Irrigation trial with Morro Bay wastewater

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The coastal community of Morro Bay, like many other cities in California, is upgrading its sewage treatment plant. As elsewhere, these plant improvements are financed to a large extent with federal and state funds, and a string is attached: Consideration must be given to possible reuse of the treated wastewater or effluent. Morro Bay now disposes of its effluent into the ocean but has the possible alternative of beneficial reuse by piping it inland 1 to 5 miles for irrigation of field and forage crops, under conditions that meet Public Health Department regulations.

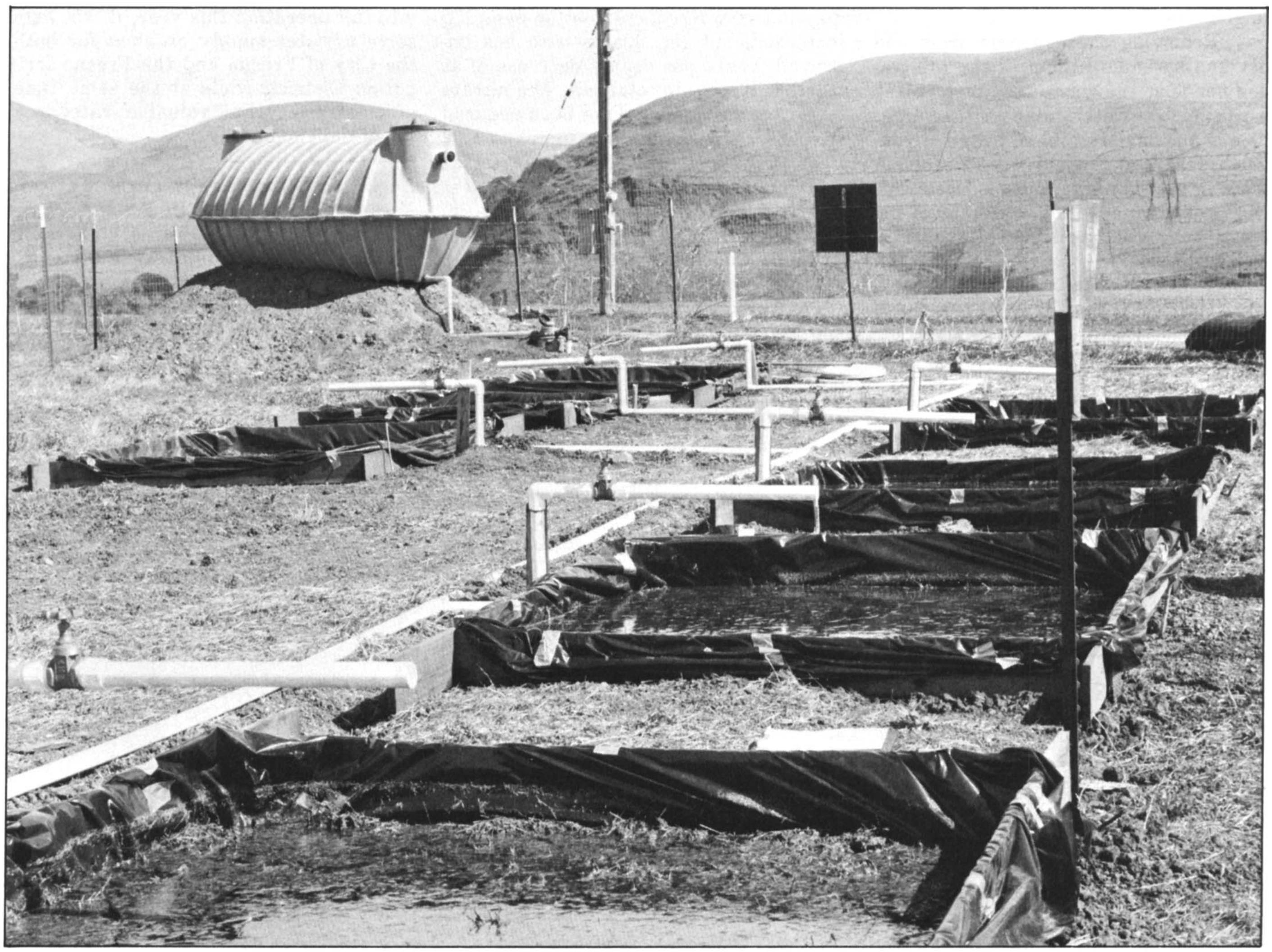
A close look at this alternative showed that the quality of the effluent, judged by guidelines used for regular irrigation waters, was satisfactory except for its sodium adsorption ratio (SAR), which indicates an irrigation water's sodium hazard. (SAR levels used here are adjusted to include effects of dissolved bicarbonate.) Irrigating with a high SAR water can lead to accumulation of sodium in the soil, which, in turn, can drastically lower water intake rate. According to water quality guidelines, this can be expected to occur if the SAR of an irrigation water is above 6. The Morro Bay effluent SAR is 16.

