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Research Proposes Cattle/Fish Feedlots!

Dr. C.B. Fedler, Department of Civil Engineering and Dr. N.C. Parker, Department of Range and Wildlife are the principal investigators for this project.

Livestock and poultry wastes have normally been considered liabilities requiring treatment and disposal rather than products to be sold. The objective of this WRC funded project, was to investigate cost effective solutions to provide an environmentally sound method to treat animal wastes. One approach was to treat the wastes in a lagoon system integrated with a system to produce fish. Fish produced from this type of system could be processed into a meal to be used as a feed ingredient for swine, poultry, fish, and shellfish or used as baitfish.

Lagoon effluent, collected from cattle feedlots on the Texas High Plains, was analyzed in the laboratory to determine if, after treatment, it would sustain growth of fish. In addition to the culture of fish, the lagoon effluent was examined for its potential to produce fresh water alga that also can be used as ingredients in fish diets.

Aquaculture production in the U.S. during 1991 was estimated at about $0.86 billion compared to imports of fish and fishery products valued at $10.1 billion. The market for fish and fishery products has expanded dramatically in the past decade and is likely to continue due to health benefits found from including fish as part of our diet. With harvest from our ocean waters at or above the sustainable limit, continued increase in demand means that aquaculture products must be produced outside the oceans. It has been estimated that the average feedlot of 50,000 head of cattle could produce about 60,000 pounds of baitfish or up to 165,000 pounds of harvestable fish for animal protein from a 30 acre aerobic lagoon. Another asset to this type of integrated waste treatment system is that it can be combined very easily with existing lagoon systems, thus reducing initial costs for the producers. In addition to compliance with the general State and EPA guidelines, this integrated waste treatment system produces valuable products — fish protein and baitfish.

Results of this research to date indicate that effluent from anaerobic lagoons receiving runoff from cattle feedlots could be treated to support fish life. Treatment would involve aeration of the anaerobic

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Radon - Identifying Current Distribution

The Environmental Protection Agency has proposed a drinking water maximum contaminant level for radon gas of 300 pCi/L. Since radon is present in many locations due to decay of natural geologic materials in the subsurface, and since no direct human health effects from radon in water have been documented, this proposed standard has become controversial. Few consumers and municipalities have even analyzed their groundwater sources for radon, and the EPA has yet to endorse a standard method for this analysis. As is now being done in many groundwater-dependent regions around the country, this project is intended to identify the current distribution of radon activities in the Southern High Plains, and to describe the possible treatment costs for radon removal that might be incurred by domestic or municipal water producers whose water exceeds the proposed MCL.

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Radon

Radon

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Two previous studies of radon activities in this region showed values ranging from less than 100 to over 2500 pCi/L. In the current project, the interest is in possible regional geologic phenomena that could control radon presence in the Ogallala. The project team includes Drs. Ken Rainwater and Tony Mollhagen of the Department of Civil Engineering, and Drs. Tom Lehman, "Tex" Reeves, and George Asquith of the Department of Geosciences. Selection of sampling locations considered five geologic factors:

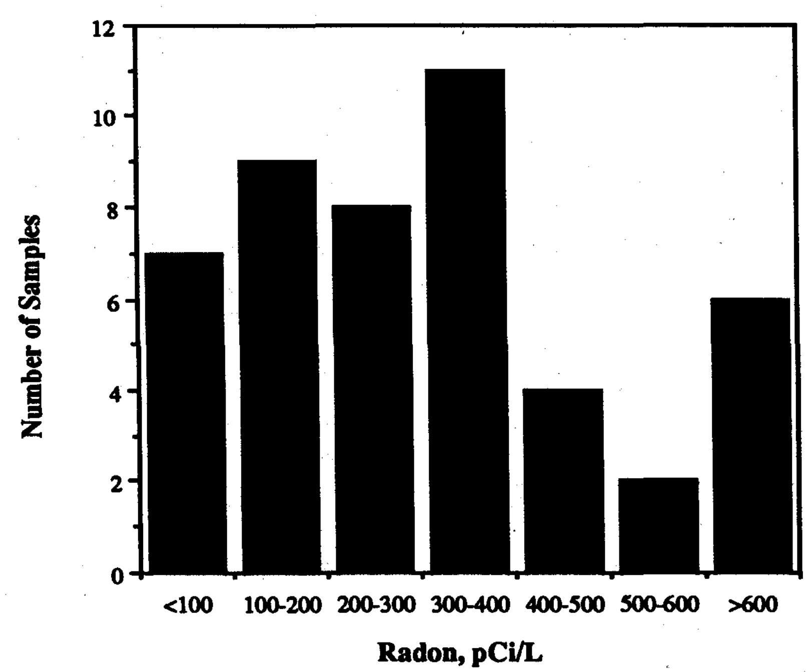
- the age of the formation below the Ogallala,
- the thickness of the Ogallala,
- the proximity of the well to playa basins suspected to contain volcanic ash,
- the proximity of the well to hydrocarbon production, and
- the proximity to the Matador Arch.

The age of the underlying formation is important for relation of the rate of decay of radon to its parent material uranium, 238U. The thickness of the Ogallala can be connected to the different materials composing the thick and thin areas of the aquifer. Where the Ogallala is thick, it represents a paleovalley and consists of coarser-grained material. Where the Ogallala is thinner, it represents a paleohigh and is composed of finer-grained material. Volcanic ash that collected in the basins can contain uranium. 238U is known to accumulate on organic material, such as petroleum deposits. Radon could possibly be concentrated around areas of high hydrocarbon production. Several factors contribute to the importance of the Matador Arch. First, the Matador Arch represents a boundary between older basement rock in the north to younger basement rock in the south. The ages of these granites can be correlated to the amount of 238U. Second, the Arch represents the start of the Midland Basin region to the south where hydrocarbon production is prominent. Third, the Matador Arch is an area of basement fractures that are possibly transmitted to the surface. These fractures could allow 222Rn gas to readily escape from parent material below.

Once these geologic zones were delineated, field sampling began. The graduate research assistant, geosciences master's student Chip Hughes, visited the targeted areas during periods of irrigation pumping. At a few locations, domestic wells have also been sampled. The water samples were analyzed by liquid scintillation counting, using an instrument housed in Texas Tech's Department of Environmental Health and Safety.

At this date, some preliminary results are available. Analyses of the forty samples of this project showed radon activities ranging from around 60 pCi/L to over 1700 pCi/L. The figure shows the distribution of the observed concentration levels among the samples. Fifteen to twenty more samples will be collected. Dr. Reeves will also perform shallow subsurface investigations this summer in one or more basins thought to include volcanic ash or other radioactivity sources. A master's degree candidate in civil engineering, Abidur Khan, has searched the literature of the current technologies for radon removal, both at point of use and in municipal treatment plants. Both water quality and economic information will be presented at the conclusion of the project.

Radon Activities in 47 Samples



PEUF - The Magic Filter?

In the past two years, polyelectrolyte enhanced ultrafiltration (PEUF) has been investigated as a potential technique to treat aqueous waste streams contaminated with heavy metals. This project, funded by the WRC, is headed by Dr. Raghu S. Narayan who is being assisted by the Ph.D. graduate student, V. Murugesh. Briefly, PEUF involves dissolving a water soluble polymer (a polyelectrolyte, PE) in the aqueous waste stream. Polystyrenesulfonate, Polyethyleneimine, and Polydiallyldimethyl Ammonium Chloride have been used as polyelectrolytes in this study. These three chemicals are commonly used in water treatment plants as flocculating agents. The PE forms a complex with the heavy metals. These complexes can be effectively separated from the aqueous stream by ultrafiltration because of its large molecular size.

