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IN THIS ISSUE

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President's Message

During 2007, your Board of Directors developed and implemented several policy initiatives that addressed some matters intentionally put on the "back burner" while major work was carried out to:
a. fulfill the mandate of the 2005 regulation,
b. produce for the Ministry of Health under terms of the Memorandum of Understanding the 2007 SPM, and
c. act as the contract administration for the Paper Audit as requested by the Sewerage System Leadership Council.

The policy initiatives developed and implemented by the board include the vetting and letting of contracts for services such as, Course & Curriculum development, Instructors, Technical Support Services development and use of non-BCOSSA members for specialized services.

In many cases, requests for proposals for these services were published on the BCOSSA website. Any Board member who wished to act on this RFPs would, after declaring their interest in a request for proposal to the Board, withdraw from the decision making process. Contracts were then evaluated by the Executive-Director in conjunction with the Treasurer before being let.

This procedure, resulting from the policy initiatives, has allowed the function of the organization to continue and to permit an open, fair and accountable process to assure the member that value is received for services performed, in a competent manner.

Another example of the policy directions of the 2007 Board, is that of engaging 2 external accountants to assist in the development for budgets and financial planning and an improved financial reporting process matching expenditures to budgets.

The 2008 Board of Directors are expected to continue developing and improving policies to provide the organization and its members with a sustainable operating structure to carry out the mandates of the government as set out in the regulation and Memorandum of Understanding. Policies that address the structure, conflict of interest issues and transparency are being developed in conjunction with outside advice and consultation.

This being your association, please do not hesitate to make your comments or questions known to us. Contact any Board member or the Executive-Director with your concerns.

At the Sewerage System Leadership Council, your association is pressing for more appropriate enforcement against unlawful activities and addressing regulation shortcomings.

The 2008 business year is showing itself to be a significantly busy year and your volunteer BCOSSA Board and Committees members are adding to their lives by working for the industry and public interests by being an active member of the Board and Committees. You are invited to participate in any way you see fit in any of the committees. Contact the office or a Committee Chairperson to advise of your willingness to participate in this grand endeavour.

Frank Hay, ROWP
President

AGM Conference and Tradeshow 2008

Our AGM/Conference and tradeshow held March 13th through 16th in Langley was a resounding success! Attendance was a record with over 200 coming to take in the event.

We had many exciting speakers presenting on a vast array of topics related to the onsite industry. The key note speaker Mike Corry, an expert on nutrient loading from onsite systems, gave a presentation on the regulation and issues surrounding nitrogen contamination form onsite systems. Stephanie Moran P.Ag gave a rousing and informative presentation on soil assessment and classification, Ms. Moren also presented a 3 ½ hour workshop on soils at the Sunday session. Dr. Cathy Ryan presented on wastewater plumes and groundwater contamination. Dr. Mieke Koehoorn discussed the findings of health outcomes as they relate to land uses, a study by UBC Bridge program carried out in Langley, and Joanna Urban from Thompson Rivers University who presented findings on endocrine disruptors in treatment plants. There were many other fine speakers who spoke on system design, maintenance, subdivision regulation and new technologies. To round out the speakers Ian Ralston, the Technical Committee Chair, presented a workshop on the Sewerage System Standard Practice Manual.

The AGM dinner was conducted on Saturday night with a wonderful buffet, door prizes and a fifty/fifty raffle to provide fund raising for the Habitat for Humanity charity, the participants raised over $500.00 for the charity. The success of our conference is in large part due to the many tradeshow participants who come to share information on their products and technology. Thanks to all the trade show participants and especially our sponsors!

As always a new board was elected by the members to manage the organization, your representatives are:
Frank Hay, Betty Holtskog, Ian Ralston, Ron Hein, Curt Kerns, Braden Marshall, Stephanie Unrau, Allan Dickie, Bon Thorburn, Steve Warren, Tim Wilson, Barry Rumsey.
Welcome back to all of the past Directors and a special welcome to the new Directors Stephanie Unrau and Bon Thorburn.

The Board will continue to work in the best interest of the membership providing leadership for the membership delivering and developing services that you need and want, such as liability insurance, health insurance, forms and computer programs for making your work easier. The Board through the Education and Curriculum Committee will be delivering and developing WOWTC courses that you need to improve your skills such as advanced soils, advanced pumps and controls, as well as providing our current slate of classes for the continuing learner.
One of the Boards major jobs this year will be the redevelopment of BCOSSAs governance model. The governance of the organization takes clear vision and proper organization to provide stability and growth. The Board has begun the task of developing terms of reference roles, responsibilities and strategic plans for the governance of the organization as a whole and all of the standing committees (Education and Curriculum, Member Services and Communication, Technical Review). Board members face the constant challenge of balancing ideologies and conflicting visions so as to develop the best possible foundation for the association.

BCOSSA is a stable and strong organization both financially and organizationally however, to provide continuing organizational sustainability, financial sustainability and membership sustainability we need a well structured governance model.

I personally look forward to assisting the Board with this work as it is fundamental to the organization as it provides the foundation for the association and a blue print for the future.

