

Optimization of an Integrated Vegetated Treatment System and Evaluation of Landguard A900 Enzyme

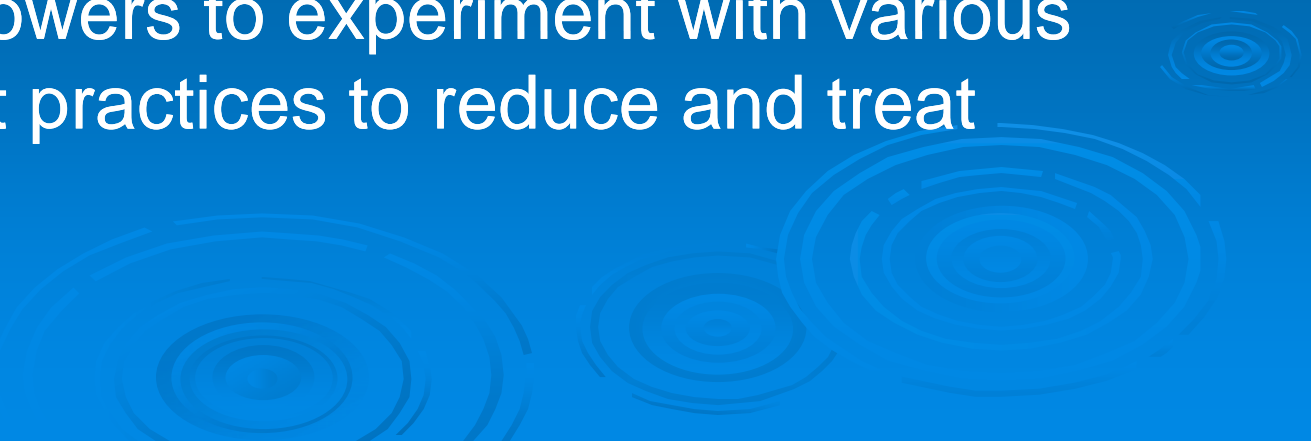
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Background

- Monterey County agriculture = \$4 billion in 2009
 - Lettuce products = \$1.4 billion in 2009
 - “The Salad Bowl of the World”
 - This equates to pesticide runoff and adverse effects in receiving systems
 - Evidence of impacts and regulations have motivated growers to experiment with various management practices to reduce and treat runoff
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Management Practices

Floating Vegetation (Pennywort)



No Vegetation

Management Practices



Integrated Vegetated Treatment System (VTS)



Sedimentation (40m)

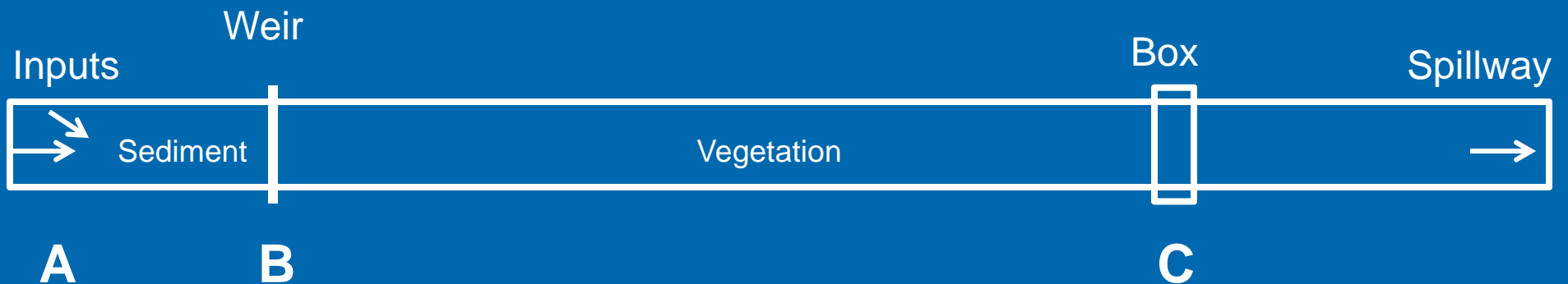


Vegetation (170m)

Volume Control



Integrated Vegetated Treatment System (VTS)



- Water drains from approximately 120 acres
- Weir holds back water for sedimentation
- Box can be adjusted to hold back water in vegetation
- Spillway drains to Lateral Ditch
- Landguard enzyme was introduced at the weir, but in previous study the enzyme was introduced at C

Landguard™ A900

Developed by Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia's national science agency.

