SEWERAGE SYSTEM STANDARD PRACTICE MANUAL
APPENDICES
1 DRAFT 0.4 1 NOVEMBER 2006

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A Sewerage System Regulation

B.C. Reg. 326/2004 Deposited July 8, 2004
O.C. 701/2004 effective May 31, 2005

Health Act

SEWERAGE SYSTEM REGULATION

Contents

Part 1 — Definitions and General Rules

Definitions

1 In this regulation:

"Act" means the *Health Act*;

"authorized person" means a registered practitioner or a professional;

"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 a professional, to supervise the doing of any matter listed in paragraphs (a) and (b);

"discharge area" means an area used to receive effluent discharged from a treatment method;

"domestic sewage" includes

(a) human excreta, and

(b) waterborne waste from the preparation and consumption of food and drink, dishwashing, bathing, showering, and general household cleaning and laundry, except waterborne waste from a self-service laundromat;

"effluent" means domestic sewage that has been treated by a treatment method and discharged into a discharge area;

"health authority" means the regional health board established under the *Health Authorities Act* that has jurisdiction over the geographic area in which a sewerage system is located;

"health hazard" includes

(a) the discharge of domestic sewage or effluent into

(i) a source of drinking water, as defined by the *Drinking Water Protection Act*,

(ii) surface water,

(iii) tidal waters, or

(iv) a sewerage system that, in the opinion of an inspector, is not capable of containing or treating domestic sewage, and

(b) the discharge of domestic sewage or effluent onto land;

"holding tank" means a watertight container for holding domestic sewage until the domestic sewage is removed for treatment;

"inspector" means a medical health officer or a public health inspector;

"maintenance", in the case of a professional, includes to supervise the maintenance of a sewerage system;

"maintenance plan" means a set of instructions for maintaining a sewerage system that, if followed, will ensure that the sewerage system does not cause, or contribute to, a health hazard;

"owner", in respect of land on which a sewerage system or holding tank is, or is required to be, constructed under this regulation, includes

(a) a person registered in the land title records as the owner of the land, whether entitled to the land in the person's own right, in a representative capacity or otherwise,

(b) a lessee or a person holding a licence to occupy the land, and

(c) if a sewerage system or holding tank serves more than one parcel, strata lot or shared interest, the strata corporation or other corporate entity that developed the parcels, strata lot or shared interest, as applicable;

"parcel" means any lot, block or other area in which land is held or into which it is subdivided, but does not include land covered by water;

"professional" means a person who meets the requirements of section 7 (3) *[authorized persons]*;

"registered practitioner" means a person who is qualified to act as a registered practitioner under section 7 (1) or (2);

"registration certificate" means a registration certificate issued by the Applied Science Technologists and Technicians of British Columbia that certifies that the holder is competent to construct and maintain a sewerage system that uses a treatment method classified as Type 1 or Type 2;

"septic tank" means a watertight container for receiving, treating and settling domestic sewage;

"sewerage system" means a system for treating domestic sewage that uses one or more treatment methods and a discharge area, but does not include a holding tank or a privy;

"shared interest" means a shared interest in land as defined in the *Real Estate Development Marketing Act*;

"standard practice" means a method of constructing and maintaining a sewerage system that will ensure that the sewerage system does not cause, or contribute to, a health hazard;

"strata lot" means a strata lot as defined in the *Strata Property Act*;

"surface water" means a natural watercourse or source of fresh water, whether usually containing water or not, and includes

(a) a lake, river, creek, spring, ravine, stream, swamp, gulch and brook, and

(b) a ditch into which a natural watercourse or source of fresh water has been diverted,

but does not include ground water or water in a culvert that is constructed to prevent the contamination of a watercourse by domestic sewage or effluent;

"treatment method" means a treatment method for domestic sewage classified as Type 1, Type 2 or Type 3 where

(a) Type 1 is treatment by septic tank only,

(b) Type 2 is treatment that produces an effluent consistently containing less than 45 mg/L of total suspended solids and having a 5 day biochemical oxygen demand of less than 45 mg/L, and

(c) Type 3 is treatment that produces an effluent consistently containing less than 10 mg/L of total suspended solids and having

(i) a 5 day biochemical oxygen demand of less than 10 mg/L, and

(ii) a median fecal coliform density of less than 400 Colony Forming Units per 100 mL.

Application

2 This regulation applies to the construction and maintenance of

(a) a holding tank,

(b) a sewerage system that serves a single family residence or a duplex,

(c) a sewerage system or combination of sewerage systems with a combined design daily domestic sewage flow of less than 22 700 litres that serves structures on a single parcel, and

(d) a combination of sewerage systems with a combined design daily domestic sewage flow of less than 22 700 litres that serves structures on one or more parcels or strata lots or on a shared interest.

Discharge of domestic sewage

3 (1) The owner of every parcel on which a structure is constructed or located must ensure that all domestic sewage originating from the structure

(a) is discharged into

(i) a public sewer,

(ii) a holding tank that is constructed and maintained in accordance with Part 2 *[Holding tanks]*, or

(iii) a sewerage system that is constructed and maintained in accordance with Part 3 *[Sewerage systems]*, and

(b) does not cause, or contribute to, a health hazard.

(2) Despite subsection (1), a person may discharge domestic sewage or effluent into waters as described in paragraph (a) (i), (ii) and (iii) of the definition of a "health hazard" if authorized under another enactment.

Part 2 — Holding Tanks

Permit for holding tank

4 (1) A person must not construct a holding tank unless the person holds a permit issued under this section.

(2) A person may apply for a permit to construct a holding tank by submitting to an inspector, in a form acceptable to the inspector,

(a) information respecting

(i) the person's name, address and telephone number,

(ii) the type of structure the holding tank will serve, and

(iii) any other information relevant to the holding tank or structure that the inspector requires,

(b) a description of the holding tank, or of alterations or repairs to the holding tank,

(c) the proposed maintenance plan for the holding tank, and

(d) a permit fee of $400.

(3) On receiving an application under subsection (2), an inspector may

(a) make an inspection to determine whether to issue a permit under paragraph (b), and

(b) issue a permit to construct a holding tank only if satisfied that

(i) a holding tank is adequate to deal with the domestic sewage originating from the structure, and

(ii) the use of the holding tank will not, if the maintenance plan is followed, cause, or contribute to, a health hazard.

(4) An inspector may attach any conditions to a permit that are necessary for the inspector to be satisfied of the matters listed under subsection (3).

(5) If an inspector attaches conditions to a permit, the person who constructs the holding tank must comply with those conditions.

Maintenance of holding tank

5 (1) An owner must ensure that a holding tank on the owner's land is maintained in accordance with the maintenance plan provided under section 4 (2) (c) *[permit for holding tank]*, as modified by any conditions attached to the holding tank permit.

(2) An owner must keep records of maintenance carried out under subsection (1).

Part 3 — Sewerage Systems

Restriction on construction and maintenance

6 (1) Unless qualified as an authorized person, a person must not construct or maintain a sewerage system that uses a treatment method classified as Type 1 or Type 2.

(2) If the registration certificate of a registered practitioner contains any restrictions or conditions, a registered practitioner who constructs or maintains a sewerage system must comply with those restrictions or conditions.

(3) Unless supervised by a professional, a person must not construct or maintain a sewerage system

(a) that uses a treatment method classified as Type 3, or

(b) designed for an estimated minimum daily domestic sewage flow of more than 9 100 litres.

Authorized persons

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

(a) has successfully completed a post-secondary training program through

(i) the West Coast Onsite Wastewater Training Centre, administered by the British Columbia Onsite Sewage Association, or

(ii) through an institution that

(A) is designated, registered or accredited under an enactment of Canada or any province, except British Columbia, to offer post secondary education, and

(B) 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 practitioner if the person

(a) demonstrates to the British Columbia Onsite Sewage Association 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.

Filing

8 (1) This section does not apply to the construction of a sewerage system in respect of which information and documents have been filed under subsection (2) on a previous occasion, unless

(a) a significant alteration or repair is being made on the sewerage system, or

(b) the construction of the sewerage system is in response to an order made under section 11 (1) (b) (ii), (iii) or (iv) *[inspections and orders]*.

(2) Before construction of a sewerage system, an authorized person must file with the health authority, in a form acceptable to the health authority,

(a) information respecting

(i) the name, address and telephone number of the owner for whom the sewerage system is being constructed,

(ii) the type of structure the sewerage system will serve, and

(iii) the type, depth and porosity of the soil at the site of the sewerage system,

(b) plans and specifications of the sewerage system, or of alterations or repairs to the sewerage system, prepared by an authorized person and with the seal of the authorized person affixed,

(c) written assurance that the plans and specifications filed under paragraph (b) are consistent with standard practice, and

(d) if construction of the sewerage system is in response to an order made under section 11 (1) (b) (ii), (iii) or (iv), a copy of the order.

(3) To determine whether the plans and specifications filed under subsection (2) (b) are consistent with standard practice, an authorized person may have regard to the Ministry of Health Services' publication ",Sewerage System Standard Practice Manual" as amended from time to time.

(4) If there is a material change in the information filed under subsection (2) before the authorized person provides a letter of certification under section 9 (1) (b) *[letter of certification]*, the authorized person must promptly file an amendment with the health authority.

Letter of certification

9 (1) Within 30 days of completing the construction of a sewerage system to which section 8 *[filing]* applies, an authorized person must

(a) provide the owner with

(i) a copy of the sewerage system plans and specifications as provided to the health authority under section 8 (2) (b),

(ii) a maintenance plan for the sewerage system that is consistent with standard practice, and

(iii) a copy of the letter of certification provided to the health authority under paragraph (b),

(b) file with the health authority a signed letter certifying that

(i) the authorized person has complied with the requirements of paragraph (a),

(ii) the sewerage system has been constructed in accordance with standard practice,

(iii) the sewerage system has been constructed substantially in accordance with the plans and specifications filed under section 8 (2) (b),

(iv) for a sewerage system described in section 2 (c) or (d) *[application]*, the estimated daily domestic sewage flow through the sewerage system will be less than 22 700 litres, and

(v) if operated and maintained as set out in the maintenance plan, the sewerage system will not cause or contribute to a health hazard, and

(c) append to the letter required under paragraph (b)

(i) a plan of the sewerage system as it was built, and

(ii) a copy of the maintenance plan for the sewerage system.

(2) To determine whether sewerage system construction and a maintenance plan in respect of the sewerage system are consistent with standard practice, an authorized person may have regard to the Ministry of Health Services' publication "Sewerage System Standard Practice Manual", as amended from time to time.

(3) If an authorized person does not file a letter of certification under subsection (1) (b) within one year from filing information about the sewerage system under section 8, the authorized person must not begin or continue construction of the sewerage system until the authorized person files new information under section 8.

Maintenance of sewerage system

10 (1) An owner must ensure that a sewerage system on the owner's land is maintained in accordance with the maintenance plan provided in respect of the sewerage system.

(2) An owner must keep records of maintenance carried out under subsection (1).

(3) An authorized person who makes a repair or alteration to a sewerage system must provide the owner with an amendment to the maintenance plan if

(a) section 8 *[filing]* does not apply to the repair or alteration, and

(b) the maintenance plan previously provided under section 9 (1) (a) (ii) *[letter of certification]* is, if followed, no longer sufficient to ensure that the sewerage system does not cause, or contribute to, a health hazard.