John Rowse, Executive Director BCOSSA

Sewerage System Leadership Council

The BCOSSA Executive continues to work with the Sewerage System Leadership Council to resolve the members concerns related to enforcement of the regulation. The Ministry, with support from BCOSSA, has hired a facilitator to assist in developing strategies to improve and maintain an adequate enforcement level for the industry especially as it relates to illegal installation. Regulatory enforcement is a key component to the success of the regulation and supports Registered Practitioners and Professionals by providing an even playing field for practitioners by reducing or eliminating illegal competition. BCOSSA knows that you have invested time and money in your business and your association and is dedicated to ensuring that this effort is respected. To further the call for better enforcement, the Executive will be meeting with Minister George Abbott to discuss the enforcement issue. Some of the options that will be discussed will be increasing health authority activities and the development of a stand alone authority that will provide enforcement across the province.

Subdivision Assessment

As a result of health authorities reducing their activities in the land use area, some practitioners and professionals have been contracted to assess lot conditions for subdivision approval. This is not a traditional role for practitioners and a clear understanding of the regulatory framework used for subdivision approval is required to ensure your understanding of the responsibilities you take on when doing this type of work.

Subdivision is governed by the Subdivision regulation which falls under the Ministry of Community Services. In rural areas the administration of the regulation is handled by the Ministry of Transportation Approving Officers. In municipalities and some regional districts the administration of the regulation and local by-laws is the responsibility of the municipal Approving officer.

The Subdivision regulation requires the approving officer to refer subdivisions under 5 acres (2 hectares) to the local health authority for comments on the subdivision's capacity to be serviced by onsite sewage systems where sanitary sewers are not available. The capability of the parcel to accept effluent flow is not assessed using the Sewerage System regulation or Sewerage System Standard Practice Manual, but by local health authority policy. In other words, the health authority retains control of the criteria a parcel must meet for service with onsite infrastructure.

Typically, health authority policy for subdivisions allows for only type 1 installations on newly created parcels. The basis for this is that only during the creation of new subdivisions can the potential cumulative effects of effluent for the whole of the subdivision be taken into consideration. Additionally, it is recognized that the use of type 2 or type 3 systems require higher levels of maintenance and that the likelihood of malfunction of these system is higher. Most health authorities will accept type 2 or type 3 systems for subdivision if a local government by-law is in place assuring maintenance is carried out.

Within the Subdivision regulation the process of assessment for onsite infrastructure includes lot sizing and percolation tests; therefore the use of permiameters is not recognized as a method of assessment. Additionally, when practitioners make reports for developers to the health authorities, they must be clear that this report is a site and soil assessment only, not a design document and not a recommendation for subdivision. It is the health authorities responsibility to make recommendations to the Approving Officer and not the authorized person.

There is considerable potential liability related to subdivision assessment and it is outside of the normal scope of work for ROWPs, therefore you should be very cautious taking on this work and ensure your contracts clearly state that you will carry out assessment only.

Standard Practice Manual

The new building season has started and as an industry we can take up the challenge with the flexible options available through the New Sewerage System Standard Practice Manual.

Many of you will have already attended the SPM workshops that have been delivered throughout the province or attended the AGM/Conference in March, and learned about the many changes within the manual.

The BC Onsite Sewage Assosiation, through the Technical Review Committee will continue to provide Technical Bulletins help you use the SPM. Additionally, the BCOSSA website has information and forums to address your questions, go to www.bcossa.com.

Design for Wastewater Effluent Infiltration

Onsite wastewater systems have historically relied on soil for disposal of human waste and wastewaters. For much of the 20th century, soil-based systems were viewed as temporary methods for waste disposal. The terminology used throughout much of the 1900s reflected a "disposal" mindset, as revealed by the widespread use of terms such as "pit privy," "cesspool," "seepage pit," "leachfield," and "drainfield." Today, the vast majority of onsite and decentralized systems include a unit operation involving soil infiltration to achieve treatment as well as serve as the ultimate receiving environment for the wastewater stream. Modern soil treatment units (STU) can achieve important performance goals: (1) hydraulically process all of the effluent applied; (2) purify the effluent within the soil to the extent needed to protect public health and water quality; (3) provide a long service life with low O&M; (4) enable resource recovery and reuse; and (5) achieve financially affordable and sustainable infrastructure. In recognition of soil infiltration as a treatment unit capable of achieving tertiary treatment with natural disinfection, terminology has evolved to better reflect this performance character: subsurface soil absorption system (USEPA 1980), subsurface wastewater infiltration system (USEPA 2002), or soil treatment unit (Siegrist et al. 2004).

