


TARRANT REGIONAL WATER DISTRICT

North Central Texas Water Quality Project

Stakeholder Meeting
Watershed Protection Plan
Development for the
Cedar Creek Watershed
 September 11, 2008
 Kaufman, Texas

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Economic Analyses of BMPs for The Cedar Creek Watershed


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Objective of BMP Economic Analyses




Identifying how to obtain the most 'bang' for the 'bucks'!

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Problem

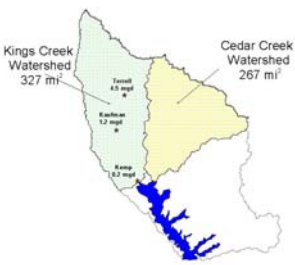
- Tarrant Regional Water District (TRWD) owns/operates 4 major water-supply reservoirs (impacting 1.6 million)
 - realizing increased/problematic levels of:
 - sediments
 - nutrients (nitrogen, phosphorous)
 - seeking to reduce/prevent intrusion via most cost-effective portfolio of BMPs



Water-Quality with BMP ECONOMICS™

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Cedar Creek Reservoir
 Total Watershed Area 1007 mi²



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Best Management Practices (BMP)




- BMP:** "As defined by the EPA, methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources."


Source: [Texas Watershed Steward Handbook](#) and David Waidler

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BMP Categories




- Cropland
- Pasture & Rangeland
- Urban
- Channel
- Watershed
- Reservoir 'In-Lake'
- Construction
- Waste Water Treatment Plants




What's Most Cost Effective (of 40+ BMPs) ?




- Classic Economic Decision Problem
- Identify the most economic-efficient BMPs on the basis of annualized cost of reducing P, N, & Sediment inflows into the Cedar Creek reservoir
- How to select the 'optimal' portfolio of BMPs?




Data Assimilation



- Interaction with rest of team
 - BMP possibilities
 - Feasibility of implementation for each BMP
 - Obvious redundancies and 'low' and/or 'expensive' performers
 - Area affected, presence of existing levels, and related performance efficiencies
 - Projecting maximum levels of adoption




Development of BMP ECONOMICS®




-- financial cost component (Excel s/s)

- Finance capital budgeting and annuity equivalent principles
- Estimating *life-cycle* costs
- Consistent, comparable values for BMPs
 - Recognize already-present levels of each BMP
 - Estimate additional or marginal levels possible
 - Recognize P, N, and Sediment reduction per BMP
 - Identify costs required to implement & administer BMPs, regardless of who/what is responsible




Development of BMP ECONOMICS®





-- optimization component (LINDO)


- Linear programming algorithm
- Simultaneously, consider, evaluate, and rate all specified BMPs based on costs and efficacy of performance relative to
 - Designated annual reduction needs in P, N, and Sediment
 - Other possible constraints, e.g., \$s, integer BMPs
- Identify portfolio of least-cost quality-improving strategy(ies)
- Sensitivity analyses to determine impact of competing issues on the preferred path of managing the problem



Status of BMP Economic Analyses

- We have results!
- First phase of validation last week with TRWD and other team members
- Today is another validation step
- Anticipate follow-up meetings with TRWD and other team members during next two weeks to finalize analyses
- Report writing in progress



RESULTS! : 1

ABCDEFGHIJK
LMNOPQRSTUVWXYZ
ABCDEFGHIJKLMNQRST
UVWXYZ

ARABIC IS A STANDARD ALPHABET FOR ARCHITECTURAL LETTERING. IT IS THE MOST COMMONLY USED ALPHABET FOR ARCHITECTURAL LETTERING.

LOWER CASE LETTERS OR SMALL LETTERS ARE USED FOR NOTES.

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RESULTS! : 2

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Excluded BMPs – for various reasons

BMP	Type	Description
#002	Cropland	Crop Residue Mgmt
#102	Pasture & Rangeland	Fencing
#103	Pasture & Rangeland	Water Facility
#104	Pasture & Rangeland	Fertilizer/Nutrient Mgmt
#106	Pasture & Rangeland	Range Planting
#301B	Channel	Channel Stabilization
#303	Channel	On or Off Channel Water and Sediment Control Basin
#304	Channel	Streambank and Shoreline Protection
#403	Watershed	Channel Stabilization
#404	Watershed	Sediment Basins
#502A	Reservoir 'In-Lake'	P Inactivation with Alum (Sweetwater) – Entire Reservoir
#503	Reservoir 'In-Lake'	Water Column Mixing (Solar Bee)
#504A	Reservoir 'In-Lake'	Dredging – Entire Reservoir
#504B	Reservoir 'In-Lake'	Dredging – Cores Only
#601	Construction	Construction Sediment Control
#602	Construction	Permeable Paving Surface
#603	Construction	Seed Roadway and Dirt Piles
#604	Construction	Storm Drain Blockage

