HEALTHY RIVERS AND STREAMS
CITIZENS ADVISORY BOARD
Church at Redstone
Redstone, CO
April 19, 2012 - 4 p.m.

4:00	**Public Comment**	
4:05	**Board Comment**	
4:15	**Approval of Minutes** February 16, 2012 meeting	
4:20	**Financial Assistance for Onsite Wastewater Treatment System Replacement**	Carla Ostberg – Pit Co Env Health Dept
	Update of Watershed Plan and Water Conservation Report **Update on Watershed Plan Brand** **Update Coal Basin Restoration** **Discussion of Water Conservation Campaign**	Sharon Clarke - Roaring Fork Conservancy
	New Watershed Gauging Project	Tim Flynn Chelsea Congdon Brundige
	Request for Proposals on study describing the relation of the real estate market in Pitkin County to the Roaring Fork River	Virginia Newton
	City of Aspen's Storm Water Program	April Long City of Aspen Storm Water Manger

Upcoming 2012 regular meeting dates
May 17
June 21
July 19

HEALTHY RIVERS AND STREAMS CITIZENS ADVISORY BOARD
Meeting Minutes
February 16, 2012
Aspen, CO

Board members present: Ruthie Brown, Greg Poschman, Lisa Tasker, Bill Jochems, and Steve Hunter

Board members absent: Rick Neiley and Andre Wille

Others present: John Ely, Lisa MacDonald, Tim Flynn, Greg Espegren and Lee Rozaklis

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Public Comment – None

Board Comment - None

Approval of Minutes
Ms. Tasker moved to approve the minutes of January 19, 2012. Mr. Hunter seconded the motion. The motion passed 5 to 0.

Pitkin County Stream Health Methodology Greg Espegren, Aquatic Specialist and Lee Rozaklis, Hydrologist AMEC Environment and Infrastructure
Mr. Espegren and Mr. Rozaklis presented the Board with the results of their methodology study. Discussions ensued and several members of the public participated as well.

Executive Session
Ms. Brown moved to enter into executive session pursuant to C.R.S. § 24-6-402 (4)(b) for the purpose of discussing the Aspen Hydro Project and discussion of drought relief from instream flows. Ms. Tasker seconded the motion. Motion passed 5 to 0.

CORE Letter of Support re: CORE's Water Conservation Education and Outreach Grant Request to the Colorado Water Conservation Board
The Board received a request for a letter of support from the Community Office for Resource Efficiency (CORE) to the Colorado Water Conservation Board for a water conservation education and outreach grant request.
Mr. Hunter moved to approve the letter of support to CORE. Mr. Jochems seconded the motion. The motion passed 5 to 0.

Adjourn
The meeting adjourned at approximately at 6:45 pm.

Approved: **Attest:**

Greg Poschman – Chairman
Healthy Rivers and Streams Board

Lisa MacDonald

AGENDA ITEM SUMMARY

April 19, 2012

TO: River Board

FROM: Carla Ostberg, Pitkin County Environmental Health Department

SUBJECT: Financial Assistance for Onsite Wastewater Treatment System (OWTS) Replacement

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Introduction: This summary is intended to generally inform the Board of the effect of failing OWTSs, commonly referred to as septic systems, on the environment and public health, as well as to alert the Board of a current situation having the potential to negatively impact the environment and public health in the Capitol Creek drainage.

"Wastewater", also known as sewage, is defined in the Pitkin County OWTS Regulation as a combination of liquid wastes that may include chemicals, household wastes, human excreta, animal excreta, other animal or vegetable matter in suspension or solution, and that is discharged from any building, dwelling, or other establishment.

Pitkin County has approximately 3000 parcels that fall outside of a sanitation district, relying on OWTSs to treat their wastewater. Malfunctioning OWTSs contribute to non-point source pollution and negatively impact water quality. Non-point source pollution differs from point source pollution in that the pollution is not coming from a single source, such as a factory. Non-point source pollution comes from the cumulative effect of day to day activities including road maintenance, fertilizer application, and use of OWTSs. The impact of non-point source pollution is often difficult quantify in the same way pollution from a point source can be identified and measured.

In the last several years, the Pitkin County Environmental Health Department has seen an increase in OWTS permits issued to address failures. Aging systems, improper maintenance, and increased water use are all factors that are likely contributing to OWTS failure rates in Pitkin County. However, failing OWTSs are not just a problem in Pitkin County. Nationwide, contamination from septic systems and sewage overflows is an issue of great concern.

American Rivers, an organization founded in 1973 to protect and restore the nation's rivers and streams, posts the following information regarding the implications of sewage contamination on the environment and public health:

> "Sewage pollutes our waters with pathogens, excess nutrients, heavy metals, and other toxins. It kills aquatic life and creates algal blooms that can suffocate fisheries.
>
> Even worse, sewage carries pathogens that can end up in our drinking water supplies and swimming areas. These disease-causing microorganisms cause diarrhea, vomiting, respiratory, and other infections, hepatitis, dysentery, and other diseases. Common illnesses

caused by swimming in and drinking untreated or partially treated sewage include gastroenteritis, but sewage is also linked to long term, chronic illnesses such as cancer, heart disease, and arthritis." (www.americanrivers.org)

In February, I was contacted by the owners of a residence located at 7030 E. Sopris Creek Road. The OWTS serving the residence on the property, permitted and installed in 1999, had failed and wastewater was coming to the ground surface. Capitol Creek is located approximately 125 feet downhill from the lowest portion of the failed absorption area. There are also several private drinking water wells in close proximity to the OWTS.

The cause of the failure is difficult to pinpoint as the system is relatively new, water use is conservative, and maintenance of the system has been consistent; however, the receiving soils are clay, meaning that it takes longer for any water or wastewater introduced to the soil to absorb. The owners immediately addressed the problem by replacing the failed system with appropriate technologies for the site and soil conditions.

I understand that maintaining and improving water quality and quantity within the Roaring Fork watershed is one of several objectives of the Healthy Rivers and Streams fund was established to attain. I believe that providing loans to homeowners needing to replace and repair malfunctioning OWTSs aligns well with that objective. There are a number of other states and counties that have established loan programs specifically to address OWTS repair and replacement. A loan program of this type would benefit Pitkin County residents while facilitating greater protection of our water resources.

Project Cost: $25,000

Requested Board Action: Approve funding a loan, based on the County Attorney's approval of the loan agreement, for the property owners of 7030 E. Sopris Creek Road to offset the cost of replacing the OWTS serving this residence.

