Moses Lake Irrigation and Rehabilitation District

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October 22, 1984

Comments on Artic Ventures, Inc. Development on Moses Lake

Gentlemen:

The Moses Lake Irrigation and Rehabilitation District has a long history of involvement in improving the quality of Moses Lake waters. The District has implemented a dilution program to reduce algal nuisances, sponsored local aquatic weed control, and assisted the City of Moses Lake in removing their sewage effluent from the lake. The District operates park and recreation facilities at Airmans Beach. We are currently sponsoring a major study of nutrient sources in the Moses Lake watershed which is evaluating nitrogen and phosphorus loads from both agriculture and urban development.

The District has gone on record in the past to support hookup of septic tanks to further reduce nutrient loadings to the lake from sewage sources. We have discussed this topic with Grant County staff and with the City of Moses Lake during the past year. Last month we added our support to a City of Moses Lake Block Grant application to help sewer the Basin Homes area.

Accordingly, any major new septic tank development proposed for the Moses Lake shoreline is clearly a matter of concern to our Board. Our Board is not opposed to development per se. However, our Board is opposed to developments such as the one planned by Artic Ventures because they rely on individual septic tank systems in coarse soils near the lakeshore. We could support such developments if community sewer systems were included that would prevent additional nutrients from reaching the lake . Our engineer has prepared a paper which summarizes some of the technical aspects of our septic tank related concerns. We encourage further consideration of an alternative sewerage approach to protect the lake. Otherwise this development undoes some of the good we feel our District has accomplished for Moses Lake.

Yours truly,

Clinton J. Connelly

A REVIEW OF NUTRIENT LOADING ASPECTS OF SEPTIC TANK SYSTEMS AROUND MOSES LAKE

The Moses Lake Clean Lake Project is currently evaluating methods to reduce nutrient loadings to Moses Lake. The project is being sponsored by the Moses Lake Irrigation and Rehabilitation District and is partially funded by Department of Ecology and EPA funds. The Moses Lake Conservation District and the Upper Grant Conservation District are also directly involved in the technical work which is being carried out with the assistance of the Soil Conservation Service, the Conservation Commission, the Cooperative Extension and consultants. The project scope covers a variety of potential sources ranging from irrigated agriculture and livestock operations to urban drainage and sewage disposal practices. On site sewage disposal (such as septic tank systems) is included among the practices being evaluated in the study. This brief information paper deals only with sewage disposal considerations.

Moses Lake water quality has long suffered from effects of fertilizing nutrients which reach the lake from land drainage, groundwater seepage and direct and indirect discharge of wastes. Nuisance level algae blooms occur in Moses Lake during the summer recreation season when excessive concentrations of nitrogen and phosphorus are present. Dilution programs in recent years have helped control algae growths around the City of Moses Lake but water is not always available to dilute the nutrients entering the lake. Some of these nutrients come from agricultural lands, others come from urban wastes. A major accomplishment occurred in the spring of 1984 when the City of Moses Lake sewage treatment plant discharge was removed from the lake. This discharge alone accounted for nearly 20 percent of the phosphorus load to Moses Lake.

However other controllable urban waste sources still contribute nutrients to the lake. Septic tank systems in the nearshore area of Moses Lake currently account for approximately 5 percent of the phosphorus entering Moses Lake. The coarse soils around the lake shore allow phosphorus to move in groundwater as has been shown in sampling of wells and springs in the area as part of the Moses Lake Project and past studies by University of Washington researchers. The high permeability of the area's soils has caused the Moses Lake Project to focus considerable attention on both phosphorus and nitrogen movement in groundwater. For this same reason the local use of septic tank systems has been reviewed to determine both their possible effects and to consider alternative technologies to reduce or eliminate discharges of nutrients reaching Moses Lake from this source.

FACTORS CONCERNING ON-SITE SEWAGE DISPOSAL

The most fundamental determinant of whether an on-site system will contribute substantially to lake nutrient loads is whether it is in proper operation. A system which has failed, if it is in a direct drainage path to a lake, can discharge large quantities of nutrients via surface runoff and interflow. A single malfunctioning system on the shore of a small Washington State lake was estimated to contribute one-quarter to one-half of the phosphorus added to the lake by all on-site disposal systems.

Drainfields in service for a long time have been observed to exhibit effluent ponding in the drainfield bed caused by formation of a crustal organic surface layer at the soil interface. Flow of effluent through this layer is impeded but not stopped resulting in unsaturated conditions below the drainfield in contrast to saturation within the bed itself. The extent of saturation in the subsurface drainage path of effluent is one factor regulating the fate of nitrogen and phosphorus. Thus this clogging surface plays an important function in the drainfield even though it reduces the infiltrative rate of the soil.