Part 4 — Enforcement

Inspections and orders

11 For the purpose of determining whether a holding tank or sewerage system is the cause of, or may be contributing to, a health hazard, an inspector may

(a) inspect, in accordance with section 61 *[inspection authority]* of the Act,

(i) the parcel on which the holding tank or sewerage system is located, and

(ii) any parcels that may be affected by the health hazard, and

(b) order an owner, in accordance with section 63 *[order]* of the Act, to do one or more of the following:

(i) connect a structure to a public sewer;

(ii) connect a structure to, in the inspector's discretion, a holding tank or sewerage system;

(iii) alter or repair a holding tank or sewerage system;

(iv) take any other action necessary to remedy the health hazard.

Offences

12 A person commits an offence if the person

(a) knowingly makes a false or misleading statement

(i) in the information submitted or filed under section 4 *[permit for holding tank]* or 8 *[filing]*,

(ii) in providing the information required under section 9 *[letter of certification]*, or

(iii) during an inspection under section 11 (a) *[inspections and orders]*,

(b) constructs or maintains a sewerage system without proper qualifications, as set out in section 6 *[restriction on construction and maintenance]*,

(c) constructs a holding tank or sewerage system, or fails to repair or maintain a holding tank or sewerage system, in a manner that causes or contributes to a health hazard,

(d) fails to comply with

(i) a requirement to file any of the matters described in section 8,

(ii) a requirement to provide information or a letter of certification under section 9, or

(iii) an order under section 11 (b), or

(e) operates

(i) a holding tank for which no permit has been issued under section 4, or

(ii) a sewerage system for which no letter of certification has been filed under section 9.

Note: this regulation replaces B.C. Reg. 411/85.

[Provisions of the *Health Act*, R.S.B.C. 1996, c. 179, relevant to the enactment of this regulation: section 8]

B Performance at boundaries

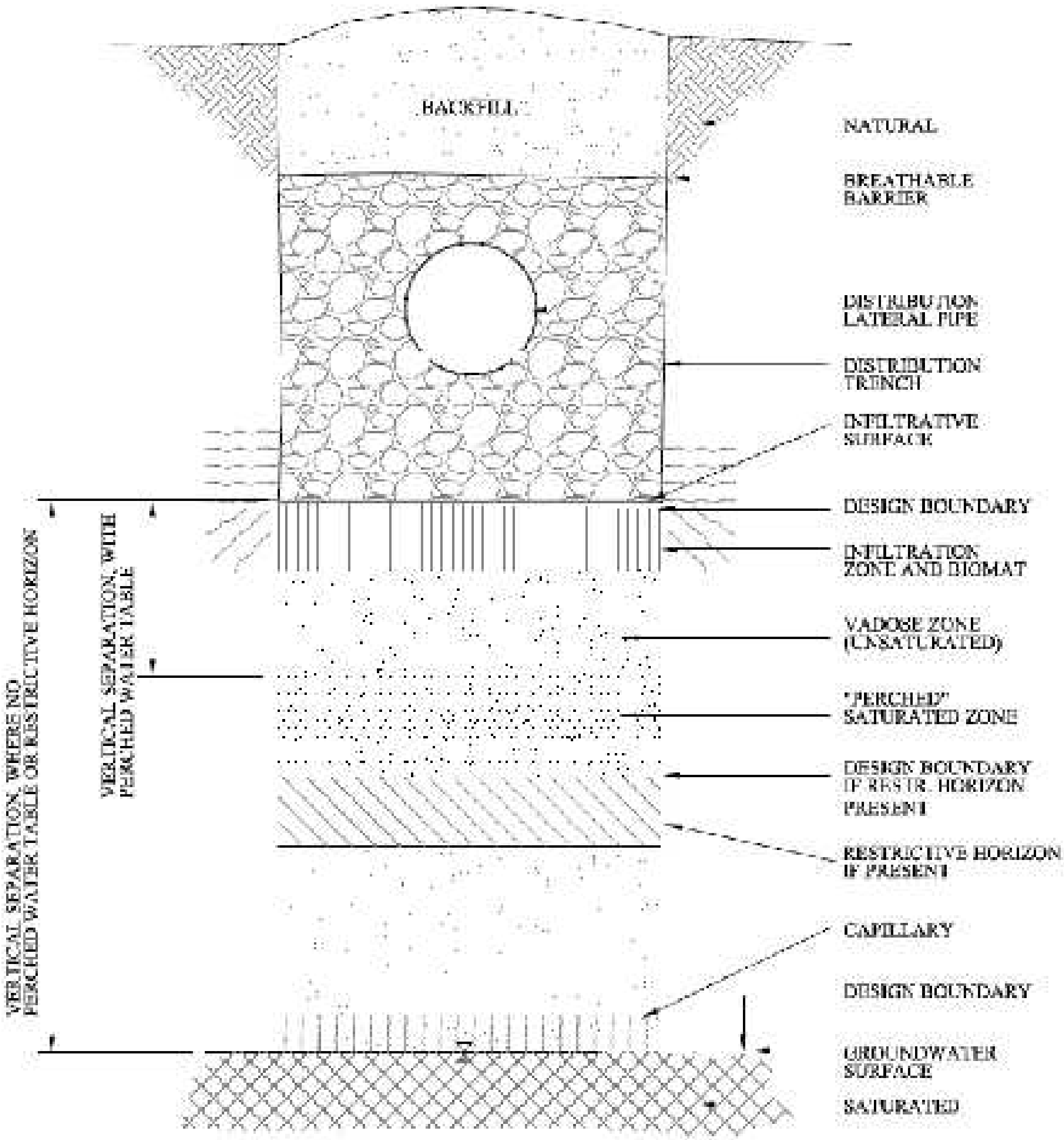
Prior to effluent reaching the groundwater table or restrictive layer below the dispersal area certain performance requirements must be met in regard to effluent treatment.

Two types of boundaries may be considered, design boundaries (example trench infiltrative surface) and compliance boundaries (example drinking water well). For the latter, monitoring must be possible to establish whether the performance is being met. For the former, in some cases monitoring is feasible, in others less so.

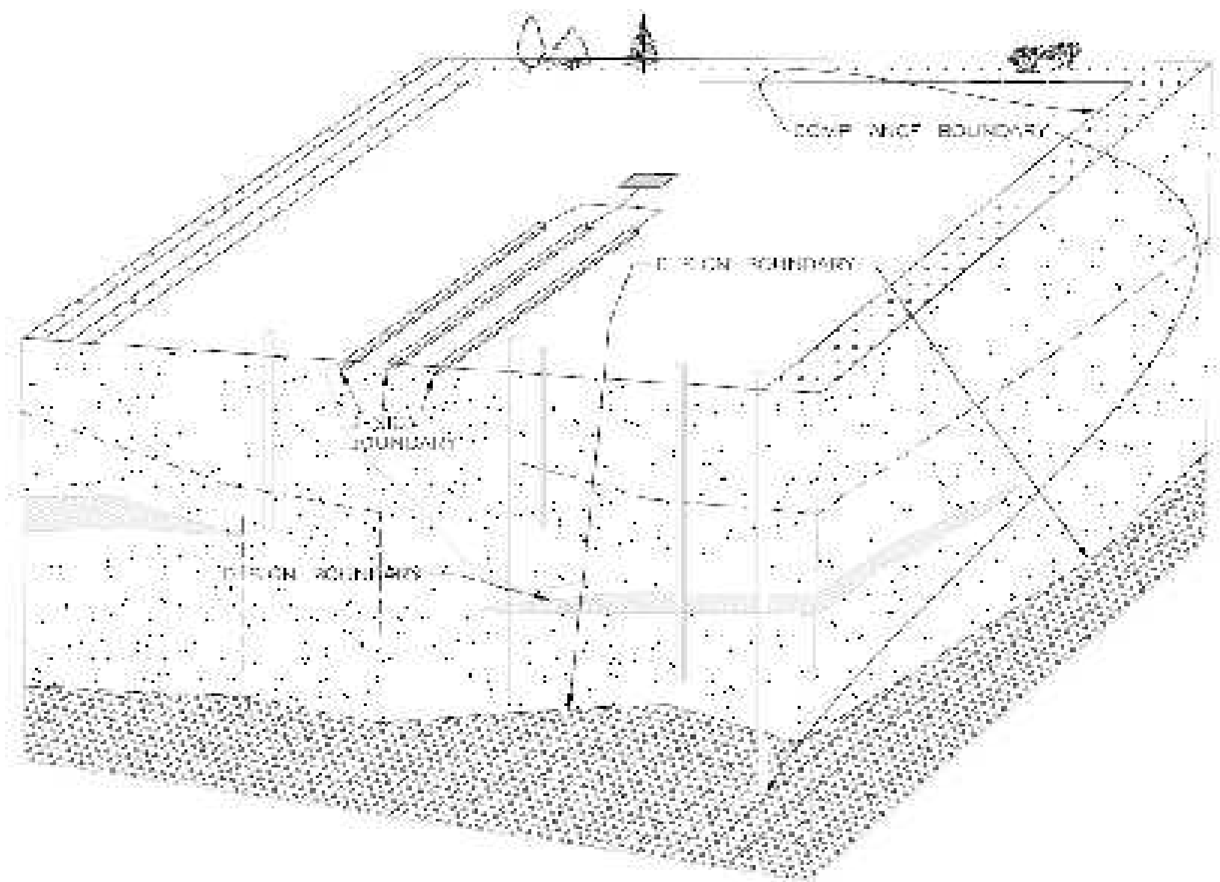
The level of treatment required is related to the risk associated with the boundary under consideration. Thus, for example, performance must be higher at fractured rock boundary where saturated flow in the fractured rock connects directly to a fractured rock drinking water aquifer than it must be at a layer of clay in an area served by a municipal water system. Performance requirements are also related to the type of soil water movement on the site. In certain cases there may also be a concern of heavy rainfall (particularly where concentrated by landform) causing contaminants to be washed from the soil to the water table.

In the current industry in BC it is more practical to utilize required vertical and horizontal separation standards than to require monitoring of performance at boundaries. However, the Authorized Person must take into account the purpose of vertical separation, and be prepared to increase vertical separation where this is mandated by the level of risk or the soil/water conditions of a site.

Where horizontal travel is in saturated soil or in an aquifer, treatment will be much slower than in the unsaturated vertical separation, unsaturated soil is 30 to 100 times more effective of a treatment medium than saturated soil. Thus, large horizontal separations may not replace proper vertical or unsaturated separation.



Cross section of a dispersl trench, showing design boundaries. The ground surface would be considered a compliance boundary.



An onsite sytem, showing some design and compliance boundaries

A.1 Guidance for professionals using performance criteria

Where a professional is considering moving outside the provisions of this manual's standards they must include in the documentation of their design a clear statement of the reasoning for their choice, including the way in which it will achieve the base and defined performance standards and support from peer reviewed sources for the choice. This may include linkage of improved vertical separation to reduced horizontal setback, for example.