Attachments: Exhibit A: Google Earth location of property
Exhibit B: Photographs of failure after excavation

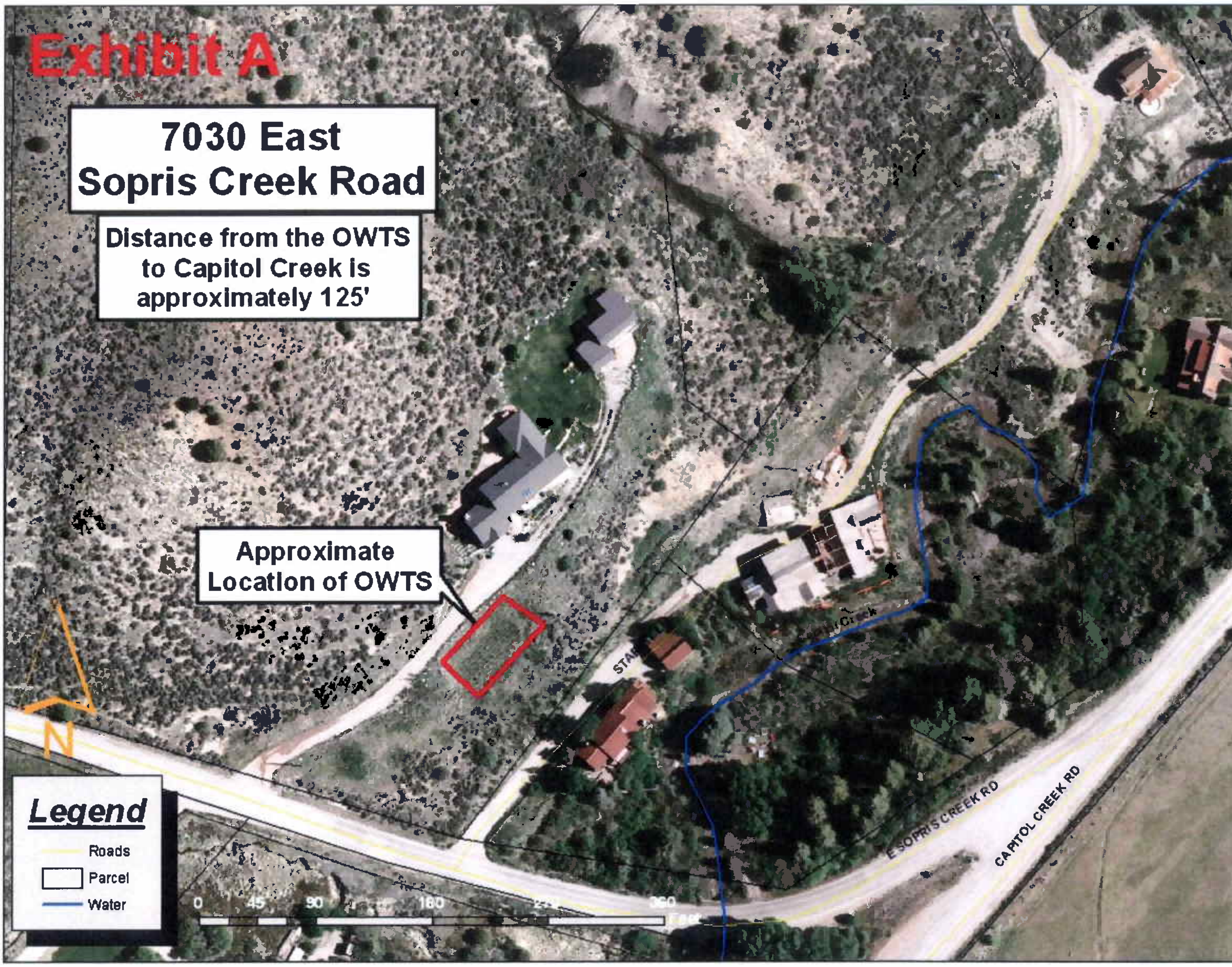
Exhibit A
7030 East
Sopris Creek Road
Distance from the OWTS
to Capitol Creek is
approximately 125'
Approximate
Location of OWTS
N
Legend
Roads
Parcel
Water
0
45
90
180
270
360
Feet
E SOPRIS CREEK RD
CAPITOL CREEK RD

Exhibit B

This photograph shows excavation of the existing absorption of the subject property. The house shown is located on an adjacent property. Capitol Creek run behind the house shown here, approximately 125’ from the failed absorption area.

This photograph illustrates the saturated absorption area, no longer accepting the effluent, or wastewater, causing it to surface. In this case, effluent first surfaced on the downhill side of the absorption area, toward the neighboring house, pictured above, and Capitol Creek.

To: Pitkin County Rivers Board

From: Mark Fuller, Ruedi Water and Power Authority and Sharon Clarke, Roaring Fork Conservancy

Date: April 12, 2012

The April 12 meeting of the Roaring Fork Watershed Collaborative featured the formal unveiling of the Roaring Fork Watershed Plan, the Water Conservation Report, and a Watershed Plan Brand. Pitkin County Rivers Board contributed to both the Plan and Water Conservation Report. On April 19th we want to thank you for your support, present an overview of the documents, and provide an opportunity for you to ask questions. Both of these documents are attached and can be found at www.roaringfork.org/watershedplan.

The Plan is the culmination of a five-year process that began with the compilation of the Roaring Fork State of the Watershed Report in 2008 and included the development of several supplementary documents, including two Phase II Guidance Documents, an Implementation Guide, a Front-Range Water Supply Update and the Water Conservation Report. The Plan is the product of dozens of meetings and the efforts of hundreds of local citizens and government and agency representatives who worked together to develop the Plan through a series of public meetings and workshops. The Ruedi Water and Power Authority is the sponsor of the Plan; Roaring Fork Conservancy, the lead consultant; and Rose Ann Sullivan, Kootenay Resources, LLC assisted with work on all aspects of the Plan.

The Plan contains over 200 recommendations for managing the watershed in the future. The recommendations are sortable by topic, by geographic area, and by responsible parties. The Plan is subdivided into five major topic areas. These include Groundwater, Surface Water, Riparian and Instream Habitat, Regional Water Management, and Water Quality. The recommendations are further subdivided into projects, legislation and regulation, and studies and range from specific and urgent (i.e. Plan and Implement Key Riparian Restoration and Protection Projects) to more general and long-term (i.e. Review and Revise Master Plans to Address the Impacts of Climate Change). The Plan's recommendations are intended to provide a guide and a series of goals for local governments, water management agencies, land managers and non-governmental organizations that can be implemented as opportunities arise.

This is a comprehensive and holistic document that should help everyone involved in water, from large government agencies to individual users, to address the needs of the watershed in a systematic way. We recognize that implementation of this Plan will be an incremental process and RWAPA and the Roaring Fork Conservancy are committed to fostering that implementation. In the future, we will be working to identify appropriate projects, sources of funding, partnerships and government support as opportunities arise.

The Watershed Plan was funded by contributions from local governments and two $40,000 grants from the Colorado Water Conservation Board. The total cost of the Planning Process, including the State of the Watershed Report and the supplemental documents, was around $250,000. The Plan has been presented in draft form to the City and County governing boards in the Valley as well as the Colorado Division of Parks and Wildlife and several local Water and Sanitation District Boards.

The Authority and the Conservancy, with the help of the Schwener Design Group, also completed a process to identify a "brand" for the Roaring Fork Watershed Plan. The purpose of branding is to build awareness by giving the Watershed Plan its own graphic identity that can be used on everything from letterhead to project signage. This brand will allow us to label implementation actions as Watershed Plan projects and not solely as projects of the Roaring Fork Conservancy, the Ruedi Water and Power Authority, or other agencies. Putting a "face" on the Plan will provide a recognizable symbol and an image that can be the focus of activities ranging from political action to fundraising to communications.

The Water Conservation Report entitled *Opportunities for Water Conservation: Realizing the Streamflow Benefits from Local Water Conservation Efforts* was completed by G. Moss Driscoll, Elk Mountain Consulting. The report investigates the potential strategies for employing water conservation to benefit streamflows and offers ten recommendations for a Water Conservation Campaign in the Roaring Fork Watershed. The research and recommendations presented in this report arose from the desire among local interests in the Roaring Fork Watershed to understand how water conservation efforts could be used to improve local streamflows. The report has its origins in a commonly heard local question: "Why hasn't Roaring Fork Conservancy engaged in a water conservation campaign to improve streamflows?" Generally, the reason has been because in Colorado water conservation raises a host of complicated legal issues, such as abandonment, waste, and potential injury to other water users. Yet such legal barriers do not change the fact that conservation efforts are likely to prove essential to ensuring adequate streamflows in the Roaring Fork Watershed.