The following quotation from the Environmental Protection Agency"s Design Manual for Onsite Wastewater Treatment and Disposal Systems summarizes many of the important factors relating to subsurface disposal.

"Where site conditions are suitable, subsurface soil absorption is usually the best method of wastewter disposal for single dwellings because of its simplicity, stability, and low cost. Under the proper conditions, the soil is an excellent treatment medium and requires little wastewater pretreatment. Partially treated wastewater is discharged below ground surface where it is absorbed and treated by the soil as it percolates to the groundwater. Continuous application of wastewater causes a clogging mat to form at the infiltrative surface, which slows the movement of water into the soil. This can be beneficial because it helps to maintain unsaturated soil conditions below the clogging mat. Travel through two to four feet of unsaturated soil is necessary to provide adequate removals of pathogenic organisms and other pollutants from the wastewater before it reaches the groundwater. However, it can reduce the infiltration rate of soil substantially. Therefore, if a subsurface soil absorption system is to have a long life, the design must be based on the infiltration rate through the clogging mat that ultimately forms. Formation of the clogging mat depends primarily on loading patterns, although other factors may impact its development."

A properly operating drainfield can treat and partially purify septic tank effluent. Most soils remove oxygen demanding substances and bacteria very effectively. However, there are definite limitations to the use of septic tank-drainfield systems. Dr. P.H. McGauhey, who directed years of research on septic tank effluent disposal probably summarized it best. Here are his words:

"In summary it may be said that at best the septic system increases the total dissolved mineral content of local groundwaters. At worst, it may introduce bacteria, viruses, and degradable organic matter as well. From an environmental viewpoint the best is not the best of all possible alternatives in an urban situation. Rationally it would seem undesirable to concentrate 2,000 to 15,000 septic systems on the roof of a single groundwater basin or along the margin of a recreational lake. Nor is it necessary today. On the other hand, the best is certainly adequate for the isolated dwelling, where service to man far exceeds any possible environmental effect."

More specific observations on nutrient aspects of septic tank leachate disposal are offered in the following paragraphs.

Nitrogen Movement In Groundwater. The Moses Lake shoreline area is characterized by the generally excessively drained soils formed in glacial outwash. These porous soils allow migration of nutrients from septic tank systems. Both nitrogen and phosphorus are present in septic tank effluents. An understanding of their behavior in soil is important to determining their potential importance to Moses Lake waterquality.

Nitrogen is present in septic tank effluents primarily in ammonium and organic forms. Typically about 80 percent of the total nitrogen is in the ammonium form, also organic nitrogen is eventually mineralized to ammonium in the drainfield soils. Ammonium, a positive ion, will sorb on soil particles in proportion to the soil's cation exchange capacity which is dependent on the proportion of negatively charged clay particles present. Coarse, sandy soils have a low exchange capacity so ammonium can move directly to groundwater. Typically, aerobic conditions exist beneath drrainfield beds and ammonia is oxidized to nitrate by nitrifying bacteria. Nitrification proceeds rapidly particularly in summer. Nitrates are highly soluble and move freely to groundwater. Denitrification, a process which can convert nitrate to nitrogen gas, requires opposite environmental conditions to nitrification. The following excerpt from a recent review by Dr. R. Horner of the University of Washington provides valuable insight on this aspect of the nitrogen cycle:

"Typically, unsaturated soils and aerobic conditions exist beneath drainfield beds. Walker et al measured 19.6 percent oxygen in soil pores within an effluent inflitration zone, almost as high as in the atmosphere. In this situation, nitrifying bacteria oxidize NH4-N first to NO3-N, obtaining energy for cell formation in the process. Nitrification is energetically favored and proceeds rapidly with high oxygen concentration and temperature and alkaline soil pH. Its rate is retarded with increased soil moisture tension (reduced aeration) and decreased temperature and pH. Viraraghvan and Warnock measured only 20-35 percent nitrification in winter in loam soils, compared to 80-90 percent in summer.

NO3-N is highly soluble and moves freely though the soil solution by convection, as well as by molecular and ionic diffusion due to concentration gradients. Its potential to enter groundwater is thus high, particularly in the case of porous soils draining seasonally high precipitation.

The only possible mechanism by which NO3-N can be reduced is denitrification, the conversion of NO3-N to nitrogen gas by heterotrophic, faculative bacteria operating under anaerobic conditions. Because NO3-N is a necessary reactant for this process and the aeration requirements are opposite for nitrification and denitrification, the two processes rarely occur in the same locale. In addition, denitrification yields bacteria relatively little energy and is greatly retarded at pH less than 5.5 and temperature under 10 degrees C. A deficiency of carbon for the heterotrophic bacteria in sandy soils is also an impediment. For these reasons, denitrification is generally of only minor importance in some soils and practically none in others.