In a modern STU as illustrated in **Figure 1,** many physical-chemical and biological processes can contribute to treatment as wastewater effluent infiltrates and percolates through the vadose zone and recharges groundwater under a site. Biochemical oxygen demand (BOD) removal can occur by biodegradation in biofilms that grow on soil grains and within soil organic matter. Suspended solids removal occurs by physical filtration and absorption followed by biodegradation. Reduced forms of nitrogen (N) (e.g., NH4+) can be biologically oxidized completely and some total N can be removed by biodenitrification. Phosphorus (P) removal varies widely depending on soil mineralogy and its P-sorption properties. Pathogens such as parasites and bacteria can be filtered out and die-off, while viruses can attach to grain surfaces and be inactivated. General soil attributes needed to achieve tertiary treatment with natural disinfection include: (1) adequate permeability for water movement; (2) adequate soil profile depth for treatment—depending on effluent loading rate and quality, a certain depth of unsaturated aerobic soil is needed; (3) conditions conducive to treatment, including unsaturated soil with film flow over soil grains and long travel times for kinetic processes (e.g., BOD and NH4+ removal and virus inactivation); (4) adequate volume of soil with the correct properties to provide adequate soil grain surface area for sorption processes (e.g., P removal); and (5) properties conducive to treatment (e.g., pH, Eh, alkalinity, temperature, and no biotoxins).

The inherent nature of an STU (defined here as the soil through which infiltration and percolation occur) can complicate the use of explicit quantitative treatment goals, because, unlike a tank-based unit, there is no outlet pipe and "effluent" per se from an STU. For most systems, the "effluent equivalent" is the soil solution at some depth (e.g., at the ground water table). In addition, from a "system design and performance" perspective, the treatment capacity of the ground water zone can also be important to achieving public health and water quality protection goals.

In recognition of the critical need for cost effective onsite and decentralized systems to support wastewater infrastructure and sustainable water systems in the U.S. and abroad, considerable investments have been directed to advance the science and engineering of onsite and decentralized technologies as well as their regulation and management to ensure proper design and performance (USEPA 1997, Siegrist 2001, Siegrist et al. 2001, USEPA 2002, USEPA 2005, NOWRA 2006). Despite major efforts and accomplishments on many fronts, the day-to-day design practices followed across the U.S. remain "constrained" based on historical perspectives and conservative regulatory practices. Design requirements for an onsite system to serve an individual home or small businesses (e.g., design flow less than 2,000 gallons per day [7.6 cubic meters per day]) are normally prescribed through codes that are administered at the county or similar local jurisdictional level. Design approaches and criteria remain tightly prescribed for various aspects of an onsite wastewater system (e.g., estimating design flows, type and extent of tank-based treatment, site suitability for in-ground or other infiltration unit types, infiltration unit geometry and loading rates for sizing, and effluent delivery and distribution). Treatment requirements are not explicitly established, discharge limits are commonly not set, and performance monitoring is normally not required. Design of larger systems (e.g., greater than 2,000 gallons per day) is normally regulated at the state jurisdiction level and engineering designs are likely to be site-specific with more flexibility allowed to achieve a required performance. Discharge limits are more likely with associated monitoring and reporting required.

In contrast to the "always have done it this way" design requirements that have seemingly arisen over the years, a rational design process would have a clearer underpinning in science and engineering. Such a process would seek to enable a cost-effective design solution for a given problem, including an explicit factor of safety appropriate for the given application and the impacts of a performance deficiency should it occur. There is no inherent reason why a more rational design process cannot support the development of better regulatory codes and prescriptive designs as well as facilitate engineering of site-specific designs.

This article focuses on the rational design of an STU to treat a design hydraulic loading rate (HLRD) for a given effluent quality delivered to the soil by a certain type of distribution method and frequency of application. Critically important to enable sound decisions is an understanding of how the hydraulic capacity of the STU and its ability to process the actual hydraulic loading rate (HLRA) is determined by various system design and operation parameters. The hydraulic capacity of the STU is determined by the soil infiltrability for the effluent applied. Soil infiltrability is simply the capacity of a soil to infiltrate water into a soil profile when it is made freely available at an infiltrative surface. While much is known about soil infiltrability for wastewater effluent and the factors affecting long-term operation and performance of an STU, a rational design approach for effluent infiltration has not yet fully evolved and been widely accepted. This article describes the basis for and some of the key elements of an evolving rational approach for design of an STU.

Process Principles Concerning Effluent

Infiltration: Features of an Infiltrative Surface and Genesis of an Infiltration Zone

The effective function of an STU, such as a subsurface infiltration trench or narrow bed, necessarily relies on the ability of the soil to infiltrate the applied wastewater effluent during the design life of the system (often 10 to 20 years or more). Infiltration into a soil profile can be controlled at the soil infiltrative surface (e.g., by damage during construction of an infiltration unit or by wastewater-induced pore clogging) or within the soil profile (e.g., by low permeability layers near the infiltrative surface or by waterchemistry induced changes in expansive clay-rich soils). For a common trench or bed infiltration unit installed in a stable, well-drained soil profile and without construction damage causing an immediate major loss in the soil infiltrability of the natural soil, wastewater application can lead to a decline in hydraulic capacity due to changes in the soil infiltrability for the effluent applied.