A qualified Professional base their onsite design on a site-specific, project-specific human health and environmental risk assessment. This would examine the actual uses of water for that project, and establish specific water quality criteria at various points-of-compliance, considering, at least:

(1) Type of water use
(2) Volume, timing, and frequency of water use

(3) Background or baseline water quality
(4) Processes that can be expected to change the concentrations between the monitoring point and the point of water use(biodegradation, denitrification, vegetative uptake, dilution, etc).

The site-specific issues listed above are relevant, in particular, where a surface water body is also a drinking water supply.

Where performance standards are used in design by a professional to reduce the SPM vertical and horizontal setback requirements, compliance with these standards must be assured.

In order to provide guidance for smaller projects, the following table summarizes generic, conservative performance standards for common compliance and design boundary conditions.

A.1.1.1 Performance at boundaries

Boundary	**Performance required**	**Performance compliance in sample taken from:**	**Notes**
	Fecal coliforms in CFU/100ml		
Drinking water well or other drinking water source	Maximum nitrate nitrogen < 10 mg/L – max. fecal coliform bacteria < 1	Water well or source, or monitoring well in same aquifer as well.	Where background nitrate levels are >10 mg/L the onsite system should not raise them above the background level.
Surface breakout	Median total nitrogen < 30 mg/L Median fecal coliform < 200 – maximum fecal < 1000 Median total phosphorous < 1.0 mg/L	Groundwater at breakout	Includes breakout to drain which discharges to surface or to a water body. Where drains do not exit to surface or surface water source, the drain receiving system must be designed to receive effluent per the standard of treatment expected.
Fresh water body	Median fecal < 400 – maximum fecal < 1000	Ground water at a point of discharge to the body of fresh water	
Fresh water body,	Median total	Ground water at a point	

where Nitrogen and Phosphorous are to be limited	nitrogen < 30 mg/L Median ammonia nitrogen < 2.0 mg/L Median fecal < 400 – maximum fecal < 1000 Median total phosphorous < 1.0 mg/L	of discharge to thebody of fresh water	
Water table or flow restrictive horizon.	BOD <5 mg/L Median fecal coliform < 200 – maximum fecal < 1000	Design boundary	Where water table does not form part of an aquifer used for drinking water supply
Ocean water	Median fecal < 14 – 90th percentile fecal < 43 Median total nitrogen < 20 mg/L Median ammonia nitrogen < 2.0 mg/L	Ground water at a point of discharge to thebody of ocean water.	90th percentile means 9 out of 10 samples. Where area of discharge is not used for food production (shellfish etc), and beach is not accessible at low tide may meet Fresh water body standards.
Property line	Median fecal < 400 – maximum fecal < 1000	Design boundary	

C Source Control Policy from BCOSSA Maintenance Plan template.

(for Residential Systems with Design Flow Rate of 550 Imperial Gallons/Day or Less)

The residence is permitted to discharge up to a design flow rate ______ Imperial Gallons per day of effluent into the system at a peak flow; however, the average flow to the system over any week period must not exceed _____ Imperial Gallons per day (50% of design flow rate).

The system is intended for use with normal residential effluent. There are various quality requirements for the effluent discharged from the home to the system, and it is the owner's responsibility to ensure that these are complied with. It is recommended that owners ensure that their liability insurance covers them for liability associated with discharge of effluent that causes damage to the environment. The following should not be discharged:

1. Any sewage in a volume or flow rate greater than shown above;
2. Any sewage in flow rate exceeding 15.4 Imp. Gallons per minute;
3. Any sewage in flow rate exceeding _____ Imp. Gallons per hour
   (8 times daily design flow rate per hour, *eg 550/24 x 8 = 183 IG/hr*);
4. Any liquid or vapor having an average temperature higher than 50°C;
5. Any flammable or explosive material;
6. Any garbage;
7. Any metal, plastic, wood or other solid or viscous substance capable of causing obstruction or interference with the proper operation of the sewerage system or treatment process;
8. Any sewage or industrial waste having a pH limit less than six (6.0) or greater than nine (9);
9. Any sewage or industrial waste containing any of the following materials in excess of the indicated concentrations:

1	B.O.D.5	300	mg/L
2	Suspended solids	350	mg/L
3	Total sulfide expressed as H2	5	mg/L
4	Phenolic compounds	2	mg/L
5	Oil and grease	50.0	mg/L
6	Total cyanide expressed as HCN	0.2	mg/L
7	Total copper expressed as Cu	1.0	mg/L
8	Total chromium expressed as Cr	1.0	mg/L

9	Total nickel expressed as Ni	1.0 mg/L
10	Total lead expressed as Pb	1.0 mg/L
11	Total zinc expressed as Zn	1.0 mg/L
12	Total cadmium expressed as Cd	.05 mg/L
13	Total phosphorus expressed as P	15.0 mg/L
14	Total arsenic	0.5 mg/L
15	Total mercury	.006 mg/L
16	Total silver	1.0 mg/L

"B.O.D.5" (denoting biochemical oxygen demand) means the quantity of oxygen utilized in the biochemical oxidation of organic matter under standard laboratory procedure in five (5) days at 20°C, expressed in milligrams per liter.
"pH" means the logarithm of the reciprocal of the weight of hydrogen ions in grams per liter of solution and denotes alkalinity or acidity.

10. Any water or waste containing a toxic or poisonous substance capable of constituting a hazard to humans or animals, or any water or waste containing substances in such concentrations that are not amenable to treatment or reduction by the sewage treatment process employed, or are amenable to treatment only to such a degree that the sewage treatment plant effluent and sludge cannot meet the requirements of any other agency having jurisdiction over discharges from the system, or which would damage the dispersal field soils (this would include such items as excess chlorine bleach, excess sodium, disinfectant cleaners, drain cleaner, photochemicals etc);

11. Any substance that when concentrated in sewage treatment plant, effluent disposal fields, or in sludge, could result in a contaminated site (this would include paints and solvents);

12. Rainwater runoff from the surface or from roofs etc, storm or surface water, water from swimming pools or hot tubs;

13. Grease, oil, solvents etc;

14. Flushing water from water softeners;

15. Output from Garburators; and,

16. It is recommended that owners refer to the information in regard of Onsite wastewater systems, attached.

D Recommendation for Field Tests of Soil Permeability

A.2 Soil Hydraulic Conductivity

This Appendix is a recommended guide for field tests of soil permeability, including percolation tests and the constant-head borehole permeameter.

Field tests of soil hydraulic conductivity, or permeability, must be conducted in the planned drainfield area, in unsaturated native soils, at the depth of the planned infiltration surface. A variety of test methods may be used, including the constant-head borehole permeameter (Pask or Guelph Permeameter), double ring infiltrometer, and trench pump-in test. These tests estimate the soil's saturated hydraulic conductivity (Ksat) by temporarily saturating a zone or bulb of soil within the unsaturated zone. The calculated hydraulic conductivity is therefore referred to as the field-saturated soil hydraulic conductivity (Kfs), which will be less than Ksat.

A.2.1 Permeameter

In order to utilize the Guelph constant head permeameter with the Glover or Elrick and Reynolds formulae; the permeameter auger hole base should be at least 2 times the water depth (H) from an impermeable layer below the base of the hole. Also, the ratio of water depth/hole radius must be greater than 5.

In addition to these constraints, care must be taken to consider the possibility of high apparent permeability due to macropore flow, particularly in root channels or where the soil is underlain by fractured bedrock or an inceptisol with very strong structure. For this reason, field calculation of the Kfs value will assist.

When using test results from a constant-head borehole permeameter, the Ksat may be estimated as 2.0 x Kfs (Gupta et al, 1994).

The Kfs value that is used to calculate HLR should normally be based on at least four field tests and the Kfs value used should be the second lowest value measured. For example, consider the following four test results for Kfs using a constant-head borehole permeameter: (1) 36 cm/day; (2) 47 cm/day; (3) 78 cm/day; (4) 19 cm/day. The design Kfs used should be no more than the second lowest value, 36 cm/day.

Using the same example, and assuming a Type 1 system with a design Kfs of 25 to 50 cm/day, the design HLR would be 24 Lpd/m^2.

If six or more tests are conducted, the third lowest Kfs value may be used as the representative value.

Where soils are sodic, or where they contain swelling clay or where SAR/salinity of the effluent to be applied is of concern; utilize water of representative SAR and salinity for testing. This will avoid problems of measuring higher or lower permeability than that which will be found when the effluent is applied. This is likely to be less of an issue where significant biomat is projected. It is not recommended to address SAR or salinity separately, as their affect on clay soils is linked. See appendix .

A.2.2 Percolation Tests

When using percolation tests, a minimum of four tests must be conducted, and the value used for selecting a soil hydraulic loading rate must be the second slowest percolation rate.

This simple protocol follows the widely recommended approach of using a design value that is no higher than the median, but higher than the worst-case measurement, which is not normally representative. A Professional may use a different protocol than that outlined above, provided the reasoning is documented.

In all cases, the planner or Professional that tests the soil permeability must document the type of test, the standard method used, the location and depth of each test, the complete test results, and the calculations of soil hydraulic conductivity. In most cases, this information can be recorded on a standard field form.

A.2.2.1 Procedure for Percolation Test

The percolation test is to be conducted as follows in order to determine the suitability of the soil to absorb effluent:

(1) percolation test holes must be made at points and elevations selected as typical in the area of the proposed absorption field;

(2) Test holes must be dug at each end of the area of the absorption field. Further holes may be required, depending upon the nature of the soil, the results of the first tests and the size of the proposed absorption field;

(3) test holes must be 30 cm (12 in.) square and excavated to the proposed depth of the absorption field;

(4) to make the percolation test more accurate, any smeared soil should be removed from the walls of the test holes;

(5) If the soil contains considerable amounts of silt or clay, the test holes must be pre-soaked before proceeding with the test. Pre-soaking is accomplished by keeping the hole filled with water for 4 hours or more. The test must be carried out immediately after pre-soaking;

(6) To undertake the test, fill the test hole with water. When the water level is 13 cm (5 in.) or less from the bottom of the hole, refill the hole to the top. No recording of time needs be done for these 2 fillings;

(7) when the water level, after the second filling (procedure (6)) is 13 cm (5 in.) or less from the bottom of the hole, add enough water to bring the depth of water to 15 cm (6 in.) or more;

(8) observe the water level until it drops to the 15 cm (6 in.) depth, at precisely 15 cm (6 in.), commence timing, when the water level reaches the 12.5 cm (5 in.) depth, stop timing, record the time in minutes;

(9) repeat procedures (7) and (8) until the last 2 rates of fall do not vary more than 2 minutes per 2.5 cm (per inch);

(10) determine the percolation rate for the proposed sewage disposal system by averaging the slowest rate determined for each of the test holes;

(11) Backfill the holes with the excavated soil and flag their locations.

E Design HLR

A.3 Introduction

Design manuals and research papers recommend various methods to estimate or select a design soil hydraulic loading rate (HLR) for an onsite sewage system. With any method used, the intent should be to try to estimate the long-term acceptance rate (LTAR) of the native soil, considering the tendency for soil clogging and biomat formation to gradually reduce the effective permeability, or hydraulic conductivity, of the soil at or near the infiltration surface. This gradual development of a LTAR is due to three main factors:

- Accumulation of suspended solids and biological growth
- Deposition of organic matter on the surface of the soil pores
- Increase in sodium concentration in the soil leading to clay particle dispersion

For Type 1 effluent, the first two factors are normally the most important and are normally termed “biomat” or “clogging mat”.