Derived from bacteria originally isolated from soil and cultured on a large scale.


Lyophilized enzyme is mixed with water and added directly to runoff.

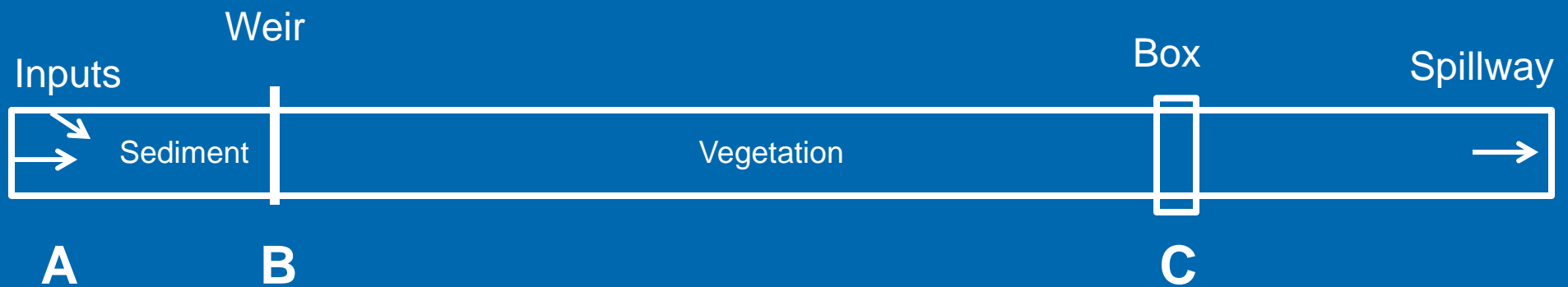


Landguard Application



Project Goals

- Refine the VTS design by measuring the performance of the vegetated component under low volume and high volume scenarios.
 - Optimize the dose and mixing time of the Landguard enzyme through laboratory spiking experiments.
 - Test optimal Landguard dose in the refined VTS and under conditions with high discharge and short mixing times in a larger drainage.
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- Water samples collected at A, B and C
- Samples tested for toxicity with *Ceriodaphnia dubia* and *Hyalella azteca* (96 hour acute tests)



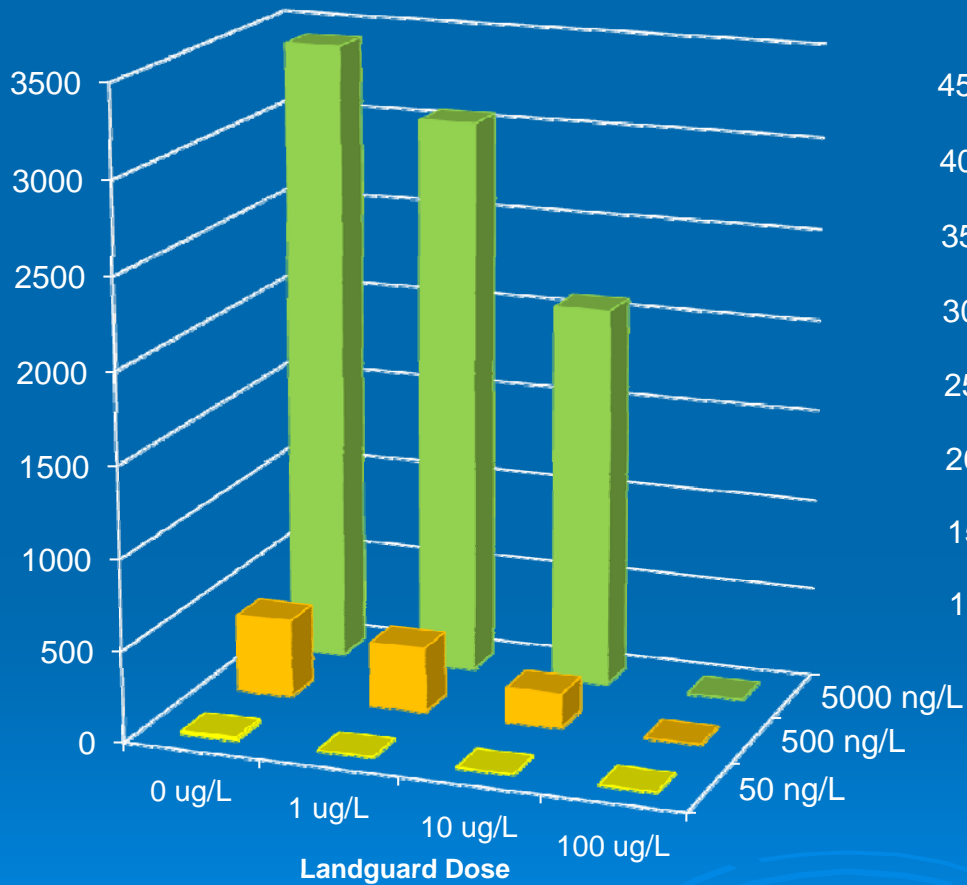
- All samples analyzed for chlorpyrifos and diazinon (also measure nitrate, phosphate and turbidity)
- Some samples analyzed for organophosphates, pyrethroids, and organochlorines

High-Volume Trials

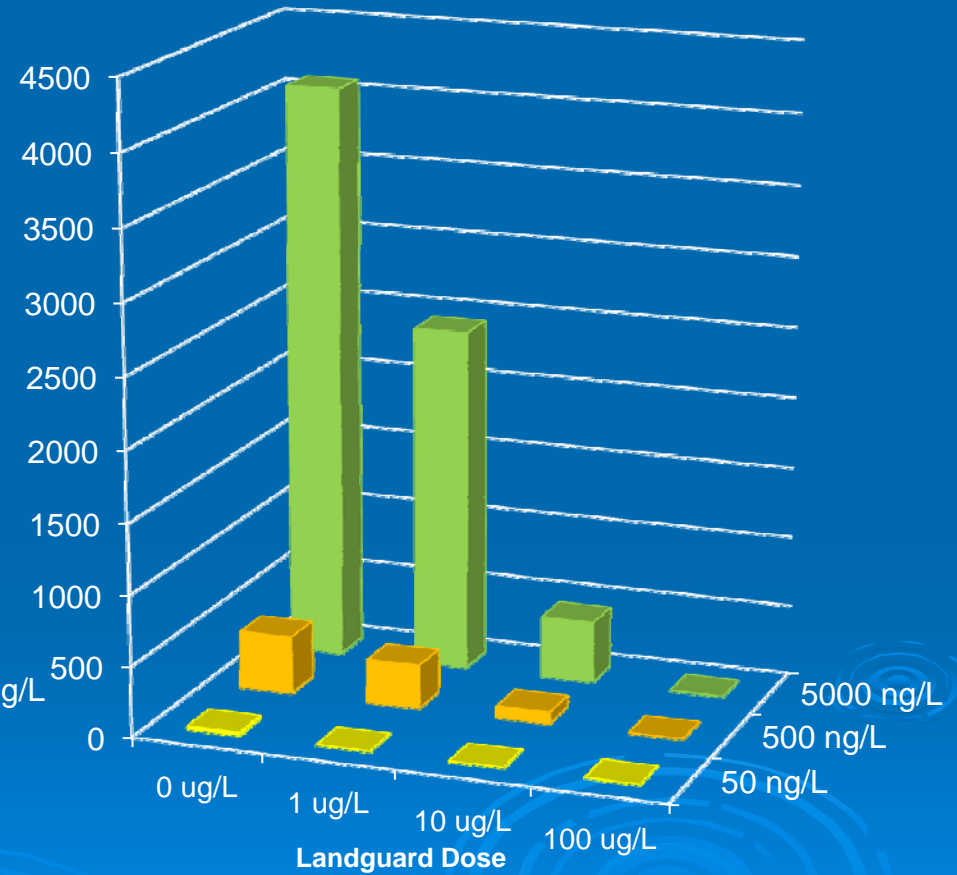
	Daphnid Surv.	Amphipod Surv.	TSS	Cyhalo-thrin	Per-methrin	4,4'-DDT	Diazinon	Mala-thion
Input	92	20	570	5.03	26.9	119.3	ND	ND
Weir	100	48	86	ND	39.2	43.9	ND	Trace
Box	97	72	12	ND	25.1	ND	12	80
Input	47	2	1340				ND	
Weir	93	24	99				ND	
Box	87	96	20				ND	
Input	0	0	3764	33.5	68.1	108.5	ND	ND
Weir	88	28	234	11.1	18.1	42.3	ND	ND
Box	88	94	30	ND	ND	ND	ND	ND
Input	52	6	3164	123	107	85	ND	ND
Weir	92	18	75	27.8	13.1	15.6	18	Trace
Box	96	62	16	5.71	ND	ND	17	Trace

