The Value of Protecting Ozark Streams

An Economic Evaluation of Stream Bank Stability for Phosphorous Reduction

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10 | 8 | 2008

1.0 Introduction

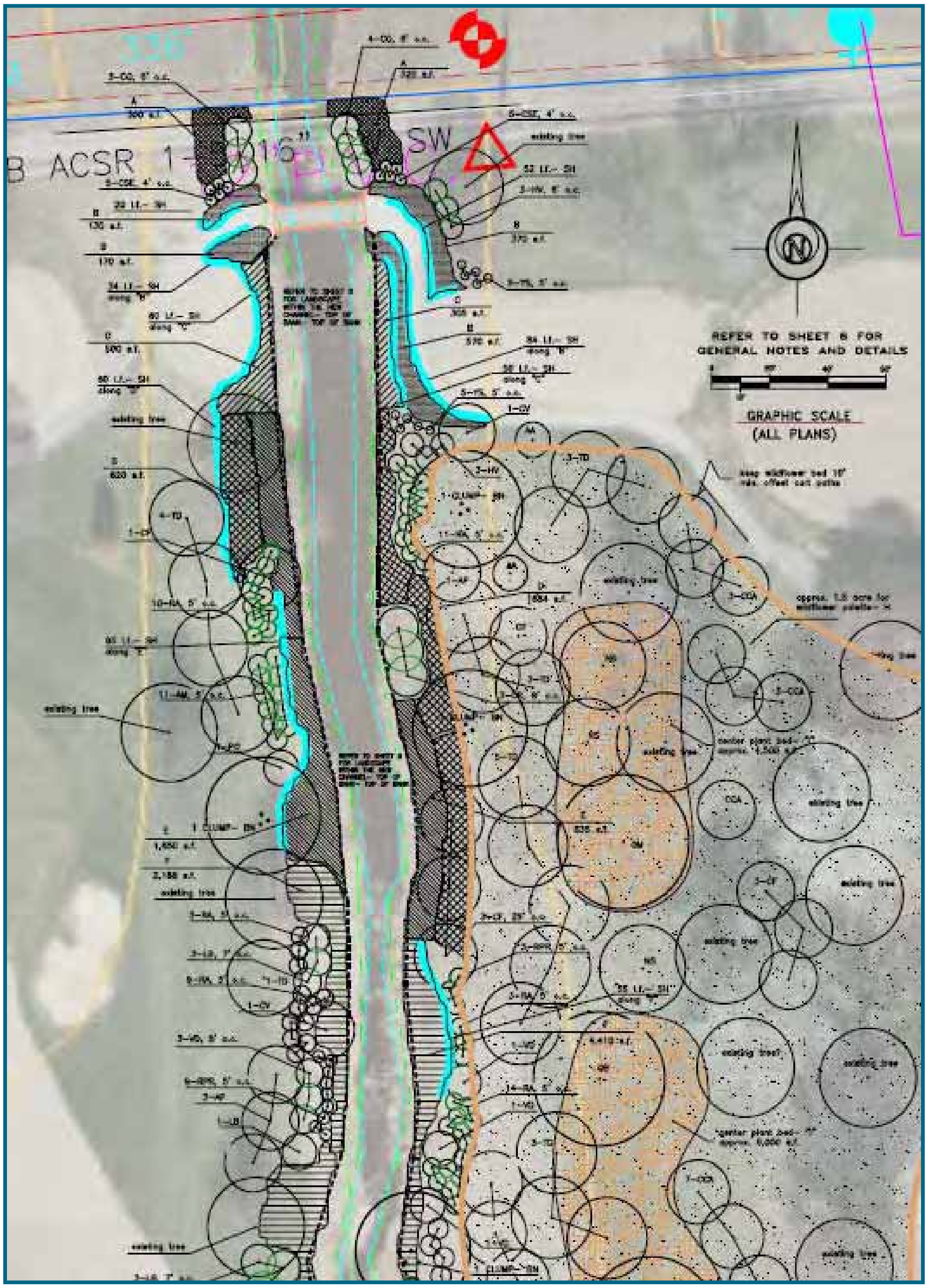
As the Ozark's see increased development, area streams are beginning to show the telltale signs of urbanization. One common impact from urbanization is accelerated stream bank erosion.

Picture 1. Bank erosion threatening an Ozark condominium building (2008 photograph by Olsson)

Stream and bank erosion liberates a tremendous amount of sediment and causes the loss of property. The City of Springfield and Greene County are making progress toward restoring degraded streams. As part of Springfield's stormwater management plan, the city began daylighting Jordan Creek. This project removes drainage tunnels and reconstructs the stream corridor. The daylighted area also features a greenway trail connecting two parks.

Picture 2. Jordan Creek Daylighting Project (Springfield MS4 Report, 2007). This entire portion was previously in an undersized box culvert. Small fish are now prevalent in the base flow stream, and the trail system is heavily used.