The three main methods for selection of a LTAR based on site investigation that are well-documented in manuals and research papers are:

(1) Percolation tests, with empirical tables to calculate either the drainfield length or the HLR;

(2) Soil texture, or texture and structure, used to select a soil HLR from an empirical table;

(3) Tests of the soil’s hydraulic conductivity (K), with a formula or table to calculate the soil HLR from K.

Registered Planners and Professionals should use at least two of these three methods when selecting a design HLR, and one of these must be method 2.

This appendix presents expanded discussion and references to provide background to the HLR table and notes provided in Part 2 of the SPM.

For a detailed literature review, refer to the report of the Washington State Rule Development Committee (2001), which is available on the internet.

Reference:

BC Sewerage System Regulation Standard Practices Manual: Recommendation for Selecting a Design Soil Hydraulic Loading Rate; Michael Payne, Payne Engineering Geology, 2005, unpublished

A.4 Discussion of HLR Table, Part 2 of SPM

The HLR table in part 2 of the SPM presents 3 methods for selection of HLR for a soil.

Percolation tests (Method 1) have seen widespread use in BC, both for small and large sewage systems with ground discharge. The practice of calculating a soil HLR based on a percolation rate is also well documented in design manuals (US EPA, 1980; Winneberger, 1985). While Method 1 may still be useful, especially for practitioners unfamiliar with the other methods, the percolation test approach has significant shortcomings, as discussed in US EPA (2002) and Smith (2000).

Other reports and manuals provide a strong technical basis for use of Soil texture and structure (Method 2), particularly Tyler (2001), Smith (2000; 2004), and US EPA (2002).

This appendix 2 additionally provides the technical basis for use of hydraulic conductivity (Method 3) for selection of a HLR.

The table utilizes a simplified classification of soil structure. A qualified Professional may choose to divide structure types and grades into 3 or 4 classes, for example, good-fair-poor-very poor.

The hydraulic loading rates in the SPM HLR table are generally consistent with those in published manuals, research papers, and regulations, including Washington State. The constraints indicated in the notes to the table and the use of daily design flows per the SPM is critical to its use.

A.4.1 Reduced BOD and TSS

With each method, the HLR that is selected for a particular system depends on the effluent quality. Generally, with a higher quality effluent, or lower BOD, the design HLR will be higher, and the infiltration surface area (AIS) will be smaller. Many designers of larger infiltration systems account for BOD loading more directly by calculating the design organic mass loading rate, commonly expressed, in metric units, as grams of BOD per day per square metre.

The US EPA (2002) recommends an organic loading rate of less than 5 g/d/sqm. Under the BC Sewerage System Regulation, the following effluent quality classes, and corresponding BOD, are defined:

Table 1 - Effluent Quality Types BC Sewerage System Regulation

Type	BOD (mg/L)
Type 1	100 – 140
Type 2	< 45
Type 3	< 10

Type 1 effluent is septic tank effluent; the BOD indicated is typical. Type 3 effluent is also disinfected to < 400 CFU / 100 mL.

Referring to the table, it is useful to note that, if a soil HLR were to be selected primarily on organic loading rate, the HLR for Type 2 pre-treatment would be about 2.5 times that for Type 1, and the HLR for Type 3 would be 12 times that for Type 2.

However, in selecting loading rates it is also necessary to consider the requirements for in-soil removal of pathogens. As loading rates are increased with wastewater that causes less biomat formation this leads to shorter in-soil retention and reduction in effectiveness of pathogen removal (Converse and Tyler 1998, Siegrist et Al 2000), assuming that the system design and HAR remain the same. This leads to the SPM standards for Type 2 effluent application, and to the recommendation for use of pressure distribution and timed dosing for Type 2 effluent application when the higher loading rates are used, particularly in coarser soils.

In the SPM HLR table, the recommended HLRs for Type 3 effluent are higher than recommended by some researchers for effluent with BOD < 10 mg/L. This is because, under the BC Sewerage System Regulation, Type 3 effluent must be disinfected, and because high frequency pressure dosing is required for Type 3 effluent discharged to sandy soils (soils with Kfs > 25 cm/d).

References:

Converse, J.C. and E.J. Tyler. 1998. *Soil Treatment of Aerobically Treated Domestic Wastewater with Emphasis on Modified Mounds. In On-Site Wastewater Treatment*: Proceedings of the Eighth National Symposium on Individual and Small Community Sewage Systems. ASAE, St. Joseph, MI. p. 306-319.

Siegrist, Robert L; Tyler, E.J.; Jenssen, P. D.; *Design and Performance of Onsite Wastewater Soil Absorption Systems*, National Research Needs Conference, May 2000

Smith, Derek, 29 March 2000. *Hydraulic Loading Rates for Type 1, Type 2, and Type 3 Effluent: Supporting Documentation.* Published by BC Ministry of Health, Public Health Protection Branch.

Smith, Derek, February 2004. *Wastewater Loading Rates for Residential Strength Wastewater.* Unpublished.

Tyler, E.J., 2001. Hydraulic wastewater loading rates to soil. In: *On-site Wastewater Treatment, Proceedings of the 9th International Symposium on Individual and Small Community Sewage Systems.* ASAE. pp. 80-86.

United States Environmental Protection Agency, February 2002. *Onsite Wastewater Treatment Systems Manual.* EPA / 625 / R-00 / 008. Published by Office of Water, Office of Research and Development.

Washington State Department of Health Wastewater Management Program Rule Development Committee Issue Research Report *Hydraulic Loading* 2001

Winneberger, J.T. 1984. *Septic-tank Systems, a Consultant Toolkit.* Butterworth Publishers, Boston, MA. pp. 222.

A.5 Wastewater Loading for Sand Mounds

Provided that a sand mound has a vertical thickness of sand exceeding 45 cm (18 inches) from the infiltration surface to the native soil surface, and is pressure dosed at least 4 doses per day at the DDF, then the sand mound can be considered a Type 2 treatment system. That is, when Type 1 effluent is discharged to the mound at the infiltration surface, this can be considered to lead to Type 2 effluent at the native soil surface, at the base of the mound. Similarly, when Type 2 effluent is discharged to the sand mound, this will lead to Type 3 effluent at the base of the mound. When sizing the base of a sand mound, using Table 2 above, the selection should be based on the expected Type of effluent at the base of the mound, and the characteristics of the native soil.

Where the sand mound is dosed at low HAR, that is, by timed dosing at less than 10% of the water holding capacity of the sand below the infiltration bed per dose, then 12" of sand will provide treatment of Type 1 effluent to Type 2 levels.

See references in Part 2 of the SPM, and discussion of HAR in appendix .

A.6 Calculating Design HLR from Soil Hydraulic Conductivity

This section provides the technical grounding for selection of a design soil HLR by conducting hydraulic conductivity tests at the location and depth of the planned infiltration surface. The simplest approach for using results from these tests, for moderately permeable soils, is to calculate HLR by multiplying the soil's saturated hydraulic conductivity (Ksat) by a factor, commonly 1% to 4% for Type 1 effluent (Crites et al, 2000; Lesikar et al, 1998; Siegrist et al, 2004; US EPA, 1992; WEF, 1990). In general, tests of hydraulic conductivity conducted in unsaturated soil will measure the field-saturated hydraulic conductivity (Kfs). Ksat is commonly about 2.0 x Kfs (Gupta et al, 1994), so this would indicate an HLR calculated as 2% to 8% of Kfs. The relationship between HLR and Kfs is not linear, and so either a curve fitted formula must be used, or the factor must be altered for different soil types.
For simplicity, this method calculates a soil HLR based on the field saturated hydraulic conductivity (Kfs), although many manuals and papers recommend calculating HLR from the saturated hydraulic conductivity (Ksat). We recommend this approach because tests conducted in the unsaturated zone will directly measure Kfs, and it is simpler to calculate the HLR directly from the Kfs.

A.6.1 Table of soil HLR based on Kfs

The following Table E-1 has been prepared based upon this approach for calculating a design soil HLR for a drainfield, using the soil's field-saturated hydraulic conductivity (Kfs), and the effluent type.

Table E-1: Method 3 — Calculating design soil hydraulic loading rate (HLR) for a drainfield from the soil's field saturated hydraulic conductivity

Field – Saturated Hydraulic Conductivity (Kfs)		Design Soil HLR (Lpd/m^2)			Typical soil texture and structure *	Typical Perc Rate * *(min/ inch)*
cm/d	mm/d	Type 1	Type 2	Type 3		
> 200**	> 2,000	40	80	161	Gravelly to very gravelly sand (single grain)**	< 1**
100	1,000	34	68	135	Sand (single grain) or gravelly sand (massive)	1 – 3
50	500	28	57	114	Loamy sand (single grain) or sand (massive)	3 – 9
25	250	24	48	96	Well structured sandy loam or silt. Massive loamy sand.	5 – 15
12.5	125	20	40	75	Well structured loam or silt loam. Poorly structured sandy loam or silt.	10 – 25
6	60	12	24	36	Well structured silty clay loam. Poorly structured loam or silt loam.	15 – 30
3	30	6	12	18	Well structured sandy clay loam or clay loam. Poorly structured silty clay loam.	25 – 60
1.5**	15	0	6	9	Well structured sandy clay, silty clay, or clay. Poorly structured sandy clay loam or clay loam.**	30 – 90**
0.5**	5	0	0	3	Poorly structured sandy clay or silty clay.**	60 – 180**
< 0.5**	< 5	0	0	0	Poorly structured clay.**	> 90**

*** Typical soil texture, structure, and percolation rate are provided here for comparison purposes.**
**** Indicates site conditions for which pressure distribution should be required.**

Note

The relationship between soil hydraulic conductivity and percolation rate is based on Winneberger (1985). The relationship between soil hydraulic conductivity and soil texture is based on Saxton et al (1985).

A.6.2 Alternatives to Table E-1:

Instead of using Table E-1, a Professional may use the following equations

A.6.2.1 Single factor equations

These equations, where Ksat is in cm/day, Ksat = 2.0 × Kfs, and HLR is in Lpd/sqm (based on Taylor et al, 1997):

Type 1: $HLR = 9 \times Ksat^{0.25}$ *{limited to a maximum HLR of 0.1 ×Ksat, in mm/day}*

Type 2: $HLR = 18 \times Ksat^{0.25}$ *{limited to a maximum HLR of 0.2 ×Ksat, in mm/day}*

Type 3: $HLR = 36 \times Ksat^{0.25}$ *{limited to a maximum HLR of 0.3 ×Ksat, in mm/day}*

The approach recommended for these methods is based on an integration of recommendations in several design manuals and research papers, primarily, Jenssen and Siegrist (1991), Taylor et al (1997), Smith (2000), Crites et al (2000), Winneberger (1985), and Kilduff (1989).

References:

Crites, R.W., S.C. Reed, and R.K. Bastian, 2000. *Land Treatment Systems for Municipal and Industrial Wastes*. McGraw - Hill, New York, USA.

