SEWERAGE SYSTEM

SPM: Appendices

Version 2

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Prepared for:

Ministry of Health
Population Health and Wellness
Health Protection
4th Floor, 1515 Blanshard Street
Victoria, BC V8W 3C8

Prepared by:

British Columbia Onsite Sewage Association
(BCOSSA)
Box 47071
Victoria, BC V9B 5T2

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Appendix A Glossary of Terms

The Glossary is in part based upon the US EPA *Onsite Wastewater Treatment Systems Manual,* 2002, and is provided for convenience only. Note that concepts clearly defined in the regulation, SPM or SPM appendices may not be fully redefined here, and that any definition in the SPM or regulation supersedes these definitions.

See Appendix B for definitions as provided by the *Sewerage System Regulation*.

A

Absorption: The process by which one substance is taken into and included within another substance, such as the absorption of water by soil or nutrients by plants.

Activated sludge process: A biological wastewater treatment process in which biologically active sludge is agitated and aerated with incoming wastewater. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation, and most of it is returned to the process. The rest is wasted as needed.

Adsorption: The increased concentration of molecules or ions at a surface, including exchangeable cations and anions on soil particles. The adherence of a dissolved solid to the surface of a solid.

Aerobic: Having molecular oxygen as a part of the environment, or growing or occurring only in the presence of molecular oxygen, as in “aerobic organisms.”

Aerobic treatment unit (ATU): A mechanical onsite treatment unit that provides secondary wastewater treatment by mixing air (oxygen) and aerobic and facultative microbes with the wastewater. ATUs typically use a suspended growth treatment process (similar to activated sludge extended aeration) or a fixed film treatment process (similar to trickling filter).

Alluvial soil: Soil developing from recently deposited alluvium and exhibiting essentially no horizon development or modification of the recently deposited materials. When capitalized, the term refers to a great soil group of the azonal order consisting of soils with little or no modification of the recent sediment in which they are forming.

Alluvium: sediments deposited by running water of streams and rivers; may occur on terraces well above present streams, on the present flood plains or deltas, or as a fan at the base of a slope.

Anaerobic: Characterized by the absence of molecular oxygen, or growing in the absence of molecular oxygen (as in “anaerobic bacteria”).

Anaerobic upflow filter: A high-specific-surface anaerobic reactor filled with a solid media through which wastewater flows; used to pretreat high strength wastewater or to denitrify nitrified wastewater.

Aquifer: A geologic formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Area of Infiltrative Surface (AIS): Infiltrative surface area receiving effluent from the distribution system.

Areal loading rate: Quantity of effluent applied to the footprint of the soil treatment area (or the absorption area of an above-grade system) expressed as volume per area per unit time, for example, gallons per day per square foot (gpd/ft^2).

ASTM: American Society for Testing Materials

Autochthon: A sediment or rock (geology) that can be found at its site of formation or deposition, as opposed to an allochthon, which has moved from that site. See "Residuum."

B

Basal Area: For sand mounds, sand-lined trenches, bottomless sand filters this is the effective surface area available to transmit the treated effluent from the filter media into the original receiving soils.

Biochemical oxygen demand (BOD): A commonly used gross measurement of the concentration of biodegradable organic impurities in wastewater. The amount of oxygen, expressed in milligrams per liter (mg/L), used by bacteria while stabilizing, digesting, or treating organic matter under aerobic conditions is determined by the availability of material in the wastewater to be used as biological food and the amount of oxygen used by the microorganisms during oxidation. Normally BOD_5 is used, being the BOD over a 5 day period.

Biomat: Soil clogging layer at and below the infiltrative surface to soil or to sand or other media. The layer of biological growth, organic compounds (including polysaccharides and polyuronides produced by bacteria in the mat) and inorganic residue that develops at the wastewater soil interface and extends up to about 25mm (1") into the soil matrix. The term is used loosely to include all soil "clogging" affects, including pore size reduction, alteration of soil structure and gas production by the micro-organisms. The affect of the biomat on soil porosity is greatest in coarse textured soils. The biomat (when present) controls the rate at which pre-treated wastewater moves through the infiltrative surface/zone for coarse to medium textured soils. Biomat may not control rate of infiltration through fine clay soils, which are more restrictive to wastewater flows than the biomat. The typical black colour is due largely to ferrous sulfide precipitate. Also referred to as *Biocrust*, *Clogging Mat*, and *Clogging Zone*.

Blackwater: Liquid and solid human body waste and the carriage waters generated through toilet usage.

Breakout or effluent breakout: (Also used to refer to a place where there is a potential for breakout.) Visible movement of effluent to the surface of the ground. Where the effluent has been treated in the soil to consistently meet the performance standards of **Error! Reference source not found.** of the SPM or accepted BC Water Quality Guidelines a breakout is not considered to be a risk to public health. A potential for breakout may be present at present or future road cuts, excavations, an exposed impervious layer in a ditch or a drain. A simple cut into the ground may not be a potential breakout if the effluent will be travelling lower in the soil profile, and definition of breakout based upon slope is also not reliable due to variations in soil water movement. The SPM provides horizontal setback standards for potential breakouts.

C

Cemented (soil): Having a hard, brittle consistence because the particles are held together by cementing substances such as humus, calcium carbonate, or the oxides of silicon, iron, and aluminum. The hardness and brittleness persist even when the soil is wet.

Centralized wastewater treatment system: A wastewater collection and treatment system that consists of collection sewers and a centralized treatment facility. Centralized systems are used to collect and treat wastewater from entire communities.

Chemical oxygen demand (COD): A measure of oxygen use equivalent to the portion of organic matter that is susceptible to oxidation by a strong chemical oxidizing agent.

Chlorine residual: The total amount of chlorine (combined and free available chlorine) remaining in water, sewage, or industrial wastes at the end of a specified contact period following disinfection.

Chroma: relative purity, strength, or saturation of a color; directly related to the dominance of the determining wavelength of the light and inversely related to grayness; one of the three variables of color; see also Munsell Color System, hue, and value.

Clarifiers: Settling tanks that typically remove settleable solids by gravity.

Clay: A textural class of soils consisting of particles less than 0.002 millimeters in diameter.

Cluster system: A wastewater collection and treatment system under some form of common ownership and management that provides treatment and dispersal/discharge of wastewater from two or more homes or buildings but less than an entire community.

Coarse fragments: In terms of use of the Site Capability Tables in the SPM; Coarse gravel is defined in the SPM as the portion of the soil consisting of gravel particles larger than 20 mm and up to 75 mm. Rock fragments larger than gravel (as defined in the SPM) are those over 75 mm in size.

In terms of the USDA soil profile evaluation standards, texture modifiers are applied to texture classes as per Table A-1.

Table A-1 Rock fragment texture modifiers (from USDA *Field Book for Describing and Sampling Soils*, Version 2.0, USDA, 2002)

TEXTURE MODIFIERS - Conventions for using "Rock Fragment Texture Modifiers" and for using textural adjectives that convey the "% volume" ranges for **Rock Fragments - Size and Quantity**.

Fragment Content % By Volume	Rock Fragment Modifier Usage
< 15	No texture adjective is used (noun only; e.g., *loam*).
15 to < 35	Use adjective for appropriate size; e.g., *gravelly*.
35 to < 60	Use "very" with the appropriate size adjective; e.g., *very gravelly*.
60 to < 90	Use "extremely" with the appropriate size adjective; e.g., *extremely gravelly*.
≥ 90	No adjective or modifier. If ≤ 10% fine earth, use the appropriate noun for the dominant size class; e.g., *gravel*. Use **Terms in Lieu of Texture**.

And fragments are classed as: Fine gravel, 2 to 5mm, medium gravel 5 to 20 mms and coarse gravel 20 to 75mm. Cobbles 76 to 250mm, Stones 205 to 600mm and Boulders over 600mm.

Coefficient of uniformity (soil or sand): This ratio is a numeric representation of how a soil or sand is graded, calculated as Cu = D60/D10 .

Coliform bacteria: A group of bacteria predominantly inhabiting the intestines of humans or other warm-blooded animals, but also occasionally found elsewhere. Used as an indicator of human fecal contamination. Normally Fecal coliforms are used as the key indicator, see Fecal Coliforms. Usually measured as number of colonies/100 mL or most probably number (MPN)

Colony-forming unit (CFU): term used to report the estimated number of live nonphotosynthetic bacteria in a water sample.

Colloids: The solids fraction that is described as the finely divided suspended matter that will not settle by gravity and is too large to be considered dissolved matter.

Colluvial (soil): Soil which consists of mixed deposits of rock fragments and soil materials accumulated at the bases of slopes) through the influence of gravity (and weathering).

Compliance boundary: A performance boundary with defined performance limits (example a drinking water well).

Confined Aquifer: An aquifer in which ground water is confined under pressure which is significantly greater than atmospheric pressure.

Consistence (soil): Attribute of soil expressed in degree of cohesion and adhesion, or in resistance to deformation or rupture. Consistence includes the resistance of soil material to rupture; resistance to penetration; and the manner in which the soil material behaves when subjected to compression. Table A-2 table shows relevant categories for onsite.

Table A-2 Consistence terms, partial (adapted from USDA *Field Book for Describing and Sampling Soils*, Version 2.0, USDA, 2002)

DRY	MOIST	CEMENTATION	~30 MM BLOCK SPECIMEN FAILS UNDER WHAT FORCE?
Loose (L)	Loose (L)	NA	Intact specimen not obtainable
Soft (S)	Very Friable (VFR)	Non-cemented	Very slight force between fingers (< 8N)
Slightly Hard (SH)	Friable (FR)	Extremely weakly cemented (EW)	Slight force between fingers (8 to < 20N)
Moderately Hard (MH)	Firm (FI)	Very weakly cemented (VW)	Moderate force between fingers (20 to < 40N)
Hard (HA)	Very Firm (VFI)	Weakly cemented (W)	Strong force between fingers (40 to < 80N)

Constructed wetland: An aquatic treatment system consisting of one or more lined or unlined basins, some or all of which may be filled with a treatment medium and wastewater undergoing some combination of physical, chemical, and/or biological treatment and evaporation and Evapotranspiration by means of macrophytes planted in the treatment medium.

Continuous-flow, suspended-growth aerobic system: A typical activated sludge process.

D

D10: In Sieve analysis of sand or soil. The size of the opening which will pass 10% (by dry weight) of a sample. Also known as effective diameter.

D60: In Sieve analysis of sand or soil. The size of the opening which will pass 60% (by dry weight) of a sample.

Decentralized system: Onsite and/or cluster wastewater systems used to treat and disperse or discharge small volumes of wastewater, generally from dwellings and businesses that are located relatively close together. Decentralized systems in a particular management area or jurisdiction are managed by a common management entity.

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous molecular nitrogen or an oxide of nitrogen.

Detention time: Average length of time a unit volume of wastewater or a suspended particle remains in a tank or chamber; for onsite tanks it is generally assumed to be the volume of water in the tank divided by the daily design flow rate through the tank. "Retention time" is often used interchangeably.

Digestion: The biological decomposition of organic matter in sludge, resulting in partial gasification, liquefaction, and mineralization.

Disinfection: The process of destroying pathogenic and other microorganisms in wastewater, typically through application of chlorine compounds, ultraviolet light, iodine, ozone, and the like.

Dissolved oxygen (DO): The oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter (mg/L), parts per million (ppm), or percent of saturation. The ratio of the dissolved oxygen content (ppm) to the potential capacity (ppm) of the water gives the percent saturation. Oxygen saturation is calculated as the percentage of dissolved O_2 concentration relative to that when completely saturated at the temperature of the measurement depth. As temperature increases, the concentration at 100% saturation decreases. The elevation , the barometric pressure, and the dissolved solids content of the water also affect this saturation value but to a lesser extent. The DO concentration for 100% air saturated water at sea level is 8.6 mg oxygen per L at 25°C and increases to 14.6 mg Oxygen per L at 0°C.

Dissolved solids: The fraction of solids dissolved in water.

Dispersal area: Subsurface Wastewater Infiltration System.

Distal: Furthest from a point of reference. The opposite of distal is proximal.

Drainfield: Shallow, covered, excavation made in unsaturated soil into which pretreated wastewater is discharged through distribution piping for application onto soil infiltration surfaces through porous media or manufactured (gravelless) components placed in the excavations. The soil accepts, treats, and disperses wastewater as it percolates through the soil, ultimately discharging to groundwater. See SWIS.

E

Effluent: Sewage, water, or other liquid, partially or completely treated or in its natural state, flowing out of a septic tank, subsurface wastewater infiltration system, aerobic treatment unit, or other treatment system or system component.

Effective size: In a sieve analysis, the particle diameter of which 10 percent of the sample is finer by weight; also known as D10 or effective diameter.

Effluent filter (also called an effluent screen): A removable, cleanable device inserted into the outlet piping of the septic tank designed to trap excessive solids due to tank upsets that would otherwise be transported to the subsurface wastewater infiltration system or other downstream treatment components.

Effluent screen: See Effluent filter.

Endosaturation: a condition in which the soil is saturated with water in all layers from the upper boundary of saturation to a depth of 2 m or more from the mineral soil surface;

Engineered design: An onsite or cluster system that is designed to meet specific performance standards for a particular site as certified by a licensed professional engineer or other qualified and licensed or certified person.

Environmental sensitivity: The relative susceptibility to adverse impacts of a water resource or other environments that may receive wastewater discharges.

Episaturation: zone of saturation held above the main groundwater body by a slowly-permeable layer, or by impermeable rock or sediment. Known as Perched Water table.

Eutrophic: A term applied to water that has a concentration of nutrients optimal, or nearly so, for plant or animal growth. In general, nitrogen and phosphorus compounds contribute to eutrophic conditions in coastal and inland fresh waters, respectively.

Evapotranspiration: The combined loss of water from a given area and during a specified period of time by evaporation from the soil or water surface and by transpiration from plants.

F

Fecal Coliforms: Members of the coliform group of bacteria that are characterized by their ability to ferment lactose at 112.1°F (44.5°C) and that are considered more specific indicators of fecal contamination than are Coliforms that ferment lactose only at 95°F (35°C). Escherichia coli and some Klebsiella pneumoniae strains are the principal fecal coliforms

Field saturated hydraulic conductivity: See Hydraulic conductivity.

Fixed-film wastewater treatment system: A biological wastewater treatment process that employs a medium such as rock, plastic, wood, or other natural or synthetic solid material that will support biomass on its surface. Fixed-film systems include those in which the medium is held in place and is stationary relative to fluid flow (tricking filter), those in which the medium is in motion relative to the wastewater (for example, rotating biological disk), and dual process systems that include both fixed and suspended biomass together or in a series.

Floor area: See “living space”.

G

Gravel: rounded or subrounded rock fragment that is between 0.1 inch (2 millimeters) and three inches (76 millimeters) in diameter.

Graywater: Wastewater drained from sinks, tubs, showers, dishwashers, clothes washers, and other non-toilet sources.

Ground water: A subsurface water occupying the zone of saturated soil, permanently, seasonally, or as the result of the tides.

Groundwater mounding: localized increase in the elevation of a water table that builds up as a result of the downward percolation of liquid into groundwater.

H

Hydraulic Application Rate (HAR): Depth of effluent applied to the infiltrative surface per dose (example mm), may also be expressed in terms of volume per area (example L/sqm).

Hydraulic conductivity (soil): The ability of the soil to transmit water in liquid form through pores. This is termed "K" and is expressed in mm/day or other units of length/time. "Ksat" is Saturated hydraulic conductivity and is normally the value intended when the term "hydraulic conductivity" is used loosely. "Kfs" is the field saturated hydraulic conductivity, as measured by the Guelph in situ permeameter, and is approximately 0.5 Ksat.

High pumping rate community well: For the purpose of determining horizontal setbacks means a well or well group supplying a water supply system providing potable water supply to more than 500 persons. A well may also be considered to be of a high pumping rate when pumped for long periods at over 50 gpm.

I

Inceptisols: Young soils. In the SPM used to refer to weakly developed (colluvium or Residuum) soils that have weathered from shale or interbedded shale/sandstone or shale/limestone parent material. Note that the term is used for a wider range of soils in a soil science context. See Saprolite.

Infiltrative Surface: In drainfields, the drain rock-original soil interface at the bottom of the trench; in mound systems, the gravel-mound sand and the sand-original soil interfaces; in sand-lined trenches/beds (sand filter), the gravel-sand interface and the sand-original soil interface at the bottom of the trench or bed.

Influent: Wastewater, partially or completely treated, or in its natural state (raw wastewater, sewage), flowing into a reservoir, tank, treatment unit, or disposal unit.

Instantaneous loading rate: Quantity of effluent discharged during a dosing event expressed as volume per unit time.

Invert (pipe): Lowest point of the internal cross-section of a pipe or fitting.

L

Landscape position: specific geomorphic component of the landscape in which a site is located; two-dimensional landscape positions (hillslope profile positions) may be summit, shoulder, backslope, footslope, or toeslope; three dimensional views of geomorphic landscape position can be described as head slope, nose slope, side slope, base slope, etc. See Figure A-1 and Figure A-2.

Figure A-1 Hillside Profile Positions

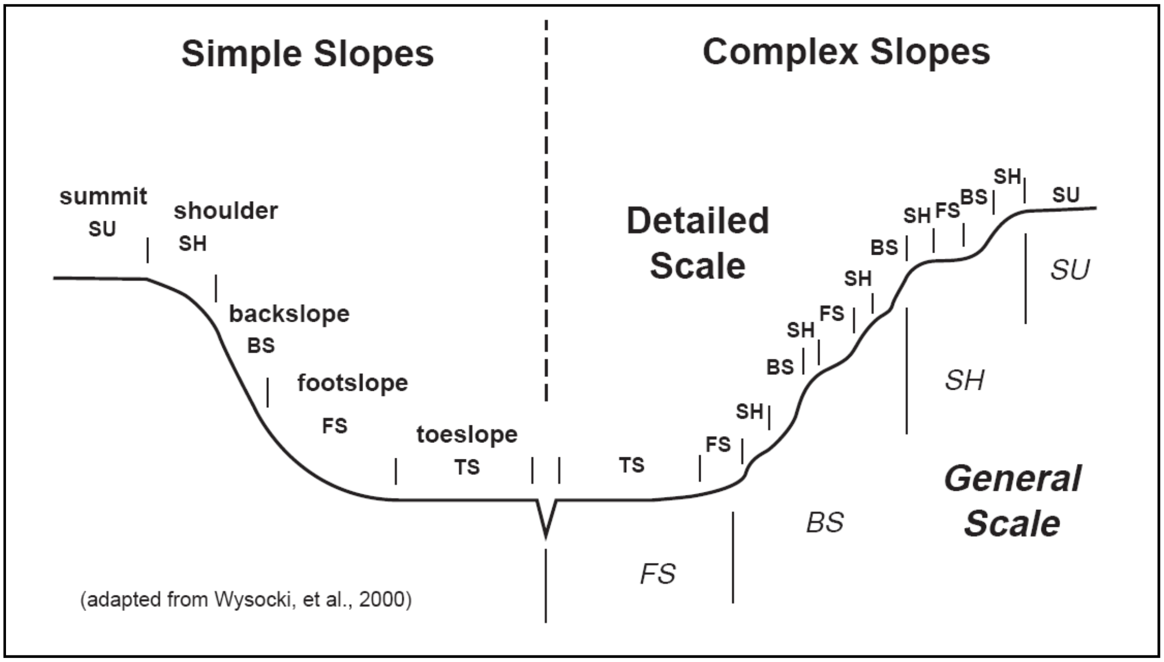
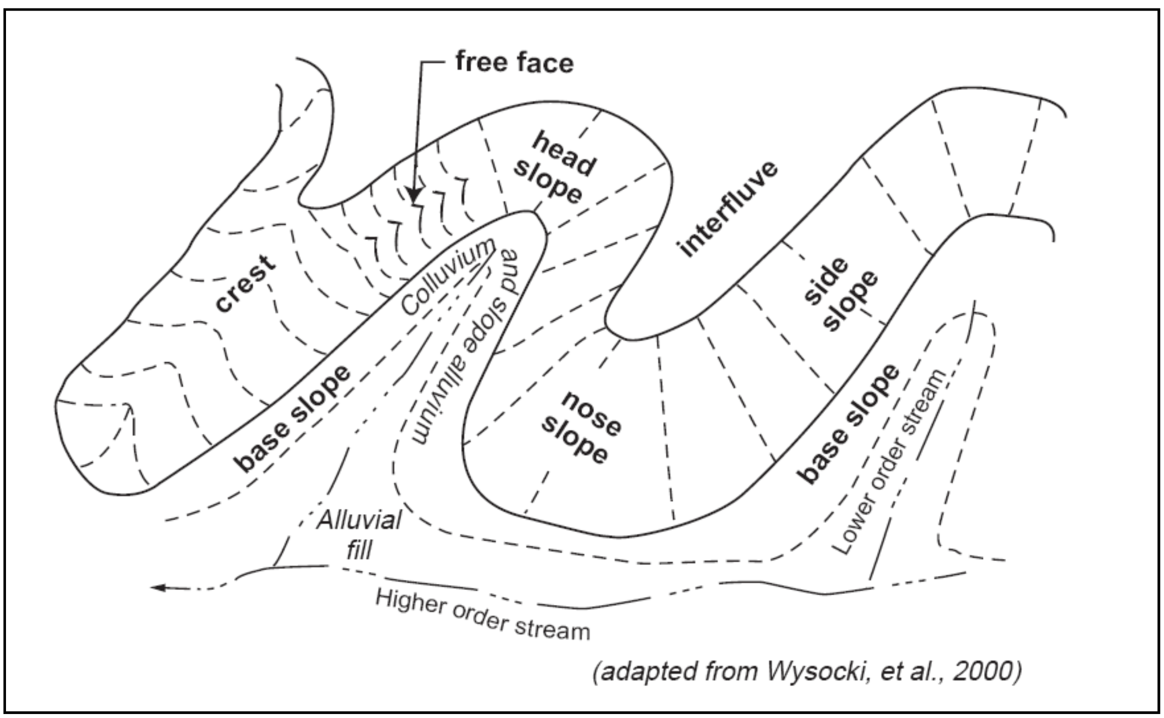


Figure A-2 Geomorphic Landscape Positions



Laminar (groundwater flow): Used to describe flat, sheet-like ground water flows that migrate laterally along the upper surface of a confining layer of soil or rock.

