



CADMUS



Source Water Protection Economic Feasibility Analysis for Beaver Water District, Arkansas – Preliminary Results

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Acknowledgements

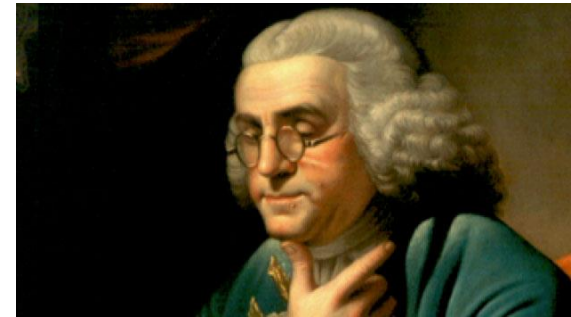
- Dr. Richard Krop – Senior Economist
- Dr. Karen Sklenar – Senior Scientist
- Ms. Jaime Rooke – Economist
- Mr. Marc Morandi – Water Quality Data Specialist
- Numerous staff of Beaver Water District, Beaver Watershed Alliance, County Extension Service, Natural Resources Conservation Service, Northwest Arkansas Council, Watershed Conservation Resource Center, and city/municipal planning and stormwater management organizations



Source Water Protection

- Taking proactive measures to prevent the pollution of lakes, rivers, streams, and ground water that serve as sources of drinking water
- It is part of a “multi-barrier” approach to providing safe drinking water; treatment alone cannot always be successful in removing contaminants.

“An ounce of prevention is worth a pound of cure” -
Benjamin Franklin



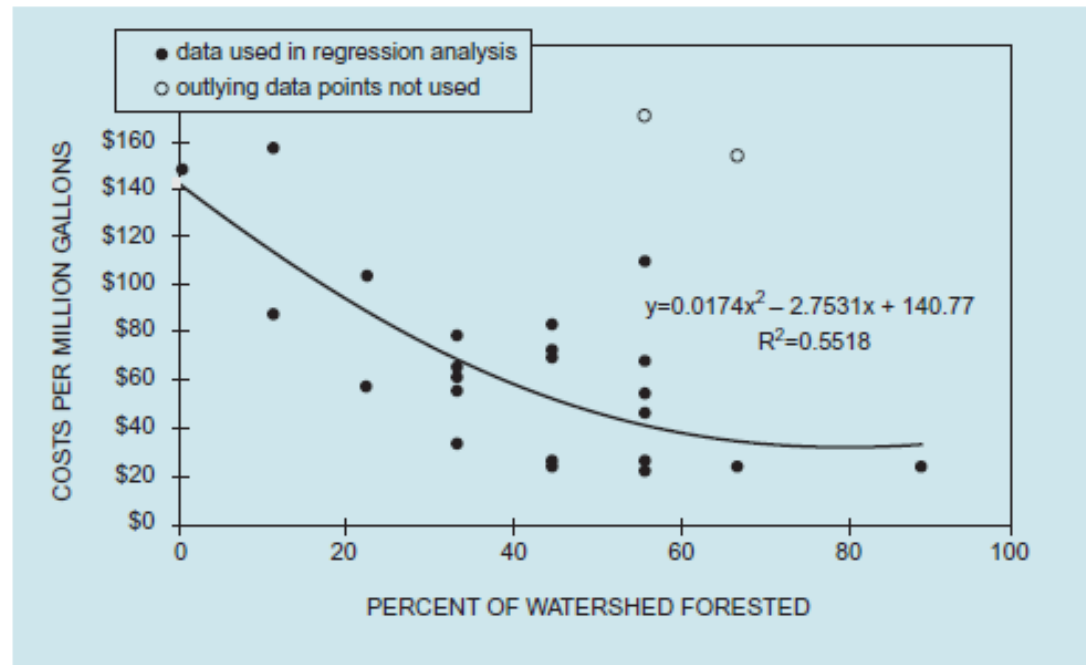
Source Water Protection

- No two water systems are created equal – due to differences in geography, source area, history, development pattern, climate change, and trajectory
- “One size fits all” is not realistic
- Numerous attempts to quantify costs and benefits associated with source water protection programs