Gupta, R.K., R.P. Rudra, W.T. Dickinson, and G.J. Wall, 1994. Spatial and seasonal variations in hydraulic conductivity in relation to four determination techniques. In *Canadian Water Resources Journal*, Vol. 19, No. 2

Lesikar, B.J., B.A. Neal, G.J. Sabbagh, and I. Jnad, 1998. Subsurface drip systems for the disposal of residential wastewater. In *On-Site Wastewater Treatment, Proceedings of the Eighth National Symposium on Individual and Small Community Sewage Systems, Hyatt Orlando, Orlando, Florida, March 8 - 10, 1998.* Published by American Society of Agricultural Engineers. pp. 146 – 154.

Saxton, K.E., W.J. Rawls, J.S. Romberger, and R.I. Papendick, 1985. Estimating generalized soil-water characteristics from texture. In *Soil Science Society of America Journal.* Vol. 50, No. 4, pp. 1031-1036.

Siegrist, R.L., J.E. McCray, and K.S. Lowe, 2004. Wastewater infiltration into soil and the effects of infiltrative surface architecture. In *Small Flows Quarterly*. Vol. 5, No. 1, pp. 29 – 39.

United States Environmental Protection Agency (EPA), September 1992. *Manual: Wastewater Treatment / Disposal for Small Communities*. EPA / 625 / R-92 / 005.

Water Environment Federation, Task Force on Natural Systems, 1990. *Natural Systems for Wastewater Treatment, Manual of Practice FD-16.*

A.6.2.2 Curve fitted LTAR formulae

Two curve fitted formulae are available, based upon empirical relationships between hydraulic conductivity and LTAR. This approach tends to fit a wider range of soils that the single factor approach. They are included here for reference.

Laak

Laak (1986) recommends the use of a curve formula based upon experimental long term acceptance rates for soils of various permeability loaded with residential strength (Type 1) effluent. Use with Ksat = Kfs x2 leads to lower loading rates in higher permeability soils and somewhat higher in lower permeability soils than those obtained from empirical tables (example Tyler 2001). This curve relates to daily design flows with embedded peaking/safety factors, with domestic design flow of 60 usg/capita/dy (versus 40 g/c/dy average indicating a peaking/safety factor of 1.5. (Laak, pers. comm.).

Where LTAR = 5Ksat - 1.2 / logKsat

LTAR in usgpd/sqft, Ksat in ft/min

Or, LTAR (mm/day)= 401.4K - [48.9 / (0.249 + logK)], where K is Ksat in cm/sec

Conversion of LTAR for differing BOD

Additionally consideration must be given to the level of treatment, and thus the biomat expected. To convert LTAR for Type 1 effluent to other BOD/TSS levels, the following formula has been presented:

AISt = AISs x $\sqrt[3]{BOD+TSS\ treated/(BOD+TSS)\ for\ septic\ tank}$

Where AISt is area of infiltrative surface with improved treatment, and AISs for Type 1.

Reference:

Wastewater engineering design for unsewered areas; Laak, R.H.; Technomic, 1986.

Taylor etAl

Developed for Indiana soils, the following curve converts Ksat in cm/day to LTAR in usgpd/sqft for Type 1 effluent.

$$\mathbf{LTAR = 0.22 * (Ksat)^{0.23}}$$

Authors recommend *HLR (Type 2) = 4 x HLR (Type 1) and HLR (Type 3) = 7.5 x HLR (Type 1).*

References:

An Evaluation of On-Site Technology in Indiana: A Report to the Indiana State Department of Health; Catherine Taylor, Joseph Yahner, and Don Jones; Agronomy and Agricultural and Biological Engineering, Purdue University, 1997

F MASS LOADING AS A DESIGN CRITERIA

For small onsite systems as covered by this manual use of the manual design flows, HLR tables and maintenance of residential equivalent sewage quality if sufficient for effective design.

Where a designer encounters a need to design loading rates in relation to mass loading (for example, for grey water systems or for systems with advanced water saving fixtures), the use of conversion factors may assist in application of HLR tables.

At no time should the BOD loading exceed those resulting from application of standard type 1 effluent per this manual, including safety factors inherent in the manual's design flow/HLR approach.

G INSTANTANEOUS HYDRAULIC LOADING RATE, DOSING RATES, DISTRIBUTION

The upper limit of water-holding capacity for a soil is when it is said to be at "field capacity", this may also be termed the "drained upper limit"

As a rule of thumb, the soil is at field capacity 24 hours after it has been soaked by rain, when saturated soils will hold considerably more water in relation to the amount they will hold at field capacity—particularly coarser soils.

The lower limit of water holding capacity is the "permanent wilting point" (PWP), at which crops wilt and will not recover. Soils under a dispersal area are unlikely to be drier than the PWP.

The "water holding capacity" of a soil is thus taken to be the difference between the field capacity and PWP.

The water holding capacity of sands tends to approach the field capacity as the sands become cleaner and coarser, note the table figures (below) for coarse sand as an example.

In order to reduce the rapid flow of effluent through the soil by saturated or near saturated flow it is necessary to keep the receiving soils under the infiltrative surface as far below field capacity as possible.

In drier soils, flow of effluent will be primarily by film flow ("matrix flow"), and treatment will be effective. As soil is wetted to field capacity and beyond, matric suction forces become insignificant and gravitational forces tend to force flow to gravity flow in mesopores (larger soil pores, ranging in diameter from 0.2 to 50 μm) and macropores (large pores such as cracks in clay soils, rock fractures, fissures in sediments, worm holes, and old root channels), overcoming the threshold for water entry into these pore spaces (meso and macro pores in coarse media, macropores in finer soils) and causing a sudden increase in conductivity.

This will tend to cause uneven flow—with some effluent being retained long enough for treatment and other parts breaking through the soil rapidly in what is termed "preferential" flow ("free surface film" (lower moisture levels), "macropore" or "by pass" flow in macropores, and, in the case of coarse soils—such as sand media--"finger" flow in mesopores).

In order to reduce the occurrence of preferential flow it is necessary to select an instantaneous hydraulic loading rate that will result in matrix flow. Clearly, at times of heavy rainfall there will still be periods of preferential flow, however, the opportunity for treatment will be maximized. Recognition of improved in-soil treatment based upon fully equalized micro dosing leads to the SPM standards for systems using this dosing approach.

It is also necessary to ensure that the effluent applied is distributed evenly over the entire infiltrative surface. Recognition of improved in-soil treatment based upon even distribution leads to the SPM standards for systems using pressure distribution, and to the requirement for the use of pressure distribution in certain cases. (Siegrist and Van Cuyk, 2001)

This instantaneous hydraulic loading rate is termed hydraulic application rate (HAR). Based upon this HAR a dose volume/frequency is calculated. The HAR may be as important for treatment as selection of the correct HLR and LLR. For example. Dosing frequency (HAR) has been shown to be more critical to sand filter performance than sand particle size or HLR.

This approach to dosing design is most critical with soils with low water holding capacity or those with very strong structure/large proportion of macropores (example shale inceptisols). The media used in sand mounds and related technology is of this type. Hence the recommendation of timed micro dosing for those systems.

HAR is also critical when considering technologies such as PSND and SDD where matric suction is relied upon to utilize the entire dispersal area, rather than just the trench basal area, and again leads to the requirement for timed micro dosing with full equalization for those techniques.

Where increased loading rates are used with effluent of low BOD/TSS (which is less likely to cause a biomat to form), then, in order to improve pathogen removal in the soil, HAR consideration is again essential. (Siegrist and Van Cuyk, 2001)

As a guideline, for sand media filters (example sand mounds) dose volumes that are 10% or less of field capacity (or water holding capacity) have been found to result in unsaturated flow and improved treatment.

In calculations for mound dosing in the SPM that 5% volumetric capacity is used for the mound sand (15mm per 300mm depth) and a target of 10% of this per dose has been set.

Example calculation:

HAR = HLR / Dosing frequency

So if the loading rate is 48 mmdy (48 L/dy/sqm) and 24 doses are applied, HAR = 48 /24 = 2mm per dose.

For 450mm of sand depth, at 15mm/300mm water holding capacity water holding capacity of the sand is (15/300) x 450 = 22.5mm
10% of 22.5mm = 2.25mm

So, the HAR is appropriate for the 18" sand depth (assuming proper distribution and equalization through the day).

G-1 Example saturated capacities, field capacities and water holding capacities:

Soil	Saturated mm per 300mm depth	Field capacity mm per 300mm depth	Water holding capacity mm per 300mm depth
Coarse sand		18	12, 6-19
Fine Sand	132	25-53	18-25
Loamy Sand		42-50	24-31
Sandy Loam		60	32-36
Fine Sandy Loam			38-50
Loam	147	81-96	45-50
Silt Loam			50-63
Sandy Clay Loam		84	45
Silty clay loam	155	112	45-50
Silty clay			38-45
Clay		120	30-38
Sand mound sand		20	15

Range of values are to be seen as these are estimated typical values from various sources. Water holding capacity of soil varies with organic matter content, density and other factors; however the ranges are sufficient for the purpose of establishing dose volumes.
Note that mm depth of application equates directly to L/sqm.
For sand mound sand water holding capacity is approx. 5% by volume. Sand field capacity varies widely depending upon silt and clay content, C33 sand has a higher water holding capacity than mound sand due to the larger proportion of fines permitted. Mound sand will have water holding capacity approximately 1% les than field capacity.
Note that dosing to soils with high clay content must also consider affect on soil structure due to clay swelling.
Dosing to natural soils is more complex to model than dosing to mound sand, and the affect of Biomat also assist in moderating flows and improving distribution where the biomat is well developed.

References:

Crites and Tchobanoglous, *Small and decentralized wastewater management systems*, WCB, (1998).

Shallow Intermittent Sand Filtration: Performance Evaluation, Jeannie Darby, Ph.D., P.E., George Tchobanoglous, Ph.D., P.E., M. Asri Nor, and David Maciolek, Small Flows Journal, Vol 2, issue 1, 1995

Irrigation Association, *Irrigation*, 5th Edn., 1983

T.J. Marshall and J. W. Holmes, *Soil Physics* CUP, 1981

Emerick, R.W., R. M. Test, G. Tchobanoglous, and J. Darby, 1997. Shallow Intermittent sand filtration: micro-organism removal. In *The Small Flows Journal*. Vol. 3, Issue 1, Winter 1997.

Emerick, R.W., J. Manning, G. Tchobanoglous, and J.R. Darby, 2000. Impact of bacteria and dosing frequency on the removal of virus within intermittently dosed biological filters. In *Small Flows Quarterly, Vol. 1, No. 1.*

Siegrist, R.L. and S. Van Cuyk. 2001. *Wastewater Soil Absorptions Systems: The Performance Effects of Process and Environmental Conditions.* In On-Site Wastewater Treatment: Proceedings of the Ninth National Symposium On Individual and Small Community Sewage Systems. ASAE, St. Joseph, MI. p. 41-51.

US Department of Agriculture Bulletin 462, 1960

William A. Jury, Zhi Wangb and Atac Tulia, *2003 A Conceptual Model of Unstable Flow in Unsaturated Soil during Redistribution ,* Vadose Zone Journal 2:61-67, 2003,

H Sodium, salinity and water softeners

A.7 Sodium and salinity

These are important factors in soils containing clays. While Type 1 effluent application will (in most cases) still likely be limited by Biomat, the long term application of Type 2 or 3 effluent may be compromised by these factors. The SAR is the ratio of Sodium to Calcium and Magnesium ions in the effluent. Where the SAR is high this will cause clay particles to deflocculate and tend toward a more platy structure, reducing permeability. This is more dramatic in the case of dispersive soils (see below).

