

**ANALYSIS OF RUNOFF WATER FROM
CROPLANDS IN THE SOUTH
TEXAS COASTAL PLAINS
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Introduction

The Corpus Christi Bay National Estuary Program (CCBNEP) is a four-year community based effort to identify the problems facing the bays and estuaries of the Texas Coastal Bend Region, and to develop a long-range, comprehensive conservation and management plan. The CCBNEP goals are to protect and improve the environmental and ecological quality of the estuarine and living resources of the 12-county study area (Figure 1). As a component of developing and implementing the plan, studies were undertaken to address nonpoint source pollution concerns relating to agricultural, urban, coastal, or geographically specific environments within the CCBNEP study area.

Objective and Scope

The general objective of this study was to assess the water-quality components for sediment, nutrients, chemical, organic material, and other water-quality constituents from rainfall and storms producing surface water runoff from croplands comprising the Odem Ranch Watershed within the CCBNEP study area. The watershed encompasses 2,775 acres solely devoted to crops production in the western portion of San Patricio County within the Nueces River Drainage Basin Area.

Slopes are relatively flat, less than one degree throughout the watershed. Soils are predominately Victoria clays interspersed with small acreages of Edroy clays, Raymondville clay loams, and Orelia fine sandy loams. All of the soils in the watershed are farmed with best management practices (BMPs) under NRCS/USDA approved conservation systems. Storm water runoff exits the watershed at two locations and eventually flows into the Nueces River and then into the Nueces Bay/Corpus Christi Bay System. The cropland acreage is planted about equally to cotton and grain sorghum each year in a one-in-one year rotation. Small acreages of corn is planted each year.

The scope of the study included identification of the types and amounts of synthetic herbicides and insecticides, Bt microbial insecticides, defoliant, desiccants, growth regulators, and nutrients applied to the crops each year. Automated fixed-station stream flow gaging and water

sampling equipment were installed at edge-of-field for all locations where surface water runoff exited the watershed. An automated weather station and rainfall sampler was located within the watershed. Water-quality samples were collected and analyzed for each rainfall event and each storm event producing runoff from the watershed. A flow-weighted sample was taken over the interval of the runoff hydrograph at fixed time intervals. The water-quality samples were analyzed for the nutrients and pesticides used to produce the crops in the watershed. Event Mean Concentration (EMC) values and nutrient and pesticide loads in the runoff water were quantified. The EMCs for the constituents in the flow-weighted samples represent the average concentrations. They were used to calculate the constituent loads in the runoff.

Field Loading of Constituents, Rainfall and Runoff

Nutrients applied to crops in 1996 were 109.3 tons of nitrogen as N, 58.8 tons of phosphorus as P, and 0.4 tons of sulfate as S. A total of 4,265 lbs active ingredient (a.i.) of synthetic herbicides, 6,993 lbs a.i. of synthetic insecticides, and 1,561 lbs a.i. of defoliant, desiccants, growth regulators were also applied to the crops (Table 1). Similar amounts of nutrients were applied to the crops in 1997 and 1998. For 1997, N equalled 112.6 tons; P equalled 35.3 tons; Potash as K equalled 0.6 tons; and sulfur equalled 0.2 tons. Total synthetic herbicides was 4,612 lbs a.i.; synthetic insecticides equalled 8,472 lbs a.i., Bt microbial insecticides was 45 lbs a.i., and defoliant, desiccants, growth regulators equalled 934 lbs a.i.

Rainfall in the CCBNEP area is generally lower compared to other coastal regions of Texas, averaging 30 inches annually (1961-1991 standard reporting period). Annual rainfall in the watershed ranged from 18.6 inches in 1996 to 33.8 inches in 1997, and 31.7 inches in 1998. Cumulative rainfall in the watershed over the January 1, 1996 to December 31, 1998 period was 84.54 inches. Cumulative runoff from the watershed was only 4.24 inches, averaging 5% of the total commutative rainfall (Figure 2). However, the runoff coefficient varied from storm to storm, depending on the rainfall intensity and the antecedent soil moisture profile. It ranged from a minimum value of 3% in June 1996 to a maximum of 39% in October, 1998.

**Nonpoint Source Event Mean Concentration (EMC)
Values**

Data collected from five storm events during 1996, 1997 and 1998 represent concentrations of nutrients, pesticides, organic matter and other inorganic chemicals in surface water runoff from agricultural croplands in the areas. Table 2 is a summary of volume-weighted event-mean concentration (VWEMC) values by constituent for two storm events occurring during the growing season (June 1996 and June 1997) for the crops, one storm event immediately following harvest of the crops (August 1996)

and two storm events during the layby period when the ground is relatively bare (October 1997 and October 1998). In general, the values are quite low for all the constituents. The potential for nonpoint source pollution is lower in the watershed than in most other areas bordering the gulf coast of Texas. The values for the watershed are all less than the screening levels used by the Texas Natural Resource Conservation Commission (TNRCC) for constituent concentrations in freshwater streams and saltwater tidal streams.

Estimated Constituent Loading from the Study Area

Table 3 presents the results where annual runoff was combined with the EMC values for constituents in the runoff from the Odem Ranch Watershed for three groups of constituents: nutrients, other inorganic chemicals and pesticides. Total annual runoff varied from 4.5 million cu. ft. in 1996 to 13.5 million cu. ft. in 1997, to 31.8 million cu. ft. in 1998. Consequently, estimated loadings of nutrients and other inorganic chemicals are higher in 1997 than 1996, depending on annual rainfall. In contrast, the pesticide loads were lower in 1997 primarily due to the largest runoff event having occurred in October, 1997 when less pesticide residues remain in the fields than during the growing or harvesting seasons. However, pesticide loadings in the runoff were quite small in both years, amounting to less than a total of 1.0 lb of residue in the annual runoff. Loadings for the October 1998 runoff event were not available at the time of this publication.

Concluding Comments

The compilation of the EMC data base for cropland use in the watershed is an important first step in characterizing stormwater runoff quality from agricultural croplands in the CCBNEP study area. The data base is applicable to the predominantly Victoria Clay soils found in the eastern portion of the study area. The seasonality of the storm events and the representiveness of the soils and topography in the watershed for some 70-80% of the cropland acreage in the eastern portion of the CCBNEP study area indicate the results are applicable to a major portion of crop-based agriculture. The BMPs used to produce the crops in the watershed are effective in limiting the loadings of nutrients and pesticides in stormwater runoff. Soils, crop rotations, and the amount of crop residue left in the soil vary from farm to farm. But the current studies here and at another location within the CCBNEP area indicate relatively low EMC values for runoff from croplands in the area.

Table 1. - Total Product Used by Crop for 1996 in the Odem Ranch Watershed

Item	Crop			Total	Units	Lbs. of Active Ingredient
	Corn	Sorghum	Cotton			
Planted Acres	69.0	1,176.0	1,619.2	2,864.2		
Synthetic herbicides: (common name)						
Atrazine 4L (Atrazine)	34.5	739.8	0	774.3	Lbs.	774.3
Cotoran 4L (Fluometuron)	0	0	550.1	550.1	Lbs.	550.1
Direx (Diuron)	0	0	34.5	34.5	Lbs.	34.5
Diuron (Diuron)	0	0	385.5	385.5	Lbs.	385.5
Milo Pro 4L (Propazine)	0	211.5	0	211.5	Lbs.	211.5
Prowl (Pendimethalin)	0	0	304.9	304.9	Pts.	125.8
Roundup (Glyphosate)	0	0	10,337.0	10,337.0	Ozs.	323.0
Super-T (Trifluralin)	0	0		75.9	Lbs.	75.9
Treflan (Trifluralin)	0	0	1,784.8	1,784.8	Lbs.	1,784.8
Subtotal						4,265.4
Synthetic Insecticides: (common name)						
Asana (Esfenvalerate)	0	0	36.2	36.2	Gals.	23.9
Baythroid (Cyfluthrin)	0	0	15.6	15.6	Pts.	3.9
Bidrin (Dicrotophos)	0	0	55.5	55.5	Qts.	111.0
Confirm (Tebufenozide)	0	0	128.5	128.5	Pts.	32.1
Counter 15G (Terbufos)	276.0	1,822.0	0	2,098.0	Lbs.	314.7
Dimethoate 4E (Dimethoate)	0	746.2	125.0	871.2	Pts.	435.6
Dimilin (Diflubenzuron)	0	0	2,570.0	2,570.0	Ozs.	80.3
Furadan (Carbofuran)	0	0	128.5	128.5	Pts.	64.2
Fury (Zeta-cypermethrin)	0	0	822.4	822.4	Gals.	1,233.6
Fyfanon (Malathion)	0	0	32,937.6	32,937.6	Ozs.	2,519.1
Guthion 2L (Azinphos-methyl)	0	0	3,138.0	3,138.0	Pts.	784.5
Methyl #4 (Methyl Parathion)	0	0	128.5	128.5	Ozs.	4.0
Orthene 90s (Acephate)	0	0	34.5	34.5	Ozs.	1.9
Provado (Imidacloprid)	0	0	86.2	86.2	Ozs.	1.1
Temik (Aldicarb)	0	0	2,192.1	2,192.1	Lbs.	328.8
Thiodan (Endosulfan)	0	0	12,799.3	12,799.3	Ozs.	300
ULV Malathion (Malathion)	0	0	9,090.0	9,090.0	Ozs.	662.6
Vydate (Oxamyl)	0	0	195.1	195.1	Pts..	92.1
Subtotal						6993.4
Bt Microbial Insecticides (common name)						
Dipel (Bacillus thuringiensis va. kurstaki)	0	0	7,265.4	7,265.4	Ozs.	8
Subtotal						8
Defoliants, Desiccants, Growth Regulators:						
(Common name)						
Cyclone (Paraquat)	0	0	12,772.0	12,772.0	Ozs.	199.6
Def 6 (Tribufos)	0	0	251.2	251.2	Pts.	188.4
Dropp (Thidiazuron)	0	0	823.1	823.1	Lbs.	823.1
Folex (Tribufos)	0	0	439.5	439.5	Pts.	329.6
Ginstar (Thidiazuron + diuron)	0	0	654.2	654.2	Ozs.	7.7
Prep (Ethephon)	0	0	257.0	257.0	Ozs.	12.1
PGR-IV (Gibberellic acid)	0	0	290.0	290.0	Ozs.	0.1
Latron CS-7 (Spray adjuvant)	0	0	5.1	5.1	Pts.	0
Subtotal						1560.6
TOTAL PESTICIDES						12827
Nutrients:						
Nitrogen	5,934.0	106,534.6	104,302.2	216,770.8	Lbs.	216771
Phosphate	0	40,455.8	77,054.2	117,510.0	Lbs.	117510
Ammonium Sulfate - Nitrogen	0	0	5,845.6	5,845.6	Gals.	1870.6
Ammonium Sulfate - Sulfur	0	0	5,845.6	5,845.6	Gals.	818.4

Table 2 - Summary of VWEMC Values by Constituent and Year for the Odem Ranch Watershed

Constituent	Unit	VWEMC for Storm		
		1996	1997	1998
Organic Chemicals:				
Atrazine	ug/L	1.80	0.09	0.03
Fluometuron	ug/L	0.87	<0.035	<0.035
Malathion	ug/L	<0.01	<0.005	<0.005
Azinphos-Methyl	ug/L	<0.032	<0.003	<0.003
Metalochlor	ug/L	0.01	<0.004	<0.004
Pendimethalin	ug/L	0.053	<0.004	<0.004
Simazine	ug/L	<0.014	<0.005	<0.005
Trifluralin	ug/L	0.097	0.007	<0.005
Diuron	ug/L	<0.02	<0.02	<0.02
Propanil	ug/L	<0.004	<0.004	<0.004
Molinate	ug/L	<0.004	<0.004	<0.004
Inorganic Chemicals:				
Fluoride	mg/L	0.356	0.708	0.210
Nitrate	mg/L	0.48	0.56	0.040
Nitrite	mg/L	0.125	0.036	<0.010
Nitrate + Nitrite	mg/L	0.606	0.90	0.050
Ammonia	mg/L	0.056	0.045	.036
Dissolved Ammonia + Organic	mg/L	0.317	0.561	<0.100
Total Ammonia + Organic	mg/L	0.870	1.307	0.930
Total Phosphorus	mg/L	0.376	0.487	0.346
Dissolved Phosphorus	mg/L	0.278	0.276	<0.050
Orthophosphorus	mg/L	0.256	0.238	<0.010
Dissolved Chloride	mg/L	3.70	7.02	1.100
Dissolved Sulfate	mg/L	1.097	3.446	0.750
Dissolved Iron	ug/L	4.956	3.948	5.500
Total Dissolved Solids	mg/L	87.0	138.0	172.0