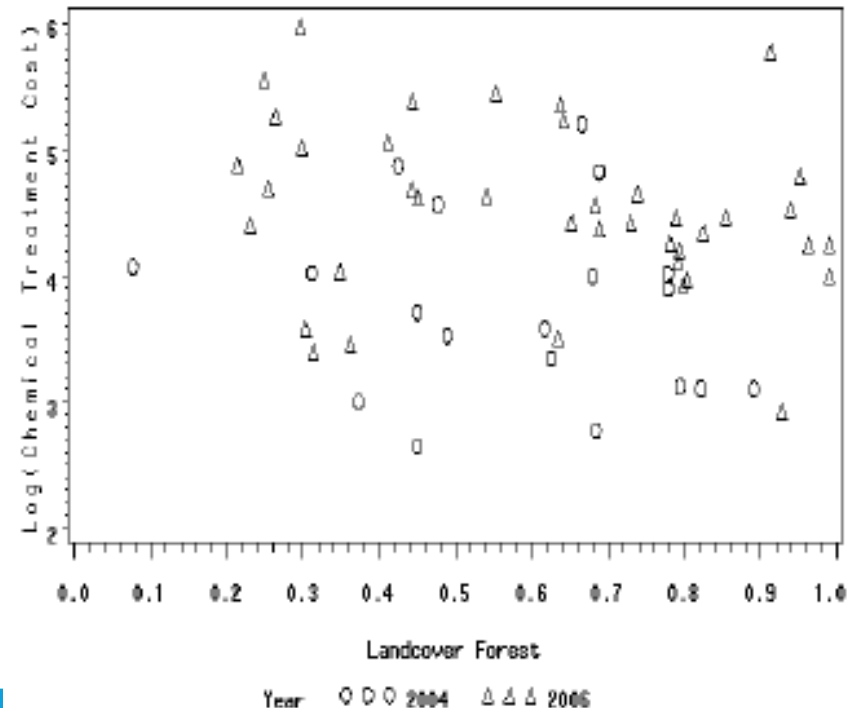
Previous Cost-Benefit Analyses

- Focus on forest cover & water treatment cost
 - 2004 Trust for Public Land (TPL) and American Water Works Association (AWWA) study



Previous Cost-Benefit Analyses

- Focus on forest cover & water treatment cost
 - 2008 TPL (with support from EPA, US Forest Service, U. Massachusetts) study



Previous Cost-Benefit Analyses

- Challenges
 - Reporting and accounting procedures regarding capital versus operation and maintenance (O&M) costs vary among water systems.
 - Diversity in the sequences of treatment and types of chemicals used by water systems may have a confounding effect on the analysis.
 - Raw water sampling methods differ (e.g., systematic/fixed frequency sampling versus event-based/random sampling) and may increase data variability.
 - Varying quality of water at the intakes (e.g., whether the system is drawing from a river/stream versus from a reservoir/lake) with different residence times, storage capacities, and operational flexibility add more variability to the analysis.



Previous Cost-Benefit Analyses

- Challenges (continued)
 - Water systems are located in many different eco-regions, and the analysis did not account for regional differences in climate, soil, and geology.
 - Land cover statistics do not capture the effects of location of specific land cover types and relative loading rates in each watershed, which may greatly affect the water quality.
 - Water treatment facilities often over-treat their raw water beyond required standards as a precaution.
 - The costs of chemicals vary widely for drinking water treatment due to differences in chemicals used, economies of scale, bulk pricing, and regional pricing.