Greene County completed a stream restoration project in 2007, stabilizing Ward Branch using geomorphic and bioengineering approaches instead of concrete. This project was 1,289 feet long, made extensive use of native plantings, and, in the future, will incorporate a greenway trail. The cost for restoring Ward Branch was $347,000 or $269 per linear foot.



Picture 3. Map of Ward Branch restoration project. Located adjacent to Twin Oaks Country Club Golf Course in southern Springfield, the stream bank was heavily eroded and contributed to phosphorus pollution in James River.

Using Ward Branch as an example, at a cost of $269 per linear foot, is it worth stabilizing the Ozark streams? This paper presents some of the economic impacts from not stabilizing the Ozark streams. The discussion focuses mainly on phosphorus (P) impacts and costs, but some of the benefits associated with a stable greenway are also considered. Local studies and local examples are used when possible and are compared to national data.

2.0 Background

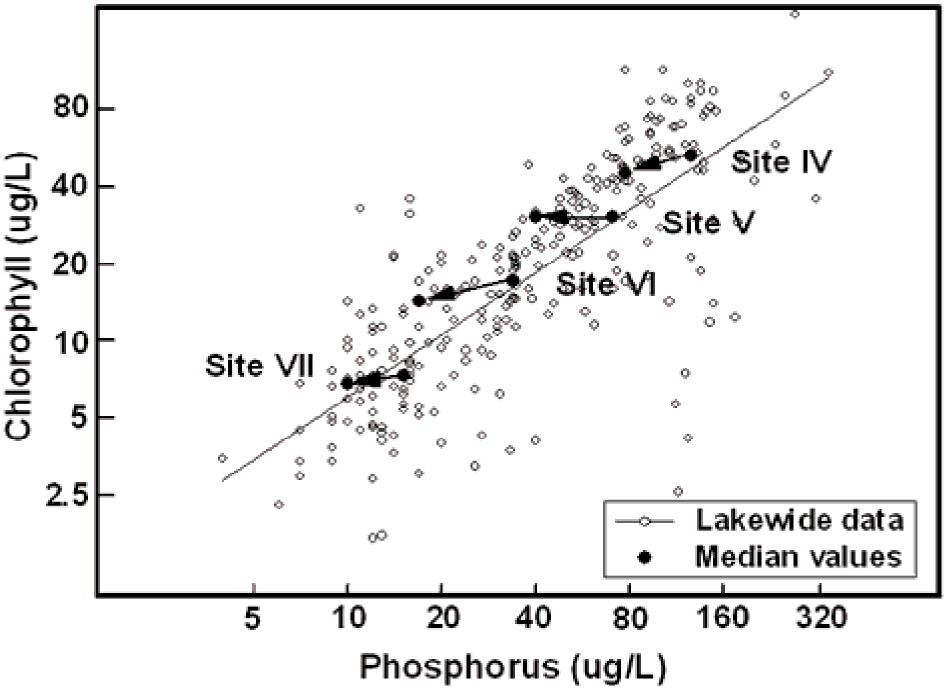
2.1 Impact of Phosphorus (P) on Water Quality

P is a particular concern because many of the Ozark's waterways and lakes are P limited (DNR 2001 TMDL). Nutrient loading analysis typically focuses on either P or nitrogen, depending on which is the limiting factor in a water body. A nitrogen to P ratio of greater than 10:1 indicates that the water body is P limited and vice versa. Stating that the nutrient is "limited" does not mean that there isn't much of it; it means that it will limit the total productivity of the water body. The following table shows published Nitrogen Limiting Thresholds taken from the DNR Total Maximum Daily Load (TMDL) for James River:

Information Source	N Limiting Threshold	Transition	P Limiting Threshold
Schanz and Juon (1983)	<10:1	10:1-20:1	>20:1
Petersen et al. (1993)			>20:1
Stockner and Shortreed (1978)			>20;1
Pringle (1987)	<10:1		
Grimm and Fisher (1986)	<10:1		
Dodds et al. (1998)	<12.6:1		
Borchardt (1996)			>17:1
Lohman (1988)	<12:1		

Table 1. Nitrogen:Phosphorus limiting thresholds

The high sediment trap efficiencies of lakes cause them to become sinks for pollutants. In addition, through sedimentation and anaerobic digestion, P can be recycled through the water column. Dissolved P is quickly utilized by algae, macrophyte, and epyphite communities for increased cellular growth. The resulting biomass shades out larger plants and benthic micro-algae or macrophytes. Picture 4 shows the relation between P and algal chlorophyll a. The implication of this relationship is that every pound of P can sustain approximately 200 lbs of biomass when all other nutrients are abundant. In comparison, one pound of nitrogen can only support 12.5 lbs of biomass (CE-QUAL, 1995).



Picture 4. Graph showing relation between chlorophyll and total phosphorus concentrations in Table Rock Lake.

