spray irrigation possible and less regulated. (California Building Standards Commission 2010).

Montana has the same definition as California for greywater and in 2011 began a tax benefit program for water reuse systems in new residential structures. Greywater systems in new homes there cost between $2500-5000. The University of Montana recommended the development of guidelines for the inclusion of kitchen water in greywater (Pedersen Woelfe-Erskine and Hill-Hart1 2007).

Quayside Village Co-Housing Ltd. Vancouver https://sites.google.com/site/quaysidevillage/home Quayside is a 20 unit co-housing apartment building in Vancouver with a renovated greywater system that recycles water for toilet flushing. The CMHC financed this demonstration wastewater project. The project uses the wastewater from all sources except toilets for re-use in toilets only. Double-plumbing was necessary and the system involves a settling tank. filtration tank, biofilter, pre-ozonation, multistage sand filtration and ozonation.

Blue Built Homes – Guelph Ontario http://guelph.ca/living/environment/water/water-conservation/greywater-reuse-system/ These homes have a greywater re-use system for water from baths/showers to be used for toilet flushing. The system uses filtration and chlorination. Another example of greywater reuse is **Station Pointe Greens**, Edmonton. http://stationpointegreens.ca/. The company Communitas http://www.communitas.ca is responsible for this project.

7.1.6 Conclusions about Greywater Reuse on Denman

In terms of currently regulated systems, high up-front costs are involved in safely treating greywater and also in providing the added plumbing system requirements to separately re-circulate the treated water. Thus, regulated greywater re-use systems are not likely to be widely used for rural homes at this time. But they are possible for those committed individuals.

Additional issues exist for those favouring the use of composting toilets and having all wastewater as greywater. The presence of kitchen sink effluent in the greywater requires further consideration for the necessary treatment. Although, this need is recognized in some of the current on-site treatment systems, it is not included in the existing standards for greywater.

In general, more interest exists in rural areas for the reuse of greywater for irrigation purposes and this is a current focus for governments and for technical development. Citizen groups are pushing for changes. Greywater Action in California http://greywateraction.org/greywater-recycling is dedicated to community greywater education with the philosophy that greywater reuse is part of sustainable backyard ecosystems, food-producing gardens, clean water and wildlife habitat. Greywater Action is committed to encouraging the development and use of simple residential greywater systems for irrigation. These systems rely on individual household water users to conscientiously steward what goes into the household water and to choose products to ensure that toxic contaminants are kept out of water used in their homes. Overall, as the potable water crisis increases, the future is likely to see public advances in knowledge and methods to make greywater use both safe and practical.

7.2 Rainwater Collection

Rainwater harvesting is simply collecting runoff from roofs and storing it for future use and this is widely used around the world. The central features of rainwater systems are:

- Catchment area – site where the rain falls *e.g.* roof
- Conveyance system – mechanism to catch, collect and direct the runoff from the catchment area *e.g.*. eaves trough
- Storage system – site to store the water for future use *e.g.* tank or cistern.
- Distribution system – mechanism to move the water from the storage site to the desired site(s) of use. Any direct rainwater plumbing must be separate from the potable water system.

Rainwater can be used either year-round or seasonally for indoor functions *e.g.* toilet flushing or for outdoor uses e.g. irrigation. The BC Centre for Disease Control points out the potential hazards of un-filtered, untreated rainwater where there is the potential for inhalation or ingestion (Struck S. 2011).

Regulatory requirements for the approval of homeowner-potable uses of rainwater are not in place at this time. The Nanaimo Regional District Rainwater Guide notes:

> "The Vancouver Island Health Authority (VIHA) does not set requirements for private, residential potable water systems that supply water to a single family dwelling. In such cases, the responsibility to ensure safe water quality rests with the system owner, and (to a lesser extent) with those who assist in the selection, installation, and maintenance of the system. By contrast, any system that supplies potable water to the public, or to more than one single connection or household, is considered by VIHA to be a Water Supply System and is subject to the provisions of the Drinking Water Protection Act and Drinking Water Protection Regulation. Some residential buildings such as duplexes, secondary suites single family homes occupied by tenants or Bed & Breakfast accommodations may fall into this category."

Certainly the treatment of rainwater would be necessary, including filtration and disinfection, if the water was going to be used for potable applications such as drinking, cooking, hand washing or bathing. Non-potable uses, such as drip-irrigation, may also benefit from filtration. Also, while "raw, screened rainwater may be used for irrigation, water closets, urinals, laundry, outdoor cleaning and water features" (Stubbs 2006), all rainwater entering a residence must have its own non-potable water distribution system installed and maintained in accordance with the applicable Code requirements.

There are many publications about rainwater collection; the following three sources provide comprehensive information for homeowners:

Islands Trust Fund

- (Author: D. Stubbs) Rainwater Harvesting on the Gulf Islands Guide for Regulating the Installation of Rainwater Harvesting Systems – Potable and Non-potable Uses, 2006.
- Rainwater Harvesting on the Gulf Islands - Frequently Asked Questions, 2005.
- Owner's Manual: Rainwater Harvesting and Water Supply System, 2006, that details the system in the Ruby Alton House.

Nanaimo Regional District

- Rainwater Harvesting Best Practices Guidebook, 2012.

CMHC

- Collecting and Using Rainwater at Home: A Guide for Homeowners, 2013.
- *Introductory guide*: Collecting and using rainwater at home, 2013.
- *Developing policy report* Guidelines for Residential Rainwater Harvesting Systems Handbook, 2012.

The 2013 CMHC report on collecting rainwater includes cost estimates for various parts of the system. As an example, for a three-person household in Guelph collecting rainwater for toilet flushing and outdoor uses, the estimated cost was approximately $8000. Another CMHC publication mentions that rainwater collection systems could cost between $6000-14000 for a single family home (CMHC 2013). The Islands Trust Fund's 2005 information noted that a complex rainwater collection system to provide potable water for a four-person household could cost as much as $35,000 (Islands Trust Fund 2005) and the Islands Trust Fund's demonstration site is described in section 7.2.2.

7.2.1 Rainwater Collection Regulation in Canada

Currently the regulation of rainwater collection systems is covered under construction criteria, as all parts are required to conform to code. Thus, the plumbing, electrical and building codes are involved. While harvested rainwater may "be used for any purpose within a single family residence" (Stubbs 2006), the National Plumbing Code of Canada limits the use of non-potable water to toilet and urinal flushing and for irrigation (CMHC 2013). The BC plumbing code also permits rainwater collection systems for the same uses. As mentioned, potable and non-potable water systems must not be inter-connected.