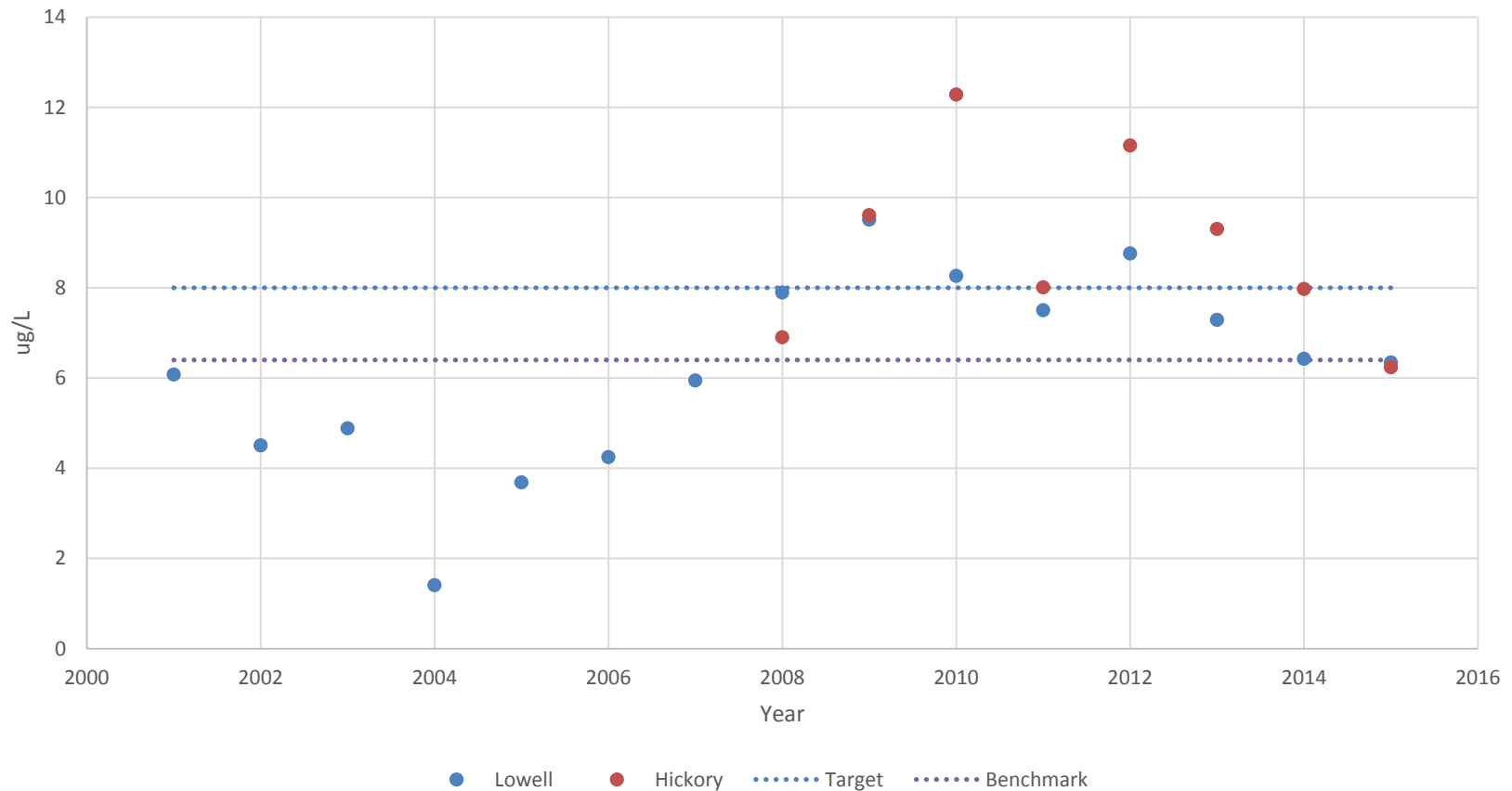
Previous Cost-Benefit Analyses

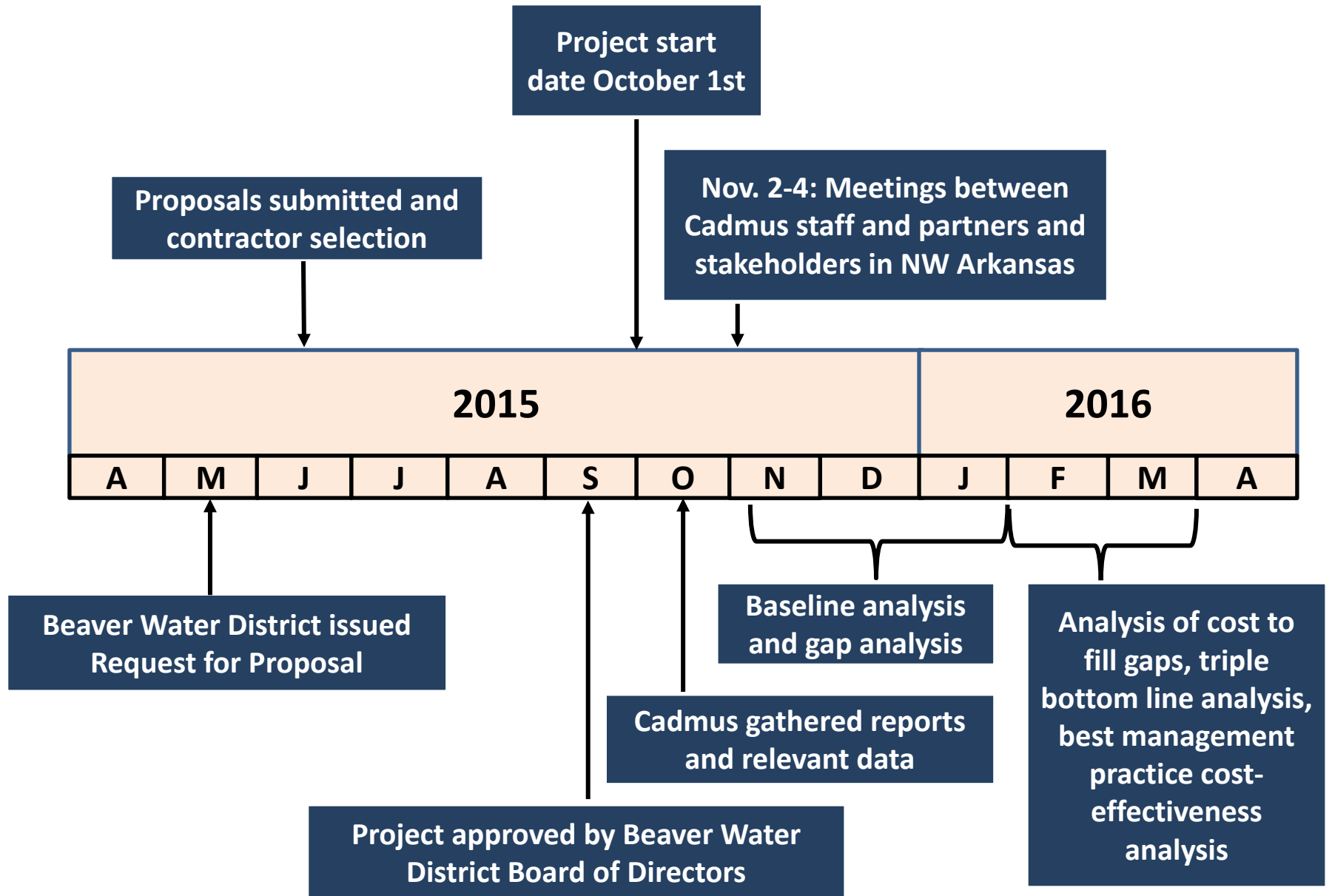
- Conclusions from source water protection experts
 - Board scale statistical approach may not yield conclusive results to facilitate the comparison of costs and benefits of source water protection
 - System or watershed specific analyses may provide a better platform to assess the costs and benefits of source water protection
 - Benefits from source water protection, including ecosystem services, social and environmental benefits, and inter-generational benefits remain challenging to quantify although progress is being made
 - Moving to risk assessment and evaluation of resilience should be considered