Pitkin County

Healthy Rivers and Streams Board

Report to Rivers Board
Roaring Fork Conservancy
April 19, 2012

May 1st and 2nd Workshop

Goal: To bring together technical experts to develop a coordinated, innovative, science-based and effective plan to implement restoration efforts in Coal Basin and the Crystal River confluence area.

44 attendees confirmed
Rocky Mt Research Station, White River National Forest, CDOT,ACOE, CDPW, Colorado Water Conservation Board, Colorado Department of Reclamation, Mining, and Safety, Pitkin County, CVEPA, Roaring Fork Conservancy, Mesa University, Wilderness Workshop, Wildland Hydrology, BioChar Solutions, John Morris representative, Ruedi Water and Power Authority, CNHP/Roaring Fork Audubon Society, Redstone Inn, Kootenay Resources, LLC, and Coal Creek Cattleman's Association

Outreach
RFC has conducted extensive outreach to ensure that the public and other interested parties are informed about the overall project and involved where appropriate. To date we have given presentations to nine groups, met with two of the private landowners several times, conducted five field trips to the area, reaching more than 200 people. Additionally, two of the local newspapers and Roaring Fork Conservancy's (RFC) Winter/Spring 2012 newsletter had articles about this project. As part of RFC's Watershed Explorations Series we have a Coal Basin Tour planned for June 22nd.

<u>Research</u>
We have identified the following sources of information that will be discussed at the May workshop: FEMA preliminary floodplain/floodway maps; historical aerial photos (1952 and 1999); climate data (1979-1994); hydrologic data (1981 and 1985); CDOT bridge as built designs ; sediment report (1990); and macro reports (1989-1999).

<u>Grants</u>
Received: Rivers Board
Pending: CWCB: Watershed/Stream Restoration and Protection and Flood Mitigation Grant and Together Green (Audubon)
Denied: River District
Planned: National Forest Foundation Matching Awards Program and Water Supply Reserve Account.

Coal Creek Restoration
ROARING FORK WATERSHED PLAN
was here

ROARING FORK CONSERVANCY PROPOSAL FOR WYSS FELLOW

Roaring Fork Conservancy
P.O. Box 3349
200 Basalt Center Circle
Basalt, Colorado 81621
Info@roaringfork.org
www.roaringfork.org

Proposed Mentor and Contact Person:
Sharon Clarke
Land and Water Conservation Specialist
clarkesha@sopris.net
(970) 927-1290

Date of Submission: January 8, 2012

Overview and Activities and Accomplishments of Roaring Fork Conservancy. Roaring Fork Conservancy is the premier watershed conservation organization in the Roaring Fork Valley. Founded in 1996 through a unique public-private partnership, Roaring Fork Conservancy has become one of the most respected watershed conservation organizations in Colorado. Our work is highly valued locally and used throughout the state. An independent, not-for-profit, 501(c)3 organization, we are funded through individual donations, grants, special events, and program fees.

Part of the Colorado River Basin, the Roaring Fork Watershed encompasses an area approximately the size of Rhode Island. It is home to internationally-renowned ski resorts, the longest contiguous sections of Gold Medal water in Colorado, some of the country's most beautiful public lands and heavily-visited tourist destinations, as well as a number of the most controversial transmountain water diversions in the state. Our mission is to inspire people to explore, value, and protect this diverse watershed. We focus on:

- **Water Quantity** -- keeping water in our rivers,
- **Water Quality** -- keeping our rivers healthy, and
- **Habitat Preservation** -- protecting and restoring our riparian and instream areas.

Roaring Fork Conservancy is well-known as an organization with the ability to build consensus on complex water issues by bridging the gaps between hard science, local and regional land use and energy policies, recreational interests, the requirements of a rural agricultural community, and the varied interests of both full and part-time residents in the Valley. Our ongoing activities and accomplishments include:

- Spearheading development of the *State of the Roaring Fork Watershed Report 2008* and a multi-jurisdictional *Roaring Fork Watershed Plan* that outlines specific actions for the protection and restoration of our surface waters and groundwater by all key stakeholders;
- Reaching 45,700 students and 17,500 adults with our hands-on, in-the-field education programs;
- Protecting 280 acres of riparian habitat (on which 80% of the wildlife in Colorado depend) *forever*;
- Bringing county and municipal planners from multiple jurisdictions together to address land use issues affecting our groundwater and surface waters;
- Informing elected officials and other regional decision makers on complex watershed issues, and helping citizens get a response from "faceless" government agencies to concerns about their rivers, streams and groundwater;
- Completing 16 scientific studies in the watershed – providing a platform for better development decisions;
- Planning and developing a premier River Center for ongoing education and scientific research on western water issues; and
- Maintaining a user-friendly website and issuing regular newsletters with information on critical and noteworthy watershed issues.

ROARING FORK CONSERVANCY PROPOSAL FOR WYSS FELLOW

In our first fifteen years as an organization we have successfully emphasized education, research, water quality data collection, and watershed planning. With the completion of the *State of the Roaring Fork Watershed Report 2008* and the *Roaring Fork Watershed Plan,* and efforts to build our River Center well underway, we are now turning to projects that directly protect or restore our water resources.

Roaring Fork Conservancy's Urgent Need for a Wyss Fellow. The recently completed *Roaring Fork Watershed Plan* recommends 200 actions to address flow alteration and other water resource issues and data gaps identified in the *State of the Roaring Fork Watershed Report 2008*. Roaring Fork Conservancy is identified as the "Coordinating Entity" or a "Key Participant" for almost half of these actions, and is specifically named on six of the *"Urgent Actions"* identified for immediate implementation. We have begun work on three of these actions: 1) water conservation, 2) a large-scale riparian restoration effort, and 3) a riparian education campaign. Of these three projects, the water conservation initiative is farthest along, has significant potential to address low flow issues within our watershed, and has statewide applicability. Its accomplishment also requires specific legal expertise.

The report, *Opportunities for Water Conservation – Realizing the Environmental Benefits from Local Water Conservation,* was recently completed as the first part of our water conservation initiative. Reviewed by multiple technical experts, including attorneys and other experts in Colorado water law, it made specific recommendations for pursuing a Water Conservation Campaign aimed at addressing low flow issues. We need a Wyss Fellow with a background in water law to develop a Water Conservation Campaign that will improve streams flows in our watershed and be a model for other groups throughout Colorado and the arid West. An aggressive Western Slope Water Conservation Campaign will also address a common Front Range complaint that the Western Slope demands stringent conservation measures from transmountain diverters but does not impose similar measures on local water users.