While the rate and extent of soil infiltrability decline is based on STU design and operational features as well as soil and site condi tions, three distinct phases typically characterize the time-dependent changes in soil infiltrability (e.g., Thomas et al. 1966, Tyler and Converse 1989, Siegrist et al. 2001, Siegrist et al. 2002). Phase 1 represents the startup and early maturation period when the actual hydraulic loading rate (HLRA) infiltrates into the soil but in a nonuniform manner (both temporal and spatial) due to imperfect distribution networks and the fact that the initial soil infiltrability is typically 10 to 100 times higher than the HLRA. With continued effluent infiltration, the soil permeability is decreased at the infiltrative surface, effluent infiltration becomes more uniform across the available infiltrative surface, and the soil infiltrability gradually declines. Phase 1 may last for a few months to a year or more, and during the first month or two of operation, purification processes (e.g., nitrification and bacterial removal) become well established. Phase 1 transitions to Phase 2 as soil infiltrability begins to decline, substantially dropping off to a small fraction of the saturated hydraulic conductivity of the natural soil and approaching the HLRA. The decline in soil infiltrability can be rapid or gradual during Phase 2, occurring over months or years, respectively. As the soil infiltrability declines to a rate that is equal to the HLRA, intermittent or continuous ponding of effluent above the infiltrative surface may ensue. Phase 2 transitions to Phase 3 as continued operation leads to a further decline in soil infiltrability such that the daily HLR can only be processed by the increased hydraulic gradients that arise from increasing ponding heights as well as through infiltration through sidewall infiltrative surfaces. Phase 3 involves a long period of operation, when the soil infiltrability has declined substantially, but the STU may function hydraulically at the HLRA for another 10 to 20 years or more of continuous operation. The pseudo steady-state soil infiltrability that can enable sustained STU operation has been referred to as a long-term acceptance rate (LTAR). Hydraulic failure can occur at any time during the operation of the STU, if the HLRA exceeds the hydraulic capacity afforded by the soil infiltrability at that time. This failure can manifest itself as effluent seepage to the ground surface or backup into the upstream treatment units and structure from which the wastewater emanates.

An understanding of the wastewater-induced processes that can cause changes in permeability can help explain the soil infiltrability behavior just described and provide insight for hydraulic design of soil treatment units. The infiltrative surface is the plane through which effluent migrates as it begins to move away into the soil pore network of the natural soil. The infiltration zone includes the original infiltrative surface as well as some depth of natural soil below it and some height above it (both of which can contain embedded stones or other deposited objects used in constructing the infiltration trench or bed). This infiltration zone is not a static system but evolves over time in response to wastewater effluent application. Due to the role of biological processes in its evolution, it has been referred to as a biozone. The genesis of a biozone in an STU can be conceptualized to include three simultaneous, interacting processes.

• *Biofilm development occurs within the soil pore network*. Biofilms form soon after effluent is applied as water, nutrients, and microbes are added to the natural soil. Biofilms can develop to depths on the order of 30 centimeters or somewhat deeper below the infiltrative surface. The biofilms can grow in thickness as dissolved organic matter and nutrients in the effluent applied are converted to biomass. During operation, the biofilm biomass may reach a pseudo steadystate condition as new biomass growth is balanced by biomass die-off and degradation.

• *Biomat development occurs on top of the infiltrative surface*. Since soil can act as a filter media, a biomat can develop as suspended solids in the effluent applied are filtered out. The morphology of a biomat depends on various conditions, but it is a distinct layer that can include some limited penetration into the soil pore network (e.g., a few millimeters) and rise above it to measurable heights (e.g., centimeters). Some of the filtered solids that are deposited in the biomat may be biodegradable and slowly decay, while some may be mineral matter and persist almost indefinitely.

• *Pore-filling agent development occurs within the soil matrix*. Pores within the soil pore network at and below the infiltrative surface can become filled with various substances, including organic and mineral matter and entrapped gases that can be deposited as the effluent infiltrates and percolates through the soil, or can develop in situ due to biological and physical-chemical processes. Humic substances can evolve over time, and these high-molecular-weight recalcitrant organics can yield a glue-like substance that retains water and other matter in soil pores near the infiltrative surface.

Factors that Control Soil Infiltrability of Effluent

It is recognized that soil infiltrability behavior during wastewater effluent application is highly complex and subject to many factors. Some of the key factors that have been reported to control infiltrability of domestic septic tank effluent (DSTE) include: (1) soil and subsurface properties, such as soil texture and structure, profile depth and layering, climate and hydrology; (2) infiltrative surface architec ture, such as geometry, depth, and interface characteristics; and (3) effluent application, including the HLRA and frequency, uniformity, and continuity of application. The effects of several key factors are highlighted in **Table 1**.