Beaver Water District – Water Quality Concerns

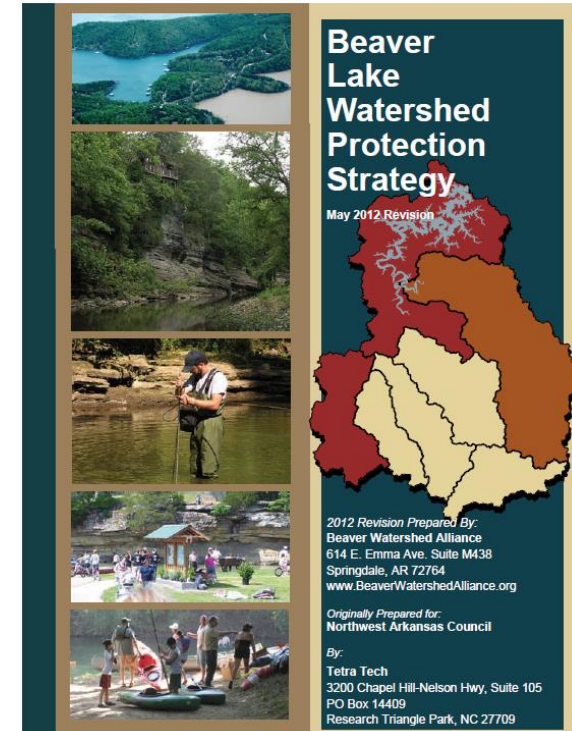
Growing season geometric mean of Chlorophyll-a for the Lowell and Hickory USGS stations





Baseline Analysis

- Information gathered through interview and literature review (e.g., 2012 version of the Beaver Lake Watershed Protection Strategy)
- Cadmus used the results of the baseline analysis to estimate the cost to Beaver Water District and the region of not expanding and accelerating the implementation of the source water protection strategy.
 - Costs, to the extent possible, will include monetary costs, including the cost of additional drinking water protection measures, loss of tourism revenue and related recreational employment and income, and future watershed remediation efforts.



Baseline – Best Management Practices

- Collected, organized BMPs by subwatershed and county from more than a dozen sources
- Identified how each BMP fits into the Strategy's Core BMPs



Best Management Practices

- BMPs
 - Land conservation
 - Improved construction site management
 - Riparian buffer and river bank restoration
 - Pasture management
 - Buffer preservation
 - Unpaved road improvements
 - Stormwater BMP retrofits



Baseline – Summary Tables

- Summary tables of implemented BMPs, by BMP and subwatershed
 - Units
 - Costs
- Qualitative assessment of progress on other components
 - Beaver Lake Watershed Council
 - Developer and Contractor Lake Protection Certification Program
 - Education & Stewardship
 - Monitoring and Adaptive Management



Example Summary Table (Units)