Description of the Wyss Fellow Position

Title: Water Conservation Campaign Director
Goals: To improve stream flows in critical low flow stream reaches within the Roaring Fork Watershed
Activities and Responsibilities: The Water Conservation Campaign Director will lead a Water Conservation Campaign following the recommendations provided in the report, *Opportunities for Water Conservation – Realizing the Environmental Benefits from Local Water Conservation:*

1. Identify agricultural irrigators willing to engage in conservation efforts based on the selective dry-up of agricultural lands or other conservation and water-saving measures in order to lease or loan the resulting Historical Consumptive Use credits to the Colorado Water Conservation Board (CWCB) for Instream Flow (ISF) purposes. Support the legal and engineering analysis necessary to support a test case.
2. Investigate the feasibility of a pilot water conservation project based on the use of deficit irrigation for perennial hay crops and pursue projects where appropriate.
3. Investigate the feasibility of a pilot water conservation project for a local municipal water provider based on the widespread adoption of weather-based landscape irrigation controllers.
4. Investigate the engineering feasibility of a local water user strategically reducing historic diversions through conservation measures and contracting with the CWCB to use the remaining water for ISF purposes between the original point of diversion and point of return flows.
5. Meet with state representatives to discuss conservation measures designed to make water available for ISFs.
6. Encourage local municipal water providers to develop comprehensive water supply, drought mitigation, and water conservations plans pursuant to state law.

7. Encourage the Colorado River Water Conservation District and the local water conservancy districts to develop a water conservation certification program.
8. Develop a "Conserve-to-Enhance" -type program (http://cals.arizona.edu/azwater/conserve2enhance.html) for one or more municipal water providers in the Roaring Fork Watershed.
9. Investigate establishment of a watershed-wide public educational campaign on landscape irrigation efficiency, working with the Colorado State University Extension network.
10. Promote a watershed-wide scope to local water conservation efforts.

The Water Conservation Campaign Director will work closely and share information with other entities involved in these issues, including the Ruedi Water and Power Authority (comprised of elected officials from all the local jurisdictions, they represents water interests in the Watershed and will be a supporter of the Fellow) , the CWCB (the state agency with sole authority to appropriate water for ISFs), the Colorado Water Trust (CWT) (a non-profit organization engaged in voluntary efforts to restore and protect streamflows in Colorado), and Pitkin County (currently engaged in a collaborative effort with CWT and CWCB to achieve a creative solution to protecting ISFs throughout the Roaring Fork Valley).

Special Skills/Requirements: The successful applicant must have good oral and written skills, the ability to understand and communicate complex legal concepts, be creative and flexible, and have (or be working toward) a J.D. from an accredited law school with coursework in water law. An undergraduate or graduate degree in a program which included coursework in hydrology and water resources management/water resources policy is highly desirable.

Location: Roaring Fork Conservancy's office in Basalt, Colorado.

Proposed Stipend for the Wyss Fellow. Roaring Fork Conservancy proposes an annual stipend of at least $43,000. A stipend set at the higher end of the allowable range will allows us to attract highly-qualified candidates to an area with an above average cost of living, and is in line with the salaries of current Roaring Fork Conservancy staff and staff at other local non-profits.

Mentoring and Hosting Commitments for the Wyss Fellow. Our fully-funded Land and Water Conservation Specialist, Sharon Clarke, would be the mentor for the Fellow. Ms. Clarke has a B.S. and M.S. in geography and has been involved in water resource issues throughout her 30-year career. She spent 15 years doing aquatic research in the Forest Science Department at Oregon State University and has been with the Roaring Fork Conservancy since 2004. She was the lead consultant during the multi-year Roaring Fork Watershed Planning process.

Sharon Clarke's personal statement: My approach to mentoring is simple - follow the golden rule (i.e., treat others as you would like them to treat you). People are drawn to this type of work because they are passionate. My goal would be to channel this passion into a much needed work product. I would foster flexibility and creativity and look forward to problem-solving, consultation, and brainstorming with the Fellow. I have mentored several people during my tenure with the Roaring Fork Conservancy and all experiences have been positive and highly productive.

The Fellow would be considered a staff person for the two years they were hosted by Roaring Fork Conservancy and have access to office space, a laptop with access to our computer network, and office support. The Fellow would work closely with our current 7-member staff, and also interact with our 13-member Board of Directors.

The current Board President is a prominent local water attorney and the Vice President is a well-known land use attorney.

The Fellow would have the opportunity to attend meetings/workshops/conferences throughout the state to learn more about western water issues and to network with other water experts and share the results of his/her work. Potential venues include: periodic meetings of the Roaring Fork Watershed Collaborative, Colorado Watershed Assembly conference, Colorado Water Workshop at Western State College, biannual Colorado Water Congress meetings, CU Natural Resources Law Center meeting, Colorado Foundation for Water Education programs, monthly Colorado Basin 1177 Roundtable meetings and events, regular Northwest Colorado Council of Government's Water Quality/Quantity meetings, Colorado Mesa University Water Center meetings, and Colorado River Water Conservation District's regular meetings. The Fellow's work will be of great interest to many of these groups and we would support making the results of their work widely accessible.

Roaring Fork Conservancy's Approach to Advertising and Hiring for the Position. We will advertise this position through law schools with well-known environmental programs such as the University of Colorado, University of Denver, Stanford University, University of Oregon, University of California, University of Michigan, University of Utah, and Lewis and Clark, as well as in *High Country News*, on the Roaring Fork Conservancy's web site and Facebook page, and in local and Denver newspapers. We would also investigate opportunities to post the position on other environmental websites which provide free job-listings and in other social media.

TO: The Board of the Healthy Rivers and Streams Fund; John Ely

From: Virginia Newton

Date: 4/16/12

RE: RFP Draft for Real Estate Economics and the Roaring Fork River

Dear All,

Thank you for allowing me to get involved with the question "What does the river have to do with our real estate market?" Real estate is not the first thing that comes to mind when protecting and conserving water. River flow rates, aquatic and riparian flora and fauna, kayaking, fishing and rafting have all been a part of the conversation in river protection communities. They are important and will continue to be. However, a more complete picture of the impact of healthy rivers and streams to our area will also include the real estate market.

Pitkin County is unique in many ways, and people pay extraordinary prices to own property here. In 2011, (a down year) real estate sales totaled 1.27 billion dollars. Is there a relationship between our rivers and streams and this remarkable economic engine? If so, to what degree? If the relationship is clear and significant, how might that information be used to benefit the goals of the Healthy Rivers and Streams Board?

At the April 19, 2012 board meeting, we can discuss the viability of an RFP, a draft which is attached.

Many thanks,
Virginia Newton

vnewton@sopris.net

Request for Proposals

To provide for a study describing the relation of the real estate market in Pitkin County to the Roaring Fork River.

Introduction

With approximately twenty-six billion in actual real estate values, and over one billion a year in real estate transactions, Pitkin County's real estate market drives much of the economic success of the Roaring Fork Valley and related communities. While local studies have quantified the economic benefits related primarily to tourism and fishing, little work has been done to quantify and qualify the relation the Roaring Fork River has to real estate values and sales.

Currently, forty percent of the natural river flow of the Roaring Fork River is diverted at the headwaters to the Eastern Slope of Colorado for municipal and agricultural use. Several studies, including the 2010 Interbasin Compact Committee report to the Governor of Colorado, indicate that increased needs for water for the Front Range communities of Colorado will require the consideration of further diversions from headwater counties such as Pitkin County. Climate change factors that cause average winter snowpack levels to vary would further impact natural stream flow volumes of the Roaring Fork River.

Scope of Work

Pitkin County is seeking qualified individuals or firms to conduct an analysis of the relationship between real estate values and the Roaring Fork River.