2.2 Table Rock Lake Eutrophication

In the 1990s, the James River Arm of Table Rock Lake, located near Branson, Missouri, started experiencing frequent algae blooms. This high dollar tourism location was well known for its crystal clear water, and the algae blooms became a stark reminder that a lake's water quality is a reflection of its watershed and streams. In the James River Basin, tourism brings over $900 million per year to the local economies (DNR TMDL 2001). Local officials and businesses understood the potential impact of poor water quality on the local economy. This led the Table Rock Lake/Kimberling City Area Chamber of Commerce to form the corporation Table Rock Lake Water Quality, Inc. in 1998. The Chamber's board of directors recognized that improving and preserving Table Rock Lake's water quality was vitally important. They concluded that the corporation would be an action group dedicated to projects that would stop pollution resulting from non-point sources such as nutrient enrichment, bacterial contamination, and contamination from point sources. This group was instrumental in formalizing and implementing the James River TMDL.

Picture 5. Table Rock Lake (algae bloom of 1999 in the James River Arm of Table Rock Lake – Missouri DNR photo).

Water quality studies performed as far back as 1969 have indicated that high nutrient loads existed in the James River. In May of 2001, the James River TMDL of 0.075 mg/L of P and 1.5 mg/L of in-stream total nitrogen was approved. The first phase of the TMDL implementation plan focuses on point sources. A P limit of 0.5 mg/L was imposed on all point sources discharging greater than or equal to 22,500 gallons per day. A major result of this first phase was the 2001 improvement to the City of Springfield Southwest Treatment Plant to reduce average P discharge to 0.5 mg/L.

The second phase of the TMDL (Total Maximum Daily Load) focuses on non-point sources and relies on riparian corridor restoration, Best Management Practices (BMPs), septic tank cleanouts, and soil testing. The City of Springfield's Stormwater Management Plan has been put into place and has helped by upgrading/creating stormwater treatment in addition to performing full spectrum detention, acquiring floodplain areas, cleaning streets, and improving the de-icing procedures. The James River Basin Partnership and the Watershed Committee of the Ozarks have also helped by contributing volunteer time, organizing cleanups, educating the public, and managing grant funds. The following chart from the DNR's TMDL Data Sheet shows the difference in P loads before the TMDL and after the combined point and non-point source controls have been partially implemented:

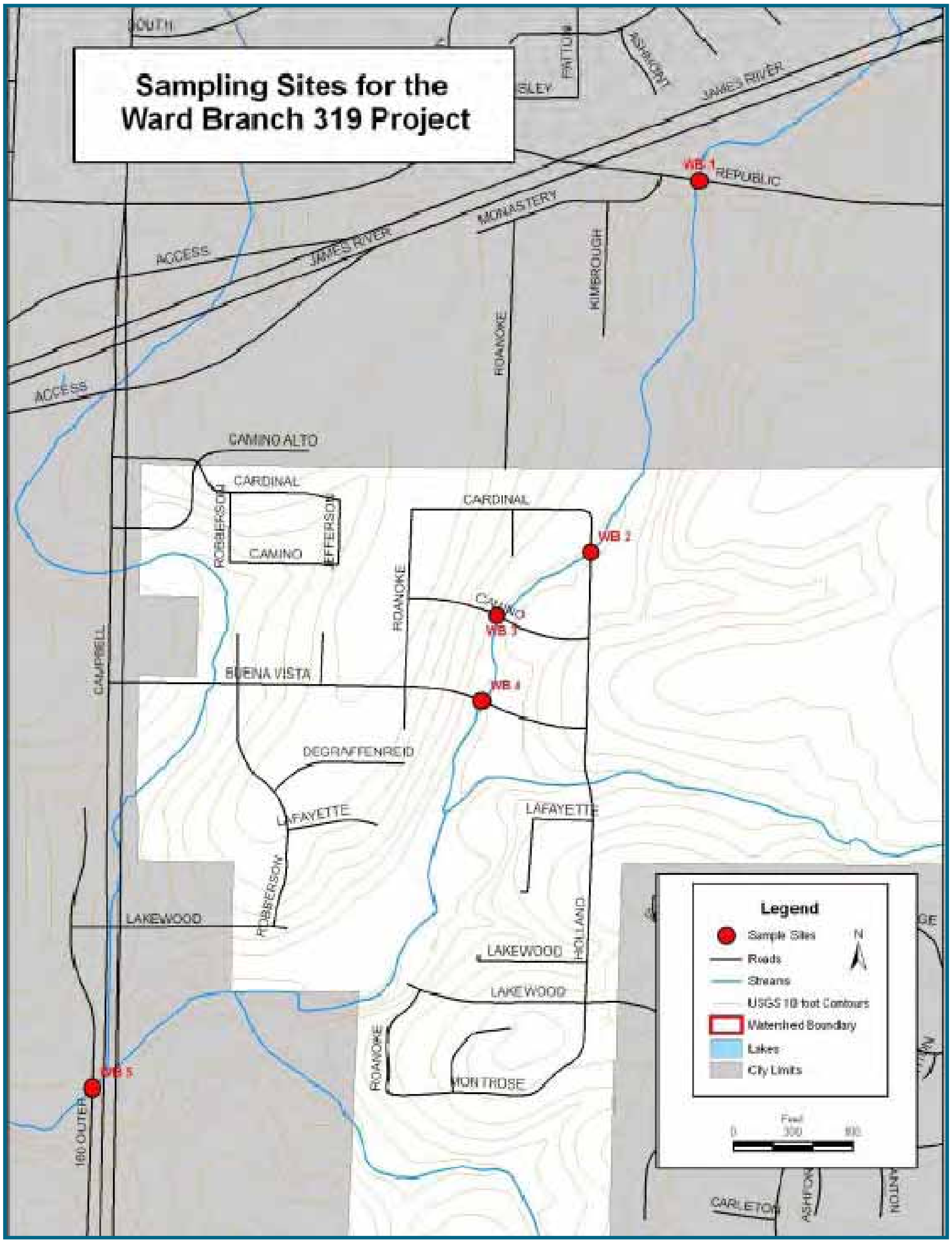
Mean Nutrient Levels for Two Locations on James River Comparing Data from 1999 to 2003 (in mg/L)				
Nutrient	**James R. near Boaz**		**James R. at Galena**	
	1999	**2003**	**1999**	**2003**
Total P	0.62	0.15	0.51	0.21