Table 3. - Annual Runoff and Loadings from the Odem Ranch Watershed

Constituent	Rainfall (lbs.)		Runoff (lbs.)	
	1996	1997	1996	1997
Total Nitrogen	1,693	1,836	453	1,852
Dissolved Organic Nitrogen	209		69	433
Total Organic Nitrogen			224	1,061
Nitrate + Nitrite	620	893	170	755
Ammonia	863	1,086	20.6	38.5
Total Phosphorus	40	63	106	409
Dissolved Phosphorus	8.8	21.3	34	231
Orthophosphorus	6.5	19.5	72	201
Calcium			4,389	17,453
Magnesium			360	1,453
Potassium			1,472	4,411
Chloride			1,041	5,938
Boron			19.3	112
Iron			1.4	5.2
Atrazine			0.505	0.077
Deethyl Atrazine			0.15	0.095
Deisopropyl Atrazine				0.033
Fluometuron			0.248	0
Malathion			0.002	0
Other Pesticides ¹			0.062	0.101
TOTAL PESTICIDES			0.967	0.306

¹ Total for eight other pesticides

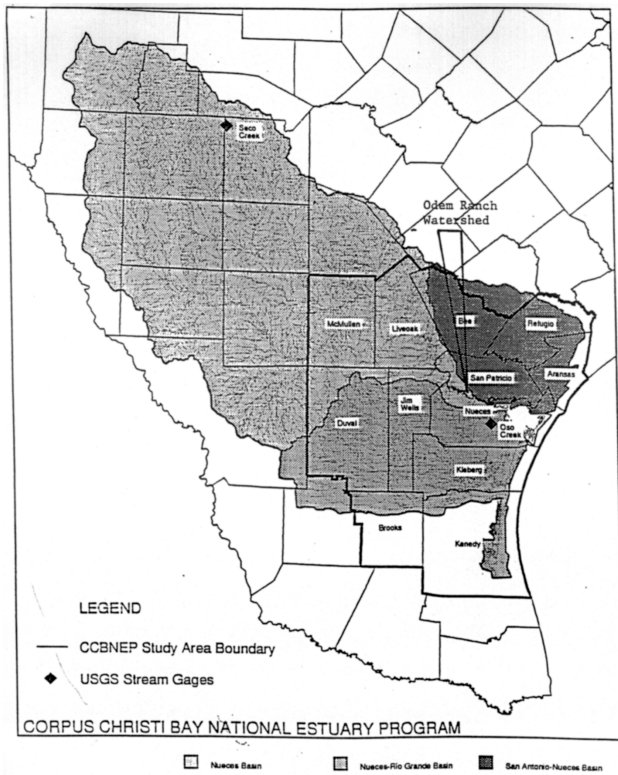


Figure 1. Corpus Christi Bay National Estuary Program Study Area and drainage Area with Location of the Odem Ranch Watershed.

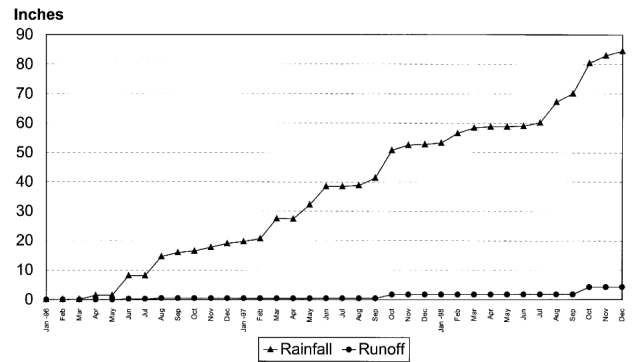


Figure 2. Odem Ranch Watershed, Edroy, Texas – Cumulative Rainfall and Runoff.