The study will include research to support the relationship between healthy river systems and real estate values such as the following:

- Analyze the real estate sector in Pitkin County and the economic impacts of the over one billion dollars in annual transactions that occur in the transfer of real estate, as well as the economic impacts of the approximately twenty-six billion in real estate value residing in Pitkin County.
- Review the literature of previous economic impact studies of rivers in Pitkin County and describe the gap in these studies related to the real estate sector.
- Develop a statistically valid method for quantitatively illustrating the relationship between the Roaring Fork River and real estate values.
- Develop a persuasive method for qualitatively showing the relationship between rivers, river health and real estate values.
- Describe potential future diversions of native river flow from the Roaring Fork River headwaters.
- Describe the impacts that future diversions would have on riparian and aquatic health management in the Roaring Fork River.

- Develop a conclusion to illustrate that reduced flow rate and compromised riparian and aquatic health of the Roaring Fork River would have a negative impact on the real estate economy, including dollar value estimates for this impact.

Other communities with denuded or restored river environments may be examined and contrasted to the rivers in Pitkin County.

Estimating the Benefits of Urban Stream Restoration Using the Hedonic Price Method

Carol F. Streiner
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Fort Collins, Colorado 80523 USA

ABSTRACT: The hedonic price method was used to estimate residents' willingness to pay for improvements in urban streams. This study examined California's Department of Water Resources Urban Stream Restoration Program to determine the economic value of stream restoration measures such as reducing flood damage and improving fish habitat. Seven projects from three counties—Contra Costa, Santa Cruz, and Solano—were pooled for analysis. Property prices in areas with restored streams were found to increase by \$4,500 to \$19,000 due to stabilizing streambanks and acquiring land for education trails. This represents from 3 to 13% of the mean property price in the study. Recommendations for facilitating further analysis are made and implications for quantifying the benefits of similar programs in other states are provided.

KEY WORDS: Nonmarket valuation, property values, water quality, willingness to pay.

INTRODUCTION

Urban streams can be assets to a community, yet flooding, erosion, streambank instabilities, and basic environmental degradation along urban creek channels pose significant problems to landowners adjacent to these creeks. Problems with urban streams arise from a change in natural stream corridor characteristics, often brought about by urbanization itself. Some properties and buildings are endangered by such processes, and despite individuals' efforts to remedy the effects, problems can recur or can cause damage farther downstream from the site.

Flooding, erosion, and streambank instability also deteriorate the natural values of streams. Historically, structural solutions such as concrete channels were typically constructed to stabilize streambanks and protect properties.

Currently, the trend is toward restoration of the natural attributes of the stream as well as structural improvements. Some structures that incorporate revegetation are wood crib walls, live fascines (which are bundles of live cuttings anchored into the streambank) and other live cuttings, and brush matting or brush layering. All are designed to slow the velocity of the stream and prevent bank instability. These methods as well as others, such as check walls, rock or stone walls, and wood plank walls, are recommended for aesthetic and functional purposes alike. Many characteristics of a natural stream are restored using such methods, but benefits provided by these more natural methods have not been measured.

URBAN STREAM RESTORATION PROGRAMS

For some communities in California, local and state agencies have realized the need for a program to mitigate the adverse affects of flooding, erosion, and bank instability. California's Department of Water Resources (DWR) initiated the Urban Stream Restoration Program in 1985 to assist communities in reducing damages from flooding and streambank instability as well as to restore environmental and aesthetic values of urban stream channels. By encouraging the involvement of local agencies and citizens' groups, both paid and volunteer, the DWR hopes to promote stewardship and maintenance of streams by community members.

An urban stream restoration program can result in a variety of benefits, both to individual property owners and to communities as a whole. These can be grouped into two broad categories: reduction in property damages, and restoration of the natural values of the stream itself.

Damages to adjacent properties can be reduced by mitigating the effects of flooding, erosion, and streambank instability through various restoration measures. The benefits accruing to property owners are intact yards, minimal damages to trees, structures, and landscaping, and healthier streamside parks.

Benefits of returning a stream to its more natural state are more stable streambanks, restoration of the riffle-pool sequences enhancing fish habitat and other aquatic habitats, and a more aesthetically pleasing ecosystem with riparian vegetation restored and wildlife habitats protected. These benefits are identifiable yet difficult to quantify in dollar terms comparable to the cost. Measuring homeowners' value of such benefits is important in documenting the economic contribution of an urban stream restoration program and allowing comparison to the costs of such a program (U.S. Water Resources Council 1983).

Estimating residents' willingness to pay (WTP) for improvements in urban streams can be accomplished by using the hedonic price method (HPM). Hedonic pricing uses residential property value differentials to measure changes in WTP for environmental amenities in two stages. The slope of the first stage hedonic equation measures how the value of the property changes with a small change in the level of an attribute. The second stage hedonic measures the demand for larger changes in the levels of that attribute, allowing calculation of the residents' WTP for that change. In this study, we used the first stage hedonic function to measure a discrete value resulting from performing a specific stream restoration measure. We hypothesized that properties along streams that have been restored will exhibit higher property values than areas that have not been restored, if buyers perceive restored streams as an amenity. Price differentials between the two areas can be statistically related to stream improvements via multiple regression analysis.

BASICS OF THE HEDONIC PRICE METHOD (HPM)

The theory behind the HPM, as explained by Palmquist (1991), lies in differentiated consumer products. Houses that are single commodities differ in environmental attributes at their location. Consumers select properties for the number and quality of characteristics that are present at the site. Housing price differentials, therefore, reflect differences in housing characteristics (Freeman 1993).

The basic hedonic property model is presented by Freeman (1993) as the price of a property as a function of its structural, neighborhood, and environmental characteristics, or:

$$P_i = f\,(S_i, N_i, Q_i) \qquad (1)$$

where P_i = price of property i

S_i = structural characteristics of i

N_i = neighborhood characteristics of i
Q_i = environmental quality characteristics of i

Both Freeman (1993) and Palmquist (1991) agree that the above equation should be nonlinear based on the fact that in the housing market, "repackaging" of property characteristics is unlikely. That is to say, individual characteristics of each property cannot be varied independently. In a particular property's "bundle," a consumer cannot trade two rooms for better air quality. Thus, consumers must choose a "bundle" that best meets their needs. The marginal implicit price of a characteristic is the partial derivative of the first stage hedonic price function in equation (1) with respect to a marginal change in Q_i or "the additional amount that must be paid by any household to move to a bundle with a higher level of that characteristic, all other things being equal" (Freeman 1993). A nonlinear hedonic function yields a marginal implicit price for a characteristic that depends on the level of that particular attribute and on the level of other characteristics as well. In the second stage hedonic, estimates of residents' WTP for different levels of each attribute can be obtained.

Specifying the Hedonic Pricing Model

The dependent variable of a hedonic price function is the full price of house and land, which is regressed against the expected determinants of property price. Freeman (1993) maintains that data on actual market transactions are preferred, but if professional assessors' values are used, care must be taken to assure that they approximate actual sales value. Data for the explanatory variables can be obtained through county tax-assessors' records and census data.

As noted above, both Freeman (1993) and Palmquist (1991) suggest that a nonlinear functional form is appropriate. Freeman and Palmquist agree that a Box-Cox Transformation works well in selecting the appropriate functional form.

In general, the Box-Cox Transformation takes the form (Johnston 1984):

$$Y^{(\lambda 1)} = \alpha_o + \beta X^{(\lambda 2)} + u \qquad (2)$$

Depending on the estimated values for λ_1 and λ_2, the best functional form can be determined. For example, if $\lambda_1 = \lambda_2 = 0$, the form would be a log-log model.