Table 2. James River TMDL

The dramatic reduction in P is notable but is largely a result of improvements at the wastewater treatment plant. Non-point sources of P, however, are much more elusive to treat. According to the TMDL for the James River Basin, 0.033 to 0.06 tons/acre/year of sediment is released from stream bank erosion. The amounts of sediment that can be liberated from modest reaches of streams are extensive. The rate of erosion found at Ward Branch produced 77 tons of soil liberated in eight months from only a 1,000-foot long stretch (OEWRI, 2007).

2.3 Phosphorus (P) Loaded Stream Banks

Fine-grain sediment in alluvial deposited stream banks is laden with nutrients such as P. This is not a surprise; the agricultural community has long valued the highly productive floodplain bottoms. Research performed by Iowa State University (Moeller, Kovar, Russell, and Haan, 2006) has found that total P concentrations of 200-to-500 mg/kg were common in grazing land in Colorado. Soil testing performed by Missouri State University on Ward Branch Stream in Green County, Missouri, has found a similar range of total P. The average P found in the stream banks was 400 mg/kg (0.035 lbs of P per cubic foot of bank material). This implies that even minor amounts of stream bank erosion have a large potential to release P into the stream and ultimately into sensitive water bodies such as Table Rock Lake.



Picture 6. Sampling sites for Ward Branch (OEWRI, 2007)

Using the averages mentioned above for the Ward Branch Study, it was estimated that erosion would liberate 93 lbs of P per 1,000 feet of channel per year. Testing found that the total P load in the stream was 175 lbs/year, so this bank alone contributed 53 percent of the P load in the stream.

The Ward Branch findings on the volume of sediment generated from stream banks are not the only such findings. Based on reservoir water quality studies performed by Olsson Associates in Nebraska, 20-to30 percent of sediment and nutrients are from stream bank erosion (Cunningham, 2003). Studies on San Diego Creek in suburban Los Angeles found that over 60 percent of the sediment resulted from channel erosion (Trimble, 1997). Likewise, a study on Goodwin Creek in northern Mississippi found that better than 80 percent of the total sediment yield originated as channel and gully erosion (Grissinger, 1990). A study of a channelized stream in Illinois found that one storm eroded as much as 1,150 tons of soil from a single bank in 1982 (Roseboom and Russell, 1985). The amounts of sediment liberated from stream banks can be greatly increased as a result of channelization, urbanization, and widespread stream instabilities such as incision (head cuts).

A link exists between the riparian buffers and stream bank stabilization. A study of 748 stream bends found that 67 percent of bends without vegetation suffered erosion during a storm, while only 14 percent of bends with vegetation were eroded (Beeson and Doyle 1995). Keep in mind, the bank erosion potentially could have removed the vegetation rather than the de-nuded banks causing the erosion. Nevertheless, this 1995 study makes it clear that bends void of vegetation are 30 times more likely to erode.

Studies have shown that P removal has been measured along a healthy stream segment (Watson, 2001). Unhealthy or deforested riparian areas cause channel narrowing, which reduces the total amount of stream habitat and ecosystem per-unit channel length and compromises in-stream processing of pollutants (Sweeny, et al., 2004). Sweeny has suggested, "Forested stream channels have a wider and more natural configuration, which significantly affects the total in-stream amount and activity of the ecosystem, including the processing of pollutants. Riparian corridors and grass filter strips work together to cause sedimentation of clay particles containing phosphorus and to slow the water as it enters the stream. The woody vegetation further assists in stream bank stabilization. These results reinforce current policies used in the U.S. to incentivize riparian buffers as BMPs resulting in re-forestation for stream restoration and water-quality." A forest and grass buffer combination not only reduces non-point source pollutants from entering streams; they also enhance the in-stream processing of both non-point and point source pollutants, thereby reducing their impact on downstream rivers and impoundments (Welsch, 1991, Lowrance, 1997). This in-stream P processing further improves the cost efficiency for stream restoration.