BMP	Units	Beaver Lake- White River	Headwater- White River	Lake Sequoyah- White River	Middle Fork- White River	Richland Creek	War Eagle Creek	West Fork- White River	Entire Watershed
Improved Construction Site Management									
Septic Maintenance	Number	7							7
Riparian Buffer and Bank Restoration Non-Pasture									
Bank Stabilization	Feet							75	75
Buffer Enhancement	Feet							6,716	6,716
Buffer Establishment	Feet							5,250	5,250
Fence	Feet	2,998	35	1,739	2,641	1,059	867	4,520	13,727
Riparian Forest Buffer	Feet						100		100
Stream Restoration	Feet	1,000						8,892	9,892
Streambank and Shoreline	Feet	8	14	12	0.5	23	57		61
Buffer Preservation									
Protected Stream	Feet	38,275		26,339	40,650	15,441	10,226	69,620	200,551
Riparian Footage Preservation	Feet							23,000	23,000
Alternative Water Source and Fencing									
Pond	Number	6	11	9	0.42	18	45		48
Pond Sealing or Lining Bentonite Treatment	Acres						0.3		0.3
Watering Facility	Number	1.7	0.1	0.4	0.5	0.3	0.63	0.9	4
Pasture Management BMPs									
Composting Facility	Number	0.6		0.4	0.6	0.2	0.2	1.0	3
Critical Area Planting	Acres	0.11		0.07	0.11	0.04	0.03	0.20	1
Heavy Use Area Protection	Acres	0.20		0.06	0.09	0.03	0.04	0.16	1
Livestock Pipeline	Feet	80		11	17	6	12	29	155
Pasture and Hay Planting	Acres	36	61	52	3	100	251	1	271
Pasture Management	Acres	230							230
Pasture Renovation	Acres							106	106
Pipeline	Feet	554		267	411	156	124	705	2,217
Prescribed Grazing	Acres	12		8	13	5	3	22	62
Structure for Water Control	Number	0.3		0.2	0.3	0.1	0.1	0.5	1.5
Waste Facility Cover	Number	0.0	0.1	0.1	0.0	0.1	0.4		0.4
Waste Storage Facility	Number	0.9	0.1	0.5	0.7	0.4	0.5	1.2	4



Gap Analysis

- Based on the baseline analysis, Cadmus evaluated the progress that has been made by Beaver Water District towards implementing its source water protection strategy – using a matrix on completion status and cost for meeting established targets



Gap Analysis

Table 1: Completion Matrix								
Component	Beaver Lake- White River	Headwater- White River	Lake Sequoyah- White River	Middle Fork- White River	Richland Creek	War Eagle Creek	West Fork- White River	Entire Watershed
Component 1: Beaver Lake Watershed Council	●	●	●	●	●	●	●	●
Component 2: Core Best Management Practices	●	●	●	●	●	●	●	●
Land Conservation Existing Forest	●	●	●	●	●	●	●	●
Improved Construction Site Management	●	○	○	○	○	○	○	●
Riparian Buffer and Bank Restoration Non-Pasture	●	●	●	●	●	●	●	●
Riparian Buffer and Bank Restoration Pasture								
Alternative Water Source and Fencing	●	●	●	●	●	●	●	●
Pasture Management BMPs	●	●	●	●	●	●	●	●
Buffer Preservation	●	○	●	●	●	●	○	●
Unpaved Road Improvements	○	○	○	○	○	●	○	●
Stormwater BMP retrofits	●	○	○	○	○	●	●	●
Total All BMPs	●	●	●	●	●	●	●	●
Component 3: Developer and Contractor Lake Protection Certification Program								
Component 4: Education & Stewardship								
Component 5: Monitoring and Adaptive Management								

Legend		
Description	Progress	Symbol
No Information	Unknown	○
Little or no progress	<5%	●
Underway	>=5%, <80%	●
Mostly complete	>=80%	●

Triple Bottom Line Analysis

- Estimate the timing of costs and benefits of fully implementing the source water protection program
- Discount future costs and benefits to their present value
- Calculate cost-benefit ratio and net present value of fully implementing the strategy to Beaver Water District, the environment, and society
- Incorporate qualitative assessments of other non-monetary impacts of the strategy
- Evaluate the uncertainty of the estimates by exploring the sensitivity of the results to key assumptions (e.g., discount rate).



Triple Bottom Line

- Compares two scenarios
 - Baseline
 - Sediment and nutrients in lake continue to increase according to “No Further Action” projections in protection strategy
 - Algae and total organic carbon (TOC) would increase, causing taste and odor problems
 - Clarity of lake would deteriorate
 - Full implementation of the protection strategy
 - Core components of protection strategy fully implemented
 - Sediment and phosphorus loading would be reduced compared to the baseline scenario



Triple Bottom Line – Accounts

- Organized by “accounts” because costs and benefits not borne equally by all
 - Beaver Water District
 - Environment
 - Society (farmer, community, and government)



Triple Bottom Line – Costs

- BMP costs derived from Strategy
 - Assigned to each triple bottom line account
- Costs for other components obtained from Beaver Water District (BWD)
 - Largely represent ongoing program costs



Triple Bottom Line – Benefits

- Water treatment
 - Avoided cost of ammonia treatment facility (immediately)
 - Avoided cost of ozone treatment facility (in 10 years)
- Recreation
 - Avoided loss of swimming, fishing, boating activities
 - Assumed an increase in recreation site closure under baseline
- Property value
 - Avoided loss in property value based on water clarity
 - Assumed reduction in Secchi depth under baseline



Triple Bottom Line – Assumptions

- Discount rates at 2%
- Strategy implementation over 40 years (through 2055)
- O&M activities conducted over 40 years
- Escalation of real cost of construction at 1%
- Water quality outcomes (chl-*a*, TOC, turbidity) tied to sediment and phosphorus loading