Hedonic Price Analysis for Urban Water Issues

Early studies using the hedonic price approach have focused on air quality issues, yet the method is equally applicable to water quality issues. Dornbusch and Barrager (1973) used multiple regression analysis to estimate the benefit of water pollution abatement. They concluded that property values of single family residences on waterfront lots increased from 8 to 25% with water pollution control.

In 1980, Feenberg and Mills also conducted a study to measure the benefits of water pollution abatement using property data. They found that the determinants of demand were water quality at the nearest beach and number of people per dwelling. The authors concluded that the willingness to pay for slightly cleaner water rises rapidly as water becomes dirtier.

To determine the impact of degraded water quality on the value of seasonal residential properties, Young and Teti (1984) studied the shoreline properties of St. Albans' Bay in Vermont. Their main objectives were to use a hedonic model to provide a measure of water quality's influences on property values and to estimate the benefits from water quality improvements. Young and Teti concluded that the largest impact of water pollution in St. Albans' Bay affected residents and recreationists. The benefits of water quality improvements, therefore, would be higher property values and enhanced recreation, as well as improved wildlife habitat and environmental aesthetics. One significant insight from this study is that property value data reflect only those benefits to property owners. When evaluating the benefits of water quality improvements, it is critical to include other potential benefits as well.

A more recent paper dealing with urban water management problems is a study by Kriesel et al. (1993) of the benefits of shore erosion protection in Ohio's Lake Erie housing market. The purpose of their study was to measure the discount of erosion-prone lakeshore properties using hedonic price analysis. They point out that determining the benefits of erosion protection is difficult because private and social benefits differ and market information is lacking. Their objectives were to determine how erosion and protection devices affect property prices and to calculate the benefits of such measures. The authors concluded that an average erosion control device lasting 8 years would raise property value by $5,500 from an initial time of 20 years to setback (years until shoreline property is eroded up to the house), while a device lasting 20 years would add $11,000 to property value. These benefits accrue to private property owners. Other social benefits are not mentioned; thus, total benefits of erosion protection may be understated.

DATA ANALYSIS

Creating the Data Set

Data for estimating the economic benefits of California's Urban Stream Restoration Program consist of property transactions, property characteristics, stream project characteristics, and demographics of the residents living in the area. The DWR compiled the data, beginning with the pairing of unfunded and funded projects according to similar locations, demographics, and project characteristics. A total of 7 project pairs were pooled for analysis. Initially 12 projects were selected to reflect a geographic mix throughout California, and to represent urban, suburban, and rural stream restoration projects. Funded projects similar in location were paired with unfunded projects in an attempt to control for location specific elements that might be difficult to quantify in a regression. This was done because we were not certain if we could pool the sample across projects in different locations due to the possibility that they might have different regression coefficients. Unfortunately, several projects had to be dropped because data on sales transactions or characteristics of the unfunded project were not available.

Two pairs were from Santa Cruz County, four from Contra Costa (near the San Francisco Bay area) and one from Solano County in northern California. The streams involved in the funded projects averaged a flow of about 500 cfs during storms and ranged from 2,000 to 3,000 cfs during peak winter flows. Each pair of projects contained an average of 80 properties adjacent to a funded project and 70 properties near an unfunded proposed project. The majority of the properties were single family residences (see Streiner 1995 for more details).

Each project, whether funded or unfunded, contained at least 50 properties located within 1,100 ft of the creek and 45 properties greater than 1,100 ft from the creek. Total sample size included 521 properties for the funded projects and 478 for the unfunded projects. Property data were obtained from the respective county assessor's office. These data list the lot number, type of residence, sale date, sale amount, assessed value, lot size, improvement size, number of rooms, bedrooms, and baths, and existence of a garage. Any information missing from the reports was researched by the DWR. Groups of properties were traced to the census maps to determine the census tract and the census block. This matched each property with its respective demographic characteristics.

Organizations that received funding from the DWR submitted a survey to the department detailing the completed project. Groups that failed to receive funding, and consequently did not carry out the proposed project, were interviewed by phone to determine their planned objectives, goals, and projected costs.

All data came from property sales between 1983 and 1993. Sales prices and assessed values were adjusted by fixed weights from the U.S. residential price index found in the Survey of Current Business (U.S. Dept. of Commerce 1995). Ideally, a California or San Francisco Bay area specific price index would have been used but we could not locate one. Percent changes in the price index were used to convert property values to a base year, 1982, for comparison over time without the influence of inflation or a characteristic increase in property prices in California's housing market.

To correctly account for changes in stream attributes, properties that were sold before the restoration projects began were coded with zeroes for the restoration mea-

TABLE 1
Correlation matrixes for restoration packages

	Fish habitat	Acquire land	Education trail			
Restoration package A						
Fish habitat	1.0000	0.8273	0.8273			
Acquire land	0.8273	1.0000	1.0000			
Education trail	0.8273	1.0000	1.0000			
Restoration package B						
	Stabilize	Redfldam	Cleanup	Clrobs	Reveg	Aesthetics
Stabilize	1.0000	0.6383	0.6562	0.7481	0.6996	0.6026
Reduce flood damage	0.6383	1.0000	0.6743	0.8532	0.6805	0.5019
Clean up	0.6562	0.6743	1.0000	0.8771	0.6996	0.7665
Clear obstructions	0.7481	0.8532	0.8771	1.0000	0.7977	0.6591
Revegetate	0.6996	0.6805	0.6996	0.7977	1.0000	0.9128
Aesthetics	0.6026	0.5019	0.7665	0.6591	0.9128	1.0000

sures. Of the seven funded projects in the sample, all but one were initiated in summer 1989. On average, restoration projects were completed in 1½ years.

Estimating the Hedonic Equation

As shown in equation (1), a hedonic equation is specified as a function of structural, neighborhood, and environmental variables. We chose variables that represented each of the three categories. In our data set, many of these variables within each category were correlated with each other. Therefore, the first step in variable selection is to conduct an analysis for multicollinearity among the candidate explanatory variables. A correlation matrix was calculated using Econometric Views (Lilien et al. 1994). Many of the stream characteristic variables are highly correlated with each other, having correlation coefficients greater than 0.80. In addition, many of the property and demographic characteristics are highly correlated. To avoid high sampling variances and low t-statistics, variables must be chosen to minimize the effect of multicollinearity.

The second step was to conduct regression analyses on groups of independent variables to calculate partial R^2's. Results from this test should indicate which variables in each of the three groups (property, stream, and demographic characteristics) are most influenced by the others. Independent variables with low partial R^2's within the three groups of projects are preferred to minimize multicollinearity.

The stream measures were grouped into "packages" according to each variable's correlation with the others. The packages and correlations are shown in Table 1. A correlation coefficient of one indicated that the two variables were always carried out in the restoration projects together and, therefore, were exactly the same in the regression, and, in fact, influence each other. For example, because both "acquire land" and "establish an education trail" variables were needed together; the correlation between those measures is one.

Based on the review of the literature and the partial R^2's, a subset of the variables in each package was selected as candidate variables that were most likely to determine the value owners place on a property. Omitting a stream restoration variable that is correlated with an included restoration variable may lead to mis-specification and bias in the included variables. We recognize this problem and consider the estimated coefficient on the included stream restoration variable to reflect the joint effect of all the stream restoration variables that it is correlated with in its package. The robustness of using different stream restoration variables from the same package in the hedonic regression is then tested by comparing the resulting sign, size, and statistical significance of the coefficients in Table 2 and the resulting marginal values in Table 3.