2.4 Other Non-Point Sources of Phosphorus (P)

The point source wastewater treatment plants are only one of the many sources of P to our streams. Urban runoff contains a considerable amount of non-point P. Table 3 breaks down sources of P pollution from an area in Marquette, Michigan (Steuer, Selbig, Hornewer, and Prey, 1997). The table also summarizes event mean concentrations in runoff from residential and commercial areas completed by the Watershed Committee of the Ozarks on Pierson Creek. Pierson Creek is located along the eastern edge of Springfield, Missouri. The 1994 Pierson Creek study sampled runoff downstream from a general residential or commercial area, so the land use was not itemized as discreetly as the Michigan study.

Source Area Sampled	Michigan Study Total P (mg/l)	Pierson Creek Study Total P (mg/l)	NURP Data (mg/l)
Commercial Parking Lot	0.2	0.281	0.201
High Traffic Street	0.31	-	
Medium Traffic Street	0.23	-	
Low Traffic Street	0.14	-	
Commercial Rooftop	0.09	-	
Residential Rooftop	0.06	0.40	0.383
Residential Driveway	0.35		
Residential Lawns	2.33		
Basin Outfall	0.29		

Table 3. Sources of phosphorus in urban areas from various data sources.

Based on the MS4 monitoring being performed by the City of Springfield in areas of the community that do not have water quality stormwater treatment, total P concentrations range from 0.05 mg/L to 0.8 mg/L, with an average of 0.26 mg/L, which compares favorably to the Michigan study. The Michigan study and the Nationwide Urban Runoff Program (NURP) data have focused on these urban sources, but many of these studies neglect stream bank erosion sources of P.

The City of Springfield has begun a notable stormwater treatment program for all new developments over one acre in size. The water quality storm of one inch must be treated using systems such as rain gardens, bioswales, extended detention, filter strips, porous concrete, and several other mechanisms to decrease the water quality impairments to our streams. Watershed groups in the area are working hard to reduce the amount of P and other stormwater pollutants from entering streams. The James River Basin Partnership sponsored the 2006 James River Watershed 319 Project. This $3.1 million project created a variety of BMPs, including riparian corridor restoration, septic tank cleanout, urban and agricultural soil testing, and educational/outreach programs. The Watershed Committee of the Ozarks is currently working with the City of Springfield to install storm water education signage at key locations around the city. In addition, the Watershed Center at Valley Water Mill is being developed as an educational showpiece for a variety of water quality BMPs.

3.0 Phosphorus (P) Removal Costs

The impacts of hyper utrophic conditions caused by excess P are well documented, but what about the costs to remove P from Ozark waterways? P enters our water from both point and non-point sources. This section will discuss an Ozark's example on the costs of P removal from a point source and will also discuss the costs of non-point source P removal using stormwater BMPs.

3.1 Point Source Phosphorus (P) Removal Costs

Point source pollution can contribute a high percentage of P to our water, but our research indicates it is much cheaper to reduce the amount of P being discharged from point sources than non-point sources. In response to the imposed TMDL on James River and the algae blooms on Table Rock Lake, the Springfield Southwest Treatment Plant performed treatment upgrades to decrease P discharges into the James River. The upgrade began in 1997 and was completed March of 2001. The project cost was $2.2 million and involved installing an alum treatment system. The most recent project followed a 1993 project, which also reduced the discharge concentrations of P.

