Ontario Cottages & Sewage System Nutrients

This is the final in a series of three articles on the topic. Access parts 1 & 2 online at www.foca.on.ca (NEWS&EVENTS - NEWSLETTERS: Part I=Spring/Summer 2010; Part II=Fall 2010).

Environmental Objectives of Septic Systems

This article addresses the removal of sewage contaminants to achieve the objective of '*environmentally benign infrastructure*.'

Conventional soil disposal can lead to anoxic 'soil eutrophication' due to excessive fertilizing of the soil by sewage organics and nutrients. Urine and feces contain organics (C) and all the N-P-K ingredients of a good fertilizer! If C, nitrogen (N) and phosphorus (P) at least are removed from the sewage, eutrophication of soils and nearby waters can be minimized. Remember, lakefront property values are linked to the health of the surrounding natural environment.

With research over the past 15 to 20 years, nutrient removal is now possible at cottages by means of basic maintenance contracts and the owner's 'careful feeding' of the treatment system. It turns out that the simplest way to deal with N & P nutrients is to keep urine out of sewage, rather than remove it after the fact. This is especially true in the case of phosphorus.

Sewage-Nutrient Technologies for Ontario Cottagers

(Related to the Ontario Building Code Part 8 & MOE)

Holding Tanks

Holding tanks are a technology akin to '*leaving nothing but footprints*' at your cottage: sewage, cleaners, etc. are all collected and removed off-site to a treatment facility. Manitoba protects certain lakes with holding tanks for existing cottages, and Ontario allows them for temporary use or for existing cottages where remedy or upgrade is otherwise impractical.

Holding tanks fully protect your soil and lake water from sewage contaminants, but the cost and frequency of pump-outs, together with the paucity of treatment facilities, make them impractical as permanent solutions.

Cluster Systems

Under Ministry of the Environment (MOE) jurisdiction, a communal sewer with a single treatment plant is the norm for campgrounds, trailer parks, and resorts on lakefront properties. These systems have the ability to keep sewage away from the lake, manage and remove nutrients more readily, disinfect, discharge to surface or subsurface, and even re-use.

The natural environment would benefit if cottages were grouped together in condominiums or communal resorts—at least their sewers. Although not the classic cottage experience, communal sewers could be the best choice for densely grouped cottages on small lots.

Primary Treatment: Septic Tanks

The treatment unit most familiar to cottagers is the septic tank, providing solids separation and anaerobic digestion similar to primary digesters at municipal facilities. Anaerobic microbes digest and prepare raw sewage through fermentation and hydrolysis reactions. (Not unlike the process of making wine or beer!) The prepared effluent, with dissolved ammonium (N) and phosphate (P) ions and various organic acids (C) and E. coli pathogens (EC), is then aerobically filter-treated and disposed of in a leaching field. Warm insulated septic tanks perform better than cold ones; snow melting above the tank is a bad sign. Although a healthy septic tank may remove up to half the organics, the remaining C, EC, and N-P components are removed only by subsequent filtration treatment.

Filtration Treatment

There are several filtration options suitable to Ontario's colder climate that have low maintenance and energy requirements. Systems should biologically remove organics to high quality 'sand filter quality' effluent with ≤10 mg/L cBOD (carbonaceous biological oxygen demand or 'organics') and ≤10 mg/L TSS (total suspended solids). This '10-10' quality is essentially clear water (see Figure 1); it is not disinfected but is palatable enough that most people would let their dog drink it. This is the standard treatment objective in MOE sites for surface or subsurface discharge. OBC Filter Beds are also designed to remove C to 10-10 quality and E. coli, but remove no N or P.

Nitrogen

Ammonium, which is bad for fish, is oxidized to nitrate, which in turn is unacceptable in groundwater. Nitrate is removed when it encounters organic matter, but organic matter has already been removed from the system by the time

nitrate is formed. So, a portion of the nitrate-rich effluent is collected and put back into the septic tank to be 'denitrified' by sewage organics into nitrogen gas. (For context, we breathe in 80% N in our air each day.) The filter-recirculation method removes 50-65% of total N from sewage with very little effort. Potable water on the Canadian Shield is invariably soft and unable to nitrify to remove N; it is much easier on limestone bedrock where the water is hard.

N-removal technologies like Waterloo Biofilter are used on individual houses in Ontario subdivisions to improve groundwater quality, as well as on condominium developments in Ontario and elsewhere. Cluster systems are preferred when more that 65% TN removal is required. This is carried out by carbon addition in an anoxic filter or by a reactive upflow filter, but these technologies are not well suited for individual cottage applications.

Figure 1. Waterloo effluent from residences in Maryland has high oxygen and low organics and nutrients to help restore nitrogen-sensitive estuarine environments like Chesapeake Bay.

Restoration

The Waterloo sampling from the Maryland Chesapeake Bay Restoration program is a unique data set of third-party 24-hour composites from individual houses. Water conservation concentrates raw sewage medians to super-residential strengths of ~400 mg/L cBOD & TSS (versus 250-300 mg/L typical for residential) and total nitrogen medians of >200 mg/L N (versus 50-70 mg/L). Waterloo Biofilter effluent from 28 composite samples has a median value of <10 mg/L for cBOD & TSS (>94% removal rate) and >65% nitrogen removal rate. High dissolved oxygen of 7.3 mg/L and low E. coli values of <3000 cfu/100mL mean that a clear safe effluent, similar in colour to tap water (see Figure 1), is easily disposed of in the subsurface to help improve groundwater and adjacent surface waters. This effect is created by simple re-circulation of effluent with little energy input. High oxygen and low organic-nutrient contents minimize soil eutrophication. A vertical separation of 10" of clear sand removes the remaining E. coli.

Phosphorus

There is no 'free lunch' with respect to P removal. Filtered effluent with dissolved P ions can be directed through a reactive iron-based medium, but the resulting effluent would be overly caustic. Furthermore, the medium has to be replenished periodically, presenting disposal problems. Aluminum sulphate can be dosed into the septic tank to form P-rich sludge which can be pumped out periodically, but this requires vigilant maintenance and is more suited to cluster systems. In cottage country where volcanic bedrock occurs, iron-rich soils will remove P as the effluent migrates down to the lake.

Septic Health Verification

Removal of N, P & EC requires collecting filtered effluent first, rather than immediate subsurface disposal. This in turn affords the added benefit of performance verification. If the effluent is cloudy or dark, the septic tank is usually dead and the cottage is using too much disinfectant. (For more on this topic, see Max Burn's updated *Country and Cottage Water Systems*, 2010, published by Cottage Life Books.) Filtration systems are 'recoverable' in that they clean themselves up within a month or so after the offending 'poison' is removed. Verification during maintenance visits prevents expensive

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replacement of failed systems. The OBC Filter Bed has a drawback, in that it cannot be verified for performance like the proprietary filters can.

Diversion of Hazardous & Superfluous Wastes

At the Cottage: Learning from the Experts

Prevention by diversion is the cheapest method of nutrient removal. Large cities have the same issues of garbage disposal in sewers as our cottage septic systems, except they have trained maintenance people onsite 24/7 and we don't.

Stockholm Water Company's website www.stockholmvatten.se/en/Brochures-and-reports/Brochures/ gives clear instructions to homeowners on keeping city sewage plants working well:

> *We need your help in making our waters cleaner – only water, urine, feces, and toilet paper go into the toilet.*
> - *Scrape or wipe dishes and pans and dispose of in the garbage*
> - *No strong detergents or very little when necessary*
> - *Take medications, solvents, paints to proper disposal facilities*

Peel Region's website www.peelregion.ca/pw/waste/hhw/ provides similar clear guidance to homeowners on the disposal of household wastes.

What the experts want for their large plants is also what we want for our septic systems.

Mature Subject Matter (Discretion Advised!)

Saving the best for the last: diversion of urine from the waste stream will come to pass—even here in Canada—and the result will be beneficial to the environment. The reason is that nutrients are so concentrated in urine that although it comprises only 1% of the volume of our sewage water, urine contains 70-80% of N and 50-60% of P and potassium (K). (see Figure 2) There is no good reason to fertilize our cottage lakes or soils this way.

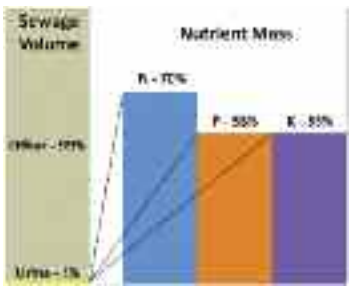

Figure 2. Urine is only 1% of volume, but has most of the N-P-K fertilizer nutrients of residential sewage – ideal circumstances for successful diversion.

It is easier to divert urine from sewage water than to treat it, especially for P which is expensive to remove. A 2006 WHO report on safe reuse of wastewater states:

> *Diversion and use of urine in agriculture can aid crop production and reduce the costs of and need for advanced wastewater treatment processes to remove phosphorus.*

Urine-separation toilets are now available for the 'pioneers.' When properly organized and more widespread, this will help maintain lakefront property values by keeping P out of the lake.

But, in the meantime, remember when you are out fishing, don't 'P' in the water—or on the ice!

Craig Jowett, craig@waterloo-biofilter.com