7.2.2 Rainwater Collection Examples

Ruby Alton Nature Reserve, Salt Spring Island "In 2005, the Islands Trust Fund (ITF) installed a rainwater harvesting system for the home at the Ruby Alton Nature Reserve to address a water shortage on the property. The system compliments the nearby stream supply, able to hold over 60% of the annual water needs for a four person household that practices water conservation". The owner's manual for this system gives a very detailed overview of the system components and maintenance involved (Islands Trust Fund 2006). This system, including the additional expenses involved in educational display components, cost upwards of $50,000 (personal communication, J. Eliason, ITF).

Of note, during 2013, the Nanaimo Regional District began an incentive program for rainwater collection (Nanaimo Regional District 2014).

With respect to large scale developments using rainwater collection, there are many examples, including the following in Canada: Regent Park Revitalization Toronto Community Housing http://www.torontohousing.ca/investing_buildings/regent_park and Station Pointe Greens, Edmonton http://stationpointegreens.ca/.

On Denman and Hornby, there are also many landowners taking advantage of rainwater collection for irrigation. The least complex system is in use by the elder housing complex on Hornby Island where rainwater is collected into rain-barrels for use in gardens. Other private residences have more elaborate conveyance systems with piping from all eaves-troughing and first flush diverters to remove the initial debris as rainwater begins to flow. This piping usually connects to one of more large plastic tanks that may have additional filters, and the rainwater collected may be pumped to fill additional tanks. Flows from tanks may be used by gravity dispersal to gardens or may be pumped to gardens. Some private landowners have complete systems for the potable use of rainwater in a similar manner as the Ruby Alton House, described above.

7.2.3 Conclusions Rainwater Collection

Allowing for the costs involved for tanks and distribution systems, rainwater collection can be both feasible and practical for irrigation purposes for most residences. The cost is much greater for domestic water use in the house, whether for potable water, requiring a purification system, or for a non-potable system, perhaps for toilet flushing, requiring separate plumbing and pumping. So rainwater use is likely to be based on a cost benefit analysis of available water supplies and will become increasingly attractive as the necessity for water conservation intensifies.

8 Project Suggestions

NOTE: The goal of the Denman Community Land Trust Association (DCLTA) wastewater management project was 'to make recommendations on viable, approvable waste management systems' appropriate for the DCLTA's current affordable housing projects. Under the BC

Sewerage System Regulation, making recommendations about the choice and construction of a particular sewage system is the role of an Authorized sewage system person, see Section 2. In addition, the process of selecting an appropriate sewage system is complex, involving a technical site assessment and an analysis of the landowner's requirements.

Consequently, the goal of this report is to provide the necessary background information to assist landowners in making informed choices about purchasing a sewage system. The following suggestions for the DCLTA projects are derived from this background information.

1. The Decision Tree, at the beginning of this document, outlines the steps involved in acquiring a domestic sewage system and could be used as an action/decision template by the DCLTA board. The process requires landowners to set the priorities for their property in terms of the size of residences, the use of the rest of the property and their waste management objectives. As well, they need to consider all possible financial resources, review available Authorized persons and make an initial assessment of the site's possible constraints and opportunities.

2. A Contracting Process for a Sewage System could consist of two-stages.

- Stage 1 - the design of the system by an Authorized person, contracted by the DCLTA board. The system would be designed to meet the goals, price, site conditions and site constraints of the projects.
- Stage 2 - a bid process for the construction/installation of the system. The proviso for possible 'landowner labour' would be part of the criteria. The bids would have to include an Authorized person. Choice of the best bid would be based on a list of pre-determined factors, *e.g.* price, quality of components, Authorized person's understanding of the design-requirements, and the installer's ability to work on site, cope with any possible local requirements, complete within a suitable time-schedule, and integrate volunteer labour.

3. Points to Consider in Choosing Sewage System Type or Components

- Choose options/components that are the least complicated.
- Consider what labour and materials are available for installation to save on cost, as officially the landowner is allowed to assist with the installation under supervision of the Authorized person.
- While considering the most economical system, ask the Authorized person to include an investigation of the cost trade offs with various types/components of systems. For advantageous options with a modest extra cost, consider the possibility of fund-raising for a demonstration site.
- Consider placement of the sewage system in forested areas. For a realistic consideration of this, consult the opinion of an Authorized person with actual experience and examples of constructing similar projects.
- Consider other sewage system components:
    - Risers and septic tank outflow filters are advisable, thus, landowners should check to see if they have been included.
    - Inspection/flushing ports on the lateral pipes of the septic field's distribution system are also important.
    - Rainwater/greywater treatment and supply companies may have practical lower-tech solutions to add if technical sewage treatment systems are chosen, *e.g.* including a hand pump (where there's an electric pump) on the system for power outages or manual use. So contacting them and /or reviewing their supply lists in concert with the chosen sewage system plans is advised.
    - A drainage tile perimeter is useful around cleared-field septic fields that might have surface or shallow subsurface ground water flows, particularly on the side bordering the direction of the flow. The added drainage protects the function and extends the life of

septic fields. Much of Denman has extensive water runoff-flows in winter-wet weather, particularly with all the recent clearing and ditching.

- Marking and/or planting on cleared-field septic field sites with suitable shallow-rooting plants either native or attractive domestics e.g. Rhododendrons, could be considered, both to delineate the septic field area and protect the site from other uses. *Local biologists and gardeners could compile an appropriate list!*

4. Maintenance

- Consider including a provision for someone living on the affordable housing site to hold a specific contract for the maintenance of the water/sewage system, following the maintenance plan and under the guidance of the Authorized person responsible for the system.
- As part of the Authorized person's management plan, consider hosting an annual sewage system inspection for each property separately or jointly for all DCLTA properties. These could include a group discussion, with or without the Authorized person, and a concluding report summarizing the functioning of the system(s). This inspection would preferably involve as many residents as possible in observing the inspection process, as well as in receiving the report. In the past, a similar event, called a "Septic Social", was a regular feature in the Comox Valley. The Denman Conservancy Association hosted a Septic Social during their Stewardship Program. Also, as part of the Authorized person's management plan, include a regular septic tank pump out schedule, dependent on the annual inspection's conclusions regarding the functioning of the system.
- Consider having an artist competition to make an attractive framed poster/picture detailing what not to put in sewage system for use in Affordable Housing Units (copies also could be sold).

5. Rainwater/greywater

The use of both rainwater and greywater, inside homes provided to the public, raises possible health concerns and the need for due-diligence with regard to potential contaminants. To supply potable water from these sources, costly treatment and testing is required. Additional costs are also involved for non-potable uses, such as toilet-flushing. Separate plumbing and pumping systems are needed to distribute the water to toilets. Also, additional treatment has been suggested if rainwater is stored and then re-used in the home, and the CSA has set standards for the treatment and re-use of grey-water for toilet flushing.