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Expected (Probable) BMP Adoption Rates: 1

BMP	Type	Description	Adoption Rates		
			Current	Maximum	Marginal
#001	Cropland	Cropland to Grass	0.0%	20.0%	20.0%
#001A	Cropland	Contour Farming	60.0%	75.0%	15.0%
#003	Cropland	Fertilizer/Nutrient Mgmt	10.0%	75.0%	65.0%
#004	Cropland	Filter Strip	15.0%	75.0%	60.0%
#006	Cropland	Grassed Waterways	10.0%	50.0%	40.0%
#007	Cropland	Terracing	60.0%	75.0%	15.0%
#101	Pasture & Rangeland	Prescribed Grazing	0.0%	10.0%	10.0%
#105	Pasture & Rangeland	Pasture Planting	0.0%	15.0%	15.0%
#107	Pasture & Rangeland	Critical Pasture Planting	50.0%	75.0%	25.0%
#s 201 - 209	Urban	Phase II Urban BMPs	0.0%	100.0%	100.0%
#210	Urban	Voluntary Urban Nutrient Mgmt	10.0%	25.0%	15.0%
#211	Urban	Required Urban Nutrient Mgmt in 2,000 ft Reservoir Buffer Strip	10.0%	80.0%	70.0%

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Expected (Probable) BMP Adoption Rates: 2

BMP	Type	Description	Adoption Rates		
			Current	Maximum	Marginal
#301A	Channel	Riparian Buffer Strips – except critical areas	0.0%	50.0%	50.0%
#302	Channel	Riparian Buffer Strips – critical areas	0.0%	10.0%	10.0%
#401A1	Watershed	Wetland - Lower Kings Creek (SB 54)	0.0%	100.0%	100.0%
#401B1	Watershed	Wetland - End Cedar Creek (SB 70)	0.0%	100.0%	100.0%
#402	Watershed	Grade Stabilization	0.0%	100.0%	100.0%
#501	Reservoir 'In-Lake'	Hypolimnetic Aeration	0.0%	100.0%	100.0%
#502B	Reservoir 'In-Lake'	P Inactivation with Alum – 1/3 of Reservoir	0.0%	100.0%	100.0%
#505	Reservoir 'In-Lake'	Hypolimnetic Water Release from Reservoir	0.0%	100.0%	100.0%
#701	WWTP	WWTP - - from Level I to Level II	0.0%	100.0%	100.0%
#702	WWTP	WWTP - - from Level I to Level III	0.0%	100.0%	100.0%

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Expected (Probable) BMP Adoption Rates: 3

BMP	Category	Description	Binary Possibilities
#s 201 - 209	Urban	Phase II Urban BMPs	0,1
#211	Urban	Required Urban Nutrient Mgmt in 2,000 ft Reservoir Buffer Strip	0,1
#401A1	Watershed	Wetland - Lower Kings Creek (SB 54)	0,1
#401B1	Watershed	Wetland - End Cedar Creek (SB 70)	0,1
#501	Reservoir 'In-Lake'	Hypolimnetic Aeration	0,1
#502B	Reservoir 'In-Lake'	P Inactivation with Alum – 1/3 of Reservoir	0,1
#701	WWTP	WWTP - - from Level I to Level II	0,1
#702	WWTP	WWTP - - from Level I to Level III	0,1

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Adjusted SWAT/WASP/ERNST BMP Efficacies: 1