Lateral: Perforated pipe or tubing used to carry and distribute effluent.

Latrine: See "Privy."

Limiting layer: A restrictive layer (see Restrictive Layer) or water table or seasonal high water table.

Living space: The total nett floor area of a building less the floor area of a garage, breezeway, carport, crawl space or decks exterior to the building's foundation walls.

Loam: A specific class of soil texture that contains a balanced mixture of sand, silt and clay. Clay must not exceed 27%. Loams have enough sand to feel some grit and enough clay to give the soil some body, but the properties and behavior of the soil are dominated by neither sand nor clay.

M

Macrofauna (soil): Mice, moles, etc.; Earthworms and other worms; Ants, beetles, termites, spiders, flies and larvae, etc.

Mesofauna (soil): Nemaodes, arthropods (mites, centipedes, and springtails), molluscs

Microfauna (soil): Protozoa

Macroflora (soil): Vascular plants, Mosses, etc.

Microflora (soil): Bacteria, Actinomycetes, Fungi, Algae

Macropore (soil): The term includes all pores that are (generally) drained at field capacity, normally stated that these are of 1mm or larger equivalent diameter. This includes root channels and soil macro structure. These pores are the main path for preferential (rapid saturated) flow in structured soils and fractured rock.

Mesopore: Pores in soil intermediate between micro and macro pores. Note that definition of pore sizes varies widely in technical literature.

Micropore: The smaller pores in the soil. They contain both available and unavailable water (in terms of plant water use). Many of the soil microbes are found here. Equivalent diameter normally stated to be less than 0.03 mm.

Mass loading: See Organic loading rate. May also refer to mass loading to a treatment facility.

Matrix flow: This is the relatively slow and even movement of solutes through the soil. The objective of careful effluent dosing and distribution is to encourage unsaturated matrix flow and so improve in soil treatment. Also termed "uniform flow."

Media, distribution: material used to provide void space (usually in a dispersal component) through which effluent flows and is stored prior to infiltration (for example, washed stone, aggregate, polystyrene blocks, chambers, etc.).

Media, treatment: Non-degradable material used for physical, chemical and/or biological treatment in a wastewater treatment component. Example sand in a sand mound.

Mineralization: The conversion of an element from an organic form to an inorganic state as a result of microbial decomposition.

MLSS: Mixed Liquor Suspended Solids — the volume of suspended solids (see SS) in the mixed liquor (see ML) of an aeration tank.

Mixed liquor (ML): Mixture of activated sludge and wastewater undergoing treatment in an activated sludge (or extended aeration) process.

Most probable number (MPN): estimate of the density of microorganisms in a sample based on certain growth rates and statistical formulas, commonly used for coliform bacteria.

Mottling: Spots or blotches of different colors or shades of color interspersed with the dominant soil color caused in part by exposure to alternating unsaturated and saturated conditions. See "Redoximorphic."

Munsell Color System: Color designation system that specifies the relative degrees of the three variables of color: hue, value, and chroma. Example: 10YR 6/4 is a color (of soil) with a hue = 10YR, value = 6, and chroma = 4; see also chroma, hue, value.

N

Nitrification: The biochemical oxidation of ammonium to nitrate.

Nitrogen (N): Gaseous element (molecular formula N_2) that constitutes 78 percent of the atmosphere by volume and occurs as a constituent of all living tissues in combined form; nitrogen is present in wastewater, surface water and groundwater as ammonia (NH_3) or ammonium ion (NH_4^+), nitrite (NO_2^-), nitrate (NO_3^-) and organic nitrogen;

O

Observation Port: Larger diameter (over 3") pipe, open bottom or slotted, used to observe the soil infiltration surface.

Oil and Grease (O&G): Fats, oils, waxes and other related constituents found in wastewater. Oil and Grease content is determined by extraction from the wastewater sample with trichlorofluoroethane, and is expressed in mg/L. Previously termed "Fat Oil and Grease" (FOG).

Onsite wastewater treatment system (OWTS): A system relying on natural processes and/or mechanical components that is used to collect, treat, and disperse/discharge wastewater from single dwellings or buildings.

Organic loading rate (to SWIS): The rate of application of soluble and particulate organic matter. It is typically expressed on an area basis as g/m^2 or pounds of BOD_5 per square foot per day ($lb/ft^2/day$).

Organic nitrogen: Nitrogen combined in organic molecules such as proteins and amino acids.

Organic soil: A soil that contains a high percentage (more than 15 – 20%) of organic matter throughout the soil column.

Oxidation: Chemical reaction in which a loss of electrons results in an increase in oxidation number (valence) of an element; occurs concurrently with reduction of the associated reactant. Chemical or biological conversion of organic matter to simpler, stable forms with a concurrent release of energy.

P

Package plant: Term commonly used to describe an aerobic treatment unit serving multiple dwellings or an educational, health care, or other large facility.

Particle size: The effective diameter of a particle, usually measured by sedimentation or sieving.

Particle-size distribution: The amounts of the various soil size fractions in a soil sample, usually expressed as weight percentage.

Pathogenic: Causing disease; commonly applied to microorganisms that cause infectious diseases.

Peat: Organic (fibric) soil material in which the original plant parts are recognizable.

Ped: A unit of soil structure such as an aggregate, crumb, prism, block, or granule, formed by natural processes. Shapes include granular, platy, blocky and prismatic. Ped sizes can range from 1mm granules to 10 cm prisms.

Peer reviewed: Material that has been read by experts in the field to evaluate its validity before publication. Also known as scholarly or refereed. For the purposes of the SPM this includes articles that have been reviewed/validated by the BCOSSA Technical Review Committee.

Perched water table: The permanent or temporary water table of a discontinuous saturated zone in a soil. The water table is “perched” upon the restrictive layer, while the normal water table is deeper in the soil profile.

Percolation: The flow or trickling of a liquid downward through a contact or filtering medium.

Performance-based management program: A program designed to preserve and protect human health and environmental resources by focusing on the achievement of specific, measurable performance standards based on site assessments.

Performance boundaries: The point at which a wastewater treatment performance standard corresponding to the desired level of treatment at that point in the treatment sequence is applied. Performance boundaries can be designated at the a point of the pretreatment system (for example, septic tank, package plant), at physical boundaries in the receiving environment (impermeable strata, ground water table, breakout), at a point of use (ground water well), or at a property boundary.

Performance standard: A standard established as part of the SPM or by a regulatory authority to ensure future compliance with the public health and environmental goals. Performance standards can be expressed as numeric limits (for example, pollutant concentrations, mass loads, wet weather flows, and structural strength) or narrative descriptions of desired performance, such as no visible leaks or no odors.

Permanent Water Table: See “Water Table.”

Permeability: The ability of a porous medium such as soil to transmit fluids or gases.

pH: A term used to indicate the acidity or alkalinity of the water. The logarithm of the reciprocal of hydrogen-ion concentration in gram atoms per liter; provides a measure on a scale from 0 to 14 of the acidity or alkalinity of a solution (where 7 is neutral and greater than 7 is more alkaline and less than 7 is more acidic).

Phosphorus (P): Chemical element and essential nutrient for all life forms, occurring as orthophosphate, pyrophosphate, tripolyphospate and organic phosphate forms; each of these forms, as well as their sum (total phosphorus), is expressed in terms of milligrams per liter elemental phosphorus; occurs in natural waters and wastewater almost solely as phosphates. Total (TP) is the sum of all forms of phosphorus in effluent.

Physical boundaries: Points in the flow of wastewater through the treatment system where treatment processes change. A physical boundary can be at the intersection of unit processes or between saturated and unsaturated soil zones. A physical boundary may also be a performance boundary if so designated in the design or in standard practice.

Piezometer: A type of monitoring well designed solely to obtain ground water levels. Instrument for estimating pressure head in a conduit, tank or soil by determining the location of the free water surface. This term was used incorrectly within a past version of the SPM to refer to observation pipes used in the SWIS.

Plastic soil: A soil capable of being molded or deformed continuously and permanently by relatively moderate pressure.

Platy structure (soil): Laminated or flaky soil aggregate developed predominantly along the horizontal axes.

Ponding: Accumulation of liquid on an infiltrative surface.

Preferential flow: Saturated flow in macropores or as finger or funnel flow in unstructured soils, it is the rapid and local transport of water and solutes in soils. For good in soil treatment this type of flow should be avoided. See Matrix flow, macropore.

Prescriptive standards: Standards or specifications for design, siting, and other procedures and practices for onsite or cluster system applications. Proposed deviations from the specified criteria, procedures, or practices require formal approval by a regulatory authority.

Pretreatment system: Any technology or combination of technologies that precedes discharge to a subsurface wastewater infiltration system or other final treatment unit or process before final dissemination into the receiving environment.

Pressure transducer: Device that measures pressure, a control panel or datalogger is used to convert that information to a measurement of depth or flow.

Primary treatment: Level of treatment involving removal of particles, typically by settling and flotation with or without the use of coagulants; some solids are anaerobically broken down but dissolved contaminants are not significantly removed in this treatment step (for example a grease interceptor or a septic tank provides primary treatment). Type 1 effluent is produced by primary treatment.

Privy: A structure used for disposal of human waste without the aid of water; it consists of a shelter built above a pit or vault in the ground into which human waste falls. The vault may be impermeable (vault privy) or may include soil absorption (pit latrine or pit privy).

Proximal: Nearest to a point of reference. The opposite of proximal is distal.

R

Redoximorphic features: or mottling, is identified by the presence of oxidized and reduced states of iron or manganese in the same ped (single unit of soil structure). In more highly weathered soils, it is identified as concentrations and depletions of iron. Redox concentrations: zones of apparent accumulation of Fe-Mn oxides in soils. Redox depletions: zones of low chroma (2 or less) where Fe-Mn oxides alone or both Fe-Mn oxides and clay have been stripped out of the soil. Iron concentrations occur as bright (red or yellow) spots in a reduced (gray) matrix. Iron depletions occur as reduced (gray) spots in an oxidized (red or yellow) matrix. See "mottling."

Reduction: Addition of electrons to a chemical entity decreasing its valence or oxidation number; for example under anaerobic conditions (no dissolved oxygen present), sulfur compounds are reduced by bacteria to odor-producing hydrogen sulfide (H2S) and other compounds.

Residuals: The solids generated and retained during the treatment of domestic sewage in treatment system components, including sludge, scum, and pumpings from grease traps, septic tanks, aerobic treatment units, and other components of an onsite or cluster system.

Residuum or Residual (soil): Soil formed in place by natural weathering. Soil formed from, or resting on, consolidated rock of the same kind as that from which it was formed and in the same location. See "Autochthon"

Restrictive Layer: A stratum impeding the vertical movement of water, air and growth of plant roots, such as hardpan, claypan, fragipan, caliche, some compacted soils, bedrock and unstructured clay soils. Includes soils with permeability of less than 60 mm/day where these underlay soils of higher permeability, and soils with consistency stronger than Firm (moist) or Moderately Hard (dry) are normally seen as restrictive.

Retention time: Time for which a liquid or sludge is retained in a process component (For example, in a lagoon). *See Detention Time.*

S

Sand filter: A packed-bed filter of sand or other granular materials used to provide advanced secondary treatment of settled wastewater or septic tank effluent. Sand/media filters consist of a lined (for example, impervious PVC liner on sand bedding) excavation or structure filled with uniform washed sand that is placed over an underdrain system. The wastewater is dosed onto the surface of the sand through a distribution network and allowed to percolate through the sand to the underdrain system, which collects the filter effluent for further processing or discharge.

An Intermittent Sand Filter is a sand filter in which pre-treated wastewater is applied periodically providing intermittent periods of wastewater application, followed by periods of drying and oxygenation of the filter bed.

A Recirculating Sand (Gravel) Filter is a sand (gravel) filter which processes liquid waste by mixing filtrate with incoming septic tank effluent and recirculating it several times through the filter media before discharging to a final treatment/disposal unit. Sand-Lined Drainfield Trench is a combination of a pressure distribution drainfield and an intermittent sand filter consisting of a two-foot layer of intermittent sand filter media placed directly below the drain rock layer in the pressure distribution drainfield trench.

A Bottomless Sand Filter is a special case of a sand-lined drainfield trench installed in a containment vessel and is usually used to utilize more suitable soils high in the soil profile for disposal, in the SPM this is termed an above ground sand-lined trench. A sand mound is a sand filter constructed without containment and dispersing directly to a basal area of native soils.

Saprolite: A chemically weathered rock. It is mostly soft or friable and commonly retains the structure of the parent rock since it is not transported, but autochthonously formed in place. Upper Saprolite may be suitable for effluent dispersal and treatment but will require sand-lined trench with timed dosing or similar techniques to prevent preferential flow, see "Inceptisol."

Seasonal High Water Table (SHWT): Upper limit of soil water table (at least 150 mm deep and within 2m of the ground surface) which persists for more than 21 consecutive or 30 total days during a year which has precipitation of at least 30% of average annual precipitation (to a maximum of 1 in 20 year return period precipitation). This may be determined from piezometer data combined with rainfall data, or may be indicated through the use of secondary methods of soil and site assessment. Secondary methods include assessment of reduction depletion of soil colors to chroma 2 or 3 (Munsell Color Chart) or less (indicative of extended reducing conditions) and/or redoximorphic features, and root penetration. The SHWT may also be a perched water table.

Seasonal Low Water Table: See Water table.

Septage: The liquid, solid, and semisolid material that results from wastewater pretreatment in a septic tank, which must be pumped, hauled, treated, and disposed of properly.

Septic tank: A buried, preferably watertight tank designed and constructed to receive and partially treat raw wastewater. The tank separates and retains settleable and floatable solids suspended in the raw wastewater. Settleable solids settle to the bottom to form a sludge layer. Grease and other light materials float to the top to form a scum layer. The removed solids are stored in the tank, where they undergo liquefaction in which organic solids are partially broken down into dissolved fatty acids and gases. Gases generated during liquefaction of the solids are normally vented through the building's plumbing stack vent.

Sequencing batch reactor: A sequential suspended- growth (activated sludge) process in which all major steps occur in the same tank in sequential order. Sequencing batch reactors include intermittent- flow batch reactors and continuous-flow systems.

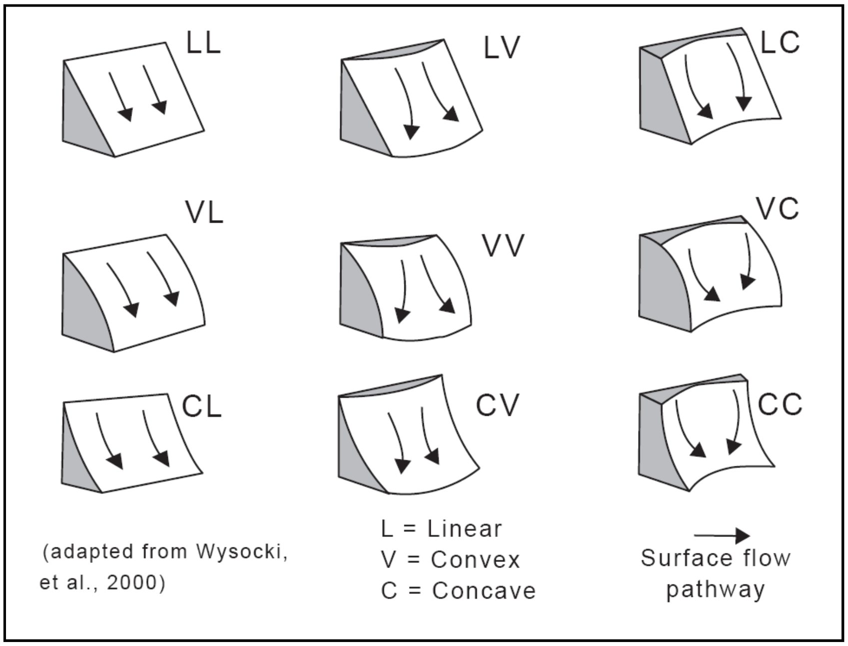
Settleable solids: Matter in wastewater that will not stay in suspension during a designated settling period.

Sewage: Any urine, feces, and the water carrying human wastes including kitchen, bath, and laundry wastes from residences, building, industrial establishments or other places. For the purposes of the SPM, "sewage" is generally synonymous with domestic wastewater or domestic sewage.

Silt: A textural class of soils consisting of particles between 0.05 and 0.002 millimeters in diameter.

Slope Shape: Slope shape is described in two directions: 1) up and down slope (perpendicular (normal) to the contour); and 2) across slope (along the horizontal contour). Concave: landscape form or feature that is curved like a segment of the interior of a hollow sphere. Convex: landscape form or feature that has a surface that is curved or rounded outward. This data element is split into two sequential parts (Slope Across and Slope Up & Down); for example, Linear, Convex, or LV.

Figure A-3 Slope Shape Diagrams



Soil horizon: A layer of soil or soil material approximately parallel to the land surface and different from adjacent layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistence, and pH.

Soil map: A map showing the distribution of soil types or other soil mapping units in relation to the prominent physical and cultural features of the earth's surface.

Soil morphology: The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness, and arrangement of the horizons in the profile and by the texture, structure, consistence, and porosity of each horizon.

Soil structure: The combination or arrangement of individual soil particles into definable aggregates, or peds, which are characterized and classified on the basis of size, shape, and degree of grade (distinctness).

Soil structure grade: Degree of distinctness (degree of aggregation), how well the structure is expressed in place. See Table A-3.

Table A-3 Soil structure grade (adapted from USDA *Field Book for Describing and Sampling Soils*, Version 2.0, USDA, 2002)

GRADE	CODE	CRITERIA FOR GRADE
Structureless	0	No discrete units observable in place or in a hand sample.
Weak	1	Units are barely observable in place or in a hand sample.
Moderate	2	Units well-formed and evident in place or in a hand sample.
Strong	3	Units are distinct in place (undisturbed soil), and separate cleanly when disturbed.

Soil Ped: A single unit of soil structure. See “Ped.”

Soil survey: The systematic examination, description, classification, and mapping of soils in an area.

Soil textural class: Percentage by weight of sand silt and clay such that each class possesses unique physical characteristics and management relative to the other textural class. The textural classes may be modified by the addition of suitable adjectives when rock fragments are present in substantial amounts; for example, "gravelly loam".

Soil texture: The relative proportions of the various soil separates (for example, silt, clay, sand) in a soil.

Soil water: A general term emphasizing the physical rather than the chemical properties and behavior of the soil solution.

Standpipe: Pipe, slotted or open bottom, which is used to measure the depth of the water table. A standpipe would normally not be sealed, and would normally be slotted over most of its length. It could range in diameter from, typically, 25 to 150 mm diameter.

Subsoil: In general, that part of the soil below the depth of plowing.

Subsurface wastewater infiltration system (SWIS): An underground system for dispersing and further treating pretreated wastewater. The SWIS includes the distribution piping/units, any media installed around or below the distribution components, the biomat at the wastewater-soil interface, and the unsaturated soil below.

Suspended solids (SS): The residue that is retained after filtering a sample of water or wastewater through a standard glass-fiber filter. The concentration of total suspended solids is the weight of the dried solids retained on the filter, divided by the volume of the sample from which the solids were collected. This is normally expressed as mg/L.

Swale: Natural or constructed elongated depressional drainage feature used to divert runon or runoff and direct the flow to an effective outlet.

T

TDHR: Measure of the cumulative energy that a pump must impart to a liquid to move it from one point to another, consisting of the sum of any residual head required, suction head (where applicable) plus friction head losses and static head.

Topsoil: The layer of soil moved in agricultural cultivation.

Total Kjeldahl nitrogen (TKN): An analytical method for determining total organic nitrogen and ammonia.

Total Suspended Solids (TSS): See Suspended Solids.

Transpiration: The process by which water absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, principally from the leaves.

U

Unconfined aquifer: An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well.

Uniformity Coefficient (particle size distribution): As used for determining grading of sands. CU: a numeric quantity which is calculated by dividing the size of the opening which will pass 60% of a sample by the size of the opening which will pass 10% of the sample. (Symbolically C60/C10=CU).

Unsaturated flow: Movement of water in a soil that is not filled to capacity with water.