- Consider setting up rainwater collection systems for irrigation purposes and if funding allowed include installing separate plumbing for the possible use of rainwater for toilet flushing. If additional funds were available, setting up a complete potable treatment of rainwater would be an admirable step for future water conservation needs.
- Greywater use inside houses in rural public-housing situations is also not practical from a cost-perspective for 'affordable housing', at this time. Greywater for irrigation is also covered under the CSA standards, which may provide a disincentive in public-housing situations. If greywater irrigation systems are considered, the practice could follow guidelines offered under other jurisdictions such as California or Arizona. Water conservation initiatives are continually evolving and additional possibilities may arise in the near future.

9 Bibliography

***Note**: The websites listed in this bibliography were accessed in January and February 2014.*

General Information

Alberta Ministry of Agriculture. Household Wastewater Management. In: Environmental Manual for Alberta Farmsteads Chapter 9. Available at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11162/$file/Chapter9.pdf?OpenElement *Note : "This chapter discusses beneficial management practices that address household*

wastewater management through proper installation and maintenance of a private sewage system on a farmstead."
Alberta Government. 2005. Factsheet. Alternative Solutions Guide for Reclaimed Water Reuse. Available at: http://www.municipalaffairs.alberta.ca/documents/ss/STANDATA/plumbing/FactSheet-AlternativeSolutionsGuideforReclaimedWaterReuse.pdf
American Rainwater Catchment Association. website Available at: http://www.arcsa.org/
Arizona Department of Environmental Quality. 2011. Using gray water at home. Available at: http://www.azdeq.gov/environ/water/permits/download/graybro.pdf.
British Columbia Government HealthLink BC. 2013. Maintenance and operation of sewage disposal systems. Available at: http://www.healthlinkbc.ca/healthfiles/pdf/hfile21.pdf.
British Columbia Government. 2005. Public Health Act: Sewerage System Regulation. (includes amendments of 2010). Available at: http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/22_326_2004.
British Columbia Government. 2010. Sewerage system regulation amendments. Available at: http://www.health.gov.bc.ca/protect/pdf/Sewerage-System-Regulation-Amendments-OIC476.pdf.
British Columbia Government. 2008. Living water smart. British Columbia's water plan. Available at: http://www.livingwatersmart.ca/docs/livingwatersmart_book.pdf Did You Know? Available at: http://livingwatersmart.ca/didyouknow.html
British Columbia Government. 2012. Environmental Management Act: Municipal Wastewater Regulation. Available at: http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/87_2012.
British Columbia Government. How to find a septic tank. Available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/septic_tank.pdf.
British Columbia Ministry of Environment. 2007. Environmental Trends in British Columbia: 2007, Fresh Water. Available at: http://www.env.gov.bc.ca/soe/archive/reports/et07/EnvironmentalTrendsBC_2007_fullreport.pdf
British Columbia Ministry of Environment. 2013. Daily water use per person in British Columbia. Available at: http://www.env.gov.bc.ca/soe/indicators/water/water_use_percapita.html
British Columbia Ministry of Environment. 2013. Water quality Onsite sewage systems. Available at: http://www.env.gov.bc.ca/wat/wq/nps/NPS_Pollution/Onsite_Sewage_Systems2/Onsite_Main.htm#onsite.
British Columbia Ministry of Health. Authorized Persons under the Sewerage System Regulation. Available at: http://www.health.gov.bc.ca/protect/reg-pract-pro-persons.pdf.
British Columbia Onsite Sewage Association. 2007. Sewerage systems standard practices manual. Available at: http://www.health.gov.bc.ca/protect/lup_standards.html.
California Building Standards Commission. 2010. Chapter 16A Nonpotable water reuse systems. California plumbing code. Available at: http://www.hcd.ca.gov/codes/shl/2007CPC_Graywater_Complete_2-2-10.pdf.
Canadian Standards Association. 2012. Installation code for decentralized wastewater systems. Available at: www.techstreet.com/products/preview/1830301. .
Capital Regional District. The problems with medications and your septic system. Victoria, BC. Available at: https://www.crd.bc.ca/service/sewers-wastewater-septic/septic-systems/local-sewer-services
Capital Regional District. Water conservation and your septic tank. Victoria, BC. Available at: https://www.crd.bc.ca/docs/default-source/septic-pdf/septic-savvy/water-conservation.pdf
Capital Regional District. 2011. Septic Savy. Victoria, BC. Available at: https://www.crd.bc.ca/docs/default-source/septic-pdf/septic-savvy/septicsavvybrochure-jan-2011.pdf
Capital Regional District. 2014. Septic Systems website. Available at: https://www.crd.bc.ca/service/sewers-wastewater-septic/septic-systems
CMHC 2013. Equilibrium communities insight: Potable water use and wastewater reduction. Available at: http://www.cmhc-schl.gc.ca/odpub/pdf/67902.pdf?fr=1385999476883.
CMHC. 2003. Buying a house with a well and septic system. Available at: https://www.crd.bc.ca/docs/default-source/septic-pdf/buyingahousewithawellandsepticsystem.pdf
CMHC. 2010. About your house: Buying a water-efficient toilet http://www.cmhc-schl.gc.ca/en/co/grho/grho_006.cfm *CMHC Green building documents can be obtained in pdf format from the CMHC documents web page*: https://www03.cmhc-schl.gc.ca/catalog/productDetail.cfm?cat=183&itm=9&lang=en&fr=1390763925296

CMHC. 2012. Guidelines for residential rainwater harvesting systems handbook. Available at: https://www03.cmhc-schl.gc.ca/catalog/productDetail.cfm?lang=en&cat=7&itm=189&sere=2&start=1&stfl=rainwater&fr=1392266545446
CMHC. 2013. About your house: Collecting and using rainwater at home. Available at: https://www03.cmhc-schl.gc.ca/catalog/productDetail.cfm?lang=en&cat=29&itm=19&fr=1390946656578
CMHC. 2013. Collecting and Using Rainwater at Home: A Guide for Homeowners. Available at: https://www03.cmhc-schl.gc.ca/catalog/productDetail.cfm?lang=en&cat=181&itm=30&fr=1390947996742
CMHC. 2009. Sloping Sand Filters for On-Site Wastewater Treatment. Available at: https://www03.cmhc-schl.gc.ca/catalog/productDetail.cfm?cat=151&itm=25&lang=en&fr=1392345745639
Converse, J.C. 2000. Pressure distribution network design. Available at: http://www.cmhc-schl.gc.ca/odpub/pdf/67902.pdf?fr=1385999476883 http://www.soils.wisc.edu/sswmp/SSWMP_9.14.pdf.
Cyganiak, K. 2011. British Columbia Household Facts About Domestic Home Water Usage. Buy Ric.com website in Vancouver Real estate magazine and directory. Available at: http://www.buyric.com/vancouver/2011/03/british-columbia-household-facts-about-domestic-home-water-usage-004/7616/
Department of Local Government, Australia. 1998. Environment and health protection guidelines: On-site sewage management for single households. Available at: http://www.dlg.nsw.gov.au/DLG/Documents/information/onsite.pdf.
Government of Newfoundland and Labrador. 2005. Guidelines for the Design, Construction and Operation of Water and Sewerage Systems. Available at http://www.env.gov.nl.ca/env/waterres/waste/groundwater/report.html
Greywater Action in California. 2014. Greywater Frequently Asked Questions. Available at: http://greywateraction.org/faqs/greywater-recycling. and Choosing Plants and irrigating with greywater. Available at: http://greywateraction.org/content/choosing-plants-and-irrigating-greywater
Gustafson DM, Anderson JL, Heger SF, Liukkonen BW. 2000. Choosing an alternative septic system for a homesite with thin soil over bedrock. University of Minnesota Extension Service. Available at: http://septic.umn.edu/prod/groups/cfans/@pub/@cfans/@ostp/documents/asset/cfans_asset_125870.pfd.
Health Canada. 2010. Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing Available at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/reclaimed_water-eaux_recyclees/index-eng.php
Islands Trust Fund. 2005. Rainwater harvesting. Frequently asked questions. Available at: http://www.islandstrustfund.bc.ca/media/39063/rainwater_harvesting_faq.pdf.
Islands Trust Fund. 2006. Owner's manual: Rainwater harvesting and water supply system. Available at: http://www.islandstrustfund.bc.ca/media/39069/ranr_harvesting_system_manual.pdf.
Light house Sustainable Building Centre. 2007. BC Green Building Code Background Research Greywater Recycling. Available at: http://www.buttecounty.net/publichealth/environmental/Graywater%20Research.pdf
Nanaimo Regional District. 2012. Rainwater Harvesting Best Practices Guidebook. Available at: http://www.rdn.bc.ca/cms/wpattachments/wpID2430atID5059.pdf.
Nanaimo Regional District. 2014. Rainwater harvesting program. Frequently asked questions. Available at: http://www.rdn.bc.ca/cms.asp?wpID=2500
Ontario Rural Wastewater Centre http://www.orwc.uoguelph.ca/index.html FAQ about Alternative treatment systems http://www.orwc.uoguelph.ca/Resources/FAQ_Alternatives.html &FAQ about Conventional systems http://www.orwc.uoguelph.ca/Resources/FAQ_Conventional.html
Pedersen A, Woelfe-Erskine C, Hill-Hart1 J. 2007. Recommendations for gray water policy Montana In: Greywater action for a sustainable water culture. Available at: http://greywateraction.org/content/policy-recommendations-montana.
Standards Council of Canada. 2012. B128.3-12 Performance of non-potable water reuse systems. Available at: http://www.scc.ca/en/standardsdb/standards/26843.

Struck S. 2011. Rainwater Harvesting for Non-potable Use and Evidence of Risk Posed to Human Health. Report for the British Columbia Centre of Disease Control. Available at: http://ncceh.ca/sites/default/files/BCCDC-Rainwater_Harvesting_Oct_2011.pdf.
Stubbs, D.F. 2006. Rainwater harvesting on the Gulf Islands. Guide for regulating the installation of Rainwater Harvesting Systems – potable and non-potable uses. Report for the Islands Trust Fund. Available at: http://www.islandstrust.bc.ca/poi/pdf/rainwaterharvestinggulfislands.pdf,
United States Environmental Protection Agency. 2004. Onsite wastewater technology testing report. Available at: http://www.waterloo-biofilter.com/downloads/waterloo-biofilter-eti-final-report.pdf.
United States Environmental Protection Agency. 2013. Water: Septic (Onsite / decentralized systems) Available at: http://water.epa.gov/infrastructure/septic/index.cfm
United States Environmental Protection Agency. 2014. SepticSmart Home. Available at: http://water.epa.gov/infrastructure/septic/septicsmart.cfm
United States Environmental Protection Agency. 2005. Handbook for managing onsite and clustered (Decentralized) wastewater treatment systems. Available at: http://water.epa.gov/infrastructure/septic/upload/onsite_handbook.pdf
United States Environmental Protection Agency. 2000. Wastewater technology factsheet Trickling filters. Available at: http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_trickling_filter.pdf
Washington State Department of Health. 2002. Hydraulic loading. Available at: http://www.doh.wa.gov/Portals/1/Documents/Pubs/337-099.pdf.
Water Harvesting Solutions. 2014. Greywater harvesting systems from water harvesting solutions. Available at: http://wahaso.com/greywater_system.php?gclid=CNHP_LyP8rsCFRFufgodoGMA7g
Wikipedia. Sewage treatment. Available at: http://en.wikipedia.org/wiki/Sewage_treatment.
Wikipedia. Wastewater treatment technologies. Available at: http://en.wikipedia.org/wiki/List_of_waste-water_treatment_technologies.
Yukon Health and Social Services**.** 2010. Design Specification for Sewage Disposal systems. A guide to their design and maintenance. Available at: http://www.hss.gov.yk.ca/pdf/septic_guide.pdf. Accessed January 2014.

Sewage Treatment Companies

See section 4.2.4 for Ecological Treatment companies, also section 4.2.2 for Packed Treatment Plants.

Various Packaged Treatment Plants/System Companies

AdvanTex Treatment System http://www.orenco.com/systems/advantex_wastewater_treatment.cfm
814 Airway Avenue Sutherlin, OR 97479 USA T: 800-348-9843 T: 541-459-4449 F: 541-459-2884

Bionest System http://www.bionest-tech.com/MR-en/product/335-336/bionest-system.html
813, Royalwood Place, Victoria (British Columbia) V8Y 3C2 T. 250 813-1310 1 866 538-5662 F. 1 877 538-5707 inquiry-bc@bionest.c

Ecoflo Biofilter http://www.ecoflobiofilter.com/ 1, avenue Premier, Rivière-du-Loup, Québec G5R 6C1 Phone (toll free): 1 800 632-6356 Phone: 418 867-8883 Facsimile: 418 862-6642 pta@premiertech.com

MicroFast Wastewater Treatment Systems http://www.biomicrobics.com/products/ Bio-Microbics, Inc.8450 Cole Parkway, Shawnee, Kansas 66227 – *an activated sludge system*

Waterloo Biofilter http://www.waterloo-biofilter.com/ P.O. Box 400, 143 Dennis St., Rockwood, ON N0B 2K0 Telephone: (519) 856-0757 Fax: (519) 856-0759 Email: info@waterloo-biofilter.com

Additional Companies Supplying Wastewater Services in BC

Brac Systems British Columbia http://bracsystemsbc.ca/support.html *Greywater Recycling Systems*.
BC Distributor: Excel Ventures Inc. 1628 Westlake Road Kelowna, British Columbia V1Z 2X9 Tel: 250-212-9750 Fax: 250-769-4074 E-mail: excel@bracsystems.com

Canadian Sewage Solutions http://www.sewagesolutions.com/contact.htm Sewage systems
250 478-1158 Victoria 250 514-9989 Pender Island.

Canwest http://www.canwest-tanks.com/products.html *Tanks and sewage treatment plants*
11975 Old Yale Road, Surrey, BC Canada V3V 3X4 604-580-3030 Canada Toll Free: 1-888-704-3030 Fax: 604-580-1171

Pacific Group Developments http://www.pacificgroupdevelopments.com/ *Septic Systems*
250-889-0007 contact@pacificgroupdevelopments.com

10 Appendices

Appendix 1 Contributors and Local Sewage System Contacts

This is partial list of companies and contacts involved in sewage, rainwater and greywater systems that could provide assistance to Denman islanders. This is a dynamic and growing industry, and many other sewage management providers exist.

Additional contributors to this report, not directly involved with the industry, were
L. Busheikin – co-housing, J. Eliason – Islands Trust Fund,
R. Keller – green builder, new sewage system, J. Millen – retired engineer, new sewage system,
M. McNamara – architect, Hornby elder housing, B. Penn – new alternative sewage system,
T. Quin – Hornby elder housing, and C. Soroczan – Senior Researcher, CMHC.

AP = Authorized Person.

Bob Burgess Gulf Islands Rainwater Connection Ltd. Thetis Island
250- 246-2155 http://www.rainwaterconnection.com/ *rainwater harvesting*
Box 3-3 Thetis Island, BC V0R 2Y0 PH: (250) CELL: (250) 709-4549

Steve Carballeira H_20 Environmental Ltd. Denman Island Professional AP
250-335-1864 http://www.h2oenvironmental.com/ *Sewage systems Ground water*
3060 Lake Road Denman Is. BC Canada V0R 1T0 F.250.335.1846 email: 2oenv@telus.net

Ed Hoepner Aquarian Systems Hornby Island ROWP AP
250-335-2037 http://www.aquariansystems.ca/about.htm *sewage systems, constructed wetlands*

Steve Isaak Forgotten Island Industries Denman Island
250-335-1853 *rainwater equipment and installation*

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250-335-2685 Email jasbreez@island.net *sewage systems, constructed wetlands*

Garth Millan Jabsite and Wastewater Solutions Hornby Island ROWP AP
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Pacific Group Developments Victoria
250-889-0007 *sewage systems*
http://www.pacificgroupdevelopments.com/services/septic-system-maintenance

Ian Ralston TRAX Developments Ltd. Thetis Island ~Professional AP
250-246-4774 http://www.traxdev.com/ *sewage systems, drip system specialist*
Box 9-6, Thetis Island, British Columbia, V0R 2Y0, Canada.

Vern Wright Jabsite and Wastewater Solutions Denman/Hornby Island ROWP AP
250-335-1887 jabexx@gmail.com *sewage systems*

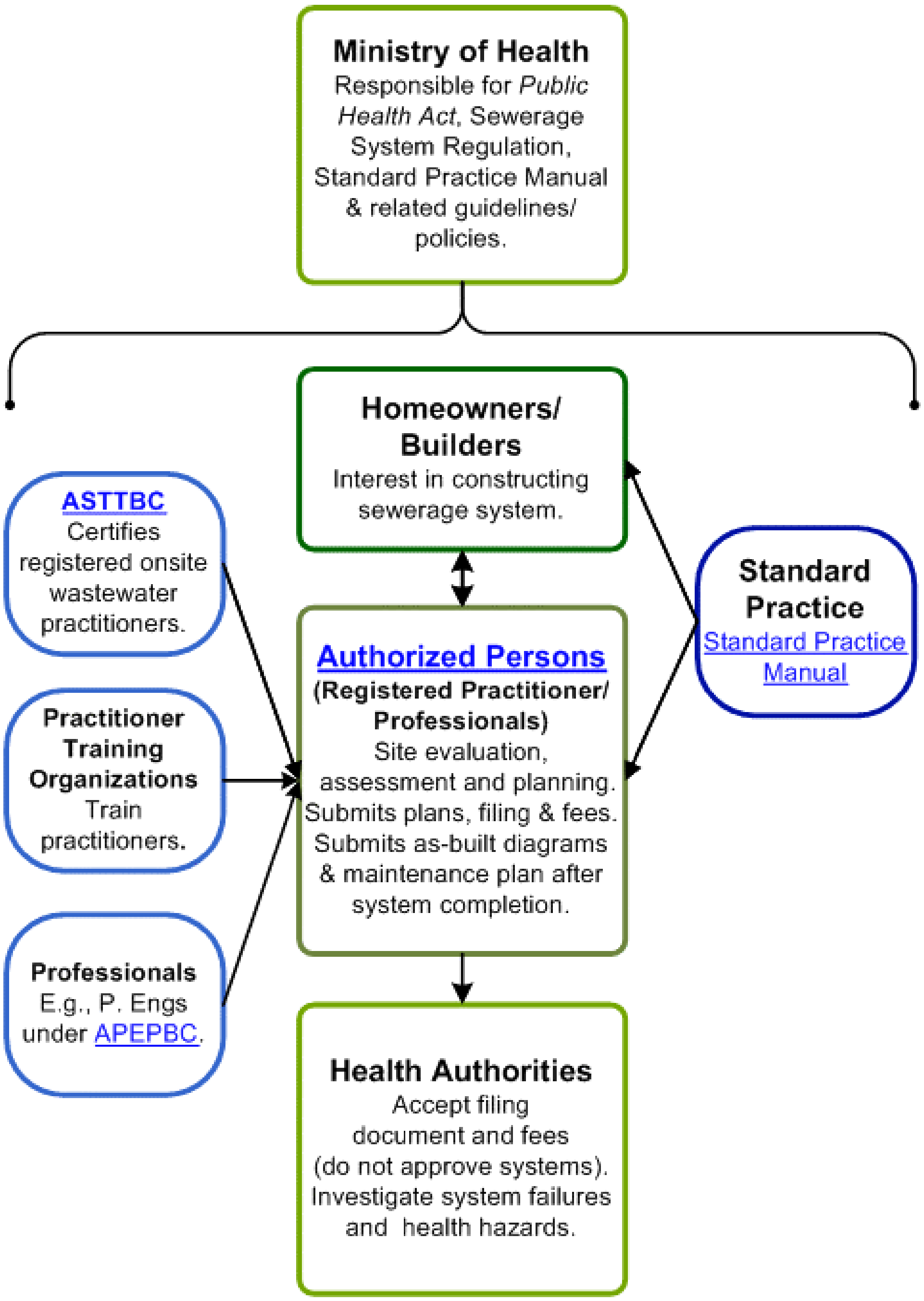
Water Tiger Tiger Purifications Inc. Courtenay
http://www.watertiger.net/ *water purification & rainwater harvesting*
212-2459 Cousins Ave, Courtenay, BC V9N 3N6 (250) 331-0888, #186-5489 Byrne Rd, Burnaby, BC V5J 3J1 (604) 630-1114 & 524 William St, Victoria, BCV9A 3Y9 (250) 412-1110