An increase in levels of sodium in the soil can cause clay dispersion and collapse of the Soil structure, leading to a decrease in permeability and adverse effects on the vegetation. This effect is linked to the salinity of the effluent, where salinity and SAR are both high the soil clays may remain flocculated. Clearly, excessive salinity will have other negative affects on the dispersal area. Where leaching is heavy (in high rainfall areas) this may reduce the impact of saline and/or high SAR effluent. In areas with lower rainfall and higher evapotranspiration sodium may be concentrated in the soil over time from effluent or from irrigation water.

Existing Sodium levels (sodicity) in soil may be assessed by the Exchangeable Sodium Percentage (ESP) of the soil.

As onsite system design is now stressing low dosing rates and the maintenance of unsaturated soil at and below the infiltrative surface the opportunity for sodium accumulation is likely to be higher. This will be of particular concern in areas with a larger moisture deficit and where soils already have a higher ESP, and where water supply is low in calcium and magnesium.

The affect of structural degradation due to sodium levels in wastewater will tend to be more clearly evident with Type 2 and 3 effluent, in terms of system life, as with Type 1 effluent the Biomat itself tends to be the limiting factor for long term acceptance rate. Amoozegar (1998) argues that "in the absence of a biological clogging mat, Na (or a compound containing Na, such as a surfactant in laundry detergent) is the most likely cause for hydraulic failure of a septic system."

Treated domestic wastewater can have a sodium adsorption ratio of between one and ten (With an average of about 3.5). For the majority of soils with significant clay content (>15%), treated wastewater with a sodium adsorption ratio of less than eight, and an electrical conductivity (EC) of less than 4 dS/m, should not cause problems. For soils with little clay or with non swelling clays, SAR levels of up to 20 may be tolerated if salinity is high (over 4 dS/m) enough.

Nevertheless, for effluent to be well absorbed by the soil, particularly given the use of low dosing rates, it is imperative to minimise the Sodium loadings in domestic wastewater. The cheapest way to decrease Sodium loading is to use low-sodium concentrated liquid detergents.

Addition of Calcium Sulphate (as Gypsum) may assist in reducing the impact of high SAR waste streams and in the rehabilitation of soils which are or have become sodic.

References:

Environment & Health Protection Guidelines On-site Sewage Management for Single Households, NSW EPA

van de Graaff, R and Patterson, R.A. (2001) Explaining the Mysteries of Salinity, Sodicity, SAR and ESP in On-site Practice in Proceedings of On-site '01 Conference: Advancing On-site Wastewater Systems by R.A. Patterson & M.J. Jones (Eds). Published by Lanfax Laboratories, Armidale

Impact of Wastewater Quality on the Long-Term Acceptance Rate of Soils for On-Site Wastewater Disposal Systems Report 316 July 1998 , Aziz Amoozegar Department of Soil Science, North Carolina State University

Crites and Tchobanoglous, *Small and decentralized wastewater management systems*, WCB,(1998).

A.8 Water softeners

Water softener wash water and chlorinated back-wash water must not be discharged to an onsite system. These are non sewage flows which may be discharged separately.

While a properly maintained water softener of a type which is water conserving and which flushes only on demand (Demand Initiated Regeneration Control Device or "DIR") may discharge flush water to an onsite system without causing significant damage, the additional water flow and the risk of discharge of high concentrations of sodium (where the softener is not properly used/maintained) and of Chloride (in all cases) support the utilization of separate discharge. Where older style water softeners are used this is critical.

In situations where SAR considerations are critical (due to soil type etc), whole house water softeners may be better avoided due to the negative impact of removal of the Calcium and Magnesium ions from the sewage stream. Note that in these cases, replacement of Calcium and Magnesium may be preferable if reduction of laundry and other surfactant use is considered to be more likely to exacerbate the SAR problem.

Potassium salts may also be used in some cases for regeneration of water softeners.

Reverse osmosis flush flows must also not be discharged to the onsite system.

References:

EPA Onsite Wastewater Treatment Systems Special Issues Fact Sheet 3

A.9 Dispersive soils

Dispersive soils deflocculate (the aggregate breaks down to individual sand, silt and clay particles) in the presence of relatively pure water. Dispersive soils usually have a high Exchangeable Sodium Percentage (ESP)--that is, they contain a higher content of sodium in their pore water than other soils (they are termed “sodic”).When water is added, the sodium attaches to the clay and forces the clay particles apart. This results in a “cloud” of colloidal clay forming around the aggregate. These fine clay particles that have dispersed, clog up the small pores in the soil and the breakdown of the aggregate degrades soil structure as well as restricting root growth and water movement. There are no significant differences in the clay contents of dispersive and non-dispersive soils.

Dispersive soils are problematic for on-site sewage management because of the potential loss of soil structure when effluent is applied, whether the soil deflocculates or not is dependant upon the SAR and the salinity of the applied effluent. Soil pores can become smaller or completely blocked, causing a decrease soil permeability, which can lead to system failure.

Several tests have been devised to recognize dispersive soils. Unfortunately no one test is successful in identifying these soils in every instance. The modified Emerson Aggregate Test is a simple field assessment of aggregate dispersiveness based on a two-hour testing period. Three undisturbed samples of soil aggregate, and three reworked aggregates (from the textured bolus), about 5 mm in diameter, are each carefully immersed in a beaker of sodium adsorption ratio (SAR) 5 solution and left undisturbed for two hours. The behaviour of the natural aggregate or worked bolus can be used as a guide to assess whether a soil is prone to dispersion.

A.9.1 Permeability tests with dispersive soils

A liquid of similar composition to the expected effluent (SAR 5 is normal) and salinity should be used for assessment of permeability of dispersive soils.

Measurements should be done by appropriately experienced and qualified persons. The clean water percolation or permeameter test should not be used to determine soil permeability for these soils.

References:

Dispersive soils: a review from a South African perspective, BELL F. G.; MAUD R. R.; Quarterly journal of engineering geology (Q. J. Eng. Geol.) ISSN 0481-2085 ,1994, vol. 27, no3, pp. 195-210

Environment & Health Protection Guidelines On-site Sewage Management for Single Households, NSW EPA

I EXPANDING CLAY SOILS

Soils shrink and swell depending on the expansive characteristics of certain clay-sized minerals that are less than 0.002 mm in diameter. There are several types of clay mineral in soils, one family of these clay minerals, called smectites, can absorb enough water to expand up to 30 percent in volume. Montmorillonite is a common clay mineral in this family. Because expansion of these clay minerals depends so much on water, soils containing high amounts of smectites shrink and swell according to soil moisture. When dry, these soils will have large cracks at the surface. When the soil minerals swell, the pore space in the soil decreases, restricting water movement.

When wet conditions cause clay minerals to expand (example effluent application), wastewater infiltration in the soil below the septic system's soil absorption field will decrease. A very small amount (5-10%) of expanding clay can have a large effect on soil drainage characteristics.

Expanding clay soils can be defined by a measurement of how much they shrink when taken from a saturated water content to a dry water content. The measurement is called a Coefficient of Linear Extensibility (COLE) and a 9% change indicates a significant Montmorillonite content. However, the COLE test does not always adequately predict the expansivity of the soil, and a safer approach is to utilize two or more factors, including the COLE, liquid limit and soil cation exchange capacity.

If these soils are a problem in your area, and you think that they are present on a site you are designing for—consult a professional soil scientist.

Washington State RS&Gs recommend use of the following simple test for expanding soil:

> "One simply mixes a soil/water solution to the point where the clay soil is almost saturated, but can still be formed into a "worm" or rod-shaped lump. The length of the rod is measured. Then the rod is placed in an oven to dry (250 degrees for about an hour should be enough), then re-measured. If the length of the rod decreases by more than 3-5%, there is probably enough expanding clay to affect soil drainage potential. I chose 3-5% somewhat arbitrarily mainly because it is about one third to one half that of that used to indicate significant content of Montmorillonite (9%)."

References:

Swelling Clays and Septic Systems, Jennifer Krenz, Brad Lee, and Phillip Owens Purdue University Department of Agronomy, 2006

An Expansive Soil Index for Predicting Shrink–Swell Potential; P. J. Thomas,* J. C. Baker, and L. W. Zelazny, SOIL SCI. SOC. AM. J., VOL. 64, JANUARY–FEBRUARY 2000

Washington State Department of Health (2001). Pressure Distribution Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance.

J SURGE FLOWS FOR FIXTURES AND TRAP SIZES

In order to estimate the peak surge flows to be expected from a residence or small commercial establishment the following tables and formulae may be used. These are based upon the US uniform plumbing code.

A.10Drainage fixture units

Firstly, the source must be examined for flow potential. This is normally expressed as "Drainage Fixture Units" (DFU), these are selected for the plumbing system served and then added to give a total for the building. The total is then multiplied by a factor to give a flow surge estimate. See table for DFUs.

Note that these surge values do not take into account the volume of water entering the trap, for example where a 2" trap serves a shower and the shower is flowing at 3 gpm, flow from t he trap will be only 3gpm and surge flow will not be an issue.

For calculation of surge flows, where DFU<40 Flow in usgpm = 0.7 x DFU , and where >40 Flow = 20 + (DFU x 0.2). Where there is only one fixture 1 WFSU = 1 usGPM = 3.79 litre/min . Note that gallons are **us gallons.**

Table J-1 Drainage Fixture Units

Drainage Fixture Units (DFU)			
Individual Appliance, Appurtenance or Fixture	(inch)	Private Installations	Public Installations
Bar sink	1 1/2	1	1
Bathroom (water closet, lavatory, bidet and tub or shower)	6	-	-
Bathtub	1 1/2	2	2
Bidet	1 1/4	1	
Bidet	1 1/2	2	
Clothes Washer	2	3	3
Dishwasher, domestic	1 1/2	2	2
Drinking fountain	1 1/4	0.5	0.5
Floor drain	2	2	2
Shower	2	2	2
Laundry tub	1 1/2	2	2
Lavatory	1 1/4	1	1
Bar sink	1 1/2	1	

Kitchen sink, domestic	1 1/2	2	2
Laundry sink	1 1/2	2	2
Service or mop basin	2		3
Urinal	2	2	2
Water closet with gravity tank	3	3	4
Water closet with flushometer tank	3	3	4

Ref: US Uniform Plumbing code.

A.11Individual fixture flows

For parts of a building or a specific fixture, the flow by fixture unit or trap size may also be useful. The following tables give peak flows expected from each fixture or trap.

Table J-2 Surge flows for individual fixtures

Fixture unit	**Surge flow rates**		
	L/min	Us gpm	I gpm
Hand basin	28	7.5	6.2
Kitchen sink (restaurant)	57	15	12.5
Single scullery sink	76	20	16.7
2 comp scullery sink	95	25	20.9
3 comp scullery sink	114	30	25.1
2 of single comp scullery sink	95	25	20.9
2 of 2 comp scullery sink	114	30	25.1
Floor drain	19	5	4.2

Table J-3 surge flows for trap sizes

Outlet or trap size	Surge flow rate		
Inches	L/min	Us gpm	I gpm
1.25	28	7.5	6.2
1.5	57	15	12.5
2	83	22	18.3
2.5	114	30	25.1
3	142	37.5	31.2
4	170	45	37.4

Note that these surge values per trap size do not take into account the volume of water entering the trap, for example where a 2” trap serves a shower and the shower is flowing at 3 gpm, flow from t he trap will be only 3gpm and surge flow will not be an issue.