Unsaturated soil: Soil in which the pore spaces contain water at less than atmospheric pressure, as well as air and other gases.

V

Vadose zone: Aerated region of soil (normally unsaturated) above the permanent water table.

Value: one of the three variables of color, described as the degree of lightness or darkness of the color in relation to a neutral gray scale; on a neutral gray scale, value extends from pure black to pure white. see also Munsell Color System, hue, and chroma.

Vegetated submerged bed: A constructed wetland wastewater treatment unit characterized by anaerobic horizontal subsurface flow through a fixed-film medium that has a growth of macrophytes on the surface.

Vertical Separation (native soil): The depth of unsaturated, original, undisturbed permeable soil below the infiltrative surface and above any limiting layer.

Vertical Separation (as constructed): The depth of unsaturated, original, undisturbed permeable soil below the infiltrative surface and above any limiting layer PLUS the depth of sand media between the infiltrative surface and the native soil.

W

Water budget: In general use this is a hydrological formula used to determine water surpluses and deficits in a given area, providing a budget of the incoming and outgoing water from a region, including rainfall, evaporation, runon, runoff, and seepage (absorbtion). For an Onsite system (Example ETA or ET bed) this is used to provide a balance sheet for the inputs and outputs of water to the unit.

Water table: (Seasonal Low Water Table) (Permanent Water Table) The level in saturated soil at which the hydraulic pressure is zero (i.e, equal to atmospheric pressure). In terms of the Standard Practice Manual vertical separation standards the permanent water table refers to the lowest elevation of the water table during a year which has precipitation of at least 30% of average annual precipitation (to a maximum of 1 in 20 year return period precipitation).

Well: a hole constructed into the ground for the purpose of extracting groundwater.

Wetland: Area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils conditions; natural wetlands generally include swamps, marshes, bogs and similar areas, but not constructed wetlands used in wastewater treatment.

Appendix B 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]

Appendix C Design Inputs Worksheet

A worksheet for collection and analysis of the inputs for normal residential onsite system design has been prepared. This is based upon the standards 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

SWIS Design Inputs summary worksheet

Job: __________________________ Date: _________ Designer: _________________

Daily Design Flow

From SPM section 2.2.1

House number of bedrooms ____________ Base flow: ____________ L/day

House floor area (sq m) ____________

1 sqm = 10.76 sqft

Maximum floor area (sqm) ____________

for # bedrooms (*from SPM*)

Additional floor area (sqm) ____________ x 4.5 L/dy per sqm _____________ L/Day

Total daily design flow **Q** = _____________ **L/Day**

Peaking factor: **2** **Average flow** = Q / 2 = ____________ L/Day

Soil/site information

A. Chosen soil type

Texture: ____________ Structure: ____________ Grade: _________ Consistency:______

Percolation rate: ____________ min/inch Kfs: _______________ mm/day

B. Soil depth in field area and 7.5m or 15m downslope (*7.5m pressure, 15m gravity*)

Soil depth to SHWT or RL: ___________ cm Type of restriction: _________________________

Soil proposed Vertical Separation: ______ cm Downslope VS (to 7.5m or 15m) _______cm

C. Site slope in field area and 7.5m or 15m downslope

Slope % : __________________ Type: _____________ Location.: ____________

Site capability: __________________________ System type: _______________________

Loading rates

From SPM table 2-8, 2-11. Proposed effluent type:_______ Mound? _______ Time dose? ______

LLR: _______________ **L/m/day** Proposed total VS: __________

HLR: _______________**L/sqm/day** (*Basal loading if for mound*)

Minimum system length = Q/LLR ___________ ÷ ____________ = _______________ Meters

AIS = Q/HLR ___________ ÷ _______________ = _______________ Square Meters

For seepage bed systems use AIS x 1.35

SWIS Design Inputs summary worksheet

Job: ________________________ Date: ________ Designer: ________________

Daily Design Flow

From SPM section 2.2.1

House number of bedrooms ___________ Base flow: ___________ L/day

House floor area (sq m) ___________

1 sqm = 10.76 sqft

Maximum floor area (sqm) ___________

for # bedrooms (*from SPM*)

Additional floor area (sqm) ___________ x 4.5 L/dy per sqm ____________ L/Day

Total daily design flow **Q** = ____________ **L/Day**

Peaking factor: **2** **Average flow** = Q / 2 = ___________ L/Day

Soil/site information

A. Chosen soil type

Texture: ___________ Structure: ___________ Grade: ________ Consistency:______

Percolation rate: ___________ min/inch Kfs: ______________ mm/day

B. Soil depth in field area and 7.5m or 15m downslope (*7.5m pressure, 15m gravity*)

Soil depth to SHWT or RL: __________ cm Type of restriction: _______________________

Soil proposed Vertical Separation: ______ cm Downslope VS (to 7.5m or 15m) _______cm

C. Site slope in field area and 7.5m or 15m downslope

Slope % : _________________ Type: ____________ Location.: ___________

Site capability: ________________________ System type: _____________________

Loading rates

From SPM table 2-8, 2-11. Proposed effluent type:_______ Mound? _______ Time dose? ______

LLR: ______________ **L/m/day** Proposed total VS: _________

HLR: ______________**L/sqm/day** (*Basal loading if for mound*)

Minimum system length = Q/LLR __________ ÷ ___________ = ______________ Meters

AIS = Q/HLR __________ ÷ ______________ = ______________ Square Meters

For seepage bed systems use AIS x 1.35

Appendix D Mass Loading, Flow Reduction Devices:

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.

Appendix E Recommendation for Field Tests of Soil Permeability

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, should be conducted in the planned drainfield area, in unsaturated native soils, at the depth of the planned infiltration surface. A variety of test methods can 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.

PERMEAMETER

In order to utilize the Pask constant head permeameter with the Glover or Elrick and Reynolds formulae; the permeameter auger hole base should be at least two times the water depth (H) from an impermeable layer, low permeability layer or laterally confined water table below the base of the hole. Also, the ratio of water depth/hole radius should be greater than five. Other formulae are available for situations where the depth to the low permeability layer is less than two times the water depth (H).

In addition to these constraints, care should 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 Saprolite 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 can be estimated as 2.0 × Kfs (Gupta et al, 1994).

The Kfs value that is used to calculate HLR should normally be based on at least four field tests using the permeameter 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) 360 mm/day; (2) 470 mm/day; (3) 780 mm/day; (4) 190 mm/day. The design Kfs used should be no more than the second lowest value, 360 mm/day.

If six or more tests are conducted, the third lowest Kfs value can be used as the representative value; if eight or more tests the representative value would be the 4^{th} lowest, and so forth.

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. As recommended in the SPM, a Professional can use a different protocol than that outlined above. Reasoning for departure should be documented.

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.

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.

PERCOLATION TESTS

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

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. As recommended in the SPM, a Professional can use a different protocol than that outlined above. Reasoning for departure should be documented.

In all cases, the qualified AP that tests the soil permeability should 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.

> Note:
>
> The current (2004) *Subdivision Regulation* also uses the percolation test and in doing so uses as the selected percolation rate the average percolation value for the tests made for each field.
>
> To quote the *Subdivision Regulation* Appendix B, (6) (j):
>
> "The time in minutes for the water level to drop 1 inch is the percolation rate for that hole and is recorded in minutes per inch. The percolation rate of the absorption field is the average rate of all the percolation tests made for that field."

Procedure for Percolation Test

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

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

2. Test holes should be dug at each end of the area of the absorption field. Further holes could be needed, depending upon the nature of the soil, the results of the first tests and the size of the proposed absorption field;
3. test holes should be 30 cm (12") 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 should 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 should 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") 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") or less from the bottom of the hole, add enough water to bring the depth of water to 15 cm (6") 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 evaluating the slowest rate determined for each of the test holes in the same way as described above for Kfs, that is, if four test holes are tested the rate selected would be the second slowest; and,
11. Backfill the holes with the excavated soil and flag their locations.

Appendix F Performance at Boundaries, setbacks and environmental monitoring

Relationship between the Prohibition of Creation of a Health Hazard under the SSR and Appendix F Standards

The Sewerage System Regulation describes discharge of sewage or effluent to the land surface or water (surface, tidal or drinking water) as a health hazard.

> "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;

Section 3(1)(b) of the SSR requires that owner's of land parcels on which a sewerage system is located must not cause or contribute to a health hazard. Section 9(1)(b)(v) requires an AP file a letter to the health authority certifying that system, if operated and maintained in accordance with maintenance plan, will not cause or contribute to a health hazard. Section 12(a) makes it an offence for a person to knowingly make a false or misleading statement in providing required information to a health authority, including assurance that a system will not cause or contribute to a health hazard in the letter discussed above. Finally, section 12(c) makes it an offence for a person to construct a sewerage system, or fail to repair or maintain a sewerage system, in a manner that causes or contributes to a health hazard.

Consequently it is of fundamental importance that an AP not cause or contribute to a health hazard in order to facilitate AP and owner compliance under the SSR.

While the standards set out in these appendices and SPM are based on performance standards and are designed to prevent the occurrence of a health hazard in the first place, they are only a guideline providing a "starting point" for APs.

It is ultimately the responsibility of AP's to ensure that they do not cause or contribute to a health hazard and to meet all other requirements of the Regulation and other legislation. APs should always evaluate these standards in light of the specific circumstances encountered in the course of their work and use their expert discretion to determine whether the standard is suitable given their legal requirements under the Regulation and other legislation. Where there is any doubt, legal counsel should be obtained on the matter.

If a guideline in this appendix or SPM conflicts with a requirement of the Regulation or other legislation, the legislation will always be paramount, and the guideline should be ignored to the extent that there is conflict.

This being said, effluent must not be permitted to surface or to contaminate water bodies or drinking water sources. Prior to effluent reaching the groundwater table or restrictive layer below the discharge area certain performance standards should be met in regard to effluent treatment to ensure that the water moving away from the discharge area will not cause a health hazard- i.e., does not contain any effluent.

Boundary performance

AP's should monitor the progress of effluent treatment by the sewerage system as well as the quality of water moving away from the discharge area. In order to conduct monitoring, it is useful to establish boundary points at which certain environmental standards should be achieved for effluent and water runoff.

Two types of boundaries should be considered:

- **Compliance boundaries** are boundaries delineating the area outside the sewerage system, the system's soils and discharge area at which point environmental standards must be met in order for an AP or owner to be in compliance with legal requirements set out in SSR or other legislation such as *Drinking Water Protection Act* (e.g., drinking water well). At this point, water moving away from the system must not contain effluent or else it would constitute a health hazard. For compliance boundaries, environmental monitoring should be possible to establish whether the performance is being met ***prior to reaching the compliance boundary***. Ultimately soil water reaching compliance boundaries must meet water quality standards and objectives established for water quality, rather than effluent quality.
- **Design boundaries** are boundaries within or encapsulating the sewerage system, its soils and discharge area at which point performance or environmental standards should be met in order for domestic sewerage and effluent to be properly treated so that compliance boundary performance will be met (based upon the system design). These boundaries are at multiple interfaces within the system and discharge area. Examples of design boundaries include the infiltrative surface of a trench or the restrictive layer below a SWIS.. Performance expectations at these boundaries are used for system design.
  - The boundary performance design can include certain process performance, for example, a design could call for Type 3 effluent to be applied to the infiltrative surface.
  - Consideration of design boundaries is also used when designing soil based dispersal system based on performance. For example, the SPM Vertical

> Separation standards are based upon a certain expectation of performance of the soil vertical separation, and the performance at a flow restrictive horizon of a design should meet the same minimum expectations.

The level of renovation needed is related to the risk and particular environmental water quality guidelines, standards and legislation associated with the boundary under consideration. This is the same concept as is applied to water quality standard guidelines and objectives, in which levels of quality are related to the potential for environmental or health impact.

Thus, for example, performance should be higher at fractured rock boundary where saturated flow in the fractured rock connects directly to a fractured rock drinking water aquifer than it should be at a layer of clay in an area served by a municipal water system. At a minimum, performance must meet requirements set out in SSR and other legislation.

Performance standards are also related to the type of soil water movement on the site. In certain cases, for example, there could also be a concern of heavy rainfall (particularly where concentrated by landform) causing contaminants to be washed from the soil to the water table.

SPM SEPARATION STANDARDS

Presently it is BC industry practice, based on practical considerations, that small onsite systems utilize recommended vertical and horizontal separation standards as opposed to requiring environmental monitoring of performance at compliance boundaries. These standards have been selected to, in normal situations, achieve the base performance standard (i.e., not to create or contribute to a health hazard), when used with the other (linked) standards of Part 2 of the manual in a well constructed, properly operated and maintained system.

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. Disease causing agents can travel great distance and remain viable under saturated conditions. Thus, large horizontal separations should not replace proper vertical or unsaturated separation.

The Authorized Person should take into account the purpose of vertical separation distances, and be prepared to increase vertical separation beyond the minimum where this is mandated by the level of risk or the soil/water conditions of a site.

The vertical and horizontal separation standards of the SPM are predicated upon use of conservative hydraulic loading rates and hydraulic application rates to the infiltrative surface.

DEPARTURE FROM SEPARATION STANDARDS

In certain cases where these simple separation standards cannot be met, and an AP reduces setbacks, the AP should utilize environmental monitoring to ensure that:

- the system is properly treating the effluent so that the water moving away from the system contains no effluent and meets other compliance boundary standards, and
- effluent is not discharged into a water body, drinking water or surface of the land. See Part 2 of the SPM, section 2.3.3.3.

Any alteration of critical separation standards should only be made based upon a report by an AP who is a Professional with competence in the field of hydrogeology or geotechnical engineering.

Where environmental monitoring is put in place to establish compliance with performance standards it is necessary to monitor background levels of contaminants to provide clarity on the impact of the onsite system and the relationship between the water moving away from the system and the existing groundwater.

Figure A-4 Cross section of a dispersal trench, showing design boundaries. The ground surface would be considered a compliance boundary.

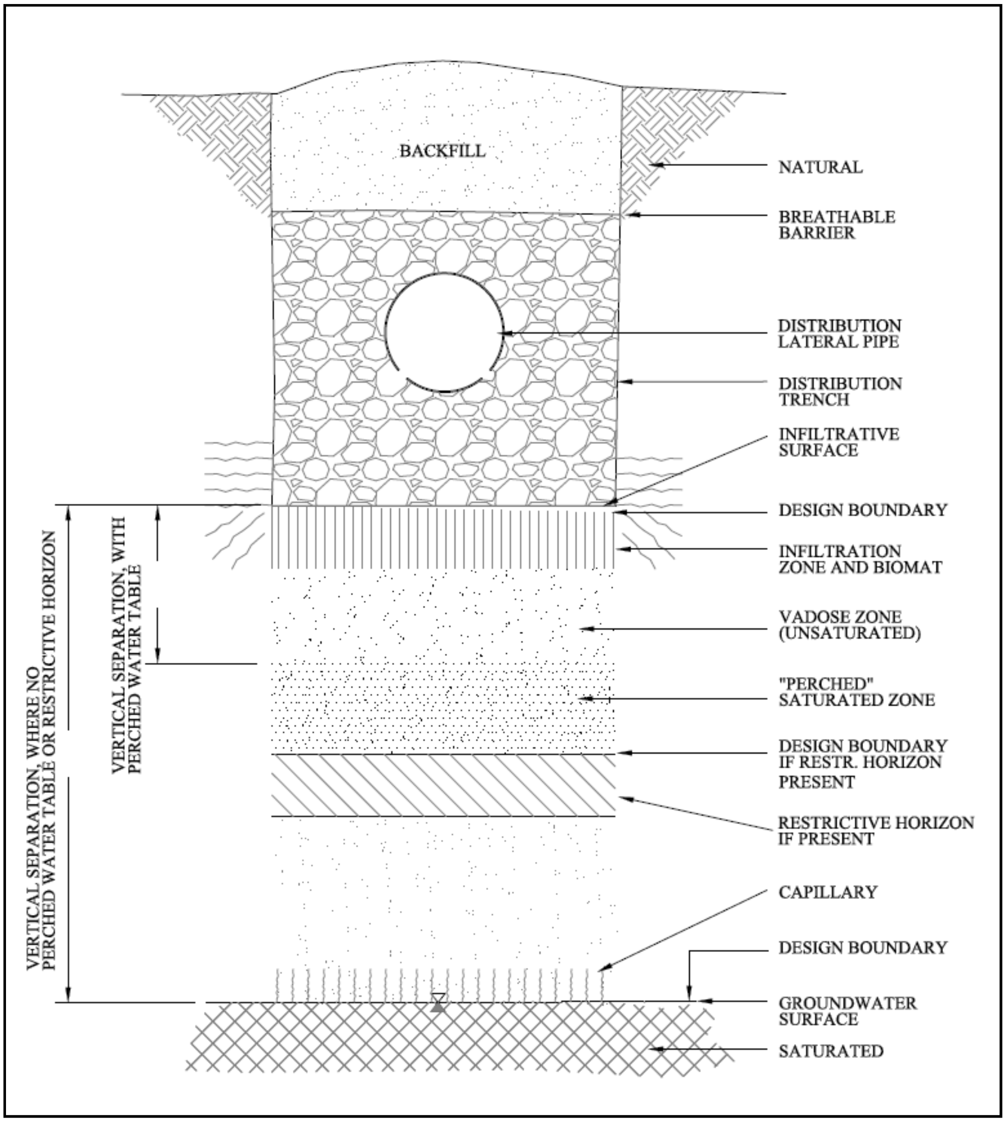
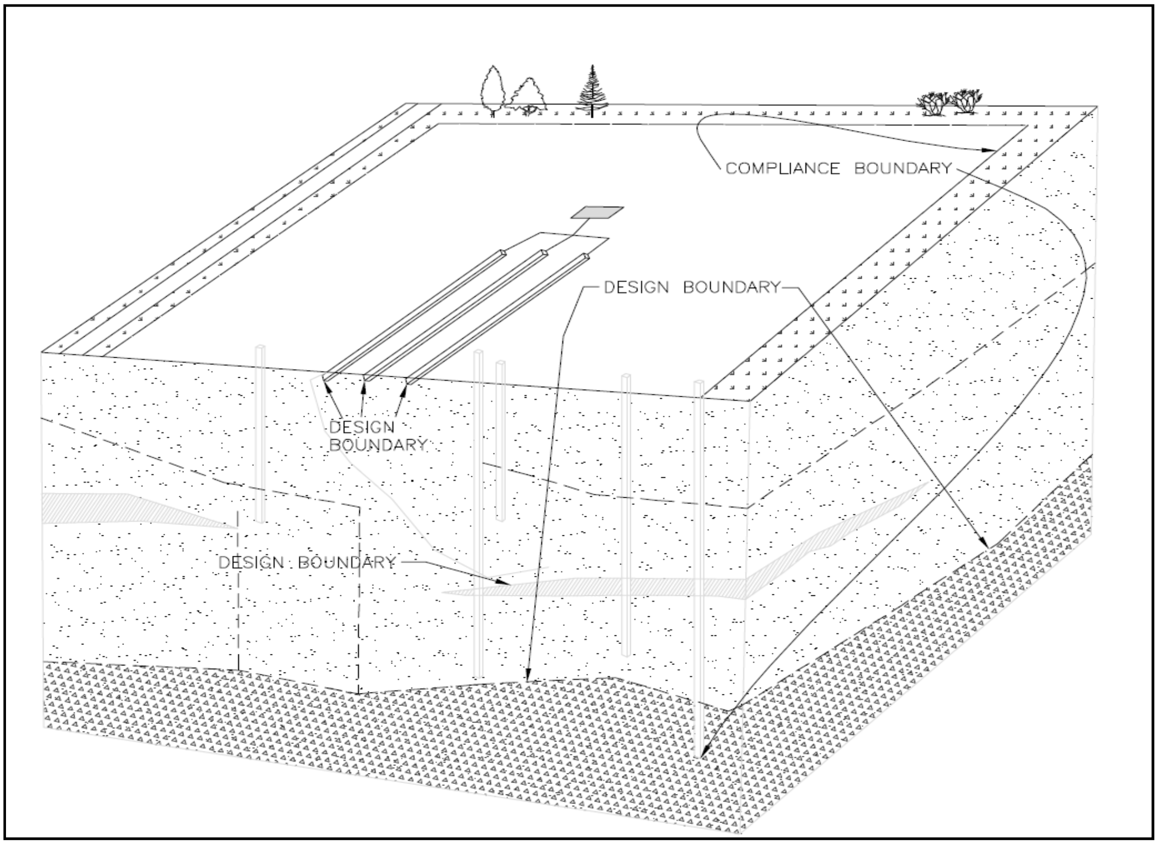


Figure A-5 An onsite system, showing some design and compliance boundaries



Guidance for use of performance criteria

Where an AP is considering moving outside the provisions of this manual's standards for separation (including those for critical horizontal separation) it is highly recommended that a professional with competence in the field of hydrogeology or geotechnical engineering should be used.

The professional should include in the documentation of their design a clear statement of the reasoning for their choice, including the way in which the design will assure the achievement of the base and defined performance standards (including the base performance standard of not constituting a health hazard); together with support from peer reviewed sources for the choice.

> For example this could include linkage of improved vertical separation to reduced horizontal setback.