TABLE 2
Box-Cox nonlinear regression models

Mean of Assessed Property Price = $144,085

	Joint Model		Edtrail		Stabilize		Acqland		Fishab		Redfldam	
Variable[a]	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Impsize	0.0104	6.94	0.0106	4.18	0.0104	4.33	0.0114	4.21	0.0112	4.24	0.0104	4.31
Lotsize	0.0002	7.22	0.0002	3.57	0.0002	3.69	0.0002	3.59	0.0002	3.62	0.0002	3.67
Year	0.2504	1.57	0.4434	2.53	0.1855	1.26	0.3902	2.22	0.3782	2.22	0.2527	1.72
Garage	2.0347	2.80	2.1222	2.51	2.1556	2.70	2.0530	2.32	2.1594	2.47	2.6866	3.04
Ckdist	−0.0006	−2.03	−0.0007	−1.92	−0.0005	−1.56	−0.0006	−1.68	−0.0006	−1.70	−0.0005	−1.63
Pcinc89	0.0010	8.76	0.0010	4.14	0.0009	4.27	0.0011	4.14	0.0011	4.18	0.0010	4.28
Travelt	−0.4419	−6.24	−0.4671	−3.58	−0.5246	−3.87	−0.5367	−3.67	−0.5323	−3.71	−0.5052	−3.79
Meanage	0.2280	3.64	0.2544	2.96	0.2014	2.74	0.2595	2.87	0.2509	2.88	0.2264	2.91
Unemprt	−0.2138	3.22	−0.2621	−3.31	−0.2242	−3.11	−0.2707	−3.22	−0.2591	−3.20	−0.2133	−2.96
Edtrail	7.1364	2.17	9.5990	2.79								
Stabilize	3.0184	3.00			2.6617	2.59						
Acqland							10.596	2.83				
Fishab									8.8092	2.88		
Redfldam											4.6474	2.98
Constant	−5.8401	−0.40	−21.883	−1.42	3.1560	0.24	−15.062	−0.97	−14.307	−0.96	−5.0554	−0.39
Lambda	0.7169	15.81	0.7230	15.86	0.7047	16.07	0.7375	16.27	0.7309	16.27	0.7097	16.15
N =	1,055		1,055		1,077		1,077		1,077		1,077	
R^2 =	0.553		0.549		0.534		0.540		0.539		0.537	

[a] where Impsize is house size, Lotsize is property size, Year is the year in which the property was sold, Garage is presence of a garage, Ckdist is distance from creek, Pcinc89 is per capita income in 1989, Travelt is travel time to work in minutes, Meanage is the mean age of the population in the sample, Unemprt is the unemployment rate, Stabilize is stabilize stream banks, Edtrail is establish an education trail, Acqland is acquire land, Fishab is fish habitat, Redfldam is reduce flood damage and Lambda is the exponent to which the dependent variable is raised.

The dependent variable in the regressions is the assessed value of the properties at the time of sale. It is not significantly different from the actual sale value. This is not surprising because with California's Proposition 13, assessed property values are updated to the new market price at the time of sale. A Box-Cox transformation was employed to determine the functional form that fits the data and the variables that best explained the variation in the dependent variable (the assessed value in real terms).

To conduct multiple regression analysis, the question of functional form was addressed using the Box-Cox transformation method (Greene 1992). This method allows the transformation of both the dependent and independent variables. The Box-Cox transformation indicated a nonlinear functional form to fit the data. This model was used in the multiple regression analysis. The Box-Cox transformation method allows transformations of both the left-hand-side and right-hand-side variables in a regression equation, depending on the nature of the data and the interaction of the independent and dependent variables. Preliminary regressions were attempted using all four possible Box-Cox specifications: transformation of the dependent variable by lambda, the independent variables by lambda, both independent and dependent variables by lambda, and transforming the dependent variable by theta and the independent variables by lambda. Using LIMDEP (Greene 1992), the model chosen for this data set, transforms only the dependent variable: assessed property value. Based on the minimum value of the log-likelihood value, preliminary regressions indicated this transformation was best. Lambda represents the exponent to which the dependent variable is raised. The model is nonlinear, as suggested by the hedonic price theory reviewed previously.

White's general test for heteroskedasticity was performed on the final regression model. A positive result indicates large variances. Weighted least squares could be used to correct for this, but there were several possible variables that might be appropriate as the weight. However, only one variable can be used as the weight. Thus, to avoid this problem, we corrected for heteroskedasticity by using White's Heteroskedasticity-Consistent Standard Errors and Covariance (Lilien et al. 1994), which reduces the standard errors and makes the t-statistics more accurate. Table 2 reports the t-statistics after the standard errors are corrected. R^2's for each of the regressions were calculated by an ordinary least squares estimation procedure using the transformation of the independent variable by lambda.

STATISTICAL AND PROPERTY VALUE RESULTS

Statistical Results

The final regression equation contains three property variables that have minimal correlations among each other, three neighborhood or locational variables, three demographic variables, and two stream improvement variables, one from each restoration "package." This can be found in the first column of Table 2. Stream restoration measures in Tables 1 and 2 are simply dummy variables for whether or not that measure was performed in the project. For all the regression results in Table 2, improvement size, lot size, garage, per capita income, travel time to work, mean age, unemployment rate, and lambda are significant at least at the 5% level. Coefficients on the nonstream variables remain stable even when different stream variables are used in the regression. Creek distance is significant at least at the 10% level. The stability of restoration measures is indicated by the coefficients on education trail, stabilize streambanks, fish habitat, acquire land, and reduce flood damage, which are each significant at the 5% level in their respective regressions. Whereas the year of sale is not significant at the 10% level, it has a t-statistic of greater than one and is included in the model to account for possible increases in real property prices over the time frame of the study.

Table 2 shows regression coefficients for the models with two measures that are grouped together in a restoration package. Both "reduce flood damage" and "stabilize streambanks" are by themselves positive and significant. As shown in Table 2, "stabilize streambanks" and "education trail" are both significant when included together. Both "reduce flood damage" and "education trail," however, were not significant when included together in the model.

Property Value Results

The individual values for the stream improvement measures can be calculated from the coefficients estimated by the model. The method evaluates the change in property price due to the measure itself, holding all other variables constant at zero. The following equation from Greene (1992) for the Box-Cox nonlinear regression model was used to calculate the individual values.

$$y = [(\lambda^*\beta X) + 1]^{1/\lambda} \qquad (3)$$

As an example of this calculation, the value of the fish habitat variable is set equal to one. This indicates the completion of that measure. If the other variables are held constant at zero, the equation becomes:

$$\text{Change in property price} = (0.7309^*8.8092 + 1)^{1/0.7309}$$

The result is 15.571, or $15,571 change per property in the area where the restoration project improved fish habitat.

When both an education trail and bank stabilization are carried out together in the projects, property values increase $19,078 over properties without these measures. These restoration measures include other aspects that were generally carried out in the sample projects, such as clearing obstructions, revegetating, acquiring land, and making other improvements.

Values for the restoration "packages" that contain stream restoration measures that can be grouped together according to each variable's correlation with each other are presented in Table 3. From Package A holding all other variables at zero, establishing an education trail is perceived by buyers to contribute $17,560 to the price of a property. When compared to the mean property value of the sample, this makes up 12% of the property value. Maintaining fish habitat was perceived to be worth $15,571, and acquiring land was valued at $19,123 per property. Similar values (each is within $2,000 to $4,000 of each other) and their high correlations with each other indicate that these measures are not independent of each other but, in fact, appear to measure the joint effect. Establishing an education trail and acquiring land are perfectly correlated. This follows because, to establish a trail, land is needed along the riparian area. The end result is that the value for an education trail calculated from the sample of projects also includes the value of acquiring land and maintaining fish habitat.