For effluents with compositions that differ markedly from that of DSTE, soil infiltrability decline can be more or less rapid and extensive than that with DSTE. For example, more rapid and extensive loss in infiltrability can occur for higher strength effluents (e.g., restaurant STE) while the opposite can occur with higher quality effluents (e.g., sand filter effluent). "Strength" is

Table 1 - Some Key Factors and Their Effects on Soil Infiltrability Behaviour and HLR Values for Sizing STU's for Wastewater Efflients[1]

STU attribute	Relative effect(s) [1]	Reference(s)
Initial Ksat of the natural soil	Minor to Moderate ~ For permeable well-drained soils with Ksats of ~5 to 2500 cm/d, the LTAR for a STU receiving DSTE under continuous use will normally approach ~2 cm/d	Jenssen 1986, Jenssen and Siegrist 1990, Beal *et al*. 2005
Subsurface soil conditions during operation	Moderate ~ higher temperatures, lower soil water contents, and higher aeration levels tend to enable reltively higher LTAR's	Siegrist *et al*. 2001q
Infiltrative surface architecture	Moderate ~ horizontal infiltative surfaces that are aggregate free in low-height, narrow trenches characterized by sidewall-to-bottow area ratios of 0.5 to 1.0 and placed shallow in the subsurface enhance infiltrability and enable higher LTAR's	Van Cuyk *et al*. 2001, Siegrist *et al*. 2004, Beach *et al*. 2005, Siegrist *et al*. 2005
Actual HLR	Major ~ For a given effluent quality, the actual HLR exerts a major effect by determining the mass loadings of total BOD and TSS which are key determinants in soil infiltrability behaviour (for clean water, the effects of HLR could be negligible if the HLR ranges below about 10% of the soil Ksat)	Siegrist 1987, Siegrist and Boyle 1987, Jenssen and Siegrist 1990, Siegrist *et al*. 2001, 2005, Van Cuyk *et al*. 2005
Effluent quality	Major ~ At a given HLR, effluent quality exerts a major effect on LTAR's based on the mass loadings of total BOD and TSS which are key determinants of soil infiltrability behavior; HLR_D values for very high quality effluents need to be limited to sustain soil infiltrability as well as achieve treatment goals	Siegrist 1988, Tyler and Converse 1989, Siegrist *et al*. 2001, Van Cuyk *et al*. 2005
Effluent application method	Minor to Major ~ For systems in continuous daily use, major effects may be exerted on soil infiltrability behaviour initially but the ultimate LTR may be unaffected; the effects observed are dependent on effluent quality and HLR_D	Hargett *et al*. 1982, Siegrist *et al*. 2001, 2002, Beach *et al*. 2005, Van Cuyk *et al*. 2005
Continuity of use	Major ~ infrequent or intermittent use with long periods of resting can sustain higher soil infiltrability and LTAR's	Siegrist *et al*. 2001

[1] It is recognized that soil infiltrability behavior during effluent infiltration is complex and that many factors contribute independently and through dynamic interactions. This table is presented for illustrative purposes, and the attributes, effects and references given are not intended to provice comprehensive coverage of this subject.

[2] The descriptors used have the following meanings: "minot" indicates a relative effect of ~+/-20% or less, "moderate" indicates an effect on the order of +/-50%, and "major" indicates an effect on the order of -100% to +100% or more.

determined by the concentrations of key wastewater constituents known to impact infiltrability: total BOD (carbonaceous and nitrogenous) and total suspended solids (TSS) (Siegrist and Boyle 1987).

Relationship of Soil Infiltrability to Effluent Purification

Effective design for effluent infiltration is critical to prevent direct exposure to untreated sewage that can occur if hydraulic failure results in seepage to the ground surface or backup into a dwelling or business. Design for effluent infiltration must also be consistent with requirements to achieve necessary purification with the STU. Soil infiltrability behavior, as affected by design and environmental factors, can affect purification within an STU. For example, the HLRA and effluent quality can affect biozone development and its concomitant effect on uniformity of infiltration and hydraulic retention time in the subsurface soil prior to ground water recharge. In the absence of a biozone, the method of delivery and distribution can be chosen based on the infiltrability of the natural soil so that a desired uniformity of infiltration and unsaturated flow regime can be achieved.

Design for Effluent Infiltration

Historical Perspectives on HLRD Guidance

Guidance for selecting a HLRD value for a given STU (whether HLRD be code prescribed or selected during engineering of a site-specific design) has evolved over the years, but the approaches to selecting HLRD values and the values used in regulatory codes across the U.S. remain remarkably varied, and it is often difficult to document the underlying scientific basis for code required design values. For example, it is difficult to document the basis for how small differences from a highly imprecise hydraulic test of a soil horizon (e.g., 10 vs. 15 minute-per-inch percolation rate) can provide adequate insight into soil infiltrability properties to enable selection of 0.60 gpd/ft2 rather than 0.55 gpd/ft2 for STE HLRD. Similarly it is difficult to understand why in some jurisdictions, 4 feet of unsaturated soil to ground water or seasonal saturation is required while in others, as little as 1 foot is all that is needed. Or, to know what the basis with respect to purification is for allowing HLRD for STU effluents discharged to an STU to be increased by 10- fold or the depth of unsaturated soil to be reduced by 50 percent.