HYDRAULIC APPLICATION RATE AND PERFORMANCE CAUTION

The vertical and horizontal separation standards of the SPM are predicated upon use of conservative hydraulic loading rates and hydraulic application rates (HAR) to the infiltrative surface.

Increased hydraulic loading rates above those for Type 1 effluent based upon Type 2 or 3 treatment systems may not be appropriate if a reduction to the vertical or horizontal separation is also being made. Higher loading rates, in the absence of a clogging zone will drive pathogens deeper and further in the soil. Note that while Type 3 effluent is partially disinfected, pathogens may still be present.

Where the hydraulic loading rate needs (due to a site that is constrained by size) to be increased based upon use of Type 2 or 3 pretreated effluent and where at the same time pathogen removal in small vertical or horizontal separation needs to be assured, the design should, at a minimum, include measures to assure unsaturated flows from the infiltrative surface (including pressure distribution, low HAR timed dosing). See discussion below of Vertical Separation and the separation standards of Part 2of the SPM.

OPTIONS FOR DESIGN

An AP could base their onsite design on a site-specific, project-specific human health and environmental risk assessment. This would examine the actual or projected 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. Environmental water and drinking water quality guidelines, objectives and legislative requirements
5. 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. It should also be considered that a surface water body or aquifer not currently used for drinking water supply could be used in that way in the future. When such water is used for drinking purposes in the future, the existing sewerage system must not constitute a health hazard or drinking water health hazard.

Where treatment and environmental performance standards and objectives are used in design by a qualified AP to reduce the SPM vertical and horizontal setback standards, compliance with these standards should be assured when the system is operated.

Compliance should include a clear indication of the way in which effluent will be renovated in order to ensure that the water moving way from the system contains no effluent and meets other compliance boundary standards and legal requirements as well as environmental, drinking water and other public health standards and guidelines. This compliance should be monitored.

As part of the design and maintenance plan, a process for this assurance should be established.

GUIDANCE ENVIRONMENTAL STANDARDS AND OBJECTIVES

In order to provide ***guidance*** for smaller projects, the following tables (Table A-4, Table A-5) summarize generic, conservative performance standards representing environmental monitoring objectives for common compliance and design boundary conditions and performance standards for common design boundaries.

Table A-4 lists minimum environmental standards which provide for a measurable indicator showing that the sewerage system is renovating effluent to a level that ensures that the water moving away from the system contains no effluent. It is also a measurable indicator of whether the system, an AP or an owner is conforming with legal requirements set out in the SSR (prohibition of the release of effluent into groundwater, surface water, tidal water or any other water source in DWPA or onto land) and other legislation.

Table A-5 lists minimum effluent standards which provide for a measurable indicator of whether the sewerage system is converting effluent within the design boundaries at an acceptable level which is a strong indicator of whether water moving away from the system contains no effluent.

These guideline environmental monitoring objectives are selected to provide standards equal to or more conservative than those of the British Columbia Approved Water Quality Guidelines, BC Ministry of Environment guidance on the development of Water Quality Objectives and the BC Municipal Sewage Regulation.

The values are also selected to represent performance standards expected for the prescribed vertical and horizontal separations of Part 2 of the SPM.

These tables (Table A-4, Table A-5) are currently under review and should always be considered in light of the caveat in the introduction of Appendix F with respect to the creation of a health hazard.

NOTE: Well protection is addressed by several regulations, including the *Drinking Water Protection Act* and Regulation, the Ground Water Protection Regulation and the Sanitary Regulation. The AP is strongly advised to consult this legislation.

The Sanitary Regulations includes the following paragraph in regard to protection of wells from probable sources of contamination:

Section 42 of the *Sanitary Regulations* (which, like the SSR, are established under the *Health Act*), prohibits the installation of wells within 100 feet of probable sources of contamination. The B.C. Supreme Court has held, in Mortensen v. Nelson [2004] B.C.J. 2283, that a septic field is a “probable source of contamination”. Although section 42 of the *Sanitary Regulations* does not expressly prohibit the installation of sewerage systems within 100 feet of existing wells, there is a potential that a court may interpret it that way. The Ministry of Health is presently reviewing the relationship between section 42 of the *Sanitary Regulations* and the SSR. In the meanwhile, owners and Authorized Persons should consult their own legal counsel before taking any steps to install a sewerage system within 100 feet of existing wells.

42. Every well hereafter sunk or dug shall be located at least 100 feet from any probable source of contamination, such as a privy vault, cesspool, manure heap, stable or pigsty, and at least 20 feet from any dwelling house, and at least 400 feet from any cemetery or dumping ground; unless, owing to the physical conformation, contamination of such well be impossible from such cemetery or dumping ground. Any like source of contamination existing within the aforesaid distances from any well now in use shall be removed where possible, or in default the well shall be abandoned and filled up; but this rule shall not *apply to wells situated less than 20 feet from a dwelling house, unless other good cause than proximity to such dwelling house can be shown why such well shall be abandoned.*

NOTE: Research indicates that .61 – 1.2 m (2 – 4') of vertical separation will adequately remove bacteria (<200 faecal coliforms per 100 mL) depending on soil type and conditions and upon type of effluent application and dose rate.

References

British Columbia Approved Water Quality Guidelines, 2006 Edition.

http://www.env.gov.bc.ca/wat/wq/BCguidelines/approv_wq_guide/approved.html

BC Municipal Sewage Regulation.

http://www.env.gov.bc.ca/epd/epdpa/mpp/msrhome.html

Table A-4 Environmental monitoring of water flowing away from sewerage system for determination of effluent renovation to environmental objectives (THESE STANDARDS ARE UNDER REVIEW AND WILL BE RELEASED WHEN FULLY DEVELOPED)

COMPLIANCE BOUNDARY	ENVIRONMENTAL MONITORING MINIMUM PERFORMANCE OBJECTIVE	ENVIRONMENTAL MONITORING PERFORMANCE IN SAMPLE TAKEN FROM:	NOTES
Drinking water well or other drinking water source	Under Review	Under Review	Under Review
Surface breakout	Under Review	Under Review	Under Review
Fresh water body	Under Review	Under Review	Under Review
Fresh water body, where waters are expected to meet low levels of nitrogen and phosphorous	Under Review		Under Review
Ocean water	Under Review	Under Review	Under Review

Note: Background monitoring is to provide a record of background levels of the contaminant being monitored for. Monitoring wells/sampling should be located to collect samples representative of the travel of effluent into the environment, and should not themselves cause or contribute to the creation of a health hazard.

Note: While the standards set out in this table are based on performance standards and represent accepted water quality guidelines and objectives that indicate where effluent water may be considered to be renovated and incorporated into the environment, they are only a guideline.

It is ultimately the responsibility of AP's to ensure that they do not cause or contribute to a health hazard and to meet all other requirements of the Regulation. AP's should always evaluate these standards in light of the specific circumstances encountered in the course of their work and use their expert discretion to determine whether the standard is suitable given their legal requirements under the Regulation. Where there is any doubt, legal counsel should be obtained on the matter.

Table A-5 Performance at design boundaries (THESE STANDARDS ARE UNDER REVIEW AND WILL BE RELEASED WHEN FULLY DEVELOPED)

DESIGN BOUNDARY	PERFORMANCE NEEDED FECAL COLIFORMS UNIT CFU/100ML	PERFORMANCE COMPLIANCE IN SAMPLE TAKEN FROM:	NOTES
Water table or flow restrictive horizon.	Under Review	Under Review	Under Review
Property line	Under Review	Under Review	Under Review

Note: While the standards set out in this table is based on the same expected performance standards that the standards of the SPM Part 2 are predicated upon, they are only a guideline.

It is ultimately the responsibility of AP's to ensure that they do not cause or contribute to a health hazard and to meet all other requirements of the Regulation.

The AP should have regard for the guidance in Table A-4 in regard to the successful renovation of effluent.

Increasing vertical separation

As noted in Part 2 of the manual the AP might need to increase vertical separation beyond the standards of the SPM Part 2 Tables 2-4 and 2-5 in certain circumstances, for instance where:

- there is a concern over groundwater mounding under the dispersal field;
- a site is underlain by fractured rock, is over an unconfined aquifer or a community well is affected;
- subsurface flow is expected to be primarily vertical, (e.g., above fractured rock or gravel) leading to an aquifer that supplies drinking water. Or where flow is primarily vertical to a shallow unconfined aquifer that supplies drinking water or it is connected to nearby surface water. In these circumstances, consideration should be given to increasing Vertical Separation in order to remove pathogens; and,
- in coarser soils, where biomat is a key element in the removal of pathogens. Where reduced biomat is expected (under-loaded fields, alternating fields, seasonal use, and high loadings with Type 2 or 3 treated effluent) consideration should be given to increasing vertical separation as well as to assuring unsaturated flow from the infiltrative surface (by use of pressure distribution and low HAR timed dosing).

NOTE: Research indicates that .61 – 1.2 m (2 – 4') of vertical separation will adequately remove bacteria (to <200 faecal coliform CFU per 100 mL) depending on soil type and conditions and upon type of effluent application and dose rate.

In order to assure an unsaturated zone of two feet (0.61m), it is usually necessary to construct a system with even greater separation (in order to account for groundwater mounding and capillary rise). Therefore, the scientific literature strongly indicates that a vertical separation greater than two feet be constructed.

requirements under the Regulation. Where there is any doubt, legal counsel should be obtained on the matter.

Appendix G Design HLR

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.

The AP should use at least two of these three methods when selecting a design HLR, and one of these should 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, where there is any disagreement between this appendix and the HLR table of Part 3 of the SPM the AP should use the HLR table rather than this appendix.

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

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 APs 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 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 AP can 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 Part 2 is critical to its use.

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/m^2. Under the BC Sewerage System Regulation, the following effluent quality classes, and corresponding BOD, are defined in Table A-6.

Table A-6 Effluent Quality Types BC Sewerage System Regulation

TYPE	BOD (MG/L)
Type 1	<150
Type 2	< 45
Type 3	< 10

Type 1 effluent is septic tank (with effluent filter) effluent; the BOD indicated is typical. Type 3 effluent is also partially 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 standards 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 should meet the coliform reduction standard per the regulation, and because high frequency pressure dosing is needed for Type 3 effluent discharged to sandy soils (soils with Kfs > 25 cm/d).

Where the hydraulic loading rate is increased based on highly pretreated effluent and pathogen removal in small vertical or horizontal separation needs to be assured, the design should include measures to assure unsaturated flows from the infiltrative surface (pressure distribution, low HAR timed dosing).

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.

Wastewater Loading for Sand Mounds

Provided that a sand mound has a vertical thickness of sand exceeding 45 cm (18") 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 Q.

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 should be used, or the factor should 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.

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 max. HLR of 0.1 ×Ksat, in mm/day)

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

Type 3: $HLR = 36 \times Ksat^{0.25}$ (limited to a max. 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

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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.

Taylor, C., J. Yahner, and D. Jones, 1997. *An Evaluation of On-Site Technology in Indiana: A Report to the Indiana State Department of Health.* Published by Purdue University.

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.

CURVE FITTED LTAR FORMULA

A curve fitted formula is 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. It is included here for reference.

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 × 2 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/day (versus 40 g/c/day average) indicating a peaking/safety factor of 1.5. (Laak, pers. comm.). As the SPM HLR tables are predicated upon a DDF with peaking/safety factor of 2 the resulting LTAR can be converted for comparison with the SPM tables.

Where LTAR = 5Ksat – 1.2 ÷ logKsat

LTAR in USgpd/ft^2, Ksat in ft/min Or,

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

To convert to DDF peaking factor of 2 this LTAR can be multiplied by a factor of 1.3333

Conversion of LTAR for differing BOD

Additionally consideration should 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:

$$AISt = AISs \times \sqrt[3]{\frac{BODt + TSSt}{BODs + TSSs}}$$

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

And, *BODt and TSSt* are the BOD and TSS for the improved treatment effluent, and *BODs and TSSs* are for Type 1 effluent.

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

Appendix H Sand Mound Systems

Worksheet

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/

Job Name: Date: Designer:

Sand mound design worksheet

UNITS: Liters and Meters

See diagrams page 6, below for dimension letters. See pressure distribution worksheet for conversions.

A. DESIGN INPUTS, FLOW AND SOIL/SITE DATA

Gather inputs using Design Inputs Worksheet, transfer necessary information below.

Soil: Type and structure ________________________

Soil depth: ___________ meters Type of restrictive layer: __________________

Effluent type: ___________ Design Flow: ___________ L/dy

Select minimum vertical separation to bed (including sand) and sand depth: See SPM Mound vertical separation table and mound sand depth standards. Consider downslope conditions, potential mounding, type of subsurface flow expected, type of restrictive layer, and consider reduction in LLR where original usable soil depth is very shallow. Note that sand depth needed is also affected by type of dosing.

Min. sand depth below bed, **D** = ____________ meters

Basal LLR: ___________ L/day/m *Must represent soil below mound AND in receiving area.*

Basal HLR: ___________ L/day/sqm (select from HLR table using Type 2 effluent type).

Site slope: __________ As decimal: __________ (in mound area)

Upslope correction factor: ___________ Downslope correction factor: ___________(See page 5, below)

Side slope for mound as a decimal: Normally 3:1 to permit mowing, can be 2:1, particularly on steep slopes where this avoids excessive toe length.

Side and upslope: **SS** = __________ Downslope: **DS** = __________

Select sand loading rate: For SPM standard Mound sand use 40 L/dy/sqm for Type 1 effluent.

Type of sand ____

Sand HLR: ___________ L/dy/sqm Effluent type: _____________

For timed dosing, calculate Hydraulic Application Rate (HAR) and dose. For mound sand base on 50mm/m water holding capacity (WHC). Round to nearest whole number of doses per day.

Sand Water holding capacity = _________ mm/m X 0.10 = 10% of WHC = _________ mm/m

Sand depth "**D**", Max. HAR = 10% of WHC X **D** = _______ mm/m x ________ m = ________mm

Dose frequency = $\frac{\text{Sand HLR}}{\text{Max. HAR}}$ = ______________ = _________ doses per day

HAR = $\frac{\text{Sand HLR}}{\text{Rounded Doses per day}}$ = ____________ = _____________ mm per dose

Dose volume = $\frac{\text{Daily Design Flow}}{\text{Doses per day}}$ = ____________ = _________ L per dose

B. **DESIGN OF THE INFILTRATION AREA (BED)**
See diagram page 6, below for dimension letters.

1. **Size the infiltration area (bed or infiltrator base AIS)**

Bottom area of bed = Daily design flow (L/dy) / Sand HLR (L/dy/sqm)

= ___________ L/day / ____________ L/dy/sqm = ____________ m^2

2. **Bed configuration**

Bed length = **B** = Design flow / LLR = ______L ÷ ________ L/dy/m

B =___________m

Bed width= **A** = Bed area / bed length = ______m^2 ÷ _________m

A =___________m

Note, on very flat site could consider full mound length for LLR, in this case ensure bed is under 3m (10') max width to address oxygen flux even where soil depth is such that flow is primarily vertical below the mound and groundwater mounding or toe breakout is not a concern.
If bed is shown to be very narrow, consider widening to practical construction width to reduce sand loading rate further.
For infiltrators consider effective length and plan bed to use whole number of units.

C. **DESIGN THE ENTIRE MOUND**

1. **Filter media height**

a. Filter media depth

1) Depth at upslope edge of bed (D) = 0.31 – 0.61 m depending on filter media and original soil and vertical separation needed.

D = ____________ m

2) Depth at downslope edge of bed (E)

= Depth at upslope edge of bed + (% slope expressed as decimal X bed width)

= D + (% slope expressed as decimal X A)

= ____________ m + (____________ X ____________ m)

E = ____________ m

b. Bed depth (F) = 0.23 m to 0.31m (9 to 12 inches) (9” min. for 1 in. laterals, 12” for infiltrators).

F = ____________ m

c. Cap and topsoil

1. Depth at bed center (H) = 0.31 to 0.46m (12 to 18 inches)
2) Depth at bed edges (G) = 0.15 to 0.31m (6 to 12 inches)

The lower depth range is minimum *AFTER* settling. *For infiltrators in single lateral layout may use 6"-12" soil cap over center and use dome shape to advantage (so H = 6 to 12" and G = 0 to 6")*

G = ____________ m **H** = ___________m

2. **Filter media length**

a. End slope width (**K**) = Total filter media depth at bed center X horizontal gradient of mound side slope, side slope from section 1 **SS** = __________

Total media depth at bed center =

$$\frac{D + E}{2} + F + H$$

= (______+________)/2 + __________ + ___________ = ___________

K = Media depth x **SS** = _______ x ________ = ___________m

b. Filter media length (L) = Bed length + (2 X end slope width **K**)

= B + 2**K** = ___________ m +(2 X __________ m)

L = _____________ m total length

3. **Filter media width**

a. Upslope width (**J**) = filter media depth at upslope edge of bed X horizontal gradient of mound side slope X up slope correction factor

= (D + F + G) X **SS** X up slope correction factor

J = (__________ m + ___________ m + ___________m) X ________ X ________

= ___________ m X ________ X _________

J = __________ m

b. Downslope width (**I**) = filter media depth at downslope edge of bed X horizontal gradient of downslope of sand mound X downslope correction factor

Down slope from section 1 **DS** = __________

I = (E + F + G) X **DS** X down slope correction factor

= (__________ m + _________ m + _________m) X _______ X _______

= ___________ m X _________ X __________

I = __________ m

c. Filter media width (**W**) = upslope width + Bed width + Downslope width

= J + A + I = ____________ m + ___________ m + __________m

W = ___________ m

4. **Check the basal area**

a. Minimum Basal area = $\frac{\text{Daily Design flow}}{\text{Basal HLR}}$

= $\frac{\_\_\_\_\_\_\_\_\_\_ \text{ L/day}}{\_\_\_\_\_\_\_\_\_\_ \text{ L/m}^2\text{/day}}$

= ____________ m^2

b. Basal area available — Is it sufficient?

1) Sloping site = Bed length X (Bed width + Downslope width)

= B X (A + I)

= ______ m X (_____ m + _____ m)

= ______ m X ______ m=

= ______ m^2

2) Level site = filter media length X Fill width

= L X W

= ______ m X _____ m

= ______ m^2

If insufficient, add toe area or length and correct dimensions. Enter critical dimensions on diagrams P. 6 below.

Note setback on sloping site considered from edge of **minimum** basal area. Calculate and draw on diagram.

Note: Reduce effective basal area by area occupied by boulders, large stumps.