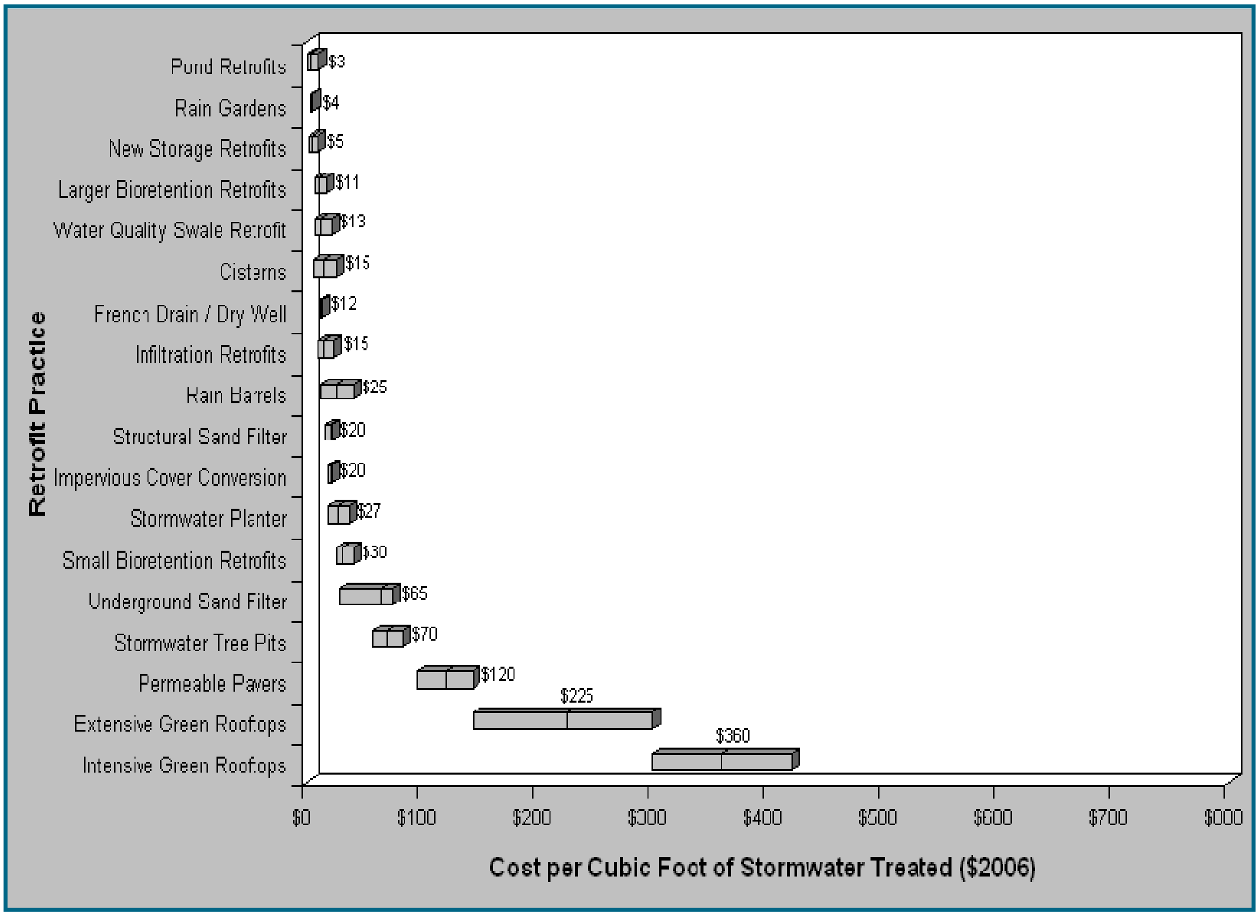
Southwest Treatment Plant Upgrade	Completion Date	Cost	Post-Upgrade Avg. Lbs of P to Creek	Prior Avg. Lbs of P to Creek
Plant Expansion	1993	$30 million	850 lbs/day	1,650 lbs/day
Alum Treatment	2001	$2.2 million	110 lbs/day	850 lbs/day

Table 4. Wastewater treatment plant upgrades and the associated pre and post total phosphorus discharges to Wilson Creek.

Including the operation and maintenance cost of the alum system, the cost for P removal at the treatment plant, due to the 2001 upgrade, resulted in approximately $4.60 per pound of P removed per year, assuming a 50-year life cycle and including an estimated O&M cost of 54 percent of construction.

3.2 Non-Point Source Stormwater BMP Phosphorus (P) Removal Costs

Olsson Associates and Wright Water Engineers recently completed a stormwater BMP retrofit cost analysis study for Overland Park, Kansas. We specifically evaluated the costs associated with constructing and maintaining various non-point source pollution treatment methods. The cost for these systems varied but is generally summarized in Picture 7.



Picture 7. Graph of BMP Cost (Olsson, 2007)

Based on the monitoring being performed by the City of Springfield in areas of the community that do not have water quality stormwater treatment, total P concentrations range from 0.05 mg/L to 0.8 mg/L, with an average of 0.26 mg/L (City of Springfield, 2007). Mean average cost was used from the graph above for a BMP of $10 per cubic foot for a 50-acre development site, which gives a total BMP cost of $1.12 million (including 4.5 percent operation and maintenance costs). BMPs all have varying percent removal rates for P, which range from zero percent for green roofs, 15 percent for grass channels, and up to 75 percent removal for wetlands (EPA, 1999). We should note that an increasing amount of data has been suggesting the removal efficiency of BMPs that may not be the most appropriate measure used in designing these systems due to the variability of inflow concentrations and a practical lower limit of removal. For simplicity, we are using a 40 percent removal rate for an average inflow concentration of 0.26 mg/L P. Using these inflow and removal rates, the BMPs would cost $466 per pound of P removed per year (EPA, 1999). Some agricultural BMPs are cheaper, such as terracing. These BMPs result in average costs of $185 per pound of P removed per year (Tippett, 1995).

3.3 Cost of Stream Stabilization Using Geomorphic and Bioengineering Approaches

National data indicates a wide range in costs for stream stabilization, from $42 per linear foot to as much as $1,000 per linear foot (especially for daylighting culverts). Projects performed by Olsson Associates in Nebraska, Kansas, and Missouri have found a range of costs from $260 per linear foot to $350 per linear foot. The Ward Branch stabilization in Greene County resulted in a cost of $269 per linear foot. Assuming a 4.5 percent operation and maintenance cost, the total cost for 1,000 feet of stream would be $874,250. In 1,000 feet of stream channel on Ward Branch, MSU measured 93 lbs of total P being exported per year from bank erosion. For Ward Branch, the cost in terms of the amount of total P prevented was $188 per pound annually for a 50-year life cycle.