A.12Sewage pump surge flow

Where a sewage pump is installed, calculate surge flows based upon capacity of the basin and design flow rate.

K Design inputs worksheet

A worksheet for collection and analysis of the required inputs for normal residential onsite system design has been prepared. This is based upon the requirements of Part 2 of the SPM, and follows the format of that section.

The worksheet is intended to select daily design flow, summarize information from the site and soils investigation report, select LLR and HLR and determine minimum system length and AIS. The worksheet is intended for use as part of a record of design.

The most up to date version of the worksheet is currently maintained at:

http://www.traxdev.com/ES930

L Testing tanks for watertightness

A.13Hydrostatic Testing

Water-pressure testing determines a tank's watertightness by maintaining a certain water level for one hour after a 24-hour absorption period.

Be careful when performing hydrostatic tests on plastic and fibreglass tanks as they gather much of their strength from the soil support. For all mid-seam tanks, keep the backfill near the mid-seam, but leave the seam itself exposed to monitor the test.

The following is a suggested water testing procedure for tanks. Note that this test does not evaluate the tank's ability to withstand external pressures: that issue must be assured through adequate engineering design.

(1) Plug the inlet and outlet pipes with a watertight plug, pipe and cap or other seal. Seal the pipes away from the tank to test any pipe connections that may be of concern.

(12) If testing a mid-seam tank, ensure that the seam is exposed for the water test.

(13) Fill the tank to the top.

(14) If the tank has a riser, add water into the riser to a maximum of 5.0 cm above the tank/riser seam. Care must be taken not to overfill as the top section of a two-piece tank may become buoyant.

(15) Measure and record the level of the water.

(16) Let the tank sit for 24 hours. Any obvious leakage during this time should be evaluated and remedied by the application of a suitable sealing compound.

(17) If the test reveals leaks that cannot be repaired, the tank is considered unacceptable.

(18) Refill concrete tanks to original level after 24 hours as they will absorb some water.

(19) Check again after 24 hours. If less than 4 litres is lost in a concrete tank, the leak test is considered acceptable.

Tables L-2 and L-3 provide information for calculating volumes in square and round risers.

Table L-2: Depth change equivalent to four litres in round risers of various interior diameters.

Riser Diameter (cm)	Depth (cm) Equal to Four Litres
46	2.4
61	1.4
76	0.9
91	0.6

Table L-3: Depth change equivalent to four litres in square risers of given interior dimensions.

Riser Dimensions (cm)	Depth (cm) Equal to Four Litres
18 x 18	1.9
24 x 24	1.1
36 x 36	0.5

When performing hydrostatic testing in cold climates, there are a few important points to consider. First, water is its densest at about 4 degrees C (just above freezing), so water put into a tank at 10-20 degrees C (typical of groundwater) and left in the tank overnight at freezing temperatures will drop the level in the tank a substantial amount (about 2% or 11 litres in a 5,600 litre tank). A 'loss' of 11 litres in the risers will look like a leak. Additionally, water used in the test will freeze and expand by approximately 9%. If the site is not occupied quickly the tank may crack as a result of the test itself.

A.14Vacuum Testing

Vacuum testing verifies that a tank is watertight if it holds 90 percent of a two-inch vacuum of mercury for two minutes.

Vacuum testing of tanks requires less time than hydrostatic testing and can be performed without having water available on the site. Testing should be done on the tank in its ready-to-use state (i.e., pipes in the inlet and outlet, risers with lids, etc.) In this test all pipe penetrations, manholes and risers are sealed airtight and a special insert is sealed on one of the tank manholes. Using a pump, air is evacuated through this insert to a standard vacuum level and the reading on a vacuum gage is recorded. Be careful not to exceed the recommended vacuum level. It is possible to damage or implode a tank.

The 2003 National Precast Concrete Association (US) standard states: “The recommended [vacuum test] procedure is to introduce a vacuum of 4 inches of mercury. Hold this pressure for 5 minutes. During this initial 5 minutes, there is an allowable pressure equalization loss of up to a half-inch of mercury. If the pressure drops, it must be brought back to 4 inches and held for a further five minutes with no pressure drop.”

If a tank will not hold the vacuum, leaks must be located and repaired. The test can then be repeated. If the tank cannot be repaired and rendered watertight, it should be replaced.

Note that vacuum testing of concrete tanks draws seams together for a positive mastic seal, assuming there are no other problems. With any tank, collapse, deflection, deformation, or cracking indicate a poor quality tank. It is important to test the entire system: tank, pipe sleeves, risers, inspection ports and lids.

A.15Testing Existing Tanks

It is more difficult to check watertightness in an existing septic tank. Adequate testing requires a period of several hours to a day or more without inflow to the tank and sealing off inlet and outlet pipes. Seal the line at the distribution box (or other appropriate place in the case of secondary treatment units) and at the cleanout between the building and the tank. Apply vacuum or water as desired. If there are no leaks, the entire system passes in one step. If there are leaks, successive tests will locate the source or sources. Although actual testing of existing tanks may be impractical, much can be discerned by a thorough inspection of a tank both before and after it has been pumped out. Most tanks built using older methods of construction (such as built-in-place block or brick tanks) would typically not be watertight or structurally sound and probably cannot reasonably be repaired. In some cases it may be possible to do more to check existing tanks. If the soil around the tank is saturated, the tank contents can be pumped down and observations made over the next few hours to detect leakage into the tank around pipe penetrations, seams or through breaks in the tank. Caution should be exercised, however, as high groundwater may cause empty tanks to become buoyant and float out of the ground. Alternately, excessive soil pressure may collapse a tank. In some cases, it may be necessary to excavate completely around the tank to make a visual inspection for leaks. If there is any doubt about the integrity of the existing tank, it should be replaced.

M PIPING MATERIALS

The piping used for a *building sewer, effluent sewer,* or gravity or pressure *distribution header,* must be certified to the following standards:

(a) CAN/CSA 8181.1 Standard for A8S Drain Waste and Vent Pipe and Pipe Fittings,

(b) CAN/CSA 8181.2 Standard for PVC Drain Waste and Vent Pipe and Pipe Fittings,

(c) CAN/CSA 8182.1 Standard for Plastic Drain and Sewer Pipe and Pipe Fittings, or

CAN/CSA 8182.2 Standard for PVC Sewer Pipe and Fittings (PSM Type).

Or equivalent US or European standards

Where there is no existing standard for the intended use of a piping material, piping use guideline Table 6-2 (Piping Standards)

Table 6-2: Piping standards

Type of Piping	Standard Reference	Gravity Sewage or Effluent Piping	Pressure Effluent Line	Weeping Lateral Piping	Pressure Effluent Distribution Lateral
Polyethylene water pipe and tubing SDR11, SDR17 IPS, Series 160 or 200 with compression fittings	CAN3-B137.1-M	N	P	N	N
Poly vinyl chloride (PVC) water pipe Series 60, 100, 125, 160 and 200	CAN3-B137.3-M	P	P	P	P
Chlorinated poly vinyl chloride (CPVC) water pipe	CAN3-B137.6-M	N	N	N	P
Polybutylene water pipe	CAN3-B137.8-M	N	P	N	N
Plastic Sewer Pipe perforated non perforated	CAN/CSA-B182.1-M92	N P	N N	P N	N N
Corrugated Polyethylene perforated non perforated	CGSB 41-GP-31	N P	N N	P N	N N

Acrylonitrile- butadiene-styrene (ABS) DWV pipe	CAN/CSA-B181.1-M90	P	N	N	N
Poly (vinyl chloride) (PVC) DWV pipe	CAN/CSA-B181.2-M90	P	N	N	N
Type PSM PVC sewer pipe 35 SDR	CAN/CSA-B182.2-M90	P	N	N	N
Profile poly (vinyl chloride) (PVC) sewer pipe PS 320 kPa	CAN/CSA-B182.6-M	P	N	N	N
Profile polyethylene sewer pipe PS 320 kPa	CAN/CSA-182.6-M	P	N	N	N
Cast iron soil pipe	CAN3-B70-M	P	N	N	N

P = Permitted N = Not Permitted

N Pressure Distribution Network Design

A worksheet for pressure distribution network and pumping system design has been prepared based upon a simplified design method developed by Converse (2000) and tables based upon those developed for the Washington State RS&G.

The worksheet is available in long form version (as below), which includes instructions and tables. It is also available as a short form version, without instructions, which is intended for use as part of a record of design.

Note that the worksheet is in **us gallons,** as are the tables.

The most up to date version of the worksheet is currently maintained at:

http://www.traxdev.com/ES930

References

Converse, J.C. (2000) Pressure Distribution Network Design.
Washington State Department of Health (2001). Pressure Distribution Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance.

Ralston, I.P., (2006), ES930 course manual, WOWTC

O Sand Mound Systems

A.16Worksheet

A worksheet for mound bed and layout design has been prepared based upon the design method and slope correction tables developed by Converse and Tyler (2000) and diagrams based upon those developed for the Washington State RS&G.

The worksheet is intended for use as part of a record of design. It also includes a checklist of construction steps for a sand mound.

Note that the worksheet is in **us gallons,** as are the tables.

The most up to date version of the worksheet is currently maintained at:

http://www.traxdev.com/ES930

A.17Sand media guidelines

C33 sand has been widely used in the past for sand mounds. However, this sand specification is not well suited to use as sand mound media. The C33 specification (within its range) permits too high a level of fines, is permitted to have an effecitve diameter that is smaller than is desirable and has a high uniformity coefficient. This has lead to some mound system failures. The SPM has, based on these concerns, moved to a modified "mound sand" specification (see Part 2). This sand is similar to C33 and is often relatively easy to produce where C33 or CSA concrete sand is already being produced, in some cases all that is requred is washing, in others the C33 already meets the mound sand standard.

In some areas it is not possible to purchase (C33 modified) mound sand. To provide further guidance on sand selection the following specifications are representative of current standard practice for intermittent sand filter sand. Note that these sands must be used with timed dosing per the SPM.

Effective size, D10 of 0.33mm, some standards reccomend D10 of 0.30 to 0.50mm

Coefficient of uniformity (D60/D10) Cu <3, some standards reccomend <4 and 1-4

<2% passing #100 sieve, <0-1% passing #200 sieve, <20% over 2mm

References:

Washington State Department of Health Wastewater Management Program Rule Development Committee *Issue Research Report (Draft) Sand/Media Specifications*, 2002

Rhode Island Department of Environmental Management; *Guidelines for the Design and Use of Sand Filters in Critical Resource Areas*; December 1999

A.18Mound Construction

The following is from Converse, J.C. and Tyler, E.J. (2000), and represents the current thinking on mound construction:

A construction plan for any on-site system is essential. A clear understanding between the site evaluator, the designer, contractor and inspector is critical if a successful system is installed. It is important that the contractor and inspector understand the principles of operation of the mound system before construction commences otherwise the system will not function as intended. It is also important to anticipate and plan for the weather. It is best to be able to complete the mound before it rains on it. The tilled area (basal area) and the absorption area must be protected from rain by placing sand on the tilled area and aggregate on the absorption area prior to precipitation. There are several different ways to construct a mound as long as the basic principles and concepts are not violated. The following are suggested construction steps:

(20) The mound must be placed on the contour. Measure the average ground surface elevation prior to tillage along the up slope edge of the absorption area. This contour will serve as the base line for determining the elevation of the bottom of the absorption area.