For **flat sites**, slope correction factor = 1 and all side slopes and widths are the same

Notes for Pressure Distribution System Design

Mound pressure distribution system is designed per standard pressure distribution worksheet. Timed dosing is preferred. Ensure minimum dose volume of 5 x draining volume of network and frequency of minimum 4 x per day at design flow, preferred more often. Keep network full if frost is not an issue. Use orifice shields

Summary of mound dimensions

Bed length (**B**) = _________m

Bed width (**A**) = __________m

Overall mound length (**L**) = ___________m

Overall mound width (**W**) = ___________m

Developed by Ian Ralston, TRAX Developments Ltd. BASED ON: Wisconsin Mound Soil Absorption System Siting Design and Construction Manual by Converse and Tyler , Jan. 2000 and Washington State Mound Systems Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance. REV. August 2007

Down slope and up slope correction factors

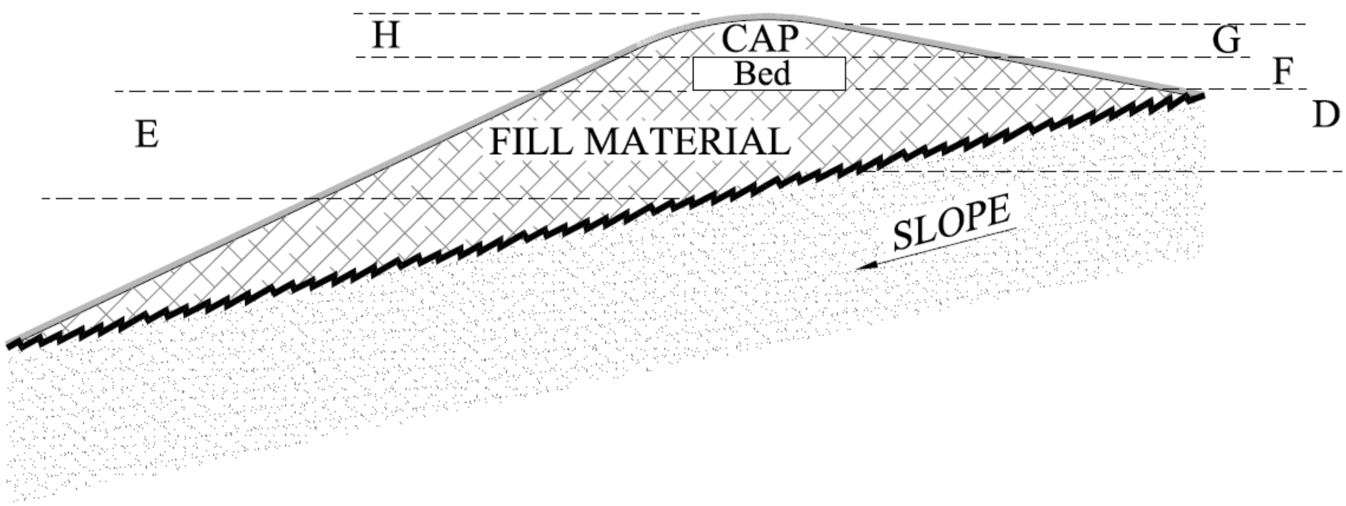
Slope %	Down Slope Correction Factor	Up Slope Correction Factor
0	1.00	1.00
1	1.03	0.97
2	1.06	0.94
3	1.10	0.92
4	1.14	0.89
5	1.18	0.88
6	1.22	0.85
7	1.27	0.83
8	1.32	0.80
9	1.38	0.79
10	1.44	0.77
11	1.51	0.75
12	1.57	0.73
13	1.64	0.72
14	1.72	0.71
15	1.82	0.69
16	1.92	0.68
17	2.04	0.66
18	2.17	0.65
19	2.33	0.64
20	2.50	0.62
21	2.70	0.61
22	2.94	0.60
23	3.23	0.59
24	3.57	0.58
25	4.00	0.5

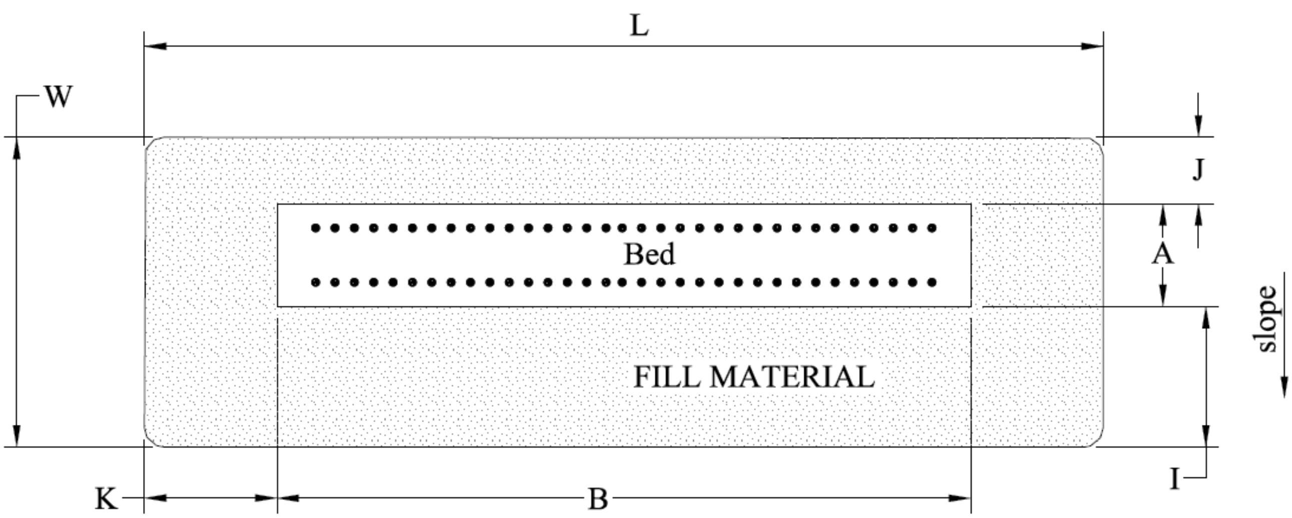
Based on *Wisconsin Mound Soil Absorption System Siting Design and Construction Manual by Converse and Tyler , Jan. 2000*

Conversions:

US unit	X	= Metric Unit	X	= US Unit	X	= secondary unit
Gallons	3.785412	Litres	0.264172	Gallons	0.8326738	Imperial Gal.
				Gallons	0.1336806	cu ft
		Cu m	35.31467	cu ft	7.480519	gallons
GPD/sqft	40.74648	Lpd/sqm	0.024542	GPD/sqft		
GPD/ft	12.418	Lpd/m	0.080528	GPD/ft		
Sq ft	0.0929	Sq m	10.76391	Sq ft		
Inches	0.0254	Meters	39.36996	Inches		
Feet	0.3048	Meters	3.28083	Feet		

Diagrams showing mound dimensions with letters as used in worksheet





Other dimensions:

Side slope/upslope gradient of the sand mound, expressed as decimal **SS**

Downslope gradient of the sand mound, expressed as a decimal **SD**

Setback, calculation of edge of required basal area on sloping site:

Length from downslope edge of bed to edge required basal area.

= (Minimum basal area ***minus*** Bed Area) ÷ Bed Length

= (________m^2 – ________m^2) ÷ ______ m = ________ m

Site Preparation and Construction

Construction Procedures—The following is a step by step procedure for mound system construction that has been tried and proven. If these procedures are followed, the potential for future problems should be minimized and the mound system should function properly. Other techniques may also work satisfactorily, but the basic principles of mound system design, construction and operation should not be violated.

1. Check the moisture content of the soil at 7-8 inches deep. If it is too wet, smearing and compaction will result, reducing the infiltration capacity of the soil. Soil moisture can be determined by rolling a soil sample between the hands. If it rolls into a wire, the site is too wet to prepare. If it crumbles, site preparation can proceed. **If the site is too wet to prepare, do not proceed until the soil moisture decreases—THIS IS ESSENTIAL. Consider the receiving area as well as the mound area to ensure that there is no negative impact to the receiving area.**

2. Stake out the mound area on the site according to the system design, so the infiltration bed runs parallel to the contours. Reference stakes offset from the corner stakes are recommended in case corner stakes are disturbed during construction. If the site conditions do not allow for layout according to the approved design, contact the designer.

3. Measure the average ground elevation along the upslope edge of the bed or the upper trench and reference this to a benchmark for future use. This is necessary to determine the bottom elevation of the bed.

4. Determine where the pipe from the pump chamber connects to the distribution system in the filter media. The location and size of this transport pipe is determined from the pressure distribution guideline.

5. Trench and lay the effluent pipe from the pump chamber to the mound. Cut and cap the pipe one-foot beneath the ground surface. Lay pipe below frost line or sloping uniformly back to the pump chamber so that it drains after dosing.

6. Backfill and compact the soil around the pipe to prevent back seepage of effluent along pipe. This step must be done before plowing to avoid compaction and disturbance of the surface. Use Bentonite in trench if necessary.

7. Cut trees to ground level, remove excess vegetation by mowing. Rake cut vegetation if it is, or will become, matted. Prepare the site using a spring-loaded agricultural chisel plow and plowing parallel to contours. Note for sand or gravel soils, may wish to reduce disturbance in order to retain lower permeability surface layer, take care to avoid breakout and use surface layer for basal loading rate check.

If there is a compacted layer such as a plow pan consider deep ripping to remediate.

The function of this preparation is to provide a cleared ground surface with a series of vertical channels to enhance transfer of moisture from the sand fill to the original soil, while inhibiting lateral movement at the sand-soil interface. In addition the vertical furrows aid in stabilizing the sand at the sand-soil interface in an inter-locking fashion.

The site should be plowed using a spring loaded agricultural chisel plow, or other acceptable apparatus or method to prepare the soil before constructing the mound system. Shallow hand spading the surface is also an acceptable alternative and may be the preferred method on some sites. Rototilling is <u>not</u> an acceptable substitute and <u>should n</u>ot be done. Do not compact the infiltrative area.

The important point is that a rough, unsmeared surface should be left, especially in fine textured soils. Careful observation is required to assure that the soil moisture content is not so high that the soil surface is smeared by the action of the plow. Plowing should not proceed until the soil is sufficiently dry so as not to smear in the plowing process.

If stumps remain, care must be taken in preparing the site. The sod layer should be broken up, yet the topsoil should not be pulverized. The objective of this step is to break up any surface mat that could impede the vertical flow of liquid into the native soil.

Immediate construction after plowing is desirable. Avoid rutting and compaction of the plowed area by traffic. If it rains after the plowing is completed, wait until the soil dries out before continuing construction.

8. Reset the corner stakes, if necessary, using the offset reference stakes and locate the bed or trench areas by staking their boundaries. Extend the transport pipe from the pump chamber (which had previously been cut off) to several feet above the ground surface.

9. Install one or more standpipes (4 inch PVC with the bottom foot perforated, rebar and with gravel around the perforations). At least one must be in the downslope portion of the mound with the bottom at the original surface and the top extending above final grade where it can be capped. Another could be located in the bed extending only from the bottom of the bed to above the final grade. The standpipes allow observations to be made of the water levels. Slotting the caps will facilitate removing the caps to allow access.

10. Place the filter media that has been properly selected around the edge of the plowed area. Keep the wheels of trucks off plowed areas. Avoid traffic on the downslope side of the mound system. Work from the end and upslope sides. This will avoid compacting the soils on the downslope side, which, if compacted, would affect lateral movement away from the mound and possibly cause surface seepage at the toe of the mound.

11. Move the filter media into place using a small track-type tractor with a blade. Do not use a tractor/backhoe having rubber-tired wheels. Always keep a minimum of 6 inches of filter media beneath tracks to prevent compaction of the natural soil. Ensure placed sand is settled to a uniform density of approximately 1.3 to 1.4 g/cm3 (81.2 to 87.4 lb/ft3). Do not over compact the sand.

12. Place the filter media to the required depth, i.e., to the top of the bed. Shape sides to the desired slope.

13. With the blade of the tractor form the infiltration bed. Hand level the bottom of the bed to within ½ inch.

14. Place the pea gravel in the bed. Level the aggregate to the design depth. Ensure the side separation from bed to surface exposure will be obtained.

15. Place the distribution pipes, as determined from the pressure distribution guidelines, on the aggregate. Connect the manifold to the transport pipe. Slope the manifold to the transport pipe. Lay the laterals level, removing rises and dips.

16. Pressure test the distribution system for uniformity of flow.

17. Place 2 in. of aggregate (pea gravel) over the distribution pipe.

18. An approved geotextile material may be placed over the aggregate, however, increasing concerns of geotextile plugging with root mat have led to some practitioners discontinuing use of the fabric. If using no geotextile use a layer of C33 sand between the bed and the soil cap material, or a layer of birds eye gravel then a layer of C33.

19. Place the soil for the cap <u>and topsoil</u> on the top of the bed. This may be a subsoil or a topsoil. A depth after settling of 12 inches in the center and 6 inches at the outer edge of the bed is desired. This creates a slope that assists the surface run-off of precipitation. Also, this layer provides some frost protection. Do <u>not</u> drive over the top of the bed as the distribution system may be damaged. Use sandy loam, loamy sand soil, ensure oxygen can get in. If landscaping requires shallow slopes, ensure positive drainage from mound surface. With infiltrators installed as a single lateral (eg 36" wide) the soil cap may follow the upper curve of the infiltrator chamber, however, ensure the side vents are covered with C33 and that the bed to surface separation is adhered to.

20. Seed or sod the mound system.

21. Protect the receiving area for a minimum of 30' and preferably 50' downslope from the toe of the mound against disturbance and compaction, vegetate to enhance evapotranspiration in the area.

Diagrams based on *Washington State Mound Systems Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance (1999).*

Sand 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 effective 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 needed is washing, in others the C33 already meets the mound sand standard.

It is critical that when testing sand for media use a wash through sieve test is used to ensure all fines are seen.

In some areas it is not possible to purchase mound sand. For guidance on sand selection in two common situations the following specifications are provided.

The first is representative of current standard practice for intermittent sand filter sand. Note that these sands should be used with timed dosing per the SPM.

- Effective size, D10, of 0.33 mm, some standards recommend D10 of 0.30 to 0.50 mm
- Coefficient of uniformity (D60/D10) Cu <3, some standards recommend <4 and 1–4
- <2% passing #100 sieve, <0–1% passing #200 sieve, <20% over 2 mm
- Loading rate for this sand should be maximum 48.9 L/day/m^2 (1 IG/day/ft^2).
- Where sand filter sand specification media is used, timed dosing should be used for all effluent types at no greater than 10% of moisture holding capacity of the media below the bed per dose.

The second is representative of a clean C33 or CSA concrete sand, and is to meet C33 specifications, with the addition that <7% may pass the #100 sieve and <3% pass the #200 sieve. Loading rate for this sand should be maximum 29L/day/m^2 (0.6 IG/day/ft^2).

As recommended in the SPM, a locally available sand which meets none of the provided specifications can be capable of use, if approved for use by a qualified AP (professional)—who will set a loading rate for the sand. As part of investigation for this purpose it is recommended that the professional build a small test mound and conduct hydraulic conductivity tests in the compacted sand, to provide real-world information about the sand's properties after placement and compaction in a mound. This should include sufficient application of water to assess the danger of media sorting over time.

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

Mound 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 should 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:

1. The mound should 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.
2. Grass, shrubs and trees should 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.
3. 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 needs to 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 should 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.
4. The footprint of the mound should 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 can be used on unstructured soils such as sand to break up the vegetation. However, they are not recommended. All tilling should be done following the contour.

5. 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 could 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.
6. Once the site has been tilled, a layer of sand should 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 should 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.
7. Place the proper depth of sand, then form the absorption area with the bottom area raked level. The sand should be settled in the trench area to minimize settling. A good backhoe operator can form the trench with minimal hand work. Keep sand clean.
8. The intent of the light settling is to eliminate large voids in the media that could collapse or settle later when effluent is added. The light settling can be accomplished by walking on the sand, then raking (with hand tools) into the corners and along the sides (for trenches) and around monitoring ports. The final sand bulk density should be approximately 1.3 – 1.4 g/cm^3 (81.2 – 87.4 lb/ft^3). Higher densities will reduce infiltration rates and oxygen exchange potential. (Ref. Washington State RS&G, Sand mounds)
9. Place a clean sound aggregate to the desired depth. Limestone is not recommended. If chambers are used, proper procedures should 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. Keep sand and aggregate clean.
10. Place the pressure distribution network with holes located downward and cover it with 2.5 cm (1") of aggregate. Connect the force main to the distribution network. If chambers are used, the pressure distribution laterals should be suspended from the chambers with holes upward. Provisions should 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 should drain after each dose.

11. Cover the aggregate with a geotextile synthetic fabric.
12. 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 should be made to control erosion.
13. 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.
14. 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
15. Inform homeowner about the type of system, maintenance needs 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

Appendix 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*.

Appendix J 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 should 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 standards 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, e.g., $550 \div 24 \times 8 = 183$ 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 having a pH limit less than six (6.0) or greater than nine (9.0);
9. Any industrial waste;
10. Any sewage containing any of the following materials in excess of the indicated concentrations:

1	BOD_5	300	mg/L
2	Suspended solids	350	mg/L
3	Total sulfide expressed as H_2	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	0.05	mg/L
13	Total phosphorus expressed as P	15.0	mg/L
14	Total arsenic	0.5	mg/L
15	Total mercury	0.006	mg/L
16	Total silver	1.0	mg/L

"BOD_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.

11. 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);
12. 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);
13. Rainwater runoff from the surface or from roofs etc, storm or surface water, water from swimming pools or hot tubs;
14. Grease, oil, solvents etc;
15. Flushing water from water softeners;
16. Output from Garburators; and,
17. It is recommended that owners refer to the information in regard of Onsite wastewater systems, attached.

Appendix K Sodium, Salinity and Water Softeners

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.

Sodium content for this purpose is expressed as the "Sodium Absorption Ratio" (SAR); the SAR is the ratio of Sodium (Na) to Calcium and Magnesium ions in the effluent. Where the SAR is high (high Sodium without compensating high Calcium and/or Magnesium) this will cause clay particles to deflocculate and tend toward a more platy or massive structure, reducing permeability. This is more dramatic in the case of dispersive soils (see below), or soils with an already high level of Sodium.

This effect is linked to the salinity of the effluent, where salinity and SAR are both high the soil clays can remain flocculated. Clearly, excessive salinity will have other negative effects on the dispersal area. Salinity is estimated by the electro conductivity of a solution (EC); this is expressed in decisiemens per m (dS/m).

> Note:
>
> The ability of the solution to carry a current is termed electrical conductivity (EC). EC is measured in deciSiemens per meter (dS/m), which is the numerical equivalent to the old measure of millimhos per centimeter

Increasing 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.

Where leaching is heavy (in high rainfall areas) this can 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 can 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 effect of structural degradation due to sodium levels in wastewater will tend to be more clearly evident with Type 2 and 3 effluents, 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 will normally have a SAR 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 electro 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 can be tolerated if salinity is high enough (over 4 dS/m).

In all cases it is important to also consider the existing ESP of the soil in question, and to consider the amount of rainfall leaching that will occur.

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

Addition of Calcium Sulphate (as Gypsum) can 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).

Water softener regeneration, filter backwash and reverse osmosis flush waters

Water softener wash water (from regeneration) and chlorinated back-wash water (from backwash of filters) should not be discharged to an onsite system. These are non sewage flows which can be discharged separately.

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”) could discharge flush water to an onsite system without causing significant damage (and could, in some cases, assist, in relation to the same system with separate discharge, by replacing the calcium and magnesium removed by the softener). The low regeneration water use will also reduce the impact on the septic tank settling process.

However, the additional water flow and the risk of discharge of high concentrations of sodium (where the softener is not properly used and/or maintained) and of Chloride (in all cases) support the utilization of separate discharge. Where older style water softeners are used this is critical, as these will discharge large short term flow peaks and will also discharge higher levels of sodium.

In situations where SAR considerations are critical (due to soil type etc), whole house water softeners should 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 can also be used in some cases for regeneration of water softeners.

Reverse osmosis flush flows should also not be discharged to the onsite system as this will increase flows and add undesirable salts to the waste stream.

References:
EPA Onsite Wastewater Treatment Systems Special Issues Fact Sheet 3

Dispersive soils

Dispersive soils deflocculate (the aggregate breaks down to individual sand, silt and clay particles) in the presence of relatively pure water. This is because 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 behavior of the natural aggregate or worked bolus can be used as a guide to assess whether a soil is prone to dispersion.

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

Appendix L Terminology for System Operation and Malfunction

Following terms are as used in the Maintenance Provider and Private Inspector BCOSSA approved courses:

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 standards;
- For a lagoon, the effluent level is below the design freeboard; and,
- 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."

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 ½ 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; and,
- For a lagoon, the effluent level is approximately at the design freeboard.

Performance Malfunction.

This is when:

- The fluid level submerges more than ½ 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; and,
- For a lagoon, the effluent level is above the design freeboard of the lagoon (normally 0.6 m below the top of berm).

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; and,
- If an effluent sample could not be obtained, the reason should be explained in the report.

This 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 should 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 neighboring 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 setback standards;
- One or more components do not meet required setbacks;
- A residential system is receiving high strength and/or high volumes of wastewater; and,
- 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.

Suspected Health or Safety Hazard.

This is when Biological Hazard could 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; and,
- 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.

This is when Electrical Hazard might be present:

- An electrical health hazard is suspected or has been identified.

This is when Physical Hazard might be present:

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

- Where an MP discovers or suspects a health or safety hazard they should 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.

Improvement

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.

Caution

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."

Repair

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.

Appendix M Piping Materials

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

1. CAN/CSA 8181.1 Standard for A8S Drain Waste and Vent Pipe and Pipe Fittings;
2. CAN/CSA 8181.2 Standard for PVC Drain Waste and Vent Pipe and Pipe Fittings;
3. 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 U.S. or European standards

Where there is no existing standard for the intended use of a piping material, piping use guideline Table A-7 (Piping standards)

Table A-7 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

Appendix N 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 can be used. These are based upon the U.S. uniform plumbing code.

Drainage fixture units

Firstly, the source should 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 A-8 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 × DFU
Where > 40: Flow = 20 + (DFU × 0.2).
Where there is only one fixture: 1 WFSU = 1 USgpm = 3.79 litre/min.
Note that gallons are **US gallons**.

Table A-8 Drainage Fixture Units

INDIVIDUAL APPLIANCE, APPURTENANCE OR FIXTURE	(INCH)	DRAINAGE FIXTURE UNITS (DFU) PRIVATE INSTALLATIONS	PUBLIC INSTALLATIONS
Bar sink	1 ½	1	1
Bathroom (water closet, lavatory, bidet and tub or shower)	6	-	-
Bathtub	1 ½	2	2
Bidet	1 ¼	1	
Bidet	1 ½	2	
Clothes Washer	2	3	3
Dishwasher, domestic	1 ½	2	2
Drinking fountain	1 ¼	0.5	0.5
Floor drain	2	2	2
Shower	2	2	2
Laundry tub	1 ½	2	2
Lavatory	1 ¼	1	1
Bar sink	1 ½	1	
Kitchen sink, domestic	1 ½	2	2
Laundry sink	1 ½	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.

Individual fixture flows

For parts of a building or a specific fixture, the flow by fixture unit or trap size could also be useful. The following tables (Table A-9, Table A-10) give peak flows expected from each fixture or trap.

Table A-9 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 A-10 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 3 gpm and surge flow will not be an issue.

Sewage pump surge flow

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

Appendix O Testing Tanks for Watertightness

Hydrostatic 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 should 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.
2. If testing a mid-seam tank, ensure that the seam is exposed for the water test.
3. Fill the tank to the top.
4. If the tank has a riser, add water into the riser to a maximum of 5.0 cm above the tank/riser seam. Care should be taken not to overfill as the top section of a two-piece tank could become buoyant.
5. Measure and record the level of the water.
6. 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.
7. If the test reveals leaks that cannot be repaired, the tank is considered unacceptable.
8. Refill concrete tanks to original level after 24 hours as they will absorb some water.
9. Check again after 24 hours. If less than 4 litres is lost in a concrete tank, the leak test is considered acceptable.