Qualitative Measures

- Many benefits are difficult to quantify and are incorporated as qualitative benefits
 - Other water quality effects: will directly enhance water quality but are unmeasurable
 - Effect on implementation: will improve the effectiveness of the strategy
 - Other environmental effects: benefits to air quality, protection of land and forest
 - Effect on efficiency: improving pasture or farming efficiency
 - Effect on corporate reputation: improves for participating companies and farmers
 - Effect on community enhancement: education, community engagement, and infrastructure improvements



Preliminary Results

- Total net benefit of the strategy is approximately \$40 million
- Likely underestimate benefits due to inability to quantify all benefits

Component/BMP				
	Costs	Benefits*	Net	Benefit/Cost
Component 1: Beaver Lake Watershed Council	\$13,253,730	\$0	(\$13,253,730)	0.00
Component 2: Core Best Management Practices	\$296,450,089	\$384,261,137	\$87,811,048	1.30
Land Conservation Existing Pasture	\$14,276,333	\$70,248,687	\$55,972,354	4.92
Land Conservation Existing Forest	\$16,797,613	\$88,237,622	\$71,440,009	5.25
Improved Construction Site Management	\$91,785,328	\$61,641,736	(\$30,143,592)	0.67
Riparian Buffer and Bank Restoration Non-Pasture	\$66,374,150	\$48,820,692	(\$17,553,458)	0.74
Riparian Buffer and Bank Restoration Pasture	\$15,711,491	\$11,110,762	(\$4,600,730)	0.71
Alternative Water Source and Fencing	\$7,473,069	\$3,906,301	(\$3,566,768)	0.52
Pasture Management BMPs	\$35,012,489	\$60,631,435	\$25,618,947	1.73
Buffer Preservation	\$20,501,249	\$20,280,628	(\$220,621)	0.99
Unpaved Road Improvements	\$9,931,698	\$14,371,064	\$4,439,366	1.45
Stormwater BMP retrofits	\$18,586,669	\$5,012,211	(\$13,574,459)	0.27
Component 3: Developer and Contractor Lake Protection Certification Program	\$1,007,591	\$0	(\$1,007,591)	0.00
Component 4: Education & Stewardship	\$11,908,113	\$0	(\$11,908,113)	0.00
Component 5: Monitoring and Adaptive Management	\$21,562,671	\$0	(\$21,562,671)	0.00
Strategy Total	\$344,182,194	\$384,261,137	\$40,078,943	

*Note: Benefits for each individual Core BMP are approximated using their relative reduction in sediment loading.



Preliminary Results - BWD

- The net benefit to BWD is approximately \$27 million
- BWD bears substantial share of education and stewardship, and monitoring and adaptive management costs
- BWD (and ratepayers) benefit from avoided treatment

Component/BMP					Other Water Quality	Effect on
	<i>Costs</i>	<i>Benefits</i>	<i>Net</i>	<i>Benefit/Cost</i>	<i>Effects</i>	<i>Implementation</i>
Component 1: Beaver Lake Watershed Council	\$6,626,865	\$0	(\$6,626,865)	0.00	✓	
Component 2: Core Best Management Practices	\$28,846,707	\$71,214,088	\$42,367,381	2.47		
Component 3: Developer and Contractor Lake Protection Certification Program	\$26,400	\$0	(\$26,400)	0.00	✓✓	
Component 4: Education & Stewardship	\$2,511,233	\$0	(\$2,511,233)	0.00	✓	
Component 5: Monitoring and Adaptive Management	\$6,570,362	\$0	(\$6,570,362)	0.00		✓



Preliminary Results – Environment

- BMPs have substantial environmental effect
- BMPs likely have unmeasurable effects on environment

Component/BMP					Other Environmental Benefit
	<i>Costs</i>	<i>Benefits</i>	<i>Net</i>	<i>Benefit/Cost</i>	
Component 1: Beaver Lake Watershed Council	\$0	\$0	\$0	0.00	
Component 2: Core Best Management Practices	\$0	\$308,865,589	\$308,865,589	0.00	✓ ✓
Component 3: Developer and Contractor Lake Protection Certification Program	\$0	\$0	\$0	0.00	✓ ✓
Component 4: Education & Stewardship	\$0	\$0	\$0	0.00	
Component 5: Monitoring and Adaptive Management	\$0	\$0	\$0	0.00	



Preliminary Results – Society

- BMP costs shared by farmers, community, and government
- Many benefits society will experience attributed to “environmental”
- Society experiences unmeasurable benefits such as reduction in wastewater treatment costs, improving corporate reputation, and education

Other Social Impact - Community Perspective							
Component/BMP					Effect on Efficiency	Effect on Corporate Reputation	Effect on Community Enhancement
	Costs	Benefits	Net	Benefit/Cost			
Component 1: Beaver Lake Watershed Council	\$6,626,865	\$0	(\$6,626,865)	0.00			
Component 2: Core Best Management Practices	\$91,355,736	\$4,181,461	(\$87,174,275)	0.05	✓	✓	✓
Component 3: Developer and Contractor Lake Protection Certification Program	\$763,172	\$0	(\$763,172)	0.00			
Component 4: Education & Stewardship	\$6,975,647	\$0	(\$6,975,647)	0.00			✓✓
Component 5: Monitoring and Adaptive Management	\$706,742	\$0	(\$706,742)	0.00			
Other Social Impact - Government Perspective							
Component/BMP					Effect on Efficiency	Effect on Corporate Reputation	Effect on Community Enhancement
	Costs	Benefits	Net	Benefit/Cost			
Component 1: Beaver Lake Watershed Council	\$0	\$0	\$0	0.00			
Component 2: Core Best Management Practices	\$149,549,299	\$0	(\$149,549,299)	0.00			
Component 3: Developer and Contractor Lake Protection Certification Program	\$218,018	\$0	(\$218,018)	0.00			
Component 4: Education & Stewardship	\$2,421,233	\$0	(\$2,421,233)	0.00			
Component 5: Monitoring and Adaptive Management	\$14,285,567	\$0	(\$14,285,567)	0.00			
Other Social Impact - Total							
Component/BMP					Effect on Efficiency	Effect on Corporate Reputation	Effect on Community Enhancement
	Costs	Benefits	Net	Benefit/Cost			
Component 1: Beaver Lake Watershed Council	\$6,626,865	\$0	(\$6,626,865)	0.00			
Component 2: Core Best Management Practices	\$267,603,382	\$4,181,461	(\$263,421,922)	0.02	✓	✓	✓
Component 3: Developer and Contractor Lake Protection Certification Program	\$981,191	\$0	(\$981,191)	0.00		✓✓	
Component 4: Education & Stewardship	\$9,396,880	\$0	(\$9,396,880)	0.00			✓✓
Component 5: Monitoring and Adaptive Management	\$14,992,309	\$0	(\$14,992,309)	0.00			

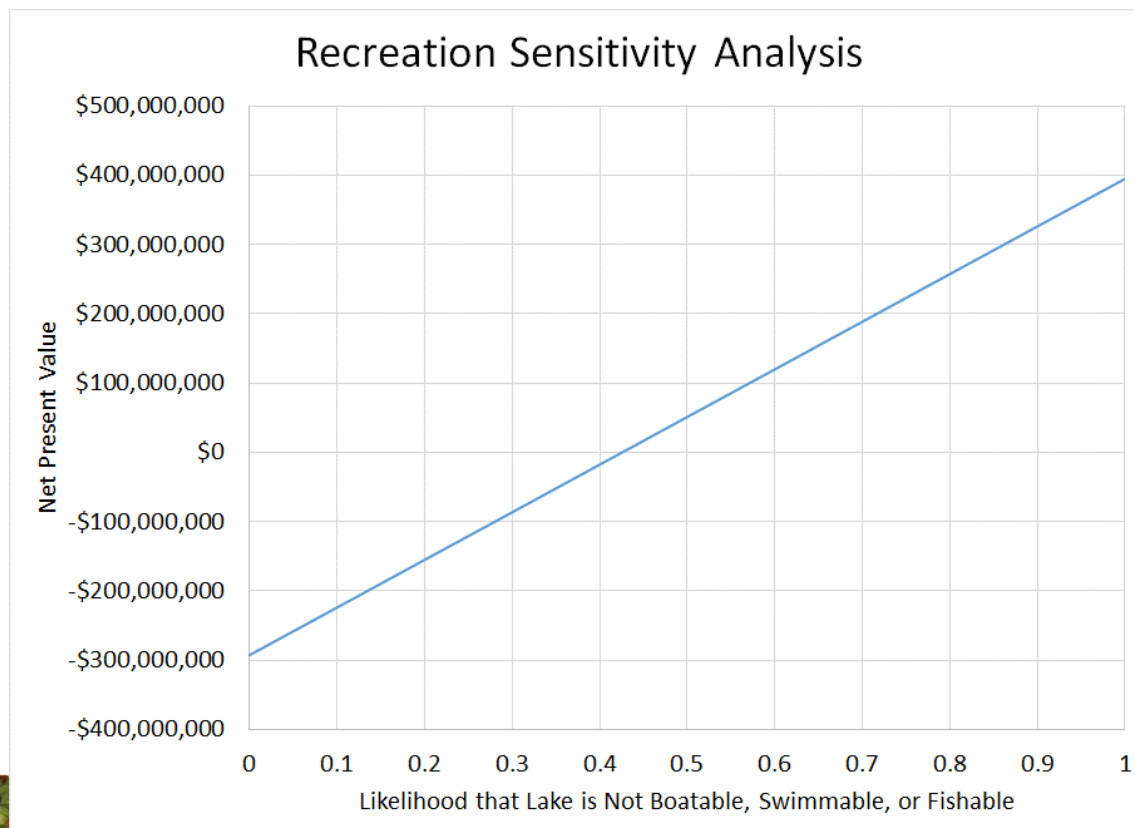
Sensitivity Analysis

- Assess the sensitivity of the analytical results to key assumptions (e.g., discount rate)
- Explore the impact of changes in the implementation schedule – accelerating or delaying implementation of the strategy



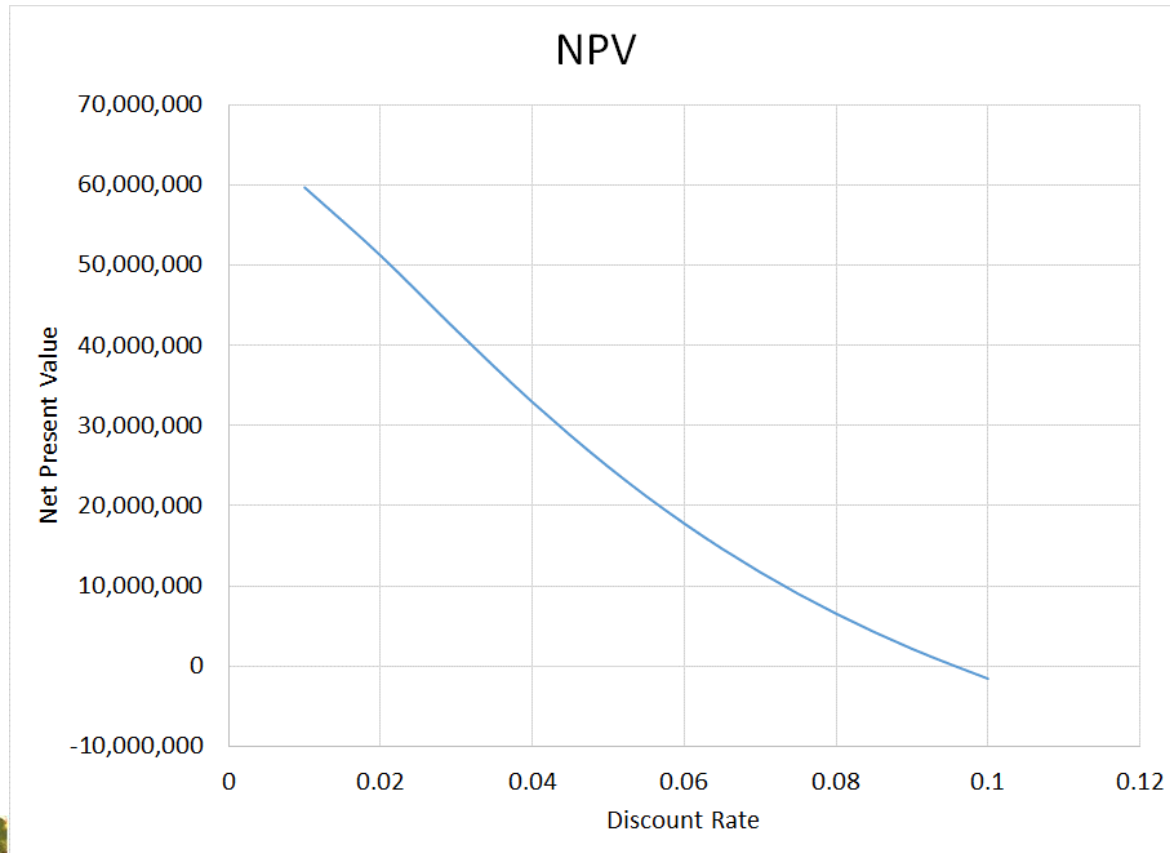
Preliminary Sensitivity Analysis

- Results highly sensitive to recreation assumptions



Preliminary Sensitivity Analysis

- Results sensitive to discount rate



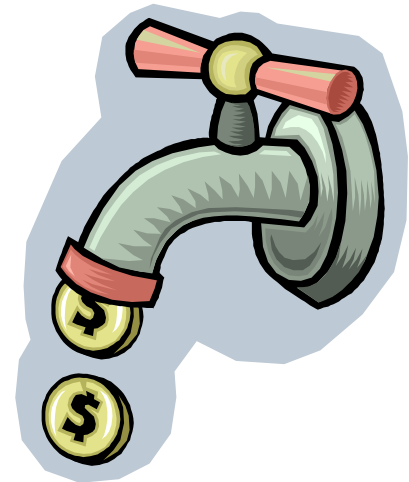
Next Steps

- Refine assumptions in triple bottom line analysis
- Conduct additional sensitivity analyses
- Develop cost-effectiveness measures
- Summarize results and estimate return on investment in Strategy



Analysis of the Ability to Leverage Funding Provided by the District

- Based on the demonstrated value of the strategy
 - Development of a value proposition to market the strategy to other stakeholders and partners



Questions?

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