Ontario Cottages & Sewage System Nutrients

Part Two of a Three-Part Mini-Series

Nutrients & Contaminants in Household Sewage

Sewage digestion and filtration processes rely on raising a healthy variety of microbes to consume contaminants and purify the water before disposal in the natural environment. Purification is easy when sewage is properly made up of biodegradable constituents like feces, soap, toilet paper and urine that microbes can readily devour. Cooking oils, food scraps, and newspapers are more difficult for microbes to eat and tend to linger about, but do eventually disappear into gases and water if the abuse is only moderate.

Modern sewage contains abundant household cleaners, medications, solvents, disinfectants, hair conditioners, bleach, and fabric softeners – these bad boys tend to poison or overwhelm the microbes so they cannot perform even the basic elements of water purification, leading to deterioration of natural soil or water.

Even when sewage is purified of most contaminants, nutrients such as nitrate and phosphate ions are not removed and these impact our natural environment – primarily groundwater and surface water resources.

This second article for FOCA discusses contaminants to be removed by filtration-purification for permanent infrastructure and nutrients to be removed to become environmentally benign infrastructure. Of interest to cottagers is that much potential harm to lakefront property is avoided by diverting these contaminants and nutrients away from the sewage system in the first place – “An ounce of prevention …”.

Organic Carbon – Soil & Water Eutrophic Pollution

Carbon is the most common element of interest in food and feces and is an important nutrient for aquatic algae or sewage biomat in soils. Added to soil or water, one litre of septic tank effluent consumes 100-300 mg of oxygen over a 5-day period, and along with nitrogen and phosphorus nutrients, leads to eutrophication of the soil or water if not corrected.

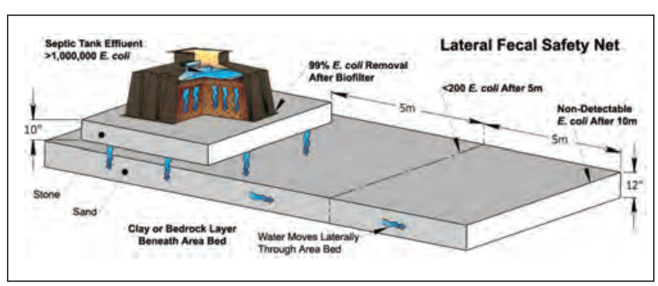
Biofiltration-purification removes organic carbon by breaking down carbohydrates and similar molecules ($C_xH_yO_z$) to form CH_4 and CO_2 gases plus H_2O. Dissolved oxygen is high in filtered effluent and carbon content is low, making it safer and more benign than septic effluent. With aerated filtered effluent soil and water remain aerobic and therefore support higher life forms like earthworms and fish instead of algae, fungus and bacteria, and eutrophication is avoided.

Microbial Pathogens – Basic Health & Safety

The prime goal of filtration-purification is to remove pathogenic microbes, including viruses, naturally occurring in sewage. The oxygen-poor septic tank and soil biomat actually utilizes these microbes to help ferment raw sewage, but then the pathogens must be removed in a second, aerated filtration process where ‘obligate anaerobes’, including most pathogens, are consumed or die off. Higher life-forms graze on pathogens but require an oxygen-rich environment and filtration medium suited to adequate retention time without undue plugging by septic biomat. Soils may not provide these conditions below the septic biomat in the trench, causing ponding especially in winter and inadequate aeration of soil beneath the trenches. A more consistent and verifiable filtration system is needed than the natural environment.

Two-Step Multiple-Barrier Safety Net

Third-party professional testing shows that standard biofiltration by sand, peat or foam removes >99% of fecal coliforms, and a subsequent 10” layer of medium grained sand removes an additional >99.9% removal for a total of >99.999%, or basically non-detectable. Bacteriophage virus is also eliminated, making it an ideal effluent from a health & safety perspective. The Ontario-developed Waterloo Biofilter + Shallow Area Bed combination is an example of a ‘multiple-barrier’ system that provides a secure safety net for lakefront properties. The attached figures show the third-party verification that microbes are removed completely within 10 m lateral distance (on clay or bedrock) or within 250 mm vertical distance (on fractured bedrock or water



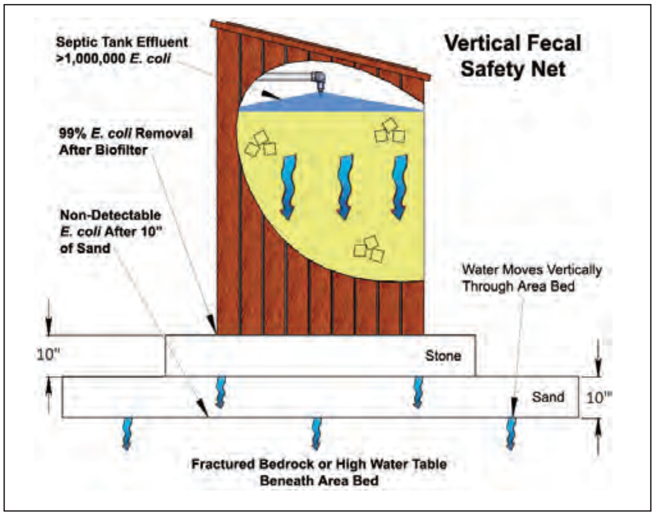


table) using this technology. The two steps also allow verification of treatment, unlike conventional sand filters for instance, and is the type of long-term sustainable infrastructure that maintains lakefront property values.

Nitrogen – Groundwater Concern

Nitrogen is another basic nutrient that algae needs to grow – typically lower quantities than phosphorus in ocean water and higher in fresh water. Nitrogen is removed first by nitrifying ammonium which requires healthy sewage and hard water (acid buffering by alkalinity). Nitrate in treated effluent is then denitrified by reacting with organic source to form nitrogen gas by recirculation to the septic tank or by migrating through soil into organic muck below a swamp or lake. If not denitrified, nitrate remains dissolved in water to contribute to algae blooms in brackish water estuaries, or builds up in fresh groundwater supplies potentially to higher than acceptable potable limits.

Phosphorus – Algae in the Lake

Ontario lakes are generally phosphorus-poor which inhibits algae growth, so it is very important to keep phosphorus out of sewage in the first place – especially since there is yet no free lunch when it comes to removing phosphorus. Phosphorus is in storm water, feces, lawn fertilizers, detergents, etc. Studies done in cottage country by the Ministry of Environment resulted in the removal of phosphorus from laundry detergent decades ago to protect lake quality, but phosphorus was allowed for automatic dish-washers until very recently. Phosphorus is now out of all dish detergent products in Canada as of July 2010, led by legislation in Manitoba and Quebec.

Foul Odours – The Aesthetic Environment

What makes odour 'putrid' rather than a 'perfume'? Bad smells have sulphur or nitrogen in a chemically reduced state (e.g., sulphide rotten-egg gas or ammonium) with little to no oxygen in the structure – nice-smelling molecules have oxygen attached as in sulphate or nitrate. Fermenting septic tanks form malodorous fatty acids, mercaptans, etc., whereas filtered, oxygen-rich effluent is odour-free. Excessive use of disinfectants or medications (e.g., chemo-therapy) causes sewage to putrify or rot instead of ferment and putrid odours are pervasively broadcast. Solvents, ammonium cleaners and fabric softeners keep ammonium from nitrifying, so imparting odour to otherwise treated sewage. Plumbing roof vents smell worse on septic tanks than on town sewers, simply due to oxygen-poor gases coming up from the septic tank.

How to Attain Health & Safety + Environmental Objectives

To attain the desired 'permanent infrastructure' through sustainable sewage treatment, we must begin with the sewage composition itself. We must ask ourselves "what did people put down the sink and toilet in the 1950s & 1960s before the common use of harsh cleaners and disinfectants" – anything else should be diverted away, used sparingly, or not at all – this will achieve our health & safety objectives. To attain the higher objective of 'environmentally benign infrastructure', the use of phosphorus and nitrogen nutrient removal techniques must be introduced. The next article in this FOCA series will discuss suitable methods to remove sewage contaminants to achieve these health & safety and environmental objectives.

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