Table A-11 and Table A-12 provide information for calculating volumes in square and round risers.

Table A-11 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 A-12 Depth change equivalent to four litres in square risers of given interior dimensions.

RISER DIMENSIONS (CM)	DEPTH (CM) EQUAL TO FOUR LITRES
18 × 18	1.9
24 × 24	1.1
36 × 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°C (just above freezing), so water put into a tank at 10–20°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 could crack as a result of the test itself.

Vacuum 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 should 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 should 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.

Testing Existing Tanks

It is more difficult to check watertightness in an existing septic tank. Adequate testing needs 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 might 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.

Appendix P 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.

Short form version is attached below after the long form version.

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/

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

Job: Date:
Designer: Design number: Option number:

Worksheet for pressure distribution system design

Long form with instructions and tables *Rev. August 2007*

*This is an iterative process, so each step might have to be repeated before final design. To be used with the **Design Inputs Worksheet**.*
Units: Worksheet and tables are in US gallons. See page 24 for conversions.

A. Design of the Distribution Network:

1 Establish Field length

Based on loading rates and design flows select total length of dispersal unit (trench or bed). It is critical to use a field flow consistent with the flows used by the agency or person who developed the HLR table or formula that you are using. Refer to Design Inputs Worksheet and enter appropriate values below.

SOIL TYPE = ______________________

DESIGN **HLR** = _________ LPD/SQM **x 0.0245** = ____________GPD/SQFT

DESIGN **LLR** = _________ LPD/M **x 0.0805** = ____________GPD/FT

DAILY DESIGN FLOW (Q) = _________LPD **x 0.264** = _____________GPD

AVERAGE FLOW = _________LPD **x 0.264** = _____________GPD

SYSTEM LENGTH GUIDE, L minimum = FIELD DESIGN FLOW (Q) ÷ LLR

= _______ gal per day ÷ _________gal per foot = _______________FEET **MINIMUM**
This gives a guideline for minimum overall system length (this is for ALL trenches on a slope or in an area). Note that this could differ in different areas of the field if the laterals are of differing lengths, in which case use the worst case area. Apply to flat and to sloping sites.

AIS = FIELD DESIGN FLOW / HLR = _______________SQUARE FEET
Remember AIS for seepage beds multiply x 1.35
TOTAL LENGTH OF TRENCHES/BED = _______________FEET
For bed design use LLR to determine bed length, see mound design worksheet, or for fixed width use AIS divided by width

WIDTH OF TRENCH/BED = _______________FEET
Use decimal feet. Is AIS divided by length

NETWORK TYPE (dispersal system piping) = _________________ (eg trench, bed)

2 Establish initial trench layout, Determine lateral lengths

Based on conditions of site select appropriate trench layout and initial manifold position (eg end or center feed or no manifold). Ensure system length meets minimum needed.

MANIFOLD TYPE = ______________________

Based on above determine lateral lengths and number of laterals, if there are several lengths, choose limiting lengths for initial design. Enter number of laterals in (A 6) below.

LATERAL LENGTH = ___________ ____________ Design individually for center feed.

NUMBER OF LATERALS = ___________ ____________

MOUNDING

If you are concerned about mounding, beyond a simple consideration of LLR consider using a computer model (eg Nova Scotia mound program). Use average flows for mounding modeling.

SKETCH:

Draw a sketch of proposed layout, include constraints. Draw a schematic elevation showing the static head and forcemain length, fittings etc. Use pencil until finalized. Show any sub areas (ie areas of field in separate location but to be dosed at the same time) or zones (areas of field dosed separately).

3 Determine orifice size, spacing, position.

Maximum 6 sqft per orifice, (24" trench this is 36" spacing). Position affects dosing design. Orifice size, for type 1 effluent start with 3/16" and adjust as necessary with respect to dose volume needed and pump/force main design. For soils or situations requiring frequent dosing with filtered effluent start with 5/32". For beds, stagger orifices.

ORIFICE SIZE = ____________FRACTIONAL INCHES __________

ORIFICE SPACING = ____________FEET __________

4 Determine lateral pipe diameter and pipe class

Using tables *LATERAL DESIGN TABLES* (Page 17 onward).

LATERAL DIAMETER = ________________INCHES ____________

LATERAL PIPE CLASS = ________________ ____________

5 Determine number of orifices per lateral

Divide orifice spacing from (A 3) above into lateral length from (A 2) above, and round to nearest whole number. Based on orifices spaced min. ½ of spacing from ends of infiltrators or trenches, and no reduction in trench length for center feed. **If your specification differs, adjust number.**

(___________ ft ÷ ___________ft) + _________ = ___________

ORIFICES PER LATERAL = _______________ ____________

6 Determine lateral discharge rate

Select distal pressure (pressure at last orifice of longest lateral), minimum is 3 feet for 3/16" and larger or 5 feet for 1/8 and 5/32" orifices. This is the **"Squirt Height"**.

DISTAL PRESSURE = _________________FEET ____________

Orifice discharge from *ORIFICE DISCHARGE RATE DESIGN TABLE* (page 13), or calculation.

ORIFICE DISCHARGE = _________________GPM ____________

Orifice discharge x number of orifices per lateral from (A 5) above to give

LATERAL DISCHARGE = _________________GPM ____________

CENTER OR END FEED? = _________________ ____________

NUMBER OF LATERALS = _________________ ____________

7 Select spacing between laterals and determine manifold length

For trench design spacing at 6 or 10 feet, for beds per design. Use information in (A 2) above.

SPACING BETWEEN LATERALS = _____________FEET (Between lateral pairs for center feed)

MANIFOLD LENGTH = _____________ FEET __________

8 Calculate manifold size

Using information from (A 2) and (A 7) determine manifold length and then use *MAXIMUM MANIFOLD LENGTHS* tables (pages 22 and 23) to select minimum manifold size, using lateral discharge from (A 6) above, Orifice size from (A 3) above and lateral spacing from (A 7) above. For center feed, flow per lateral on either side of manifold is used in table.

MANIFOLD SIZE = __________________INCHES __________

MANIFOLD PIPE CLASS ______________

9 Determine distribution network discharge rate

Multiply lateral discharge rate from (A 6) above x number of laterals from (A 6) above, check against total number of orifices X orifice discharge rate.

NETWORK DISCHARGE RATE = __________________GPM ____________

TOTAL NUMBER OF ORIFICES (γ) = ____________ X ______gpm = ___________GPM

At this point, iterate (repeat) until reasonable flow and manifold size results based on your experience. Adjustments may include reducing orifice size, changing manifold location, manifolding laterals at a central location, splitting to zones. More than one option can be retained for comparison at the next stage– use separate worksheets and number options as required, destroy or label as not used options that you do not use in the final design.

B. Design of the Force Main, Pressurization Unit (Pump or Siphon), Dose Chamber and Controls.

1. Develop a system performance curve.

Determine approximate network head requirement by multiplying Distal pressure (from (A 6) above) x 1.31. This is based on assumption of a household sized system, constructed with normal manifold and lateral layout and normal fittings, if your design varies, adjust accordingly.

NETWORK HEAD REQUIREMENT = _______________FEET ____________

Determine static head, from off float of pump chamber to highest point of network.
If negative take steps to prevent siphoning of pump chamber and, if this is by using an orifice in the discharge piping in the pump chamber, add orifice discharge rate (based on orifice size) to pump discharge and use orifice head (3 feet min) plus lift from pump chamber plus 3 feet min(to avoid negative pipe pressures) subtracted from value of negative elevation difference as static head.
For sloping sites and simplified design base Static Head requirement on highest lateral. Consider this when selecting pump.

STATIC HEAD (Indicate if anti siphon required) = __________FEET SIPHON?_______

NETWORK DISCHARGE (from (9) above) = ____________________GPM

NETWORK 2 DISCHARGE (if more than 1 sub area or zone 2) = _____________GPM

NETWORK 3 DISCHARGE (if more than 1 sub area or zone 3) = _____________GPM

NETWORK 4 DISCHARGE (if more than 1 sub area or zone 4) = _____________GPM
Add more as required.

ANTI SIPHON/PRIMING ORIFICE DISCHARGE (if used) = _____________GPM

PUMP DISCHARGE Required = ____________________GPM
Sum of maximum network discharge (largest zone) (only add secondary network discharges together if they are sub areas rather than zones–since zones discharge separately) PLUS anti siphon or pump priming orifice discharge. If you have sub zones you may need to add a sheet to address subsidiary forcemains.

Determine friction loss in force main (transport line to field), first select initial force main sizing, use manifold size or next pipe size up. Can use pipe velocity guide (page 16) to select forcemain initial size Base on maximum **network** discharge.

Check that flow velocity is over 2 and under 10 feet per second using table *FRICTION LOSS IN PLASTIC PIPE* (page 14) assuming use of PVC sch 40, then use that table to provide head loss for force main based on system discharge and length,. Add equivalent length for fittings as needed from *EQUIVALENT LENGTHS OF FITTINGS* Tables (page 15). **OR** use other friction loss/flow velocity calculation. Note that for end suction pumps it is necessary to also consider losses in the suction piping and fittings, using the same methods.

FORCE MAIN LENGTH α = _______________________FEET

FORCE MAIN DIAMETER = ___________ INCHES

FORCE MAIN TRUE INTERNAL DIAMETER = ___________ INCHES
Only required if not using Sch 40 pipe and the table.

Fittings used, including size.	Number	Equivalent length per fitting	Total equivalent length

FITTINGS EQUIVALENT LENGTH β = ____________________ FEET

TOTAL EQUIVALENT LENGTH (α + β) / 100 = **L** = ____________________ FEET / 100

HEAD LOSS PER 100' (from table) = _________________ Ft/100ft

FRICTION LOSS IN FORCE MAIN = _____________________ FEET
This is Head loss per 100' times Total Equivalent Length (L).

SUCTION HEAD LOSS (if applicable) = _______________FEET
Repeat if required for the suction lines. Ensure no cavitation. Use manufacturer's data for loss in pump intake for end suction pumps.

SUCTION LIFT (if applicable) = _______________FEET

NET POSITIVE SUCTION HEAD REQUIRED (NPSH) = _______________FEET
Add lift plus suction head losses.

CHECK FLOW VELOCITY = ___________FEET PER SECOND
If not using PD table. V= Flow (cu ft per second) / cross sectional area of the inside of the pipe (sq ft).

TOTAL DYNAMIC HEAD REQUIREMENT
TDHR = __________________FEET
This is Static Head + Network Head requirement + Friction Loss In Forcemain(s) + NPSH

PUMP DISCHARGE/HEAD = ___________GPM AT ___________FEET HEAD
Develop more than one option if required, to examine impact of changes to network, piping, pump type etc.

ADDITIONAL SECTIONS OF FORCEMAIN, ZONE VALVES, EXTRA ORIFICES
Where there are parts of the focemain at different diameters, or if you are using a zone valve and attendant fittings (perhaps at a different diameter also) add an extra sheet to develop head loss figures for these and add them in to the TDHR. Also use to develop head losses for these at the various flows for the system head curve.

NOTES

2 System curve

Use step 1 several times for discharges either side of the system discharge (if orifice Distal pressure was based on the minimum required squirt height use mainly discharges above the theoretical discharge) to generate a system curve. This takes into account the real world as far as available pumps are concerned to show the operating points for various pumps by plotting the system curve on transparent paper and overlaying various pump curves. This will also point up any calculation errors and give you a graphical representation of the various head requirements of the system.
Note that for each new discharge a different Distal Head and thus a different Network Head Requirement is generated based on the orifice flow calculations. Pick discharges that match the increments in the *ORIFICE DISCHARGE RATE DESIGN TABLE ,* or use calculation. To facilitate this process, express total flow as equivalent flow per orifice (ie. Flow divided by number of orifices). Remember to add pump chamber office flow (if used) to give total flow, and add in losses at the network flow for additional sections of forcemain, zone valves etc.

NUMBER OF ORIFICES = ______________________(γ) From (A 9) above.

TOTAL EQUIVALENT PIPE LENGTH (**L**) = _________________FT/100 From (B 1) above.

Squirt height (Distal Head)	Orifice flow at squirt height	Network discharge = (flow per orifice x γ)	Pump/anti siphon orifice discharge, if used	Friction factor (ft loss per 100')	Force main(s) head loss (ft) = friction factor x **L**	Network head required (1.31 X squirt ht.) (ft)	Static head (ft) plus other losses	TDHR (ft)	Total flow (gpm) = network discharge + pump orifice (if used)

Static head stays the same for all cases except for if using an anti siphon orifice. Add NPSH if necessary, use separate sheet for zone valves, extra forcemains etc.

3 Select pump (or siphon)

Use pump curves and system curves to select pump and determine operating point. Be careful to avoid undesirable pipeline velocities (too high or too low). Ensure pump will provide minimum required squirt height.

ITERATE UNTIL PUMP AND FORCEMAIN ARE ECONOMIC.

PUMP SELECTED = ________________________Voltage and max. current: ___________

Discharge diameter: _________ Height: __________ ft Minimum water level:________ ft
(Recommended is full pump ht, often min. is ½ pump motor submerged).

OPERATING POINT = _______________ GPM at ___________ FT head.
Include manufacturer, series, part number, pump voltage, discharge diameter and HP rating. For larger pumps record breaker size and switch capacity (or magnetic starter) required (avoid using breaker larger than pump locked rotor amperage).

4 Determine dose volume

Based on soil type select type of dosing and minimum/desired dose frequency.

Dosing frequency (**minimum**)	Soil type
Timed dosing	Coarse sand, gravels, sand mounds etc, certain clays
4 X per day	Medium sand, fine sand, loamy sand, Sandy Clay, silty clay or clay
2 X per day	Sandy loam, Loam, Silt Loam, Clay Loam

TYPE OF DOSING (demand or timed) = ____________________

DOSE FREQUENCY = minimum________________ times per day

Determine draining volume, use *VOLUME OF PIPE* table, page 16.:

VOLUME OF LATERALS (if draining) = _______ft x _______gallons per ft = ______g
Total length of laterals x volume per foot.

VOLUME OF MANIFOLD (if draining) = _______ft x _______gallons per ft = ______g

VOLUME OF PART OF FORCEMAIN (if draining) = _______ft x _____gallons per ft = ______g

TOTAL DRAINING VOLUME = ____________________GALLONS

Determine dose volume, two possible methods:

Method 1; Determine dose volume based on dose frequency, and then check against draining volume of network and any part of force main that drains.

Dose volume is determined by dividing frequency into DAILY DESIGN flow (from A(1)).

For more conservative design, use AVERAGE flow

_____________ gpd ÷ ___________ times per day

DOSE VOLUME = ___________________GALLONS

Then, ensure dose volume is minimum 5 x the draining volume. If not, consider constraints (soil type etc) and redesign manifold location etc to achieve this.

DOSE VOL. ÷ TOT DRAINING VOL. = ________G ÷ ________G = _______ (min. 5)

Method 2; Determine minimum dose volume as 5 times the draining volume of network and any part of force main that drains to the SWIS, then check that this meets minimum number of doses per day.

TOT DRAINING VOLUME X 5 = ___________ G Minimum dose volume

DESIGN FLOW ÷ MINIMUM DOSE VOLUME = ___________ Doses per day at minimum dose volume. Check that this is greater than minimum needed.

Check pump run time per dose is within manufacturer specifications for minimum run time, often 2 mins. Consider using twin smaller pumps (0.5HP or less) if very short run time is needed.

PUMP RUN TIME = Dose volume ÷ Pump flow rate

= _______G ÷ ________GPM = ____ MINS

Note that in climates where freezing may occur in undrained laterals it may be difficult to attain very small doses. **Use smallest dose/most frequent dosing possible.**
Note other steps to be taken to improve distribution, pump constraints.
Notes: For lateral hole positions, draining and distribution:

5. Size pump vault

SPM guideline for small systems; minimum vault sizes for demand activation volume 1 day design flow, for timed dosing 2 times daily design flow. **Timed dosing worksheet is also available**.

DESIGN FLOW = _____________ GPD From section (A 1), peak flow

DOSE VOLUME = _____________ GAL From (B 4)
For time dose this is the timer allow volume.

RESERVE VOLUME = _____________ GAL To alarm float from pump on float level. Minimum 15% of peak flow for demand dosed systems, per design for timed dose (Minimum 67% peak flow with timed dose for small systems with lag/override operation).

*RESERVE VOLUME TO LAG FLOAT = _______ GAL For **timed** dose systems only.*

ALARM RESERVE VOLUME = ______________GAL Above alarm float to highest allowable liquid level. Minimum 50% of peak flow, consider higher value for case where water flow can occur during power outage or in remote area, this may also include reserve volume provided by surcharge of the septic tank.

DEPTH REQUIRED FOR PUMP SPACER = _________INCHES
With effluent filter spacer is only required to prevent rock chips etc from entering pump. Some pumps have suitable legs.

Use this information and the **float setting worksheet** (below) or timed dosing worksheet to determine float or other control setpoints. Ensure the above volumes will fit in the vault, iterate until satisfactory.

PUMP CONTROL FLOAT = ______________________________
If direct control, ensure float is of sufficient capacity.

FLOAT TETHER LENGTH = __________ INCHES

SEPTIC TANK SURCHARGE FOR ALARM VOL. ______________________________(If used)

PUMP CHAMBER "**V**" VALUE = __________________________ INCHES/USGAL

After installation check that the floats switch as designed. Mark "**V**", float types, heights, ranges (including tether lengths if required) and dose volume on headworks for future reference. Can use more than one vault to make up required volume. With large vaults can specify smaller pump sub vault to allow float control.
NOTES:

Calculating the Dose Volume For Systems Designed to Drain Back to Pump Chamber:

When draining system back to pump chamber, the volume of effluent in the manifold and transport pipe should be added to the dose volume and considered when sizing the pump chamber Use *VOLUME OF PIPE* table, page 16.

If only part of the system drains back, use appropriate pipe lengths.

Volume in manifold = manifold length x volume in gallons per foot

Volume in manifold = ______________________ GAL

Volume in Transport Pipe = Transport pipe length x volume in US gallons per foot

Volume in transport pipe = ____________________________ GAL

Total drain back volume = Manifold volume + Transport pipe volume

TOTAL DRAINBACK VOLUME = ___________________ GAL
Add this volume to dose volume and use per dose volume in worksheet.

TANK FLOAT SETTING WORKSHEET JOB NAME ______________ DATE ___________

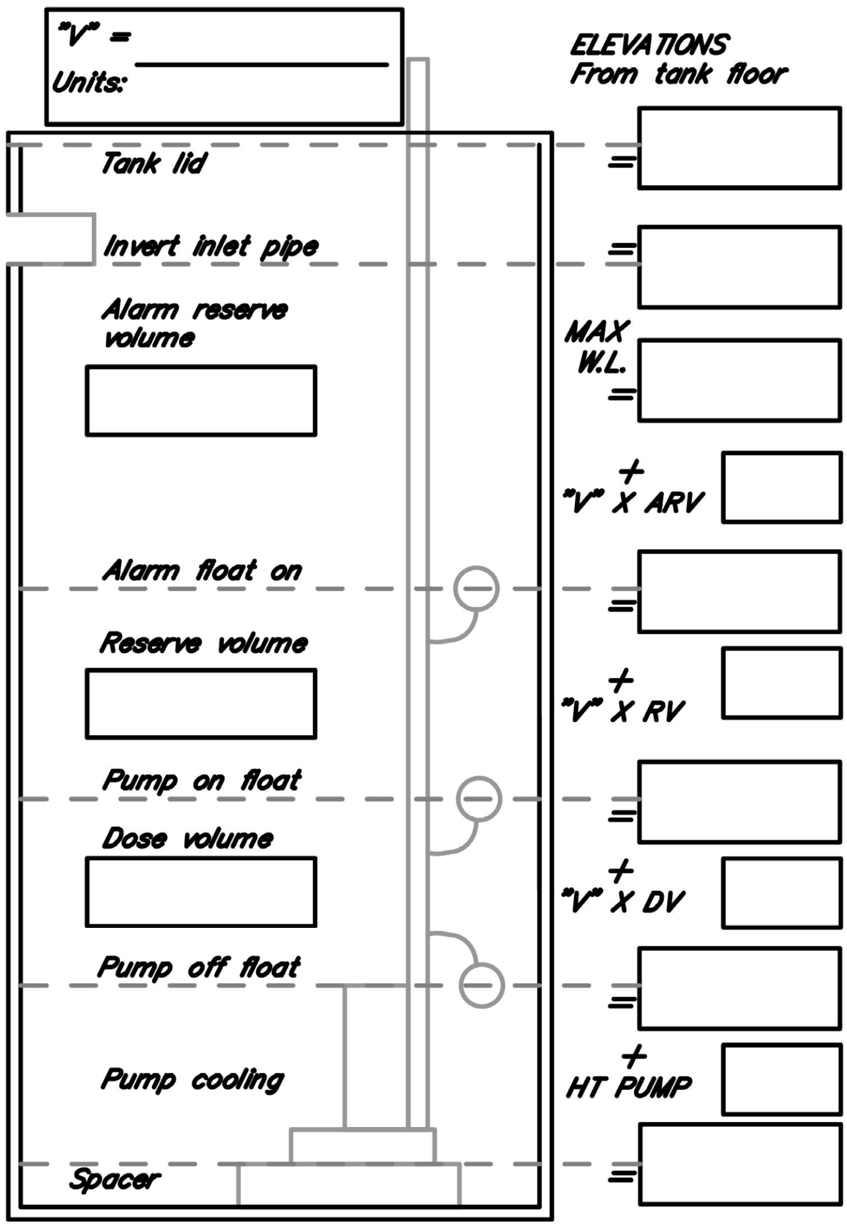
TANK SELECTED ________________________ UNITS us gal / inch

INTERNAL FLOOR AREA = (L - 2 X wall thickness) X (W - 2 X wall thickness) = ____________ SQ IN

VOLUME IN ONE INCH OF DEPTH =___________ CU IN X 0.00433 = ____________US G PER IN

"**V**" = 1 ÷ VOLUME PER INCH = 1 ÷ ___________ = ______________ FEET PER US GALLON

"V" X VOLUME = HEIGHT HEIGHT ÷ "V" = VOLUME



CU FT X 7.48 = US GALS ~ CU IN X 0.00433 = US GALS
CU METERS X 1000 = LITERS ~ INCHES X 0.0254 = METERS

Tank dimensions:

HT:________________

L: ________________

W: ________________

Wall thickness: ______

Lid thickness: _______

Base thickness: _____

Inlet invert: _________

Internal heights:

Inlet invert: __________

Tank lid: ____________

NOTES

NOTES

Add other notes on system design and operation requirements.