For additional companies and treatment systems see section 9. Bibliography and WCOWMA also lists suppliers by region: http://www.wcowma-bc.com/locate-a-pro/supplier/

Appendix 2 BC Sewerage System Administration Process

Copied from: http://www.health.gov.bc.ca/protect/lup_regchart.html

British Columbia's Process and Parties Involved in Administering the Sewerage System Regulation and Health Hazards



Appendix 3. Authorized Persons for BC SSR

http://www.health.gov.bc.ca/protect/reg-pract-pro-persons.pdf

Authorized persons

7 (1) A person is qualified to act as a **registered onsite wastewater practitioner** if the person

(a) has successfully completed a postsecondary training program through

(i) an organization recognized by the Applied Science Technologists and Technicians of British Columbia as offering sewerage system training programs that provide an applicant with the qualifications required for registration under the Applied Science Technologists and Technicians Act, or

(ii) an institution that

- is designated, registered or accredited under an enactment of Canada or any province, except British Columbia, to offer postsecondary education, and
- includes, as part of its curriculum, training in soil analysis and sewerage system construction and maintenance, and

(b) holds a registration certificate.

(2) Despite subsection (1), a person who does not meet the educational requirements of that subsection is qualified to act as a registered onsite wastewater practitioner if the person

(a) demonstrates to the Applied Science Technologists and Technicians of British Columbia that the person is competent to construct and maintain a sewerage system that uses a treatment method classified as Type 1 or Type 2, and

(b) holds a registration certificate.

(3) A person is qualified to act as a professional if the person

(a) has, through education or experience, training in soil analysis and sewerage system construction and maintenance, and

(b) is registered as a fully trained and practising member of a professional association that

(i) is statutorily recognized in British Columbia, and

(ii) has, as its mandate, the regulation of persons engaging in matters such as supervision of sewerage system construction and maintenance.

What is the Role of an Authorized Person?

Under section 6(1)(b) of the SSR, an authorized person may construct or maintain a sewerage system, or supervise an owner constructing or maintaining a sewerage system on his/her own land. The authorized person must file with the health authorities before beginning to construct, and provide a letter of certification after completing a sewerage system. The SSR provisions are based on a practitioner reliance model for the proper design, construction and maintenance of sewerage systems.

Registered onsite wastewater practitioners, as per the SSR definition, are required to meet the requirements of section 7(1) or 7(2).

A professional is an individual who meets the two requirements of section 7(3) of the SSR:

1. Section 7(3)(a) specifies the kind of training the individual must have.
2. Section 7(3)(b) establishes the type of professional association to which the individual must belong as a fully trained and practising member.

What Can a Registered Practitioner Do? What Can a Professional Do?

Both registered practitioners and professionals can construct or maintain a Type 1 or Type 2 sewerage system. Only a professional can construct or maintain a Type 3 system. Where a professional acts in a supervisory capacity, the actual work does not need to be carried out by an authorized person. In other words, it is not necessary for a professional to employ registered practitioners to do the work on the system.

Definitions

The SSR defines "construct" and "maintenance" as follows:

" **'construct'** includes

(a) to plan or conduct a site assessment in respect of a sewerage system,
(b) to install, repair or alter a sewerage system, and
(c) in the case of an authorized person, to supervise the doing of any matter listed in paragraphs (a) and (b)

'maintenance,' in the case of an authorized person, includes to supervise the maintenance of a sewerage system"

The Three Types of Sewerage Systems

Type 1: treatment by septic tank only.

Type 2: treatment that produces an effluent consistently containing less than 45 mg/L of total suspended solids and having a five day biochemical oxygen demand of less than 45 mg/l.

Type 3: treatment that produces an effluent consistently containing less than 10 mg/l of total suspended solids and having:

- A five day biochemical oxygen demand of less than 10 mg/L.
- A median fecal coliform density of less than 400 Colony Forming Units per 100 ml.

Appendix 4. Ecological Treatment Descriptions

The following are treatment descriptions by some of the USA ecological treatment companies.

- **Solar Aquatics Systems** http://www.ecological-engineering.com/solaraquatics.html
  Ecological engineering Group
  "series of aerated translucent tanks that host plant communities and aerobic microorganisms. SAS duplicates and optimizes the natural water purification processes of freshwater wetlands. Wastewater is circulated inside a greenhouse through a series of clear tanks, each with its own aquatic ecosystem, and marshes. In this treatment process, sunlight, oxygen, bacteria, algae, plants, snails and fish work together to purify the water. SAS uses aeration and mixing in the tanks to prevent sludge from settling. This enhances degradation of solids and results in fewer solids than conventional wastewater systems."
- **Living Machine Systems** , http://www.livingmachines.com/Home.aspx L3C 1180 Seminole Trail, Suite 155 Charlottesville, VA 22901 USA t 00+1+434 973 6365
  "Living Machine® Technology blends cutting-edge science and engineering with plants and beneficial bacteria to efficiently treat and reuse wastewater, providing lasting water solutions for communities everywhere. Based on the principles of wetland ecology, our patented tidal process cleans water, making the Living Machine® the most energy-efficient system to meet high quality reuse standards. The Hydroponic Living Machine has withstood the test of time, with systems remaining in operation for close to two decades."
- **Eco-Machines** http://toddecological.com/about_us/
  John Todd Ecological Design Post Office Box 497 Woods Hole, MA 02543
  Uses "natural systems for the removal of chemicals, petroleum hydrocarbons, endocrine disruptors, and other detrimental water pollutants. An Eco-Machine™ , can be a tank based system traditionally housed within a greenhouse or a combination of exterior constructed wetlands with Aquatic Cells inside of a greenhouse". Possible components include "an anaerobic pre-treatment component, flow equalization, aerobic tanks as the primary treatment approach followed by a final polishing step, either utilizing Ecological Fluidized Beds or a small constructed wetland." "Within the Eco-Machine, all the major groups of life are represented, including microscopic algae, fungi, bacteria, protozoa, and zooplankton, on upward to snails, clams, and fishes. Higher plants, including shrubs and trees, are grown on adjustable industrial strength fiberglass racks suspended within the system. The result is an efficient and refined wastewater treatment system that is capable of achieving high quality water without the need for hazardous chemicals." "The outlet from the last tank may be equipped with an effluent filter, similar to the ones installed in septic tanks. This will prevent the discharge of unwanted solids, most likely plant detritus, to the polishing component. Nitrogen will be removed in anoxic zone of the Eco-Machine through a process called de-nitrification. If the rate of de-nitrification in the Eco-Machine is insufficient, a portion of the effluent may be recycled back to the anaerobic reactor with an ample supply of carbon. Additional removal of nitrogen and phosphorous nutrients may be achieved through plant assimilation and other microorganisms."