Variability is not only present in code-prescribed values for HLRD, but also in national guidance that has been developed

Table 2 - Some Historical Perspectives Concerning HLR_D Guidance for Sizing STU's

	Soil type	Max loading rate (gpd/ft^2)
Soil Types = 4 Basis = soil K - curves Design infiltration surface = bottom area HLR_D's = 3 rates for DSTE	I. Sand	1.20
	II. Sandy loam	
	III. Silt loam	
	IV. Clay	

Source: University of Wisconsin-Madison, Small Scale Waste Management Project (Bouma 1975, SSWMP 1978

	Soil type	Percolation rate (min/in)	Application rate (gpd/ft^2)
Soil types = 6 Basis = soil percolation test Design infiltration surface = bottom area only HLRD's = 5 rates for DSTE	Gravel, coarse sand	<1	Unsuitable
	Coarse to medium sand	1 - 5	1.2
	Fine sand, loamy sand	6 - 15	0.8
	Sandy loam, loam	16 - 30	0.6
	Loam, porous silt loam	31 - 60	0.45
	Silty clay loam, clay loam	61 - 120	0.2

Source: USEPA Design Manual for Onsite Wastewater Treatment and Disposal Systems (USEPA 1980)

	Table 1 - Conceptual framework for hydraulic loading rates for subsurface foil treatment systems based on wastewater quality and soil classification according to the MESO diagram (Fig. 3) abot.			
Soil types = 3 Basis = soil grain size including mean grain size (d_{50}) vs. sorting (d_{50}/d_{10}) Design infiltration surface = bottom area HLR_D's = 3 rates for DSTE (o.25, 0.62, 1.2 gpd/ft^2) with adjustments for 4 other effluents (0.4x to 15.0x based on total BOD and TSS mass loadings)	Effluent type	Clayey + loamy + fine sand soils (Section 1 + 2A)[3)]	Loading rates (cm/d)2) Sorted soils (Section 2B)	Coarse sands + gravelly soils (Section 3)
	1. Septic Tank Effluent Restaurant and farm milkroom	0.5	1.0	2.0
	Domestic	1.0	2.5	5.0
	Graywater	1.5	5.0	10.0
	2. Aerobic unit effluent	2.0	7.5	15.0
	3. Domestic sand filter effluent	7.5	15.0	30.0
	1) The information is for informational purposes only and not intended for direct use in system design at this time. 2) If the hydraulic capacity is limited, lower loading rates may have to be applied. 3) If the saturated hydraulic conductivity of the soil is above 25m/d, loading rates as for Section 2B can be applied.			

Source: Jenssen and Siegrist (1990)

Table 2 (continued)

Texture	Structure		Hydraulic loading (gal/ft2-day)		Organic loading (lb BOD/1000ft2 - day)	
	Shape	Grade	BOD=150	BOD=30	BOD=150	BOD=30
Coarse sand sand, loamy coarse sand, loamy sand	Single grain	Structureless	0.8	1.6	1.00	.40
Fine sand, very fine sand, loamy fine sand, loamy very fine sand	Single grain	Structureless	0.4	1.0	0.50	0.25
Coarse sandy loam, sandy loam	Massive	Structureless	0.2	0.6	0.25	0.15
	Platy	Weak	0.2	0.5	0.25	0.13
		Moderate, strong				
	Prismatic, blocky, granular	Weak	0.4	0.7	0.50	0.18
		Moderate, strong	0.6	1.0	0.75	0.25
Fine sandy loam, very fine sandy loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.2	0.6	0.25	0.15
		Moderate, strong	0.4	0.8	0.50	0.20
Loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, mod., strong				
	Prismastic, blocky, granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Silt Loam	Massive	Structureless		0.2	0.00	0.05
	Platy	Weak, mod., strong				
	Prismatic, blocky granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Sandy clay loam, clay loam, silty clay loam	Massive	Structureless				
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.2	0.3	0.25	0.08
		Moderate, strong	0.4	0.6	0.50	0.15
Sandy clay, clay, silty clay	Massive	Structureless				
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak				
		Moderate, strong	0.2	0.3	0.25	0.08

and disseminated over the years. As revealed in **Table 2**, the design guidance for HLRD varies from relatively simplified onstructs with only a few rate values for a few soil groupings based on soil hydraulic properties to more complicated design matrices with numerous rate values for numerous soil classifications. Guidance addressing the other factors known to affect soil infiltrability has also varied (e.g., HLRD's for different effluent qualities).

Elements of a Rational Design Approach

Design guidance followed today in many jurisdictions across the U.S. is often "constrained" based on historical perspectives and conservative regulatory practices. Guidance normally focuses on treatment of DSTE and addresses basic parameters including: soil and site suitability for subsurface infiltration, design flow and sizing of the infiltrative surface area, geometry and features of the infiltration unit, and effluent application and distribution method. Guidance may also address special situations such as non-residential wastewater or larger flows. Regulatory requirements (e.g., state codes) and field practices may not promptly incorporate new research findings and modern guidance regarding system design and performance capabilities.

Major research findings during the past 5 to 10 years provide

Table 3 - Soil classification Scheme for Selecting HLR_D Values for STU Design

Soil class	Representative soil textures with structures that yield the representative hydraulic conductivity values shown	Representative cleanwater hydraulic conductivity (gpd/ft^2)	Maximum daily hydraulic loading rate (gpd/ft^2)
Class I	Sand, loamy sand	250 (1000 cm/d)	12.5 (50 cm/d)
Class II	Sandy loam, loam, silt loam	25 (100 cm/d)	2.5 (10 cm/d)
Class III	Silty clay loam, clay loam	2.5 (10 cm/d)	0.25 (1 cm/d)

Table 4 - Effluent Classification Scheme for Selecting HLR_D Values for STU Design

Effluent Type	Effluent compostion (mg/L)	Example treatment to achieve an effluent type	Base HLR_D for Class I soils (Sand, loamy sand)	Base HLR_D for Class II soils (Sand loam, silt loam)	Base HLR_D for Class III soils (Silty clay loam, clay loam)
Type I	$cBOD_5$ = 150 TKN = 60 TSS = 75	Anaerobic bioreactor with effluent screen	1.0 gpd/ft^2 (4 cm/d)	0.5 gpd/ft^2 (2 cm/d)	0.12 gpd/ft^2 (0.5 cm/d)
Type II	$cBOD_5$ = 30 TKN = 5 TSS = 30	Fixed film aerobic treatment unit	2.0 gpd/ft^2 (10 cm/d)	1.0 gpd/ft^2 (4 cm/d)	0.12 gpd/ft^2 (0.5 cm/d)
Type III	$cBOD_5$ = 5 TKN = 5 TSS = 5	Packed bed biofilter and effluent filter	4.0 gpd/ft^2 (20 cm/d)	1.0 gpd/ft^2 (4 cm/d)	0.25 gpd/ft^2 (1 cm/d)

new insight into STU design and performance. Enhanced understanding can be used to appropriately simplify the design process and assure reliable performance. It is likely and appropriate that "presumptive designs" will continue to be codeprescribed for isolated small systems treating domestic wastewater in areas where receiving environments have relatively high assimilative capacity. "Site-specific, performance-based designs" should increasingly be encouraged and facilitated for isolated small systems in sensitive settings as well as for larger commercial and non-residential systems, and clusters of sources and small communities. Presumptive- and performance-based designs should be based on contemporary scientific findings in light of previous research and insights from field experiences. Design guidance for HLRD (as well as other facets of a STU or complete onsite system) should not be over-complicated based on the level of understanding available. Rather, simplified design approaches and criteria should be used, consistent with the principles of Occam's Razor—"Shave off" (do not introduce) unnecessary entities in explanations.

Soil classification for setting a base hydraulic loading rate should be determined from the hydraulic properties of the soil profile within the STU with the hydraulic properties (e.g., Ksat) measured by sufficiently accurate and appropriate methods (i.e., something better that a crude percolation test). Maximum levels for HLRD should be set to sustain soil infiltrability at that rate during long-term, continuous application (i.e., routine daily operation) for a typical design life (e.g., 20 years). Maximum HLRD values for near-clean water quality effluent applied to an open soil infiltrative surface should be set such that the HLRD will not exceed 5 to 10 percent of the soil's Ksat (Table 3). Effluent classification should include three major effluent types as presented in Table 4. Base HLRD's are established for the three soil types and three effluent classes. These HLRD values are for an open, horizontal infiltrative surface based on the relative concentrations of key pollutants that control soil infiltrability and set to limit the applied loadings of total BOD and suspended solids to rates that can normally be assimilated by an aerobic soil environment. To facilitate lower soil water contents and higher profile aeration, these base HLRD values are constrained so that regardless of effluent quality, they do not exceed an upper limit set at 5 to 10 percent of the clean water Ksat of the soil prior to any effluent loading and assuming no construction damage. Adjustments to the base daily HLRD's are then made for design or operational features such as those outlined in **Table 5**.

Table 5 - Adjustment Factor Scheme for Selecting HLR_D Values for STU Design

Design or operation feature	Factor	Rationale
Construction impacts	0.1x or less	Account for the loss in clean-water Ksat due to compaction and smearing during installation
Infiltrative surface architecture	0.50x to 0.75x	Account for loss in long-term capacity due to solid objects including effects of fines and embedment as well as greater difficulty for monitoring and rehabilitation
Discontinuous operation during normal 20- year life	1.5x to 2.0x	Account for cyclic operation with extended rest periods; e.g., 1 year online and 3 years offline
Relatively short design service life	2.0x to 4.0x	Account for lessened loss in infiltration rate during 1- to 5-year design life.

The base HLRD values shown in **Table 4** are multiplied by a factor shown in **Table 5** to increase or decrease the base HLRD and arrive at the final HLRD. It is noted that factors of safety could be applied at this stage in the design process (assuming they are not embedded in the estimate of design flow or otherwise elsewhere during design). Some other hydraulic loading rate-related design parameters that need to be specified based on their effects on soil infiltrability and treatment performance are outlined in **Table 6**.