Orifice Discharge Rate Design Table

The following figures are guidelines based on Toricelli's equation. The orifice coefficients used are intended for use with sharp edged orifices in plastic pipe, with experience of your orifice drilling technique adjust accordingly. Figures in italics are below the recommended minimum head.

Orifice Discharge Rates (GPM)					
Squirt height (Head) (ft)	Orifice diameter (inches)				
	1/8	5/32	3/16	7/32	1/4
1			*0.43*	*0.58*	*0.77*
2	*0.26*	*0.41*	0.61	0.82	1.09
3	*0.32*	*0.51*	0.74	1.01	1.34
4	*0.37*	*0.59*	0.86	1.17	1.55
5	0.42	0.65	0.96	1.30	1.73
6	0.46	0.72	1.05	1.43	1.89
7	0.50	0.77	1.13	1.54	2.05
8	0.53	0.83	1.21	1.65	2.19
9	0.56	0.88	1.28	1.75	2.32
10	0.59	0.93	1.35	1.84	2.45
11	0.62	0.97	1.42	1.93	2.57
12	0.65	1.01	1.48	2.02	2.68
13	0.68	1.05	1.54	2.10	2.79
Coefficient used	0.61	0.61	0.62	0.62	0.63

Orifice discharge rates can be calculated using Toricelli's equation:

$$Q = C_d A_o \sqrt{2gh}$$

Where: Q = the discharge rate in ft^3/sec
C_d = the discharge coefficient (unitless)
A_o= the cross sectional area of the orifice in ft^2
g = the acceleration due to gravity (32.2 ft/sec^2)
h = the residual pressure head at the orifice in ft

Head loss in PVC pipe, table Based on table in *Converse (2000)*

Flow (usgpm)	Nominal pipe size in inches, PVC pipe sch 40. For headloss in feet per 100' of pipr							
		3/4	1	1.25	1.5	2	3	4
1								
2								
3		3.24		Velocities in this area are under 2 feet per second, too low for effective scouring.				
4		5.52						
5		8.34						
6		11.68	2.88					
7		15.53	3.83					
8		19.89	4.91					
9		24.73	6.10					
10		30.05	7.41	2.50				
11		35.84	8.84	2.99				
12		42.10	10.39	3.51				
13		48.82	12.04	4.07				
14		56.00	13.81	4.66	1.92			
15		56.63	15.69	5.30	2.18			
16		71.69	17.68	5.97	2.46			
17		80.20	19.78	6.68	2.75			
18			21.99	7.42	3.06			
19			24.30	8.21	3.38			
20			26.72	9.02	3.72			
25			40.38	13.63	5.62	1.39		
30			56.57	19.10	7.87	1.94		
35				25.41	10.46	2.58		
40				32.53	13.40	3.30		
45				40.45	16.66	4.11		
50	Velocities in this area are over 10 feet per second.			49.15	20.24	4.99		
60					28.36	7.00	0.97	
70					37.72	9.31	1.29	
80						11.91	1.66	
90						14.81	2.06	
100						18.00	2.50	0.62
125						27.20	3.78	0.93
150							5.30	1.31
175							7.05	1.74

Check with your manufacturer for design aids for other pipe.

Friction Loss for PVC Fittings

Equivalent Length of Pipe (feet) PVC Pipe Fittings								
Pipe Size (in)	90º Elbow	45º Elbow	Through Tee Run	Through Tee Branch	Male or fem. Adapter	Gate valve	Swing check	
.5	1.5	0.8	1.0	4.0	1			
.75	2.0	1.0	1.4	5.0	1.5	.55	7.0	
1	2.25	1.4	1.7	6.0	2.0	0.7	9.0	
1.25	4.0	1.8	2.3	7.0	3.0	0.9	11.5	
1.5	4.0	2.0	2.7	8.0	3.5	1.0	10	
2	6.0	2.5	4.3	12.0	4.5	1.0	11	
2 1/2	8.0	3.0	5.1	15.0	5.0	1.0	14	
3	8.0	4.0	6.3	16.0	6.5	1.0	16	
4	12.0	5.0	8.3	22.0	9.0	2.0	22	

Friction loss for fittings, steel pipe

Fitting	Equivalent length in feet per inch of pipe diameter
Angle Valve (fully open)	12.0
Butterfly valve	3.3
Gate valve (fully open)	1.1
Globe valve (fully open)	28.0
Foot valve with strainer	6.3
Swing check valve	11.0
Check valve	12.5
90 deg. Elbow	2.5

From various industry sources. Note that swing check losses vary widely, check with your manufacturer.

VOLUME OF PVC PIPE (US GALLONS PER FOOT)

	PVC pipe class		
Nominal Diameter (in)	SERIES 160	SERIES 200	Schedule 40
0.75		0.035	0.028
1	0.058	0.058	0.045
1.25	0.098	0.092	0.078
1.5	0.126	0.121	0.106
2	0.196	0.188	0.174
2.5	0.288	0.276	0.249
3	0.428	0.409	0.384
4	0.704	0.677	0.661
5	1.076	1.034	1.039
6	1.526	1.465	1.501

Guideline pipeline flow velocities

- Safe design velocity 5 feet/sec (1.5 m/s)
- Minimum scouring velocity 2 feet/sec
- Do not exceed 10 feet/sec even in short pipelines

How much flow for 5 feet/sec?

•1” pipe	13 Usgpm	(Sch. 40)	
•1.25” Pipe	23		
•1.5” Pipe	32		
•2” Pipe	52		(59 for SDR26)
•2.5” Pipe	75		
•3” Pipe	115		
•4” Pipe	198		(211 for SDR26)

How much flow for 2 feet/sec?

•1” pipe	5 Usgpm	(Sch. 40)	
•1.25” Pipe	9		
•1.5” Pipe	13		
•2” Pipe	21		(24 for SDR26)
•3” Pipe	46		
•4” Pipe	79		(84 for SDR26)

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
1/8	1	1.5	42	51	
1/8	1	2	50	62	
1/8	1	2.5	57.5	72.5	
1/8	1	3	66	81	
1/8	1	4	80	96	
1/8	1	5	90	110	
1/8	1	6	102	126	
1/8	1.25	1.5	66	76.5	79.5
1/8	1.25	2	80	92	96
1/8	1.25	2.5	92.5	107.5	110
1/8	1.25	3	105	120	123
1/8	1.25	4	124	144	148
1/8	1.25	5	145	165	175
1/8	1.25	6	162	186	192
1/8	1.5	1.5	85.5	96	100.5
1/8	1.5	2	104	116	120
1/8	1.5	2.5	120	135	140
1/8	1.5	3	135	150	156
1/8	1.5	4	164	184	188
1/8	1.5	5	190	210	220
1/8	1.5	6	210	240	246
1/8	2	1.5	132	141	145.5
1/8	2	2	160	170	176
1/8	2	2.5	185	197.5	202.5
1/8	2	3	207	222	228
1/8	2	4	248	268	276
1/8	2	5	290	310	320
1/8	2	6	324	348	360
5/32	1	1.5	31.5	39	39
5/32	1	2	36	46	46
5/32	1	2.5	42.5	52.5	52.5
5/32	1	3	48	60	60

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
5/32	1	4	56	72	72
5/32	1	5	65	80	85
5/32	1	6	72	90	96
5/32	1 1/4	1.5	48	55.5	58.5
5/32	1 1/4	2	58	68	70
5/32	1 1/4	2.5	67.5	77.5	80
5/32	1 1/4	3	75	87	90
5/32	1 1/4	4	92	104	108
5/32	1 1/4	5	105	120	125
5/32	1 1/4	6	120	138	144
5/32	1 1/2	1.5	63	70.5	73.5
5/32	1 1/2	2	76	84	88
5/32	1 1/2	2.5	87.5	97.5	102.5
5/32	1 1/2	3	99	111	114
5/32	1 1/2	4	120	132	136
5/32	1 1/2	5	140	155	160
5/32	1 1/2	6	156	174	180
5/32	2	1.5	96	103.5	106.5
5/32	2	2	116	124	128
5/32	2	2.5	135	142.5	147.5
5/32	2	3	150	162	168
5/32	2	4	184	196	200
5/32	2	5	210	225	235
5/32	2	6	240	252	264
3/16	1	1.5	24	30	
3/16	1	2	28	36	
3/16	1	2.5	32.5	42.5	
3/16	1	3	39	45	
3/16	1	4	44	56	
3/16	1	5	50	65	
3/16	1	6	60	72	
3/16	1.25	1.5	37.5	43.5	45
3/16	1.25	2	46	54	56
3/16	1.25	2.5	52.5	62.5	62.5
3/16	1.25	3	60	69	72
3/16	1.25	4	72	84	88

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
3/16	1.25	5	85	95	100
3/16	1.25	6	96	108	114
3/16	1.5	1.5	49.5	55.5	57
3/16	1.5	2	60	68	70
3/16	1.5	2.5	70	77.5	80
3/16	1.5	3	78	87	90
3/16	1.5	4	92	104	108
3/16	1.5	5	110	120	125
3/16	1.5	6	120	138	144
3/16	2	1.5	76.5	81	84
3/16	2	2	92	98	102
3/16	2	2.5	105	112.5	117.5
3/16	2	3	120	129	132
3/16	2	4	144	152	160
3/16	2	5	165	180	185
3/16	2	6	186	198	210
7/32	1	1.5	19.5	24	
7/32	1	2	24	30	
7/32	1	2.5	27.5	35	
7/32	1	3	30	39	
7/32	1	4	36	44	
7/32	1	5	45	55	
7/32	1	6	48	60	
7/32	1.25	1.5	31.5	36	37.5
7/32	1.25	2	38	44	46
7/32	1.25	2.5	42.5	50	52.5
7/32	1.25	3	48	57	60
7/32	1.25	4	60	68	72
7/32	1.25	5	70	80	80
7/32	1.25	6	78	90	90
7/32	1.5	1.5	40.5	45	46.5
7/32	1.5	2	50	54	56
7/32	1.5	2.5	57.5	62.5	65
7/32	1.5	3	63	72	75

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
7/32	1.5	4	76	88	88
7/32	1.5	5	90	100	105
7/32	1.5	6	102	114	114
7/32	2	1.5	63	66	69
7/32	2	2	76	80	84
7/32	2	2.5	87.5	92.5	95
7/32	2	3	99	105	108
7/32	2	4	116	124	132
7/32	2	5	135	145	150
7/32	2	6	156	162	168
1/4	1	1.5	16.5	21	
1/4	1	2	20	24	
1/4	1	2.5	22.5	27.5	
1/4	1	3	27	33	
1/4	1	4	32	40	
1/4	1	5	35	45	
1/4	1	6	42	48	
1/4	1.25	1.5	27	30	31.5
1/4	1.25	2	32	36	38
1/4	1.25	2.5	37.5	42.5	45
1/4	1.25	3	42	48	48
1/4	1.25	4	48	56	60
1/4	1.25	5	55	65	70
1/4	1.25	6	66	72	78
1/4	1.5	1.5	34.5	39	39
1/4	1.5	2	42	46	48
1/4	1.5	2.5	47.5	52.5	55
1/4	1.5	3	54	60	63
1/4	1.5	4	64	72	76
1/4	1.5	5	75	85	85
1/4	1.5	6	84	96	96
1/4	2	1.5	52.5	55.5	58.5
1/4	2	2	64	68	70
1/4	2	2.5	72.5	77.5	80

			Maximum Lateral Length (ft)		
Orifice	**Lateral**	**Orifice Spacing**	Pipe Material		
(inches)	(inches)	(feet)	**Schedule 40**	**Class 200**	**Class 160**
1/4	2	3	81	87	90
1/4	2	4	100	104	108
1/4	2	5	115	120	125
1/4	2	6	126	138	144

Manifold design tables based on *Washington State design manual*

These tables can be used to determine maximum manifold lengths for various manifold diameters, lateral discharge rates and lateral spacings. For 6" manifolds see *Washington State design manual*.

The maximum lateral lengths were developed to assure there will be no more than a 10% variance (drop) in the discharge rates between the proximal and distal orifices in any given lateral. The maximum manifold lengths in the tables below were developed to assure there will be no more than a 15% variance in discharge rates between any two orifices in a given distribution system (assuming the system is designed using the above procedure and tables). These tables are quite conservative.

Two assumptions used to develop these tables are: (1) the maximum variance in orifice discharge rates within a network occurs between the proximal orifice in the first lateral connected to a manifold and the distal orifice on the last lateral connected to the manifold and (2) the friction loss that occurs between the proximal orifice of a lateral and the point where the lateral connects to the manifold is negligible. If your fittings are not normal, additional network head loss may need to be considered.

For marginal situations consider use of series 200 pipe. For situations where feeder pipes are used from a short manifold, design using head loss calculations, on sloped sites the slope assists where top fed feeder pipes are used.

Note that the Central Manifold discharge rates are ½ the end fed rates—this is because the discharge is PER LATERAL, and with a central manifold there are 2 laterals per lateral spacing.

Instructions:

Example A: Central manifold configuration, lateral discharge "Q" = 40 gpm (this is discharge for each lateral, one both sides of the center manifold), lateral spacing = 6 ft., manifold diameter = 4 inch; Maximum length = 18 ft.

Example B: End manifold configuration, lateral discharge "Q" = 30 gpm, lateral spacing = 6 ft., manifold length = 24 ft.; Minimum diameter = 3 inch

Round flows to nearest number in table.

Make sure you are using the table that matches your orifice size!

Lateral discharge rate (gpm per lateral)		Maximum Manifold Length (ft) For 1/8" and 5/32" orifices and min. 5' distal pressure																													
		Manifold diameter (inches), Schedule 40																													
		1 1/4						1 1/2						2						3						4					
		Lateral spacing (feet)																													
Central Manifold	End Manifold	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10
5	10	6	9	8	12	16	10	8	12	12	18	16	20	14	18	20	30	32	40	30	39	48	60	72	80	48	63	76	96	120	130
10	20	4	3	4	6	8	10	4	6	8	6	8	10	8	12	12	18	16	20	18	24	28	36	40	50	30	39	48	60	72	80
15	30	2	3	4				4	3	4	6	8	10	6	6	8	12	8	10	14	18	20	24	32	30	22	30	36	42	56	60
20	40	2						2	3	4	6			4	6	8	6	8	10	12	15	16	18	24	30	18	24	28	36	40	50
25	50							2	3	4				4	6	4	6	8	10	10	12	12	18	16	20	16	21	24	30	40	40
30	60							2						4	3	4	6	8	10	8	9	12	12	16	20	14	18	20	24	32	40
35	70							2						2	3	4	6			8	9	12	12	16	20	12	15	20	24	24	30
40	80													2	3	4				6	9	8	12	16	10	12	15	16	18	24	30
45	90													2	3	4				6	6	8	12	8	10	10	12	16	18	24	20
50	100													2	3					6	6	8	6	8	10	10	12	12	18	24	20
55	110													2	3					4	6	8	6	8	10	8	12	12	18	16	20
60	120													2						4	6	8	6	8	10	8	9	12	12	16	20
65	130													2						4	6	4	6	8	10	8	9	12	12	16	20
70	140													2						4	6	4	6	8	10	8	9	12	12	16	20
75	150																			4	3	4	6	8	10	6	9	8	12	16	20
80	160																			4	3	4	6	8	10	6	9	8	12	16	10
85	170																			4	3	4	6	8		6	9	8	12	16	10
90	180																			2	3	4	6	8		6	6	8	12	8	10
95	190																			2	3	4	6	8		6	6	8	12	8	10
100	200																			2	3	4	6			6	6	8	12	8	10

Lateral discharge rate (gpm per lateral)		Maximum Manifold Length (ft) For 3/16" and up orifices and min. 2' distal pressure																													
		Manifold diameter (inches), Schedule 40																													
		1 1/4						1 1/2						2						3						4					
		Lateral spacing (feet)																													
Central Manifold	End Manifold	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10
5	10	4	6	4	6	8	10	6	6	8	12	8	10	10	12	16	18	24	20	22	27	32	42	48	60	34	45	52	72	80	90
10	20	2	3	4				2	3	4	6	8		6	6	8	12	8	10	12	15	20	24	32	30	22	27	32	42	48	60
15	30	2						2	3	4				4	6	4	6	8	10	10	12	12	18	24	20	16	21	24	30	40	40
20	40							2						2	3	4	6	8		8	9	12	12	16	20	12	18	20	24	32	30
25	50													2	3	4				6	9	8	12	16	10	10	15	16	18	24	30
30	60													2	3	4				6	6	8	6	8	10	10	12	16	18	24	20
35	70													2	3					4	6	8	6	8	10	8	12	12	18	16	20
40	80													2						4	6	4	6	8	10	8	9	12	12	16	20
45	90																			4	3	4	6	8	10	6	9	8	12	16	20
50	100																			4	3	4	6	8	10	6	9	8	12	16	10
55	110																			2	3	4	6	8		6	6	8	12	8	10
60	120																			2	3	4	6			6	6	8	12	8	10
65	130																			2	3	4	6			6	6	8	6	8	10
70	140																			2	3	4				4	6	8	6	8	10
75	150																			2	3	4				4	6	8	6	8	10
80	160																			2	3	4				4	6	4	6	8	10
85	170																			2	3					4	6	4	6	8	10
90	180																			2	3					4	3	4	6	8	10
95	190																			2	3					4	3	4	6	8	10
100	200																			2						4	3	4	6	8	10

Conversions

Gallons in this worksheet are US unless shown as "IG".

US unit	X	= Metric Unit	X	= US Unit	X	= secondary unit
Gallons	3.785412	Litres	0.264172	Gallons	0.8326738	Imperial Gal.
feet Atmosphere	0.3048 101.325	meter Kpa	3.28083 0.1450377	ft of head PSI	0.4329004 0.06894757	PSI Bar (=100 Kpa)
				Gallons	0.1336806	cu ft
		Cu m	35.31467	cu ft	7.480519	gallons
GPD/sqft	40.74648	Lpd/sqm	0.024542	GPD/sqft		
GPD/ft	12.418	Lpd/m	0.080528	GPD/ft		
Sq ft	0.0929	Sq m	10.76391	Sq ft		
Inches	0.0254	Meters	39.36996	Inches		
Feet	0.3048	Meters	3.28083	Feet		

References

This worksheet developed by Ian Ralston, TRAX Developments Ltd. Based on *Pressure Distribution Network Design By James C. Converse January, 2000* and *Recommended Standards and Guidance For Pressure Distribution, by Washington State Department of Health*.

For Converse's papers see:
http://www.wisc.edu/sswmp/

For Washington State guidelines see:
http://www.doh.wa.gov/ehp/ts/WW/

See also
http://www.traxdev.com/
For the most current version of this worksheet, the Design Inputs Worksheet, Timed Dosing Worksheet, and for a short form version of this worksheet, without tables and instructions (for use as part of a record of design).

Job: Date:
Designer: Design number: Option number:

Worksheet for pressure distribution system design

Short form *Rev. August 2007*

*This is an iterative process, so each step may have to be repeated before final design. To be used with the **Design Inputs Worksheet** and the **Long Form Worksheet (LFW)** instructions and tables.*
Units: Worksheet and tables are in US gallons. See page 10 for conversions.

A. Design of the Distribution Network:

1 Establish Field length

Refer to Design Inputs Worksheet and enter appropriate values below.