Landguard Laboratory Efficacy Tests - Chlorpyrifos


One Hour



Three Hour



Lateral Ditch

- Larger drainage with approximately 20 times the discharge of the VTS.
 - Drains several properties and hundreds of acres.
 - Approximately 300m long with a 2m fall.
 - Deeply incised and essentially unvegetated.
 - Pulse transit times of about 10 to 45 minutes.
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Landguard Application – Lateral Ditch

Station	Daphnid % Survival	Amphipod % Survival	CHL (ng/L)	DIA (ng/L)	DIM (ng/L)	MAL (ng/L)	MEP (ng/L)	CYH (ng/L)
Weir	0	0	1558	130				
Bottom	85	8	<RL	<RL				
Weir	0	0	388	ND				
Bottom	92	4	ND	ND				
Weir	0	80	76	ND	371	Trace	405	ND
Bottom	76	94	ND	ND	405	Trace	ND	ND
Weir	0	0	95	ND	ND	84	ND	8.77
Bottom	94	71	ND	ND	ND	81	ND	ND
Weir	0	42	63	ND	ND	82	ND	ND
Bottom	92	66	ND	ND	ND	ND	ND	ND
Daphnid LC50			53	350		2120		200
Amphipod LC50			86	6510				2.3

Percent Reduction

Parameter	Current Study	Previous Study
CHL and DIA (with enzyme treatment)	100	100
Other OPs(with enzyme treatment)	Mixed	NA
Organochlorines	97-100	91
Pyrethroids	98-100 (21)	100
Turbidity	98-100	89-94

Are the post-VTS Concentrations Low Enough?

Parameter	Ag Waiver Objective	Current Study (no enzyme)	Current Study (with enzyme)
Chlorpyrifos	25 ng/L	13.7 ng/L	ND
Diazinon	140 ng/L	19.3 ng/L	ND
Nitrate	30 mg/L	23.1 mg/L	
Turbidity (narrative)	25 NTU	41.8 NTU	
Toxicity	None	Some	

Next Steps

- CSIRO is developing a time-release enzyme application for organophosphates that will need evaluation
- CSIRO is also developing similar applications for synthetic pyrethroid pesticides
- Additional Outreach

Acknowledgements

- Cooperating Growers
- Monterey County Resource Conservation District
- California Department of Pesticide Regulation
- U.S. Department of Agriculture
- U.C. Davis Department of Environmental Toxicology – Marine Pollution Studies Lab
- CSIRO – Commonwealth Science and Industrial Research Organization