Department of Health and Human Services
Bureau of Health
Division of Health Engineering
Wastewater and Plumbing Control Program

DISPOSAL FIELD DESIGN THEORY

1. DISPOSAL FIELD TREATMENT

The purpose of a system: The effluent from a septic tank is delivered to a disposal field where it leaches into the soil under unsaturated flow conditions. The purpose of a disposal field is to remove pollutants from the septic tank effluent. The removal processes include physical filtration of bacteria, absorption of virus and bacteria by clay and organic matter, biological destruction of pathogens by soil microorganisms, chemical fixation or precipitation of phosphorous, biochemical transformations of nitrogen compounds, and biological assimilation of nitrogen and phosphorous.

Clogging mat: Continuous or frequent ponding of septic tank effluent on the bottom of the disposal field results in the growth of a biological layer that filters out more and more solid particles and dissolved pollutants from the septic tank effluent. A clogging mat is formed at the point of infiltration into the soil. This mat normally penetrates 1/2 to 6 centimeters into the soil. It consists of a slimy mass of septic tank effluent solids, mineral precipitates, microorganisms, and the by-products of decomposition. Microorganisms in the mat feed on septic tank effluent nutrients to produce slimes, polysaccharides, carbon dioxide, etc. Filtered-out cellulose, undigested food residues, etc., hydrolyze and biodegrade slowly. Mineral precipitates, such as ferrous sulfide, etc., also contribute to the clogging mat.

The clogging mat is in constant flux, that is, building, degrading, and creeping downward into the soil as a viscous fluid where it is dispersed. The process is self-cleaning; otherwise, disposal fields could not last more than a few years. This self-cleaning property, along with a constant septic tank effluent load, allows a properly designed disposal field to be passive and function without maintenance. The clogging mat develops at a rate dependent upon the septic tank effluent load. As the clogging mat matures, the septic tank effluent infiltration rate through the clogging mat decreases. A clogging mat's average infiltration rate, or disposal field application rate, is usually reached after a period of 3 to 36 months.

Disposal field application rate: The clogging mat acts as a hydraulically restrictive soil horizon. Its limited permeability is accounted for in the disposal field application rates used for designing systems. The acceptance rate of the clogging mat is dependent on the texture, structure, and consistence of the soil. This rate typically ranges somewhere between 0.2 to 0.8 gallons per day per square foot of bottom and sidewall area.

Treatment in the clogging mats: Once the clogging mat is established, the organisms in the mat are extremely effective in stabilizing organic waste, removing particulates, and removing pathogenic organisms. Bacterial indicators of pathogenic contamination are total coliforms, fecal coliforms, and fecal streptococci. Total coliforms concentrations of 57,000 colonies per milliliter within the disposal field are

typically reduced to less than 200 colonies per milliliter at or beyond a foot of the clogging mat. Fecal coliforms concentrations of 19,000 colonies per milliliter within the disposal field are typically reduced to less than 2 colonies per milliliter at or beyond a foot of the clogging mat. Fecal streptococci concentrations of 1,600 colonies per milliliter within the disposal field are typically reduced to less than 2 colonies per milliliter at or beyond a foot of the clogging mat. The clogging mat typically removes approximately 10% of the nitrogen but is less effective in removing phosphates.

Zone of treatment: This code requires a minimum 12 inch zone of treatment in the soil column below the bottom of the disposal field. This allows a reaction time as the partially treated septic tank effluent passes through the soil under unsaturated conditions and assures adequate treatment. This 1 foot of suitable soil, or fill material, below the level of the bottom of the disposal field removes pollutants from the septic tank effluent by processes including physical filtration, and ionic-anionic attraction.

Movement through the clogging mat: The movement of septic tank effluent through the clogging mat is due to the hydrostatic or gravity head pushing the septic tank effluent down through the clogging mat, and the capillary tension force or matrix potential pulling the septic tank effluent through the clogging mat.

Maximize the sidewall area: In many soils the capillary potential of the soil itself is more effective than the small hydrostatic heads in forcing the septic tank effluent through the clogging mat. Therefore, an effort should be made to design disposal fields with as much sidewall possible for any given bottom area, such as found in a trench system. This type of design takes maximum advantage of the capillary rise in the soil and evapotranspiration.

Shallow disposal fields: All disposal fields should be installed as shallowly as practical to: take advantage of seasonal evapotranspiration potentials; stay in the generally more permeable upper soil horizons; and stay as far as possible above the seasonal ground water table.

Disposal field configuration: Long, narrow disposal fields should be used whenever possible. Such designs increase the sidewall area to bottom area ratio. This reduces the potential for water mounding under the disposal field and, by spreading out the septic tank effluent plume, increases the potential for dilution as the plume travels down slope.

Vehicular traffic: Except where site limitations make it unavoidable, no driveway, or parking or turning area, should be located over any disposal field. Disposal fields located under vehicular traffic tend to be compacted by the traffic and in many cases are paved. The paving essentially eliminates all upward capillary and evapotranspiration potential.

Bottom of the disposal field: The bottom of each disposal field should be excavated and/or maintained to a level grade. In both stone and proprietary disposal fields, the bottom of the disposal field serves as an integral part of and is the final stage of the distribution network within a disposal field.

Infiltration: Rain, surface, and subsurface water should not be drained into any component of a system or the disposal field will be come overloaded and fail.

2. SEPTIC TANK TREATMENT

Primary treatment: The primary function of a septic tank is to retain fats, grease, and other solids. Primary treatment of sewage takes place within the tank, where anaerobic bacteria digest these materials. The undigestible portion remains in the tank and is disposed of when the tank is pumped. The effluent which leaves the tank for secondary treatment in the disposal field is, ideally, free of suspended fats, grease, and other solids. However, it does contain organic materials, bacteria, and viruses.

Those solids that are stabilized settle to the bottom of the septic tank where they form a sludge blanket. Fats and greases rise to the top of the septic tank forming a scum blanket. The sludge and scum blankets shall be removed periodically to preserve the liquid capacity necessary for satisfactory solids removal.

These are further broken down and deactivated in the disposal field. Septic tank cleaners or degreasers are designed to liquify or emulsify the fats, grease, and solids in the septic tank in order to reduce or eliminate the need for pumping the tank. These preparations defeat the septic tank's purpose. Instead of remaining in the tank, the liquified or emulsified fats, grease, and solids leave the tank in the effluent and enter the field. Much of this material now entering the field is not subject to bacterial breakdown and can significantly shorten the life of the field by reducing soil permeability. Furthermore, some of these cleaners and degreasers themselves have the potential to pollute the ground water.

Typical treatment: A typical septic tank removes about 40 to 50% of the 5-day biochemical oxygen demand, 50 to 70% of the total suspended solids, 20 to 30% of the nitrogen, and up to 30% of the phosphates. Disease organisms do not multiply in the septic tank; they can only survive or be reduced.