It should be pointed out that these approaches do not completely eliminate stream bank erosion. Natural systems in dynamic equilibrium will migrate over time, and sediment will be liberated and subsequently deposited so that the net transport out of the system balances with the net sediment inflow rate.

Picture 8. Before and after stream restoration done by Newbury Hydraulics – Waukegan Brook – Washington Park, Michigan: 1991 before restoration (left), and three years post-construction in 1995 (right).

One approach historically taken to reduce stream bank erosion is to concrete line or enclose the stream. This approach is quite expensive and also reduces environmental benefits. Using lower Ward Branch as an example, the upstream culvert is a 10-by-12-foot concrete box culvert. Assuming this culvert was extended with the same size structure, it would result in a construction cost of nearly $1.6 million ($1,580 per linear foot) for the culvert and fill necessary to the cover 1,000 feet of conduit. This cost does not include permitting costs and downstream erosion protection. This cost is over five times more costly than the natural stream design.

3.4 Stream Buffers

To arrive at a unit cost basis, several design parameters were applied. Using a 100-foot wide buffer with woody vegetation for the first 50 feet next to the stream and a 50 grass filter outside the woody area yielded a 50 percent removal efficiency using a relatively flat slope of 1-to-5 percent (Wenger 1999). A flow through velocity of 0.5 fps with a design depth of 1-inch deep during the two year storm was used to establish the number of acres a unit width of buffer could treat (Harner et al 2000). Combined with an assumed predominantly residential land use, the buffer could treat 0.0148 drainage area acres per foot of width. Installation bid tabulations from the Jordan Creek daylighting project in Springfield and projects in Christian County, Missouri, were reviewed, and, based on these local Ozark projects, an average installation cost of $15,000 was estimated. The installation cost includes three-to-five gallon trees, shrubs, native grass seeding, erosion control, and grading to ensure sheet flow through the buffer. Maintenance costs are estimated to be similar to stormwater BMPs at 4.5 percent of construction. The sediment accumulated in buffers must be removed to maintain the buffer treatment efficiency (Daniel and Moore, 1997). An assumed 10 year cleanout of the accumulated sediment in the grass area, followed by reseeding, was assumed at a 10 year interval over the 50 year design life. These calculations indicate that a 100-foot wide grass and tree buffer would cost approximately $20 per linear foot to install and an additional $140 per linear foot to maintain for a 50 year period. The amount of phosphorus removed during the 50 year design life was estimated at 0.58 lbs per foot of buffer. The cost efficiency is calculated at $278 per pound of phosphorous removed.

4.0 Cost Efficiency Comparison

We have presented some of the costs associated with removing P from the water column once it has been liberated and also the costs associated with stabilization measures taken to prevent the P from being eroded from the stream banks. Is an ounce of prevention worth a pound of cure? The following table summarizes the results:

P Removal Method	Data Source	Cost per Pound Removed Annually
Wastewater Treatment Plant	Springfield WWTP Upgrades, EPA Guidance Documents	$4.60
Stormwater BMPs	EPA 1999 Study	$698 to $1,535
	Olsson 2006 Study	$466
Stream Restoration	Ward Branch and Other Restoration Plans in Nebraska, Kansas, and Missouri	$188
Stream Buffers	Jordan Creek, Springfield Christian County, Missouri	$278

Table 5. Phosphorus removal cost comparisons

Point source reductions stood out as the most effective method to reduce P entering the James River. Of the three non-point source methods reviewed, the data indicates that performing stream stabilization projects is a cost-efficient method to reduce the amount of P in our streams and lakes. Stream bank stabilization projects should be an integral portion of a watershed plan and a TMDL implementation strategy. However, if full-spectrum detention and adequate stream buffers are in place, the stabilization projects may not be needed, and the phosphorus processing of the healthy corridor is, in essence, "free" treatment. The associated prevention of stream instabilities offers an even more attractive economic proposal, as do the added benefits of healthy streams and the ensuing recreational opportunities.

5.0 Other Economic Benefits of Stream Restoration and Greenways Trails

The prior discussion was limited to quantifiable dollars spent to prevent P from reaching critical areas. As the Ozarks continue to see urban development, increasing pressures will encourage us to encroach on our streams. Riparian areas are dynamic and provide many functional benefits to the stream ecosystem. Effective riparian management could ameliorate many ecological issues related to land use and environmental quality. Riparian corridors should play an essential role in conducting water and landscape planning, in the restoration of aquatic systems, and in catalyzing institutional and societal cooperation for these efforts (Nainmen et al 1993). Riparian zones need to be viewed as an active river area framework, which includes a spatially explicit, holistic view of rivers that comprises both the channels and the riparian lands necessary to accommodate the physical and ecological processes associated with the river system. The framework informs river conservation by providing an approach to account for the areas and processes that form, change, and maintain a wide array of habitat types and conditions in and along rivers and streams.