BMP	Type	Description	P	N	Sed
#001	Cropland	Cropland to Grass	-7.12%	-5.45%	-5.38%
#001A	Cropland	Contour Farming	-2.37%	-0.34%	-2.30%
#003	Cropland	Fertilizer/ Nutrient Mgmt	-2.63%	0.01%	0.01%
#004	Cropland	Filter Strip	-21.61%	-12.00%	-14.92%
#006	Cropland	Grassed Waterways	-0.80%	-1.47%	-1.96%
#007	Cropland	Terracing	-2.70%	-0.46%	-2.55%
#101	Pasture & Rangeland	Prescribed Grazing	-0.56%	-1.64%	-0.83%
#105	Pasture & Rangeland	Pasture Planting	-0.84%	-2.46%	-1.24%
#107	Pasture & Rangeland	Critical Pasture Planting	-2.82%	-8.19%	-4.14%
#s. 201 - 209	Urban	Phase II Urban BMPs	-14.70%	-16.43%	-7.20%
#210	Urban	Voluntary Urban Nutrient Mgmt	-1.58%	-1.00%	-0.29%
#211	Urban	Required Urban Nutrient Mgmt in 2,000 ft Reservoir Buffer Strip	-1.02%	-2.12%	0.00%

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Adjusted SWAT/WASP/ERNST BMP Efficacies: 2

BMP	Type	Description	P	N	Sed
#301A	Channel	Riparian Buffer Strips — except critical areas	-2.38%	-1.99%	-9.99%
#302	Channel	Riparian Buffer Strips — critical areas	-0.15%	-0.09%	-0.55%
#401A	Watershed	Wetland - Lower Kings Creek (SB 54)	-1.61%	-1.90%	-2.68%
#401B	Watershed	Wetland - End Cedar Creek (SB 70)	-0.63%	-1.04%	-1.42%
#402	Watershed	Grade Stabilization	-2.54%	-1.49%	-2.53%
#501	Reservoir 'In-Lake'	Hypolimnetic Aeration	-1.53%	0.00%	0.00%
#502B	Reservoir 'In-Lake'	P Inactivation with Alum - 1/3 of Reservoir	-3.01%	0.00%	0.00%
#505	Reservoir 'In-Lake'	Hypolimnetic Water Release from Reservoir	-0.62%	0.00%	0.00%
#701	WWTP	WWTP - from Level I to Level II	-4.80%	-1.72%	0.02%
#702	WWTP	WWTP - from Level I to Level III	-5.55%	-2.85%	0.02%

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BMP Financial Economics: 1

BMP	Type	Description	Initial Costs	AE of All Costs	Ranked Order for Least Cost		
					P	N	Sed
#001	Cropland	Cropland to Grass	\$ 1,402,084	\$ 1,450,125	11	10	8
#001A	Cropland	Contour Farming	\$ 30,000	\$ 235,077	4	15	5
#003	Cropland	Fertilizer/ Nutrient Mgmt	\$ 15,000	\$ 2,071,863	18	22	20
#004	Cropland	Filter Strip	\$ 371,810	\$ 2,000,442	3	6	6
#006	Cropland	Grassed Waterways	\$ 39,076	\$ 139,754	7	3	4
#007	Cropland	Terracing	\$ 656,549	\$ 536,135	10	16	7
#101	Pasture & Rangeland	Prescribed Grazing	\$ 3,039,238	\$ 230,980	16	18	15
#105	Pasture & Rangeland	Pasture Planting	\$ 7,072,286	\$ 1,684,675	21	14	14
#107	Pasture & Rangeland	Critical Pasture Planting	\$ 789,797	\$ 188,159	2	1	2
#s. 201 - 209	Urban	Phase II Urban BMPs	\$ -	\$ 2,295,974	6	4	9
#210	Urban	Voluntary Urban Nutrient Mgmt	\$ -	\$ 285,721	8	8	13
#211	Urban	Required Urban Nutrient Mgmt in 2,000 ft Reservoir Buffer Strip	\$ 250,000	\$ 331,641	15	5	19

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BMP Financial Economics: 2

BMP	Type	Description	Initial Costs	AE of All Costs	Ranked Order for Least Cost		
					P	N	Sed
#301A	Channel	Riparian Buffer Strips — except critical areas	\$ 5,350,000	\$ 471,182	9	7	3
#302	Channel	Riparian Buffer Strips — critical areas	\$ 3,300,000	\$ 213,028	20	17	11
#401A	Watershed	Wetland - Lower Kings Creek (SB 54)	\$ 12,406,800	\$ 886,601	17	11	10
#401B	Watershed	Wetland - End Cedar Creek (SB 70)	\$ 9,572,000	\$ 659,579	19	13	12
#402	Watershed	Grade Stabilization	\$ 330,000	\$ 45,102	1	2	1
#501	Reservoir 'In-Lake'	Hypolimnetic Aeration	\$ 1,200,000	\$ 404,915	13	19	16
#502B	Reservoir 'In-Lake'	P Inactivation with Alum - 1/3 of Reservoir	\$ 6,700,000	\$ 915,714	14	20	17
#505	Reservoir 'In-Lake'	Hypolimnetic Water Release from Reservoir	\$ 1,800,000	\$ 1,910,250	22	21	18
#701	WWTP	WWTP - from Level I to Level II	\$ 6,865,942	\$ 512,753	5	9	22
#702	WWTP	WWTP - from Level I to Level III	\$ 11,957,148	\$ 1,403,465	12	12	21