Ultrafiltration (UF) membrane processes separate dissolved species by differences in their molecular size. UF is a pressure driven process, in which pure water, a small molecule, permeates across the membrane separating it from larger dissolved molecules. These membranes are characterized by their Molecular Weight Cut-Offs (MWCO). In the last 10 years, significant strides have been made in the development of high permeability membranes, making ultrafiltration a highly viable commercial process. Membranes made from Cellulose Acetate and Polysulfone were used in this study. Removal efficiencies of well over 90% were observed for Cd, Cr, Pb, As and Hg.

While PEUF has demonstrated its efficacy to separate heavy metal ions, our work has revealed that UF membranes with small pore sizes (10 to 20 angstroms in a 1000 MWCO membrane) limit the permeate water flux to between 10 and 15 gal/day/ft^2. This limitation is primarily due to the molecular size of the PE's. For example, to produce 10,000 gal/hr of treated water using a 1000 MWCO UF membrane, approximately 24,000 ft^2 of membrane surface area will be needed.

Therefore, a more radically improved metal-ion complexing process, followed by ultrafiltration will be investigated. Such a process would be capable of using higher MWCO membranes which have much higher water flux rates of nearly 250-300 gal/day/ft^2. This would significantly enhance the economic viability of the process compared to PEUF. In this new concept, recently developed macromolecules called star polymers (SP) which have a much larger molecular size than the PE's used so far, will be evaluated.

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lagoon effluent for about 1 day to provide adequate levels of oxygen. However, fish could not survive in the lagoons due to the high level of ammonia. Additional aeration and biological filtration in tests reduced ammonia levels by about 97%. The remaining ammonia was still too high for survival of most species of fish. Further reduction of ammonia and its metabolites will require additional water treatment before these systems can be used for fish culture. The integration of either hydroponics or aquatic plants is expected to further improve water quality by removing residual nutrients.

This research was a component of on-going efforts supported by the Texas Department of Agriculture, the Texas General Land Office, the Texas Department of Commerce, the U.S. Fish and Wildlife Service, and private industry to develop environmentally and economically sound methods to recycle and preserve our water resources. Currently, the U.S. Department of Energy is interested in the installation of an integrated, four-stage waste treatment system that produces single cell protein and fish. Also Fedler and Parker are negotiating a contract to develop this system at the Texas Tech University Burnett Center near New Deal, Texas.

LEPA Irrigation - Saving Water for Future Producers

The semi-arid High Plains of Texas receives less than 20 inches of rain annually, yet is one of the most productive agricultural regions in America. Water for irrigation is essential. Since this water comes from underground sources with little recharge back into the aquifer, saving water resources is vital for agriculture to continue in this semi-arid region. In the past twenty years center pivot irrigation technology has improved the water use efficiency over furrow irrigation.

In the last ten years, newer, more efficient modifications of center pivot systems have been developed here on the High Plains by Dr. Bill Lyle, Texas Agricultural Experiment Station and Leon New, Texas Agricultural Extension Service. Low Energy, Precision Application or LEPA systems allow the producer to put small amounts of water out more frequently at a lower pumping pressure, saving operating costs. Special nozzles allow the producer to have a flat spray for prewatering or germination, an upward spray for chemigating, a bubble mode for irrigation and fertigation. Double ended socks are also used for furrow diked fields for the highest water use efficiency. Full LEPA systems with socks can have 95-98% water use efficiency. This technology has the potential to save a great deal of water for future generations of High Plains producers.

A video is currently being produced that will inform producers of the benefits of LEPA. People who are using the systems are excited about them, but acceptance of the technology is a little slow in the High Plains and very limited outside this area.

This video project, supported by the WRC, is a joint effort of Pam Alspaugh, Manager of Video Services of the Texas Tech University Office of News and Publications, with matching funds from Texas A&M to Dr. Rose Mary Seymour of Lubbock and Leon New of Amarillo, both Texas Agricultural Extension Service irrigation specialists. Commodity groups for corn, grain sorghum, cotton, peanuts and wheat, as well as the Mesa Underground Water District have also supported this project. The goal of the video tape is to help farmers become more informed consumers and managers of irrigation water and equipment.

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