By leaving a buffer around streams during construction, developers realize not only immediate cost savings, but also the possibility of gaining long-term value to the property. The developer realizes an economic advantage for keeping the stream open and employing an adequate stream buffer, full-spectrum detention, and erosion control during construction and stormwater quality treatment.

The National Park Service has well-documented studies on the economic value of greenways (NPS, 1995). Greenways that border streams offer many benefits, one of which is a marked increase in home values. In a subdivision in Springfield, the assessed valuations of the homes that back to the South Creek greenway is 15 percent higher than comparable homes in the remainder of the subdivision. In Boulder, Colorado, a study of property values found that homes next to a greenway had 32 percent higher property values than homes 3,200 feet away. In Apex, North Carolina, developers of the Shepherd's Vineyard subdivision found that they could charge $5,000 more for a home adjacent to a greenway. In Brown County, Wisconsin, homes along the Mountain Bay Trail sold for nine percent more than similar property not adjacent to a trail. Assuming an average lot width of 120 feet, an average lot value of $35,000, and residential houses backing to both sides of the stream, the benefit is approximately $87 per linear foot of stream. In a 2002 survey of recent homebuyers sponsored by the National Association of Realtors, trails ranked as the second most important community amenity out of a list of 18 choices. The increase in home values also leads to increased property tax revenue. In Boulder, Colorado, a study of one subdivision revealed that the greenway increased the aggregate property value by $5.4 million. This resulted in $500,000 more in potential property tax revenue, which could pay for the $1.5 million greenway in three years.

Greenway trails also decrease the amount of pollution reaching our streams by serving as alternative modes of transportation. Studies have shown that two-thirds of the trips that people living in urban areas make are less than five miles in distance. Using the trails for walking and biking has also been shown to decrease public health costs $3 for every $1 spent on trail development (Wang, Macera, Scudder-Soucie, Schmid, Pratt, and Buchner, 2005).

Greenway trails can be incorporated as floodplain acquisitions. FEMA estimates that flooding causes over $1 billion in damages every year, and approximately 10 million homes are currently located in floodplains. After flooding in Tulsa, Oklahoma, the city designed a greenway along Mingo Creek that included woods, wetlands, and parks to enhance the floodplain. As a result, flood insurance rates in Tulsa dropped 25 percent. The Minnesota DNR found that the average value of one acre-foot of flood storage is $300. Therefore, if one acre-foot of floodplain or wetland is developed, it would cost the public $300 to replace the water storage. Preserving and maintaining an “active river area” provides for future economic return while at the same time preventing future costly restoration or remediation projects.

Streams, trails, and lakes also bring tourism dollars to communities. In the James River Basin, tourism brings over $900 million per year to the local economies (DNR TMDL 2001). The recreational benefits of trails, healthy streams, and lakes can be quantified using the “willingness-to-pay” system (National Parks Service, 1995). These values (converted to 2008 dollars) show what the average person would be willing to pay to have certain activities available to them per person, per day.

Average Willingness to Pay by Activity	
Activity	**Average Value per Activity Day**
Picnicking	$25
Hiking	$40
Non-motorized Boating	$68
Warm Water Fishing	$41
Non-consumptive Wildlife	$28

Table 6. Willingness to Pay

6.0 Conclusion

This study has shown that stream restoration can be one of the most cost-effective methods of preventing phosphorus from entering lakes. BMPs are more expensive, though necessary, because not only do they treat a myriad of pollutants, including phosphorus, they also decrease the rate of runoff, thereby preventing some erosion. The calculations in this study show that phosphorus emissions from point sources such as treatment plants are the least-costly to reduce. However, as the James River TMDL states, non-point source pollution needs to be addressed in conjunction with point source pollution to decrease the amount of nutrient loading in our lakes.

Our streams and lakes are very valuable resources. What would happen today if the entire Table Rock Lake was affected the way the James River arm was affected by the algae blooms of 1998? As recent as the spring and summer seasons of 2008, visitation to Table Rock Lake decreased dramatically due to two factors: 1) lake levels remaining at or near record flood stages for several weeks due to large amounts of rainfall, and 2) public perception and fear that the lake was contaminated and unsafe to swim or boat in (Table Rock Lake Water Quality). As a result, local business owners realized decreased revenues. This recent event emphasizes the impacts impaired water quality has to local economies. Considering alone the amount of P that is released by eroding stream banks, compared to the cost of removing P by other non-point source removal methods, it is obvious that our streams need to be protected. The economic benefits of having healthy streams and lakes equate to millions of dollars per year in tourism, health care benefits, and home values. Protecting streams in urban settings generates approximately $250 worth of increased land value per linear foot and results in one of the least costly methods of reducing non-point source P. Protecting Ozark Streams is a necessary investment into the sustainability of the environment and the future economic viability of the region.

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