Considering the relative unimportance of N removal processes, such as adsorption of NH4-N and precipitation or denitrification of NO3-N, there is little to stop N transport to groundwater, especially in loose soils. Walker et al and Starr and Sawney documented N transport to groundwater without apparent loss in sandy soils. The former authors commented that the only active mechanism of lowering NO3-N concentrations in this situation is by dilution with uncontaminated groundwater. If groundwater intercepts a lake, however, the load of N it carries is available to potentially stimulate photosynthesis in the lake.

Considering the potential nitrogen transformations and generally prevailing soil moisture tensions in different textural classes, Sikora and Corey predicted the N forms likely to be present in the various soils. Nitrification is expected to be nearly complete at most times in sands, sandy loams, loamy sands and loams. Thus, N will be primarily in the NO3-N form. In silt loams and silty clay loams, a mixture of NH4-N and NO3-N is likely. In these soils, there is some possiblity of NO3-N reduction through denitrification. Nitrification would be severely retarded in clay loams and clays, such that NH4-N would predominate.

In summary, most nitrogen in septic effluent rather quickly takes the ammonium form. NO3-N is subsequently formed with effective soil drainage in all but the heavier textured soils. This form is easily transported in soils and has a high potential to enter groundwater and, ultimately, surface waters. N breakthroughs to lakes as high as 50-70 percent have been reported. Using a leachate detector which measures conductivity and fluorescence, the former workers estimated a mean of 16 percent N breakthrough (in a range of 3-49 percent) around Crystal Lake, Michigan. They observed the most erupting plumes in areas of high groundwater. Weather in the NH4-N or NO3-N form, leached nitrogen is available to stimulate algal and aquatic plant growths in receiving waters."

Phosphorus Movement in Groundwater. Anaerobic digestion in septic tanks converts most phosphate forms to soluble ortho phosphate. Various researchers have found more than 85 percent of the total phosphorus in septic tank effluents were in this soluble form and most of the remainder is soon converted in the drainfield when effluent phosphates first contact soil sorption occurs to an extent determined by the soils capacity. The soil's capacity to retain phosphate depends on pH and soil chemistry and texture. Adsorption capacities are low in coarse sands of low organic content and are higher in finer textured soils. Precipatation of phosphorus is also a consideration and can be predicted from soil pH relationships. The most important hydrogeological conditions influencing actual phosphorus removal are soil drainage and the position of the groundwater table relative to the drainfield. Insufficient spacing between the drainfield and the seasonal high water table would not allow opportunity for the phosphorus present in the waste and soil retention coefficients developed for various soils. However phosphorus retention is observed for coarser soils. For example a coarse sandy soil may retain less than 5 percent of the phosphorus whereas a silty sand mixture may retain 60-70 percent of the phosphorus. Computations of phosphorus retention for lake shore areas using this approach are described in Dr. Horner's paper. These examples considered areas extending back approximately 1000 feet from the lake shore. Dr. Horner's review states that it would be appropriate to assume all phosphorus discharged is transported to the lake in areas with steep slopes or excessively rapid drainage.

ALTERNATIVES FOR ONSITE SEWAGE TREATMENT AND DISPOSAL

Numerous studies of alternatives to individual septic tank systems have been completed by water pollution control agencies. Well known examples include the Wisconsin Small Scale Waste Management Project and the Oregon Evaluation of Alternatives for Onsite Sewage Treatment and Disposal and the EPA Design Manual for Onsite Systems and publications on Alternatives for Small Wastewater Treatment Systems. These studies describe newer technologies used to overcome site constraints and ways to reduce nutrient migration to groundwater. Well known examples include mound systems which are now commonly used in many northwestern communities where poor soil permeability or high water tables prevent development and evapotransporation beds which can be used to dispose of wastewater to the atmosphere so no discharge to surface or groundwater is required. These systems are often used to service small community developments as alternatives to facilities involving more complex mechanical systems and direct discharge.

Development around the Moses Lake shoreline should be planned with sanitary sewer systems as a requirement so wastewater can be managed to minimize nutrient migration to the lake. Sewer systems serving shoreline areas could be designed so wastewater could be pumped away from the shore and treated with discharge to subsurface disposal systems such as evapotranspiration beds or for seasonal irrigation and storage of effluent as is practiced by the City of Ephrata. It is recognized that in general community sewer systems are not economical where lot sizes exceed two acres. Accordingly some incentives should be considered that would allow cluster development or smaller lots where satisfactory community sewer and treatment/disposal alternatives are offered.