TABLE 3
Value of restoration packages

	Absolute amount	Percent of property value
Restoration package A[a]		
Fish habitat	$15,571	11
Acquire land	$19,123	13
Education trail	$17,560	12
Restoration package B[a]		
Stabilize	$ 4,488	3
Reduce flood damage	$ 7,804	5
Joint model		
Package A (Edtrail)		
Package B (Stabilize)		
Total	$19,078	13

[a] NOTE: The individual measures cannot be added together because they are simply alternative measures of the joint effect of all these variables in the package.

Both "stabilize" and "reduce flood damage" enter into the regression equation positively and their values are also listed in Table 3. Stabilize has a value of $4,488 per property and reduce flood damage contributes $7,804 or 5% of property value. Individually, it appears as though stabilizing streambanks does not add as much to property value as does reducing flood damage and the measures in Package A. The values reflect buyers' perceptions at the time of purchase; perhaps education trails and less damaged banks are more visually important to home buyers than the technical details of bank stabilization.

Reducing flood damage is highly correlated with other stream measures, such

TABLE 4

Linear feet of stream restoration regressions

Mean of Assessed Property Price = 144,085

Variable	Education trail			Fish habitat			Reduce flood damage		
	Coeff.	*t*-Ratio	Mean of X	Coeff.	*t*-Ratio	Mean of X	Coeff.	*t*-Ratio	Mean of X
Impsize	0.0106	4.189	1,456.3	0.0113	4.231	1,455.9	0.0110	4.260	1,455.9
Lotsize	0.0002	3.578	7,471.3	0.0002	3.614	7,518.7	0.0002	3.643	7,518.7
Year	0.4434	2.538	88.87	0.3810	2.220	88.91	0.3027	1.890	88.91
Garage	2.1222	2.512	0.627	2.1314	2.428	0.635	2.4266	2.714	0.635
Ckdist	−0.0007	−1.920	1,188.1	−0.0006	−1.70	1,181.3	−0.0006	−1.633	1,181.3
Pcinc89	0.0010	4.145	17.378	0.0011	4.173	17.431	0.0011	4.218	17.431
Travelt	−0.467	−3.581	28.278	−0.532	−3.696	28.27	−0.512	−3.690	28.37
Meanage	0.2544	2.965	33.129	0.2541	2.886	33.162	0.2479	2.901	33.162
Unemprt	−0.2621	−3.317	5.99	−0.2608	−3.189	5.92	−0.2285	−2.952	5.92
Trailfeet	0.0383	2.796	6.16						
Fishfeet				0.0382	2.899	7.335			
Damagefeet							0.0381	3.113	11.64
Constant	−21.88	−1.42		−14.56	−0.965		−9.19	−0.645	
Lambda	0.7230	15.861		0.7334	16.289		0.7283	16.336	
N =	1,055			1,077			1,077		
R^2 =	0.549			0.540			0.541		

as stabilizing streambanks, clearing obstructions, and revegetating the riparian area. The value obtained for reduced flood damage, therefore, cannot be entirely attributed to that individual measure.

It is important to remember that the values for each measure do not take into account the costs of performing that measure. The benefit differential among measures may be offset by a differential in the costs of restoration. In other words, deciding to acquire land solely because it produces the greatest gross benefit is not an adequate reason. The higher cost of acquiring land may far outweigh the benefits of the measures, thus reducing the net benefit (benefit-cost) of the measure.

Maximizing net benefits, therefore, would be a better objective in deciding which restoration measures to carry out in a project. The benefits must be weighed against the costs. For instance, the following hypothetical example illustrates the proper analysis:

The benefit of acquiring land has been determined to be $19,123 per property. The benefit of stabilizing streambanks is $4,488. If costs of acquiring land, however, are $18,000 per parcel of land in a project, and it costs only $400 to stabilize the same area of streambank, the net benefit of acquiring land is only $1,123 while the net benefit of stabilizing is $4,088.

Performing bank stabilization and establishing an education trail together yield a total value of $19,078, or 13% of mean property value. It must be kept in mind that because each variable in a package contains the influence of the other variables, only one variable from each package can be chosen to calculate total value. In addition, individual measures from A cannot be added to individual measures from B to determine the total value because of the nonlinear functional form of the hedonic equation.

Continuous Measures of Restoration Activities

Where the previous values have been discrete measures, values for certain restoration activities can be represented in an alternative fashion, in terms of linear feet restored. Regression results are reported in Table 4. Changes in the value of property with different amounts of restoration, measured in linear feet, are determined for establishing an education trail, improving fish habitat, and reducing flood damage. The values for a change in property value as the linear feet of an education trail along a creek are expanded are valid for restoration between one and 250 linear ft. These values are based on the range of our data and are approximately $1,000 to $17,560 per property. Note this value of $17,560 is the same value determined using the dummy variable approach for establishing an education trail.

The property value changes with increasing linear feet of fish habitat maintained are relevant from one to 250 linear ft of restoration. The values for improving fish habitat range from $1,000 for one linear ft to $15,000 for the mean amount of restoration (225 linear ft). Again, these values are based on the range of the data in the sample. Changes in property values from $1,000 for one linear ft to $11,350 for 175 linear ft of reduced flood damage are determined from the model. These values represent a continuous measure of the value of restoration activities.

CONCLUSION

The hedonic pricing method proved applicable to measuring the benefits of selected urban stream measures. The Box-Cox nonlinear regression model provided an equation for which the coefficients of stream restoration variables could be estimated. From the regression coefficients, property value changes were calculated and the value of restoration measures determined. These increases in property values were attributed to specific stream restoration measures, yet the high correlation among measures indicates that generally more than one measure is reflected in the value of any one individual measure.

For measures such as establishing an education trail, maintaining fish habitat, and acquiring land and/or easements along a stream, the one time increase in property value ranges from about $15,570 to $19,120 per single family residence. For stabilizing streambanks (which includes cleaning obstructions, revegetating streambanks, and cleaning up the stream) and reducing flood damage, property values increase about $4,480 to $7,800 per single family residence. These values are specific to our sample of projects, which reflects the San Francisco Bay area and Santa Cruz. It may not be appropriate to generalize these values to other geographic areas. However, the basic method would be applicable.

To alleviate the problem of multicollinearity among project measures, it would be useful to have information on the amount of restoration done, such as the number of linear feet. Three measures of this type—linear feet of fish habitat maintained, education trail established, and flood damage reduced—produced changes in property prices from $1,000 to $17,560, depending on the number of linear feet restored. It is important for analysis to have all projects report the amount of restoration completed for valid calculation of values.

Another recommendation for alleviating the correlation among stream variables is to define measures more specifically. If one objective can be accomplished by performing another, then the objective is too broadly defined and increases the difficulty of computing a separate value for each measure.

The benefit of these increases in property values also benefits communities as a whole. In California, using the Proposition 13 tax rate of 1.25% of property value, an increase in property value of $19,078 would provide about $240 per house in additional property tax to the community annually. When added up over the large number of single family homes in the funded areas, the present value of the added tax money over the life of the restoration project is likely to contribute far more revenue than the program costs (which in our study has a median value of $34,920).

Based on our research, the basic hedonic property approach appears to be useful for evaluating the benefits of a wide variety of urban stream restoration programs.

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