Table 6 - Some Other HLR_D Related Design Parameters and Suggested Design Attributes

Design or operation feature	Suggested design attributes and criteria
Geometry of the infiltration unit	Infiltration trenches preferred: width = $\leq$ 3 ft. and height $\leq$ 2 ft. Avoid large beds, especially for Type I effluents

Conclusions

Onsite and decentralized systems will continue to play a critical role in providing cost-effective wastewater infrastructure while enabling water reuse and resource recovery in the U.S. and abroad. For these systems to realize their full potential, the design process used to establish presumptive designs

Placement of the infiltration unit in the soil profile	Shallow placement in the soil profile: horizontal infiltrative surface normally ≤ 3 ft. bgs Depth to limiting condition (e.g. saturated conditions, bedrock): Type I to III effluents in Class I soil = ≥ 2 ft. Type I to III effluents in Class II and III soil = ≥ 3 ft.
Effluent distribution to the infiltration gallery (e.g., trench network)	Dosed application for all systems, such as provided by a pump: Class I soil = ≥ 4 doses per day Class II and III soil = ≤ 2 doses per day Equalized application to all online infiltration units For Type I effluent, soil clogging will enable more uniform infiltration out the horizontal infiltrative surface For Type II and III effluents, engineering (e.g. pressurized small diameter, perforated pipe) should ensure "uniform distribution" under conditions where clogging may be retarded or absent The instantaneous dosing rate should ≥ the soil's Ksat e.g., 1 gpm from an orifice to infiltrate 10 ft^2 provides a dosing rate of 144 gpd/ft^2 or 0.007 cm/s (similar to a Class I soil Ksat) For sensitive receiving environments (e.g., drinking water source water) consider: Use of Type III effluents For Type I and II effluents, use subsurface spray application within an open trench or shallow or at-grade drip dispersal
Cyclic and sequential loading	Application can be engineered using a pumping system with controls and data capture (e.g., cycles) to deliver effluent sequentially to online units of the STU Rather than attempting tryly "uniform distribution" aat startup, using dosing and sequential application of effluent at higher HLR_D values to one of more parts of the system; for example, a 4- trench network could be loaded with a 4- yr. cycle of 1 yr. on-line at 4x HLR_D and 3- year off-line; resting cycles on the order of 12 mon or more can help rejuvnate the hydraulic capacity of an infiltrative surface.

(e.g., local code requirements for small systems) and support site-specific engineering (e.g., for small systems in sensitive settings or for larger systems serving commercial businesses and small communities) needs to become more rational and more uniform across jurisdictions. This article outlines a potential design process and some selected design attributes for soil treatment units. The process and attributes described herein are not intended to be final but rather are provided to stimulate thinking about what the current design process is and how it might be made more rational. Moreover, preparation of this article will hopefully lead to dialogue and re-finements, not just for design of STU, but for the further development of a rational design process for a range of onsite and decentralized system technologies.

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This article was reproduced by permission of Robert L. Siegrist. Author Robert L. Siegrist, Ph. D, P.E. earns his B.S. and M.S in Civil Engineering, and his Ph.D. in Environmental Engineering at the University of Wisconsin. Dr. Siegrist is an internationally recognized expert in onsite water reclamation using natural systems and appropriate technology, and remediation of contaminated soil and groundwater using active and passive physicochemical and coupled bioprocess technologies.

The Standard Practice Manual ~ An ASTTBC Position

Glance into the Ministry of Health Sewerage System Standard Practice Manual (SPM) introduction and you will find a section dedicated to its purpose and content. To quote the document directly, the SPM "provides a form of standard design, installation, maintenance and supervision practice for sewerage systems.". As well, this manual serves as a guideline for acceptable standard practice for an authorized person in order to comply with the Ministry's Sewerage System Regulation (SSR).

So what does that mean for ASTTBC's registered practitioners – the Registered Onsite Wastewater Practitioner (ROWP)? ASTTBC has mandated through policy that its registered members use and strictly follow the SPM. In fact, you'll find this type of language common throughout the policy document.

It is ASTTBC's expectation for all ROWPs to adhere to the guidelines set forth by the SPM. An exception would be a case where there could be a deviation from those guidelines but where it is fully supported by appropriate professional opinions and supporting documents – a professional engineer for example. Not following ASTTBC's strict requirement to adhere to the SPM could have negative results and consequences.

Take this recent ASTTBC Practice Review Board (PRB) ruling summary, where it was alleged that an ASTTBC ROWP failed to meet the requirements of the SPM. Primarily, there was concern expressed by the local Health Authority with respect to a member who installed a septic system under the required SPM setback requirements from a water source. Through ASTTBC's practice review and investigation, it was deemed that the member did fail to meet the requirements as well as committing a breach of the ASTTBC Code of Ethics. In this case, the Practice Review Board expedited the resolution of this matter by the ROWP member agreeing to a stipulated Order, which included the following as one of the conditions: The ROWP member agreed to make acceptable compensation to the owner of the site for remedial work required to the property along with a verification of compliance.

Take time to really know and understand the requirements of the Standard Practice Manual. It is through extensive technical consultation that the SPM has been created and maintained. It is exactly what its title says – a manual of standard practice. The fact is again, ASTTBC's registered practitioners are required to follow it.

Jason Jung, ASTTBC

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