SOIL TYPE = ______________________

DESIGN **HLR** = _________ LPD/SQM **x 0.0245** = ____________GPD/SQFT

DESIGN **LLR** = _________ LPD/M **x 0.0805** = ____________GPD/FT

DAILY DESIGN FLOW (Q) = _________LPD **x 0.264** = _____________GPD

AVERAGE FLOW = _________LPD **x 0.264** = _____________GPD

SYSTEM LENGTH GUIDE, L minimum = FIELD DESIGN FLOW (Q) ÷ LLR

= _______ gal per day ÷ _________gal per foot = _______________FEET **MINIMUM**

AIS = FIELD DESIGN FLOW / HLR = _______________SQUARE FEET
Remember AIS for seepage beds multiply x 1.35

TOTAL LENGTH OF TRENCHES/BED = _______________FEET

WIDTH OF TRENCH/BED = _______________FEET
Use decimal feet. Is AIS divided by length

NETWORK TYPE (dispersal system piping) = _________________ (eg trench, bed)

2 Establish initial trench layout, Determine lateral lengths

Ensure system length meets minimum needed.

MANIFOLD TYPE = ______________________

LATERAL LENGTH = ___________ ____________

NUMBER OF LATERALS = ___________ ____________
SKETCH:

3 Determine orifice size, spacing, position.

ORIFICE SIZE = ____________FRACTIONAL INCHES __________

ORIFICE SPACING = ____________FEET __________

4 Determine lateral pipe diameter and pipe class
Using tables *LATERAL DESIGN TABLES* (Page 17 *LFW* onward).

LATERAL DIAMETER = ________________INCHES ____________

LATERAL PIPE CLASS = ________________ ____________

5 Determine number of orifices per lateral

Divide orifice spacing from (A 3) above into lateral length from (A 2) above, and round to nearest whole number.

(___________ ft ÷ ___________ft) + _________ = ___________

ORIFICES PER LATERAL = _______________ ____________

6 Determine lateral discharge rate

Select distal pressure (pressure at last orifice of longest lateral), minimum is 3 feet for 3/16" and larger or 5 feet for 1/8 and 5/32" orifices. This is the **"Squirt Height"**.

DISTAL PRESSURE = _________________FEET ____________

Orifice discharge from *ORIFICE DISCHARGE RATE DESIGN TABLE* (page 13 *LFW*), or calculation.

ORIFICE DISCHARGE = ________________GPM ____________

Orifice discharge x number of orifices per lateral from (A 5) above to give

LATERAL DISCHARGE = ________________GPM ____________

CENTER OR END FEED? = ________________ ____________

NUMBER OF LATERALS = ________________ ____________

7 Select spacing between laterals and determine manifold length

Use information in (A 2) above.

SPACING BETWEEN LATERALS = _____________FEET

MANIFOLD LENGTH = _____________ FEET __________

8 Calculate manifold size

Using information from (A 2) and (A 7) determine manifold length and then use *MAXIMUM MANIFOLD LENGTHS* tables (pages 22 and 23 *LFW*) to select minimum manifold size, using lateral discharge from (A 6) above, Orifice size from (A 3) above and lateral spacing from (A 7) above. For center feed, flow per lateral on either side of manifold is used in table.

MANIFOLD SIZE = __________________INCHES __________

MANIFOLD PIPE CLASS ______________

9 Determine distribution network discharge rate

Multiply lateral discharge rate from (A 6) above x number of laterals from (A 6) above, check against total number of orifices X orifice discharge rate.

NETWORK DISCHARGE RATE = __________________GPM ____________

TOTAL NUMBER OF ORIFICES (γ) = ____________ X ______gpm = ___________GPM

B. Design of the Force Main, Pressurization Unit (Pump or Siphon), Dose Chamber and Controls.

1. Develop a system performance curve.

Distal pressure (from (A 6) above) X 1.31 __________FEET X 1.31 =

NETWORK HEAD REQUIREMENT = _______________FEET ____________

Determine static head
STATIC HEAD (Indicate if anti siphon required) = __________FEET SIPHON?_______

NETWORK DISCHARGE (from (9) above) = ____________________GPM

NETWORK 2 DISCHARGE (if more than 1 sub area or zone 2) = _____________GPM

NETWORK 3 DISCHARGE (if more than 1 sub area or zone 3) = _____________GPM

NETWORK 4 DISCHARGE (if more than 1 sub area or zone 4) = _____________GPM
Add more as required.

ANTI SIPHON/PRIMING ORIFICE DISCHARGE (if used) = _____________GPM

PUMP DISCHARGE Required = ____________________GPM

Determine friction loss in force main (transport line to field), first select initial force main sizing, use pipe velocity guide (page 16 *LFW*) to select forcemain initial size Base on maximum **network** discharge.

Check that flow velocity is over 2 and under 10 feet per second using table *FRICTION LOSS IN PLASTIC PIPE* (page 14 *LFW*) assuming use of PVC Sch 40, then use that table to provide head loss for force main based on system discharge and length,. Add equivalent length for fittings as needed from *EQUIVALENT LENGTHS OF FITTINGS* Tables (page 15 *LFW*). **OR** use other friction loss/flow velocity calculation. Note that for end suction pumps it is necessary to also consider losses in the suction piping and fittings, using the same methods.

FORCE MAIN LENGTH α = _______________________FEET

FORCE MAIN DIAMETER = ___________ INCHES

FORCE MAIN TRUE INTERNAL DIAMETER = ___________ INCHES
Only required if not using Sch 40 pipe and the table.

Fittings used, including size.	Number	Equivalent length per fitting	Total equivalent length

FITTINGS EQUIVALENT LENGTH β = ___________________ FEET

TOTAL EQUIVALENT LENGTH (α + β) / 100 = **L** = ___________________ FEET / 100

HEAD LOSS PER 100' (from table) = ________________ Ft/100ft

FRICTION LOSS IN FORCE MAIN = ____________________ FEET
This is Head loss per 100' times Total Equivalent Length (L).

SUCTION HEAD LOSS (if applicable) = ______________FEET

SUCTION LIFT (if applicable) = ______________FEET

NET POSITIVE SUCTION HEAD REQUIRED (NPSH) = ______________FEET
Add lift plus suction head losses.

CHECK FLOW VELOCITY = __________FEET PER SECOND
If not using PD table

TOTAL DYNAMIC HEAD REQUIREMENT
TDHR = _________________FEET
This is Static Head + Network Head requirement + Friction Loss in Forcemain + NPSH

PUMP DISCHARGE/HEAD = __________GPM AT __________FEET HEAD
Develop more than one option if required, to examine impact of changes to network, piping, pump type etc.

ADDITIONAL SECTIONS OF FORCEMAIN, ZONE VALVES, EXTRA ORIFICES

NOTES

2 System curve

NUMBER OF ORIFICES = ______________________(γ) From (A 9) above.

TOTAL EQUIVALENT PIPE LENGTH (**L**) = ________________FT/100 From (B 1) above.

Squirt height (Distal Head)	Orifice flow at squirt height	Network discharge = (flow per orifice x γ)	Pump/anti siphon orifice discharge, if used	Friction factor (ft loss per 100')	Force main(s) head loss (ft) = friction factor x **L**	Network head required (1.31 X squirt ht.) (ft)	Static head (ft) plus other losses	TDHR (ft)	Total flow (gpm) = network discharge + pump orifice (if used)

Static head stays the same for all cases except for if using an anti siphon orifice. Add NPSH if necessary, use separate sheet for zone valves, extra forcemains etc.

3 Select pump (or siphon)

ITERATE UNTIL PUMP AND FORCEMAIN ARE ECONOMIC.

PUMP SELECTED = _________________________Voltage and max. current: ___________

Discharge diameter: _________ Height: __________ ft Minimum water level:________ ft
(Recommended is full pump ht, often min. is ½ pump motor submerged).

OPERATING POINT = _______________ GPM at ___________ FT head.

4 Determine dose volume

Based on soil type select type of dosing and minimum/desired dose frequency.

Dosing frequency (**minimum**)	Soil type
Timed dosing	Coarse sand, gravels, sand mounds etc, certain clays
4 X per day	Medium sand, fine sand, loamy sand, Sandy Clay, silty clay or clay
2 X per day	Sandy loam, Loam, Silt Loam, Clay Loam

TYPE OF DOSING (demand or timed) = ___________________

DOSE FREQUENCY = minimum________________ times per day

Determine draining volume, use *VOLUME OF PIPE* table, page 16.:

VOLUME OF LATERALS (if draining) = _______ft x _______gallons per ft = ______g
Total length of laterals x volume per foot.

VOLUME OF MANIFOLD (if draining) = _______ft x _______gallons per ft = ______g

VOLUME OF PART OF FORCEMAIN = _______ft x _____gallons per ft = ______g
(if draining)
TOTAL DRAINING VOLUME = ____________________GALLONS

Determine dose volume, two possible methods:

Method 1; Determine dose volume based on dose frequency, and then check against draining volume of network and any part of force main that drains.

Dose volume is determined by dividing frequency into DAILY DESIGN flow (from A(1)). For more conservative design, use AVERAGE flow

_____________ gpd ÷ ___________ times per day

DOSE VOLUME = ____________________GALLONS

Then, ensure dose volume is minimum 5 x the draining volume. If not, consider constraints (soil type etc) and redesign manifold location etc to achieve this.

DOSE VOL. ÷ TOT DRAINING VOL. = ________G ÷ ________G = _______ (min. 5)

Method 2; Determine minimum dose volume as 5 times the draining volume of network and any part of force main that drains, then check that this meets minimum number of doses per day.

TOT DRAINING VOLUME X 5 = ___________ G Minimum dose volume

DESIGN FLOW ÷ MINIMUM DOSE VOLUME = ___________ Doses per day at minimum dose volume. Check that this is greater than minimum needed.

Check pump run time per dose.

PUMP RUN TIME = Dose volume ÷ Pump flow rate

= _______G ÷ ________GPM = ____ MINS

Use smallest dose/most frequent dosing possible.

Notes: For lateral hole positions, draining and distribution:

5. Size pump vault

Timed dosing worksheet is also available.

DESIGN FLOW = _____________ GPD From section (A 1), peak flow

DOSE VOLUME = _____________ GAL From (B 4)
For time dose this is the timer allow volume.

RESERVE VOLUME = _____________ GAL To alarm float from pump on float level. Minimum 15% of peak flow for demand dosed systems, per design for timed dose (Minimum 67% peak flow with timed dose for small systems with lag/override operation).

*RESERVE VOLUME TO LAG FLOAT = _______ GAL For **timed** dose systems only.*

ALARM RESERVE VOLUME = ______________GAL Above alarm float to highest allowable liquid level. Minimum 50% of peak flow.

DEPTH REQUIRED FOR PUMP SPACER = _________INCHES
With effluent filter spacer is only required to prevent rock chips etc from entering pump. Some pumps have suitable legs.

Use this information and the **float setting worksheet** (below) or timed dosing worksheet to determine float or other control setpoints. Ensure the above volumes will fit in the vault, iterate until satisfactory.

PUMP CONTROL FLOAT = ______________________________
If direct control, ensure float is of sufficient capacity.

FLOAT TETHER LENGTH = __________ INCHES

SEPTIC TANK SURCHARGE FOR ALARM VOL. ______________________________(If used)

PUMP CHAMBER “**V**” VALUE = __________________________ INCHES/USGAL

After installation check that the floats switch as designed. Mark “**V**”, float types, heights, ranges (including tether lengths if required) and dose volume on headworks for future reference.

NOTES:

Calculating the Dose Volume For Systems Designed to Drain Back to Pump Chamber:

When draining system back to pump chamber, the volume of effluent in the manifold and transport pipe should be added to the dose volume and considered when sizing the pump chamber Use *VOLUME OF PIPE* table, page 16.

If only part of the system drains back, use appropriate pipe lengths.

Volume in manifold = manifold length x volume in gallons per foot

Volume in manifold = ______________________ GAL

Volume in Transport Pipe = Transport pipe length x volume in US gallons per foot

Volume in transport pipe = ____________________________ GAL

Total drain back volume = Manifold volume + Transport pipe volume

TOTAL DRAINBACK VOLUME = ___________________ GAL
Add this volume to dose volume and use per dose volume in worksheet.

TANK FLOAT SETTING WORKSHEET JOB NAME ______________ DATE ___________

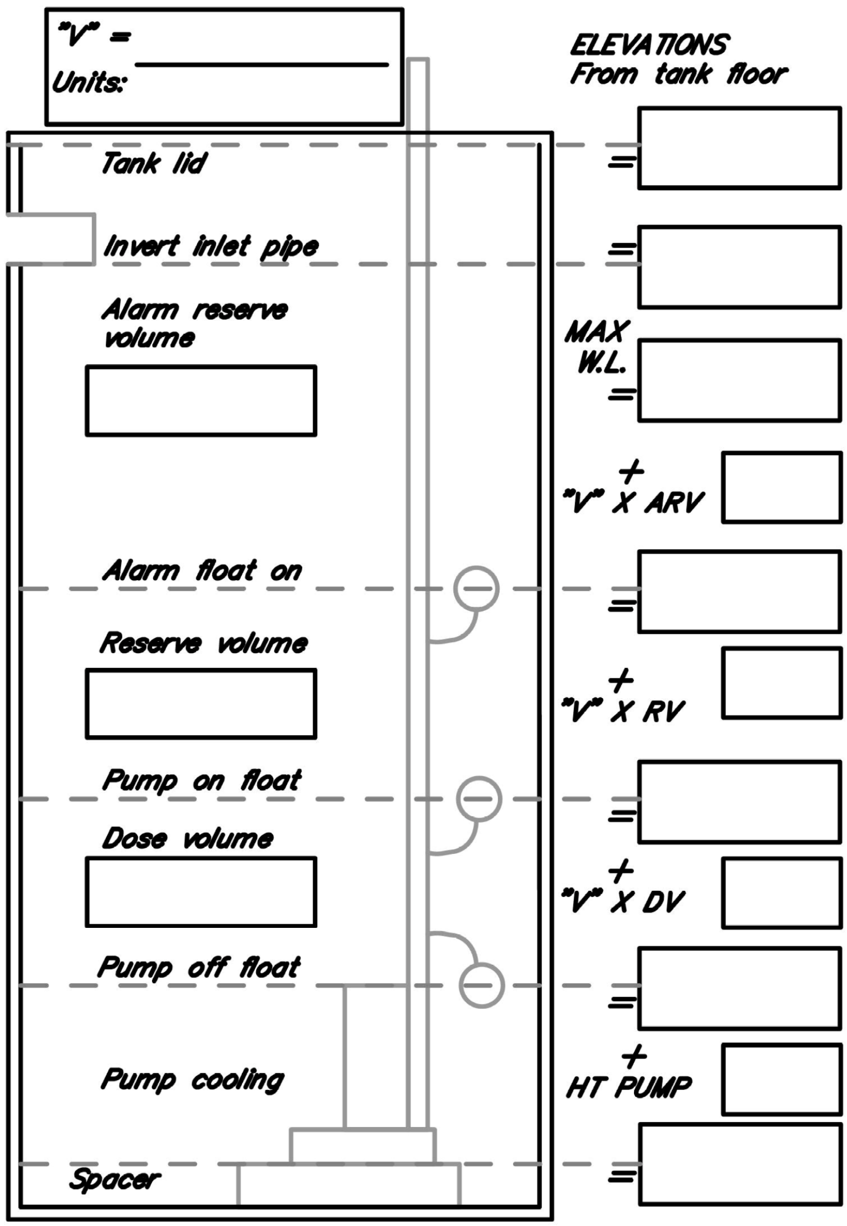
TANK SELECTED ________________________ UNITS us gal / inch

INTERNAL FLOOR AREA = (L - 2 X wall thickness) X (W - 2 X wall thickness) = ____________ SQ IN

VOLUME IN ONE INCH OF DEPTH =___________ CU IN X 0.00433 = ____________US G PER IN

"**V**" = 1 ÷ VOLUME PER INCH = 1 ÷ ___________ = ______________ FEET PER US GALLON

"V" X VOLUME = HEIGHT HEIGHT ÷ "V" = VOLUME



CU FT X 7.48 = US GALS ~ CU IN X 0.00433 = US GALS
CU METERS X 1000 = LITERS ~ INCHES X 0.0254 = METERS

Tank dimensions:

HT:________________

L: __________________

W: _________________

Wall thickness: _______

Lid thickness: ________

Base thickness: _____

Inlet invert: __________

Internal heights:

Inlet invert: ___________

Tank lid: _____________

NOTES

NOTES

Conversions

Gallons in this worksheet are US unless shown as “IG”.

US unit	X	= Metric Unit	X	= US Unit	X	= secondary unit
Gallons	3.785412	Litres	0.264172	Gallons	0.8326738	Imperial Gal.
feet	0.3048	meter	3.28083	ft of head	0.4329004	PSI
Atmosphere	101.325	Kpa	0.1450377	PSI	0.06894757	Bar (=100 Kpa)
				Gallons	0.1336806	cu ft
		Cu m	35.31467	cu ft	7.480519	gallons
GPD/sqft	40.74648	Lpd/sqm	0.024542	GPD/sqft		
GPD/ft	12.418	Lpd/m	0.080528	GPD/ft		
Sq ft	0.0929	Sq m	10.76391	Sq ft		
Inches	0.0254	Meters	39.36996	Inches		
Feet	0.3048	Meters	3.28083	Feet		

References

This worksheet developed by Ian Ralston, TRAX Developments Ltd. Based on *Pressure Distribution Network Design By James C. Converse January, 2000* and *Recommended Standards and Guidance For Pressure Distribution, by Washington State Department of Health*.
See also
http://www.traxdev.com/
For the most current version of this worksheet, the Design Inputs Worksheet, Timed Dosing Worksheet, and for the long form version of this worksheet, with tables and instructions.

Appendix Q Hydraulic Application Rate, Distribution

The upper limit of water-holding capacity for a soil is when it is said to be at "field capacity," this can 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 and a per dose loading 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 recommendation for the use of pressure distribution in certain cases. (Siegrist and Van Cuyk, 2001)

The loading rate per dose is termed hydraulic application rate (HAR). Based upon this HAR a dose volume/frequency is calculated. The HAR can be as important for treatment as selection of the correct HLR and LLR. For example, 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 (for example, shale inceptisols, highly weathered upper saprolites). The media used in sand mounds and related technology is of this type (clean sand). 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 need for timed micro dosing with full equalization for those techniques. For SDD systems the instantaneous hydraulic loading rate (emitter flow rate) is also important.

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 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 for the HAR.

Example calculation:

HAR = HLR / Dosing frequency

So if the loading rate is 48 mm/day (48 L/day/m^2) and 24 doses are applied, HAR = 48 ÷ 24 = 2 mm per dose.

For 450 mm of sand depth, at 15 mm/300 mm water holding capacity water holding capacity of the sand is (15 ÷ 300) × 450 = 22.5 mm

10% of 22.5 mm = 2.25 mm

So, the HAR is appropriate for the 450mm (18") sand depth (assuming proper distribution and equalization through the day).

Table A-13 Example saturated capacities, field capacities and water holding capacities:

SOIL	SATURATED MM PER 300 MM DEPTH	FIELD CAPACITY MM PER 300 MM DEPTH	WATER HOLDING CAPACITY MM PER 300 MM 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/m^2.

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 should also consider affect on soil structure due to clay swelling.

Dosing to natural soils is more complex to model than dosing to mound sand.

The affect of Biomat also assist in moderating flows and improving distribution where the biomat is well developed.

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Appendix R Temporary industrial camps

To be inserted when developed.

Appendix S Soil evaluation log forms

A template for record of soil test pit evaluation is provided (sized to copy to survey book sized paper at 4.5 by 7 inches); the AP can use these forms or can develop their own equivalent forms.

The test pit log should record at minimum the information as shown in this template and as recommended in the standards of Part 2 and 3 of the manual.

Site/Soil log

Job:	Site:	Date: Recorded by:
Weather:	No/type of pits:	Surface water:
Slope:	Slope type/locn:	Freq/duration fl:
Vegetation:	Substorey:	Type of bedrock/limiting layer:
		Rock outcrops:
Notes:		

Soils/site to be described using USDA or CANSIS system and abbreviations. Slope type: LL, LV, LC, VL, VV, VC, CL, CV, CC Slope position: SU, SH, BS, FS, TS
Horizon: O, P (organic); A (mineral, humus accum/clay depletion); B (weathered mineral, oxidized, clay accum., structure); C (parent); E (mineral, loss of Fe, Al or org),
Flooding/ponding: NO, VR, RA, RA, OC, FR, VFR Duration: EB, VB, B, L, VL
Texture (of portion passing 2mm sieve): S, L, SI, C plus CO, F, VF for sand Coarse fragements can be shown by term (eg. “gravelly” or by percent).
Structure: GR, ABK, SBK, PL, WEG, PR, COL, SGR, MA, CDY Grade: 0, 1, 2, 3 (where 0 = structureless, 1 = weak, 2= moderate, 3 = strong. Size: VF, F, M, CO, VC, EC
Redoximorphic: RMX, Quantity: f, c, m Size: 0, 1, 2, 3, 4, 5 Roots: Size: VF, F, M, C, VC Quantity: few=1, common=2, many=3
Consistency: L, VFR,FR ,FI ,VFI moist or L, S, SH, MH, HA, VH dry

Profile Description

TP #: Site: Date: Slope: Veg.:

	Depth		Matrix Colour	Texture	C. Frags Kind, %	Structure		Consist	Roots Depth, sz/qty	Mottles Depth, qty	Moist Seepg
	From	To				Grade	Type				

Notes (Pores, cracks, other tests, samples):

Estimated WT: SHWT: R. Layer (Type, depth): Usable soil depth: