Agricultural Management Practices Reduce Phosphorus in the Salton Sea Watershed

In the Salton Sea Watershed, more than 2.8 million acre-feet of Colorado River water are used every year to irrigate more than 500,000 acres of lands in the Imperial Valley. Approximately one-third of applied irrigation water leaves irrigated fields as surface runoff and subsurface drainage and enters the Salton Sea. Excessive loads of nutrients (mainly phosphorus and nitrogen) in Imperial Valley rivers and agriculture drains contribute to the eutrophic conditions that impair the Salton Sea. In the Imperial Valley, approximately 20 million pounds of phosphorus may be used annually to fertilize alfalfa alone. This project implemented standard and improved irrigation and fertigation management practices on a commercial alfalfa field to reduce the load and concentration of phosphorus and sediment in agriculture drainage waters. The loads of phosphorus in runoff waters were reduced by as much as 75% compared to standard irrigation and fertigation practices.

The Salton Sea, located in Imperial and Riverside Counties, is the largest inland body of water in California. The Salton Sea Watershed (Salton Sea, Alamo River, New River, Imperial Valley Agriculture Drains) provides significant habitat for wildlife and supports recreation activities such as camping, bird watching, fishing, boating, hiking, and hunting. Rising salinity, sediment, nutrients, and other pollutions found in agriculture drainage water threaten recreational uses and wildlife habitats in the Salton Sea Watershed. Impairments of recreation beneficial uses (REC I and REC II); warm freshwater habitat (WARM); wildlife habitat (WILD); and preservation of rare, threatened, or endangered species (RARE); caused the Salton Sea, Alamo River, New River, and Imperial Valley Agriculture Drains to be listed on the State's 303(d) List of Impaired Waters for pollution by sediments, pesticides, nutrients, salinity, and selenium.

Approximately one-third of applied irrigation water leaves irrigated fields as surface runoff and subsurface drainage. Surface and subsurface drainage water enters the Salton Sea, which has been serving as a drainage sink for the Imperial and Coachella Valleys since its formation in 1905. The Salton Sea continues to exist because of drainage water from agriculture in Imperial and Coachella Valleys as well as flow of agricultural drainage and untreated and partially treated sewage from the Mexicali Valley in Mexico.

Clean Water Act Section 303(d) requires the State to list impaired water bodies and to establish Total Maximum Daily Loads (TMDLs) for those pollutants causing water quality impairments to ensure that impaired water bodies attain their beneficial uses. The Colorado River Basin Regional Water Quality Control Board (Regional Board) developed and adopted Sedimentation/Siltation TMDLs and Implementation Plans for the Alamo River, New River, and Imperial Valley Drains. Reducing the load and/or the concentration of suspended sediment in runoff has numerous benefits including reducing the amount of water applied and the load of other regulated contaminants such as pesticides and phosphorus that are attached to eroded soil particles. TMDLS for other pollutants, including a nutrient TMDL for the Salton Sea, are currently being developed

Table 1 compares pre-TMDL sediment (TSS) measurements at the river and drain outlets with the numeric target for the Silt TMDLs. The numeric targets are to be attained by the year 2014.

Table 1. Silt TMDL numeric target and annual average TSS concentrations (mg/L)

Sample Location	**TMDL Target**	**Pre-TMDL**	**2003**	**2004**	**2005**	**2006**
Alamo River Outlet	200	377	262	237	234	273
New River Outlet	200	271	179	215	184	179
Niland 2 Drain	200	410	N/A	72	59	123
P Drain	200	235	N/A	171	87	144
Pumice Drain	200	610	N/A	203	118	173

A commercial alfalfa field in the Imperial Valley, California was selected to conduct the project. The field is approximately 80 acres and it was planted with alfalfa in October 2004. Best management techniques (BMTs) for phosphorus load reduction were implemented during the second year and third year of the project (first year normal practices, BMTs in 2nd and 3rd year). Dry phosphorus fertilizer (11-52-0) at a rate of approximately 100 lb of P_2O_5 (200 lbs of actual fertilizer) per acre was applied to the project in October 2004 prior to alfalfa planting. Phosphorus fertilizer was applied again in 2006 and 2007, approximately one year after the first hay harvest in 2005. Flumes to measure water flow rates were installed at the head end and at the tail end of the field.

The first management technique used in this project was “irrigation water management”. This technique determines and controls the rate, amount, and timing of irrigation water applied with the aid of a computer software program called Alfalfa XLe developed by University of California Cooperative Extension (UCCE) faculty. The second management technique used in this project was “runoff reduction”. This technique reduces the amount of surface runoff, using a runoff reduction method developed by UCCE, in just a single irrigation per year when broadcast phosphorus fertilizer is applied.

Irrigation management is a key factor in controlling the concentration and the load of phosphorus discharged from irrigation fields in the Imperial Valley. Reducing the rate of surface runoff during and after phosphorus application practices could reduce phosphorus load into surface waters by as much as 75% as compared to standard irrigation practices.

Water-run application of phosphorus increased the concentration and load of phosphorus in runoff water by almost double the load generated from dry phosphorus application practices. Controlling the rate and the amount of applied water is the most effective way to reduce the concentration and load of P in runoff waters. None of the implemented P application practices had any negative impact on yield.

Table 2. Average phosphorus (PO_4) concentration in runoff water (mg/L) in 2006.

		P application type and irrigation practice			
Irrigation number after P application	Irrigation date	Standard P rate broadcast-standard irrigation (borders L7, L10, L13)	Standard P rate broadcast-reduced runoff (borders L1, L8, L9)	Standard P rate water-run-standard irrigation (borders L3,L6, L11)	75% of standard P rate- water-run-standard irrigation (borders L4, L5, L12)
Pre-application irrigation	3/21-23/2006	3.99	3.76	1.77	1.63
1st irrigation	4/27/2006	117.93	77.41	192.30	218.44
2nd irrigation	5/10/2006	3.97	4.35	5.49	5.62
3rd irrigation	5/29/2006	2.32	3.85	2.68	2.94
5th irrigation	6/26/2006	1.32	4.49	2.79	3.22
6th irrigation	7/11/2006	0.71	1.51	1.42	1.24
Average (1st-6th)		25.25	18.32	40.94	46.29

Table 3. Average phosphorus (PO_4) concentration in runoff water (mg/L) in 2007.

		P application type and irrigation practice			
Irrigation number after P application	Irrigation date	Standard P rate broadcast-standard irrigation (borders L7, L10, L13)	Standard P rate broadcast-reduced runoff in 2006 (borders L1, L8, L9)	Standard P rate water-run-standard irrigation (borders L3,L6, L11)	75% of standard P rate- water-run-standard irrigation (borders L4, L5, L12)
Pre-application irrigation	4/8/07	1.34	2.24	1.73	1.76
1st irrigation	4/28/07	54.22	47.35	113.25	109.5
2nd irrigation	5/10/07	3.42	4.99	6.43	3.54
3rd irrigation	6/2/07	2.30	2.14	4.63	2.81
4th irrigation	6/11/07	1.70	1.83	2.22	1.57
5th irrigation	6/28/07	1.69	2.52	2.19	1.09
6th irrigation	7/13/07	0.98	1.11	1.46	1.09
Average (1st - 5th)		10.72	9.99	21.70	19.93

Table 4. Additional costs for implementing various management practices on alfalfa in the Imperial Valley (2006 cost estimates)

Management Practice	**Additional labor costs per $/ac per year**	**Total water savings $/ac per year**	**Total water savings Ac-ft/ac per year**	**Net cost of practice $/ac per year or (net return)**
Irrigation water management	$2.84	$15.00	0.83	($12.16)
Runoff reduction	$2.89	$0.81	0.05	$2.08

As irrigators and farm managers become more attentive to the quantity of water applied and the quality of drainage water leaving their fields, they must adjust their irrigation practices to ensure compliance with TMDL targets. This 319 (h) grant project brought the use of runoff management to the forefront for both farm managers/irrigators and regulators as a useful best management practice in the Imperial Valley.

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The project is located in Congressional District 51. The Salton Sea Watershed is located in Congressional District 51 and 45.

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