It should be pointed out, however, that the guideline of 6 is based on experience with regular irrigation waters. How well it applies to sewage effluents is not known, because researchers have had little experience in evaluating effluent effects on infiltration rate.

At Morro Bay's request, an irrigation trial was carried out in 1976 by University of California Cooperative Extension to determine what effects the city's effluent would have on sodium accumulation and infiltration rate in two different soils—a fine sandy loam and a clay—in the local farming area. Treatments, replicated three times, included: (1) effluent, (2) effluent plus gypsum (10 tons per acre applied to the soil surface), and (3) city water, representing normal irrigation water, because it is from the same underground source as local farmers' well water. Chemical composition of the two waters is shown in the table. Measurements of infiltration rate and SAR were made periodically to assess the effects of the treatments.

Procedures

All plots were prewetted with several inches of city water and planted to an oat-pasture grass mix in February 1976. Differential treatments started early in March and continued for six months, ending in late September. Once



View of water percolation basins on Diablo clay soil. Fiberglass septic tank in background served as storage tank for effluent water.

each week a volume of water equivalent to a $4\frac{2}{3}$-inch irrigation was applied to each plot. After 5 feet of water had been applied, the application rate was doubled so that, by the end of the project, each plot had received a total of 17 feet of water.

Five sets of soil samples were collected: before treatment; after 70, 103, and 168 inches of water had been applied; and after termination of the treatments.

The SAR values for the 0- to 3-inch depths are shown in figures 1 and 2. Similar relationships were found at lower depths. City water had a negligible effect on the SAR. Effluent water raised SAR levels at both sites, but gypsum acted to lessen this effect. Maximum SAR values of 4.5 to 5.5 were reached after less than half the total amount of effluent water had been added. Further applications did not increase the SAR value. Electrical conductivity of the saturation extract (ECe) for the surface foot of soil from effluent-treated plots did not rise above 1.9 mmhos at either site.

Chemical Composition of Waters Used for Irrigation

Item	City water		Morro Bay effluent	
Calcium	58	mg/l	62	mg/l
Magnesium	96	mg/l	45	mg/l
Sodium	77	mg/l	269	mg/l
Potassium	1.5	mg/l	12	mg/l
Ammonium	.		24	mg/l
Chloride	144	mg/l	321	mg/l
Sulfate	55	mg/l	81	mg/l
Bicarbonate	543	mg/l	505	mg/l
Boron	0.1	ppm	0.6	ppm
EC x 10	1.1		2.0	
SAR	1		6	
SARadj	4		16	
pH	8.2		7.6	

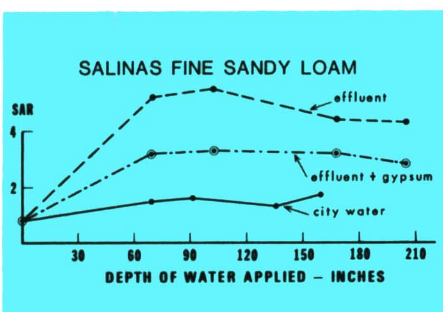


Fig. 1. Sodium adsorption ratio (SAR) values of saturation extracts of Salinas fine sandy loam (0- to 3-inch depth) versus total depth of water applied.