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Which BMPs to Select?

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BMP ECONOMICS®

-- optimization component (LINDO)

- **Four scenarios for consideration**
 - (A) Base, focused on reducing P by 35%
 - (B) Base, with value accorded also reducing sediment
 - (C) Perceived "Most Likely" adoption path
 - (D) No Ag BMPs
- **Model results of importance**
 - Objective function value (AE)
 - Initial costs
 - BMPs in the solution
 - Other details available

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BMP ECONOMICS®
-- optimization component (LINDO)

(A) Base, focused on reducing P by 35%

BMP ECONOMICS® RESULTS
-- optimization component (LINDO)

Labels	A	B	C	D
Obj Fcn	\$ 3,293 M			
Initial \$s	\$ 8,388 M			
001 301A				
001A 302 001A				
003 401A				
004 401B 004				
006 402 402				
007 501				
101 502B				
105 505				
107 701 107 701				
2011 209 702				
210				
211				

Legend
 In solution at maximum level
 In solution at partial level
 Blocked from being included in the solution

BMP ECONOMICS®
-- optimization component (LINDO)

(B) Base, with value accorded also reducing sediment

BMP ECONOMICS® RESULTS
-- optimization component (LINDO)

Labels	A	B	C	D
Obj Fcn	\$ 3,293 M	\$ 3,028 M		
Initial \$s	\$ 8,388 M	\$ 8,910 M		
001 301A				
001A 302 001A 001A				
003 401A				
004 401B 004 004				
006 402 402 006 402				
007 501				
101 502B				
105 505				
107 701 107 701 107 701				
2011 209 702				
210				
211				

Legend
 In solution at maximum level
 In solution at partial level
 Blocked from being included in the solution

BMP ECONOMICS®
-- optimization component (LINDO)

(C) Perceived "Most Likely" adoption path


BMP ECONOMICS® RESULTS
-- optimization component (LINDO)

Labels	A	B	C	D
Obj Fcn	\$ 3,293 M	\$ 3,028 M	\$ 3,306 M	
Initial \$s	\$ 8,388 M	\$ 8,910 M	\$ 8,910 M	
001 301A				
001A 302 001A 001A 001A				
003 401A				
004 401B 004 004 004				
006 402 402 006 402 006 402				
007 501				
101 502B				
105 505				
107 701 107 701 107 701 107 701				
2011 209 702				
210				
211				


Legend
 In solution at maximum level
 In solution at partial level
 Blocked from being included in the solution

BMP ECONOMICS®

-- optimization component (LINDO)




(D) No Ag BMPs




BMP ECONOMICS® RESULTS

-- optimization component (LINDO)



Labels		A	B	C	D
Obj Fun		\$ 3,293 M	\$ 3,028 M	\$ 3,206 M	\$ 9,416 M
Initial \$s		\$ 8,388 M	\$ 8,910 M	\$ 8,910 M	\$ 82,359 M
001	301A			301A	301A
001A	302	001A	001A	001A	302
003	401A				401A
004	401B	004	004	004	401B
006	402		402	006	402
007	501				501
101	502B				502B
105	505				505
107	701	107	701	107	701
201+209	702				201+209
210		210			210
211					211


Legend
■ In solution at maximum level
■ In solution at partial level
■ Blocked from being included in the solution




What's Next?




- Interested in your perspectives today
- Discuss these results with TRWD and rest of team
- Conduct additional sensitivity analyses
- Evaluate results in greater detail
- Finalize this phase of planning
- Prepare the final report



Questions?





Thank You

Collaborators & Supporters !



~ Bringing Economics, Finance, Accounting, and
 Computer Modeling to Water Planning in the Cedar
 Creek Watershed and beyond!~

source: <http://images.google.com>