Appendix 5. Wikipedia's list of wastewater treatment technologies

This list includes various terms, company treatment names and processes used in treating wastewater http://en.wikipedia.org/wiki/List_of_waste-water_treatment_technologies:

- Activated sludge systems[1]
- Advanced oxidation process
- Aerated lagoon
- Aerobic granular reactor
- Aerobic granular sludge technology
- Aerobic treatment system
- Anaerobic clarigester
- Anaerobic digestion
- Anaerobic filter
- API oil-water separator
- Anaerobic lagoon
- Batch filter technology
- Belt filter
- Bioconversion of biomass to mixed alcohol fuels
- Biofilters
- Bioreactor
- Bioretention
- Biorotor
- Carbon filtering
- Cesspit
- Chemical addition wastewater treatment
- Clarifier
- Coarse bubble diffusers
- Composting toilet
- Constructed wetland
- Dark fermentation
- Diffuser (sewage)
- Dissolved air flotation
- Dissolved gas flotation
- Distillation
- Desalination
- EcocyclET systems
- Electrocoagulation
- Electrodeionization
- Electrolysis
- Expanded granular sludge bed digestion
- Facultative lagoon
- Fenton's reagent
- Fine bubble diffusers
- Flocculation & sedimentation
- Flotation process
- Froth flotation
- Humanure (composting)
- Imhoff tank
- Induced gas flotation
- Iodine
- Ion exchange
- Lamella clarifier (Inclined Plate Clarifier)[2]
- Living machines
- Maceration (sewage)
- Microbial fuel cell
- Media filter
- Membrane bioreactor
- Nanotechnology
- NERV (Natural Endogenous Respiration Vessel)
- Parallel plate oil-water separator
- Reed bed
- Retention basin
- Reverse osmosis
- Rotating biological contactor
- Sand filter
- Sedimentation
- Sedimentation (water treatment)
- Septic tank
- Sequencing batch reactor
- Sewage treatment
- Soil bio-technology
- Stabilization pond
- Submerged aerated filter[3]
- Treatment pond
- Thermal hydrolysis
- Trickling filter
- Ultrafiltration
- Ultraviolet disinfection
- Upflow anaerobic sludge blanket digestion
- Vacuum evaporation
- Wet oxidation

Appendix 6. Illustrating Sewage Systems/Pacific Group Developments Inc.

Pacific Group Developments Inc. Excavating & Construction Victoria BC

http://www.pacificgroupdevelopments.com/

The educational material on Pacific Group Developments Inc. webiste covers:

- Septic Systems - General Introduction
- Septic Tanks
- Septic Fields
- Septic Treatment Plants
- Septic System Maintenance

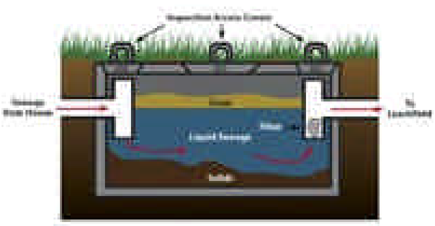
What is included here, with permission, is a small portion of their material particularly their illustrations and accompanying notes. The rest of the excellent background information about sewage systems can be seen on their website.

Pacific Developments notes at the beginning of their material: "*Pacific Group Developments wants to help educate our clients about the process, parts, materials, installation and assembly of*" each part of the sewage system.

Septic Tanks

This is a picture of **concrete septic tanks** with standard weight-bearing lids, which are not designed to take heavy weights. The lids have two access hatches with no access risers on them

This is a picture of a 1,000-gallon **single-chamber concrete** septic tank being lowered into an excavated hole by an excavator for a new septic system



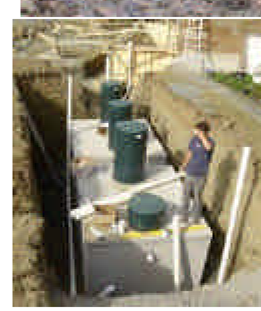
This diagram shows a **basic septic tank** and how it works. It shows how the sewage is separated into scum, liquid sewage and solids. Note the inlet and outlet are in the cleanest point in the liquid sewage

Here is a picture of a **plastic two-chamber** septic tank. It has ribbing on the exterior to provide rigidity. This tank weighs approximately 260 Lbs. so it is easily moved by hand.

Here is another **plastic** septic tank in another shape. It also has **ribbing for strength**. This shape is stronger and can withstand more pressure than the one pictured above.

This picture shows a new concrete septic tank with **two chambers**. Kevin is applying sealant before the lid is installed to prevent any leaks or contamination.

This is a picture of a septic tank with two concrete **risers,** which raise the height of the access lids. The access lids are concrete.

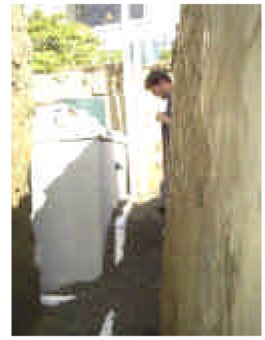


This is a picture of two concrete septic tanks, the septic tank and pump chamber placed in the hole. The one beneath the contractor is being used as a septic pump chamber for a pressure distribution system. Plastic risers are being installed. These concrete tanks also have ground water drainage pipes installed around the bottom to keep the hole dry and prevent the tanks from floating

This picture is of a **concrete septic tank with two plastic access lids**. The lids are easily opened with two cam locks.

Here we're preparing a hole for part of a septic system. This hole will have two concrete tanks placed inside it. One will be a septic tank and the other will be a septic pump chamber.

Here's a picture looking back through the trench to the septic tank and pump chamber

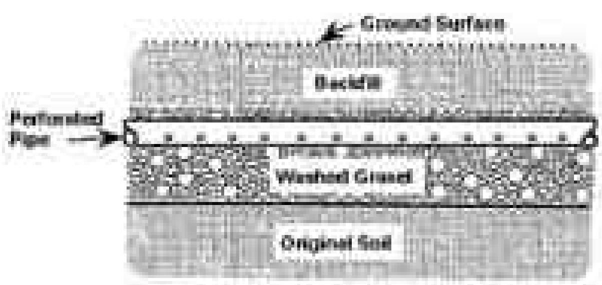


Here's a picture of the inlet pipe into the septic tank. This is the sewage pipe from the house, which feeds the septic tank, then onto the pump chamber, then into the septic drain fields.

Here's another picture of the septic tanks' ground water drainage. This is not a septic field.

Here's a picture of the groundwater drainage pipe leaving the perimeter of the septic tank and pump chamber.

Septic Fields



This drainage diagram shows a cross section of a typical septic drainage field without any baffles or vaults covering the pipe. This diagram represents most conventional systems.

This picture shows a new installation of a gravity septic system. This is a four-inch perforated PVC pipe, which will have gravel above and below it. This is what is referred to as a trench.