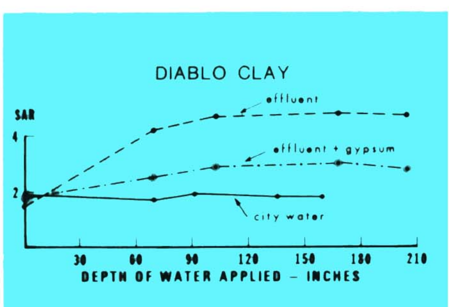


Fig. 2. SAR values of saturation extracts of Diablo clay (0- to 3-inch depth) versus total depth of water applied.

Infiltration rates

Infiltration tests were made at approximately three-week intervals throughout the six months of water application. Initial rates were high for the Salinas fine sandy loam (12 inches per hour) and gradually declined to about 7 inches per hour after six months. There was no significant difference in infiltration rates between city water and effluent water, with or without gypsum on the plots.

Initial rates were moderate for the Diablo clay (1 inch per hour), and actually increased during the experiment to around 4 inches per hour. These high rates were attributed to the applied water being conducted downward through vertical cracks in the soil, which never closed up completely. To compensate for this anomaly, duplicate 6-inch-diameter infiltrometer rings were driven into each plot. Resulting in-ring infiltration rates were dependent on whether or not the rings intersected cracks. Those that did gave rates of 1 to 3 inches per hour. Those that did not gave rates as low as 0.01 inch per hour. Again, there was no consistent difference between the city and effluent waters.

Conclusions

On the basis of information obtained in this trial, it may be concluded that use of this effluent water on these soil types would not be expected to result in excessive sodium accumulation and serious water penetration problems.

Even though amounts of water equivalent to at least four years of irrigation were applied, soil SAR values leveled off and remained below 6 in the effluent treatments. At this level, no lowering of infiltration rates would be expected from continued use of effluent water, and none was found.

The trial results also indicate that guidelines used for evaluation of the sodium hazard of irrigation waters may need to be modified to make them applicable to sewage effluents.

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Irrigating with wastewater in Sonoma County

Lloyd M. Harwood

Treated wastewater has been used successfully to irrigate forage crops on 1,100 acres in Sonoma County during the past two years. The city of Santa Rosa, with the help of federal and state funding, is delivering effluent to local farmers from a treatment plant with a dry-weather flow of approximately 5.5 million gallons per day.

The North Coast Regional Water Quality Control Board, which has jurisdiction over the area being served, has established discharge requirements governing the use of secondary-treated effluent for irrigation of forage crops. One important problem is wastewater disposal during winter months, when farmers cannot use the water. The Board also allows secondary-treated effluent from this plant to be discharged into Santa Rosa Creek during the winter months, as long as certain dilution factors are maintained.

Meanwhile, various cities and sanitation districts within Sonoma County are working on plans to irrigate an additional 4,000 acres with treated wastewater. These agencies are considering crop irrigation with wastewater for a specific purpose—to meet their discharge requirements with costs equal to or lower than other methods. The following comments were made by Brandon J. Riha, director of public works for Santa Rosa, in discussing plans for a large new regional treatment facility serving the cities of Santa Rosa, Sebastopol, Rohnert Park and Cotati:

"The decision to go to land irriga-

Estimated Profit or Loss Based on Operator Owning Own Irrigation System*

Crop	Total costs	Gross value	Profit	Loss
Barley	$162.58	$194.94	$32.36	
Wheat	166.42	205.10	38.68	
Oats				
Calif. Red	157.91	165.00	7.09	
Kanota	156.14	142.34		$13.80
Forage mix	195.08	183.30		11.78
Sudan				
Piper	211.24	207.45		3.79
Trudan 6	207.51	211.50	3.99	
Corn	235.55	361.50	125.95	

Note: Rent or interest on land not included.

*Rental charge for pump, motor, electrical panel, main line, and laterals was $45.15 per acre. Invoice price of the rental equipment was $66.36. Using a 10-year depreciation factor and interest charge at 10% on one-half of capital investment, the cost per acre would be $19.13.

Silage crops at $3.75 per ton for harvest costs.

Fertilizer rate on all crops: Nitrogen 64 lb per acre; phosphorus, 80 lb P O basis per acre (35 lb phosphorus).

Cultural costs: Tractor (75 h.p.) at $20 per hour; smaller tractor at $12 per hour