(21) Grass, shrubs and trees must be cut close to the ground surface and removed from the site. In wooded areas with excess litter, it is recommended to rake the majority of it from the site. Do not pull out the stumps and do not remove the sod or the top soil or boulders.

(22) Determine where the force main from the pump chamber enters the mound. It will either be center feed or end feed. For long mounds, center feed is preferred and all end feeds can be made into center feed. For center feed the force main can enter from the up slope center (preferred), the down slope center or exit the native soil at the end and be placed horizontally on a slight slope in the sand beneath the aggregate or just up slope of the aggregate. If it must be brought in from the down slope side, especially on slowly permeable soils with high seasonal saturation where the effluent flow may be horizontal, it should be brought in perpendicular to the side of the mound with minimal disturbance to the down slope area. All vehicular traffic must be kept in a very narrow corridor. Minimal damage is done if the soil is dry. Soil should be packed around the pipe and anti-seep collars should be installed to minimize effluent and water following the pipe. Entering from the down slope center should be the last choice on sites that are slowly permeable with shallow seasonal saturation.

(23) The footprint of the mound must be tilled only when the soil moisture is within a satisfactory range. The satisfactory moisture range, to a depth of 6-7", is defined as where the soil will crumble and not form a wire when rolled between the palms. The purpose of tillage is to roughen the surface to allow better infiltration into the top soil. It also provides more contact between the sand and the soil. Excessive tillage will destroy soil structure and reduce infiltration. The preferred methods in order of preference are i) using chisel teeth mounted on a backhoe which can be easily removed, ii) using a chisel plough pulled behind a tractor, and iii) using a backhoe bucket with short teeth which requires flipping the soil. Normally it takes much longer to use the backhoe bucket than a chisel teeth mounted on the backhoe with the added cost quickly recovered. Mouldboard ploughs have been used successfully but are the least preferred. Rototillers are prohibited on structured soils but may be used on unstructured soils such as sand to break up the vegetation. However, they are not recommended. All tilling must be done following the contour.

If a platy structure is present in the upper horizons, the tillage depth should be deep enough to try to break it up without bringing an excessive amount of subsoil to the surface. Deep tilling for the sake of deep tilling is not recommended. Till around the stumps without exposing an excessive amount of roots. Chisel teeth, mounded on a backhoe, is the preferred and an easier method for tilling around stumps. Stumps are not to be removed but some small ones may be inadvertently pulled out during tilling. If so, remove them from the site. If there are an excessive number of stumps and large boulders, the basal area should be enlarged or another site selected but that is the rare occasion.

(24) Once the site has been tilled, a layer of sand must be placed before it rains. Driving on the exposed tilled soil is prohibited so as not to compact it or rut it up. Sand should be placed with a backhoe (preferred) or placed with a blade and track type tractor. A wheeled tractor will rut up the surface. **All work is to be done from the up slope side so as not to compact the down slope area especially if the effluent flow is horizontally away from the mound.**

(25) Place the proper depth of sand, then form the absorption area with the bottom area raked level. The sand should be reasonably compacted in the trench area to minimize settling. A good backhoe operator can form the trench with minimal hand work.

(26) Place a clean sound aggregate to the desired depth. **Limestone is not recommended.** If chambers are used, proper procedures must be performed to keep the chambers from settling into the sand. Procedures are available from the manufacturers that include compacting the sand to a certain specification and placing a coarse netting on the compacted surface prior to chamber placement.

(27) Place the pressure distribution network with holes located downward and cover it with 2.5 cm (1 in.) of aggregate. Connect the force main to the distribution network. If chambers are used, the pressure distribution laterals must be suspended from the chambers with holes upward. Provisions must be made to allow the laterals to drain after dosing. This is accomplished by having several holes located downward or sloping the pipe in the chamber toward the force main. The laterals and force main must drain after each dose.

(28) Cover the aggregate with a geotextile synthetic fabric.

(29) Place suitable soil cover on the mound. There should be 15 cm (6") on the sides and shoulder (G) and 30 cm (12") on the top center (H) after settling. The soil cover should support vegetation. If not, provisions must be made to control erosion.

(30) Final grade the mound and area so surface water moves away from and does not accumulate on the up slope side of the mound. Use lightweight equipment.

(31) Seed and mulch the entire exposed area to avoid erosion. Advise the homeowner on proper landscaping. The top of the mound becomes dry during the summer and the down slope toe may be wet during the wet seasons. Avoid deep rooted vegetation on the top of the mound to minimize root penetration into the distribution network

(32) Inform homeowner about the type of system, maintenance requirements and do’s and don’ts associated with on-site soil based systems.

References

Converse, J.C. and Tyler, E.J. (2000) *Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual.* Paper #15.24. Small Scale Waste Management Project. University of Wisconsin – Madison.

Washington State Department of Health (2000), *Mound Systems; Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance*

Ralston, I.P., (2006) *ES930 course manual*, WOWTC

P Terminology for system operation and malfunction

Following terms are as used in the MP and PI WOWTC courses:

A.19 This system is operating in a normal manner as intended by its plan/design.

This is when:

All wastewater was confirmed to arrive at each component and it travels through the system in a normal manner without wastewater backing up or being diverted.

In a pressurized distribution system, all laterals flow equally, or

The squirt height measured at the ends of all laterals are approximately equal and the squirt height is at least 75% of the specifications from the Planner / Designer's filing documents. Note: would you prefer to use "when the squirt height has a difference of 25% greater or lower than the original squirt height."

The effluent sample(s) taken from the treatment plant / process meet the permit / filing document requirements.

For a lagoon, the effluent level is below the design freeboard.

Where a treatment plant or process is installed, the results of laboratory testing will determine whether the effluent quality meets the requirements of the design. Even if all other aspects of the system are or appear in good order, where effluent strength exceeds the requirements, the system is deemed to be a "performance malfunction."

A.20 This system is operating, but a partial restriction or backing up is occurring.

This is when:

All wastewater was confirmed to arrive at each component but was found to partially back up or was restricted at any component. This can be evident as a fluid level which submerged approximately up to 1/2 of the outlet pipe.

At the end of a pump cycle or flow test, effluent is observed to flow backward into the distribution box from one or more distribution pipes.

In a pressurized distribution system, flow is visible from all laterals; but one or more ends of laterals has more than or less than 10% variation from the squirt height recorded in the system commissioning or as compared to the other laterals.

For a lagoon, the effluent level is approximately at the design freeboard.

Performance Malfunction

This is when:

The fluid level submerges more than 1/2 of the outlet pipe of any component, or
the outlet pipe is fully submerged at any component including the distribution box.

Any backing up is found in the pump chamber or siphon.

Wastewater is escaping or groundwater is entering from any point in the system contrary to plan/design.

Wastewater or groundwater is found to flow backward into the distribution box from the field or mound.

In a pressurized distribution system, one or more laterals have no visible flow.

The effluent sample does not meet the requirements of the original Health Permit or final filing document.

For a lagoon, the effluent level is above the design freeboard of the lagoon (normally 0.6m below the top of berm).

A.21 This system's operation could not be fully determined.

This is when:

You could not gain access to the building to confirm where all wastewater flows go.

The system has not been in use for several weeks.

The water supply into the building was not functioning.

One or more components could not be accessed with available equipment or within the approved expenses at the time of the site visit. Explain this in the report.

The effluent sample is about to be submitted to the lab.
If an effluent sample could not be obtained, the reason must be explained in the report.

A.22This system has an illegal or prohibited feature.

This is when:

It is suspected or confirmed that the system was installed without a permit or final filing document. This must be clarified in the report with all details given to substantiate the claim.

There is an intentional or non-intentional diversion that could or is allowing effluent to escape continuously or seasonally from the system.

The number of bedrooms or building floor space exceeds the original design of the system or the permit or final filing document issued.

A second residence or building is connected which exceeds the original design of the system or the permit or final filing document issued.

A sani-dump or other connection is installed that permits wastewater from sources other than this building to enter the system.

Backwash from, or floor drain around, a swimming pool or hot tub is connected to the system.

Backwash or drain from water treatment equipment is connected to the system.

A building, or extension to the building, was made over top a component after the system was installed.

The system is partially / fully within a neighbouring property.
Note: Only permitted if both property owners make a legal agreement that is registered on the land titles.

Some or all of the system was modified, reducing required setbacks.

One or more components do not meet required setbacks.

A residential system is receiving high strength and/or high volumes of wastewater.
The type and/or volume is contrary to the intended design and is not permitted unless prior permission from the Designer/Planner/Health Authority was obtained.

A.23Suspected Health or Safety Hazard.

This is when:

Biological Hazard may be present:

Effluent is or appears to be escaping the system to the surface.

Effluent is backing up into the building where the effluent is or could likely overflow at some point within a plumbing fixture or appliance.

Effluent is or has the potential of coming into contact with people in any manner that is or could pose a Health Hazard as defined under the Sewerage System Regulations, provincial Health Act, or any other regulation or act that may be applicable.

Electrical Hazard may be present:

An electrical health hazard is suspected or has been identified.

Physical Hazard may be present:

A severely broken, damaged, or unsecured lid, or a structurally unsound component that could pose a physical health hazard has been identified.

Where an MP discovers or suspects a health or safety hazard they must report the issue to the landowner immediately and coordinate the necessary corrective action to ensure the hazard is resolved without delay. If the landowner is not cooperative or an unreasonable delay in correcting the hazard becomes apparent, notification of the location and circumstances needs to be made to the local Health Authority, BC Safety Authority (electrical), local Building Department (electrical), Ministry of Environment, Environment Canada, Department of Fisheries & Oceans, or other appropriate agencies/authorities who will investigate and make a final determination whether such a hazard exists or not. The MP is required to make this notification under the ASTTBC code of ethics Principle 1 and Principle 9.

A.24Improvement

A recommendation that could improve safety or performance, or prevent a malfunction or health hazard if implemented. Often, these are items that were not required at the time the system was installed, such as risers to the surface, an effluent filter, or other features on systems built pre-Sewerage System Regulations. A baffle still in place but showing deterioration (preventative maintenance), or a pump chamber that does not have a high level alarm are two examples of improvements which could prevent serious future problems.

A.25Caution

A component, device, or feature that while allowed or legal to use, can be a source of problems or a need for increased maintenance and monitoring of some or all of the system. Continuous flushing urinals, over-sized jet tubs, multi-headed showers and garburators for example. If any of these items are specifically not allowed according to the information on the permit or final filing document, the item also becomes an “Illegal or Prohibited Feature.”

A.26Repair

A requirement that affects safety or performance and is necessary regardless of the system’s age. A missing baffle (performance) or a cracked lid (safety) are two examples of repairs.