This is a picture of a gravity septic system with 4” perforated PVC pipe. This is a septic drain field bed with no distribution box and almost ready for backfill. Just a bit more gravel is required and then to unroll the filter cloth.

Here is a picture of a septic gravity system. This is a 4” perforated PVC pipe before the gravel is installed in the trenches.

This is a picture of a gravity septic system distribution box. This is a concrete box and lid with 4” perforated PVC pipe. One pipe fills the distribution box while the others drain out to the septic drain field.

In this photo a tracked Bobcat is filling a septic drain field trench with drain rock. Filter cloth will be placed over the drain rock and then backfilled with soil.

In this photo we see a septic pressure distribution system. The septic field is a bed of drain rock. Small PVC caps will be used here over the holes and then backfilled with more gravel, filter cloth and then soil

This is a picture of a gravity septic system for a commercial building. Here, 4” perforated PVC with baffles/vaults is used instead of drain rock. A special C-33 sand is being used with baffles/vaults over top of the pipe.

Here’s a picture of a septic pressure distribution system on a bed of gravel before the baffles/vaults are placed on top. The system is pressurized now and just balanced to ensure even pressure throughout the septic drain field. Note the water plumes are all at the same height, indicating equal pressure.

This is a picture of a small septic pressure distribution field in a septic drainage bed.

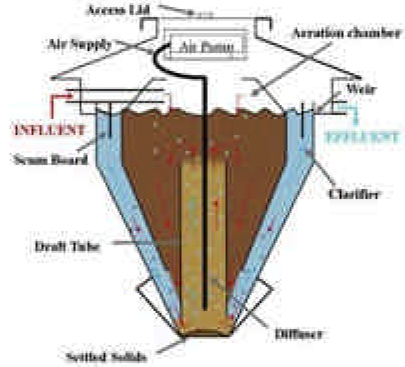
Here’s a picture of a pressure distribution septic system drain field. This system has 1.25” PVC pipes with 3/16” holes every 30” and then baffles/vaults (the black pieces) are placed over the pipe. Once all baffles/vaults are installed, it can be backfilled

This is a picture of a Type 1 gravity septic field which was constructed in Duncan BC. This is a very basic and functional septic system which does not use and pumps or treatment techniques

Sewage Treatment Plants

In this diagram we can see a plastic septic treatment plant located after the septic tank. This septic treatment plant relies on an agitating mixing whip, which keeps the sewage moving to help it break it down and introduce oxygen for aerobic bacteria. The next stage is a settling/filter chamber followed by a septic effluent pump chamber to be pumped out to a septic pressure distribution field.

This is a Fiberglass septic treatment plant being lowered into a hole. This treatment plant is an air pump system and is hooked up after the septic tank



This diagram shows how the septic treatment plant works. The air pump blows air down the tubes and then the bubbles float up from the bottom. This action agitates the septic effluent and oxygenates the liquid feeding the aerobic bacteria.

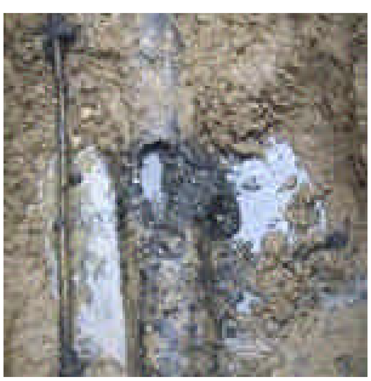
This is another kind of septic effluent treatment plant. This model has three chambers and relies on an air pump to treat the sewage effluent

This is a picture of a sewage effluent pump, along with a diagram of a septic effluent pump with float switches and an alarm float switch. Beneath the switch diagram is an alarm module, which has an audible alarm and a flashing light on top.

This is a picture of a septic treatment plant air pump. Its function is to blow air from outside, down through the sewage so that air bubbles up from the bottom to the top, agitating and oxygenating the sewage feeding aerobic bacteria

In this picture it's possible to see effluent from a septic treatment plant, which was taken to the lab for testing. It looks quite clear, which is what you want. The test results came back very good, which means the system is working well with enough bacteria and time for them to work in dosing intervals.

Sewage System Maintenance



Here's a picture of a completely **full septic drain field pipe**. The septic tank was neglected by not pumping it out every 2 years. A new septic drainage field had to be installed. It was also necessary to relocate the half-inch copper water line, which runs parallel, because it was too close.

In this picture is evidence that a septic drain field has completely **failed.** The septic tank was not pumped regularly and now the septic drain field pipes are plugged and a new septic drain field is required. You should walk over your septic field annually to visually inspect it. Watch for pooled water or depressions indicating collapse.

Here's what a **clogged septic drain field pipe** looks like. This became plugged because the size of the septic tank was too small and didn't give the bacteria any time to break down the sewage.

Here's an example from a **clogged distribution box** from a gravity system. The septic tank was emptied, but the septic distribution box was not.

Here's an excellent example of an old septic pipe made from concrete. It's full of **tree roots**, preventing septic effluent from entering. The result was that a new septic field was required. It's very important to keep tree roots away from your septic drainage field.

In this photo, a contractor is **pumping out** a septic tank in Victoria BC. It's important to thoroughly pump out the tank every two years.

The toilet image is a reminder to be **careful what is flushed**. Sanitary products, condoms, dental floss, kids' toys, and harsh cleaning products can cause problems. Service and repairs to septic drain fields and septic tanks are required and can be costly!

This is a picture of a homeowner's septic tank. He didn't know he had to pump it and now the **contents of the tank are hard enough to walk on**. The tank had to be abandoned and an entirely new tank and septic field had to be installed. Call us to pump out your tank.

In this image we can see a section of Big O perforated **pipe, which is completely clogged** from roots growing into the pipe from decorative trees planted on top of the septic drainage field. A new septic drainage field had to be built.

It's good to use **biodegradable toilet paper** as bacteria can break it down and contribute far less sludge on the bottom of the tank. This saves pumping costs and protects your septic drain field longer.

Filters are the best protection you can have in order to protect your field. Annual cleaning ensures the longevity of your septic drain field.

Here is a picture of a **concrete septic tank floating**. This is a result of pumping the tank at a time with a very high groundwater table.

Poem for Septic Tank Users

This poem is a composite of familiar verses with personal adjustments and additions.

All of us folks with septic tanks
Give to all friends our heartfelt thanks
For putting nothing in the pot
That is not guaranteed to rot

Kleenex is bad and matchsticks too,
The butts from cigs likewise taboo.
For hair and nails please use the bin,
These things you need to put there in.

Our septic tank can do a lot,
There are still things that it cannot.
But with your kind cooperation,
The tank, we'll keep in operation.

So please take note and do not throw
Those things that are not meant to go
Down pipe or drain, or through the spout,
Or you'll be asked to fish them out.

Remember we all like to eat
And so we'll need to use this seat.
Please help out with the septic care,
A bother, but so necessaire.