January 11, 2007

Mr. Rick Brown
Interstate Water Management Development Section
Colorado Water Conservation Board
1580 Logan Street, Suite 1600
Denver, Colorado 80203

Subject: Water Supply Reserve Account 2007 Grant Application for the Strategic Plan for the Long Term Management of Non-Native Phreatophyte Trees and a Mapping Project for the Arkansas River Basin

Dear Rick:

Enclosed is a grant application from the Southeastern Colorado Water Conservancy District for the Water Supply Reserve Account 2007 Grant Application for the Strategic Plan for the Long Term Management of Non-Native Phreatophyte Trees and a Mapping Project for the Arkansas River Basin for $50,000. At the Arkansas Basin Roundtable's (ABRT) recent meeting, this grant application was approved with full consensus for the Statewide Competing Fund. The ABRT Needs Assessment Committee approved this on a 11-1 vote at their December 8, 2006, meeting to move this to the full Roundtable for consideration yesterday. This application has received a thorough review and full discussion by our Roundtable at a regularly scheduled and noticed meeting, with a quorum present.

In closing, if I can be of any assistance to you and your staff or the Water Conservation Board in their evaluation, please do not hesitate to contact me at: 719.584.0221 or ahamel@pueblowater.org.

Sincerely,

Alan C. Hamel, Chair

lkm
enc
c: Jay Winner
Jonathon Fox
Gary Barber
Eric Hecox

S O U T H E A S T E R N C O L O R A D O
Water Conservancy District
"Your Investment in water"

January 11, 2007

Mr. Rick Brown
Intrastate Water Management and Development Section
Colorado Water Conservation Board
1580 Logan Street, Suite 600
Denver, CO 80203

Dear Mr. Brown,

The Southeastern Colorado Water Conservancy District is requesting a $50,000 grant from the Water Supply Reserve Account to fund the development of a Strategic Plan for the Long-Term Management of Non-Native Phreatophyte Trees and for a mapping project for the Arkansas River Basin.

Non-native phreatophytes trees (Tamarisk, Russian olive and Siberian elm), have infested much of the riparian lands and are moving into the upland areas within the Arkansas River Basin. These invasive trees are causing serious impacts to our limited water resources. In addition, dense stands of the non-native trees have restricted recreational accessibility, negatively impacted wildlife habitat, and increased the risk for wildfires and flooding.

To compliment the Plan a comprehensive data base will be developed that will assist property owners and land managers in determining proper control, restoration, monitoring, and long-term maintenance methods for a particular infestation level and land situation. This data base will be available on a website and it will enable the District and agencies to track the progress of projects and evaluate the methods that are implemented.

Another extremely important element of the project is to map the entire basin to provide a clear understanding of the extent of the problem. The Tamarisk Coalition, with funding from the Colorado Water Conservation Board, the District and the Purgatoire River Water Conservancy District, recently mapped the lower portion of the main stem of the Arkansas River and several of the major tributaries. Unfortunately, the mapping project is incomplete because it does not include the upper basin from Pueblo Reservoir west to the headwaters, small reservoirs, lakes and ponds, nor the hundreds of miles of creeks, ephemeral streams, canals, ditches, and dry washes that harbor these thirsty invaders. This type of information is invaluable in determining the total acres of infestation and average density, estimate of current and future water losses, as well as the costs associated with control, revegetation and long-term management.

31717 UNITED AVENUE • PUEBLO, CO 81001-4817 PHONE (719) 948-2400
• FAX (719) 948-0036

We believe this project fits the constraints of Senate Bill 06-179 as called out in subparagraph III. The Strategic Plan development and mapping project complies with items C and D of that Act. The Plan development meets several of the SWSI objectives: Optimize existing and future water supplies, enhance recreational opportunities, and provide for environmental enhancements.

The development of the Strategic Plan would assist the Basin in implementing Governor Owens' 2003 Executive Order and the Department of Natural Resource's 2004 10-year Plan to Control Tamarisk and Restore Riparian Plant Communities in Colorado. The Strategic Plan will also assist the Basin in taking advantage of the funding source created by the recently passed Federal legislation H.R. 2720, "The Salt Cedar and Russian Olive Control Demonstration Act". In addition, it will support securing funds to implement the Plan from new and existing state and federal programs, foundations, and other sources.

CWCB has already invested time, energy, and dollars in mapping the main stem of the Arkansas and the major tributaries and reservoirs. It is clear that the long-term management of the non-native phreatophytes in Colorado is in the best interest of the Board, the State and the Arkansas Basin. Your consideration of the grant application is greatly appreciated.

Sincerely,

James W. Broderick
Executive Director

COLORADO WATER CONSERVATION BOARD

WATER SUPPLY RESERVE ACCOUNT
2006-2007 GRANT APPLICATION FORM

Development of a Strategic Plan for the Long-Term Management of Non-Native Phreatophyte Trees and a Mapping Project for the Arkansas River Basin

Name of Water Activity/Project **River Basin Location**

$50,000.00				
Amount of Funds Requested	[ ]	Basin Account	[X]	Yes
	[X]	Statewide Account	[ ]	No
	Please Check Applicable Box		Approval Letter Signed By Roundtable Chair and Description of Results of Evaluation and Approval Process	

*** For the Basin Account, the Application Deadline is 60 Days Prior to the Bimonthly CWCB meeting. The CWCB meetings are posted at www.cwcb.state.co.us and are generally the third week of the month.**

*** For the Statewide Account, the Application Deadline is 60 Days Prior to the March and September CWCB Board Meetings.**

*** In completing the application you may attach additional sheets if the form does not provide adequate space. If additional sheets are attached please be sure to reference the section number of the application that you are addressing (i.e., A.1. etc.).**

Instructions: This application form should be emailed, typed, or printed neatly. The Water Supply Reserve Account Criteria and Guidelines can be found at http://cwcb.state.co.us/IWMD/. **The criteria and guidelines should be reviewed and followed when completing this application**. You may attach additional sheets as necessary to fully answer any question, or to provide additional information that you feel would be helpful in evaluating this application. Include with your application a cover letter summarizing your request for a grant. If you have difficulty with any part of the application, contact Rick Brown of the Intrastate Water Management and Development (Colorado Water Conservation Board) for assistance, at (303) 866-3514 or email Rick at rick.brown@state.co.us.

Generally, the applicant is also the prospective owner and sponsor of the proposed water activity. If this is not the case, contact the Rick Brown before completing this application.

Water Supply Reserve Account – Grant Application Form

Form Revised October 2006

Part A. - Description of the Applicant (Project Sponsor or Owner);

1. Applicant Name(s): Southeastern Colorado Water Conservancy District

   Mailing address: 31717 United Ave.
   Pueblo, CO 81001

   Taxpayer ID#: 846012143 Email address: jean@secwcd.com

   Phone Numbers: Business: 719-948-2400
   Home: 719-251-2845
   Fax: 719-948-0036

2. Person to contact regarding this application if different from above:

   Name: Jean Van Pelt

   Position/Title: Conservation Outreach Coordinator

3. Provide a brief description of your organization below: Refer to Part 2 of criteria and guidance for required Information. Attach additional sheet(s) as needed.

The Southeastern Colorado Water Conservancy District (District) was formed under Colorado State Statutes on April 29, 1958 by the District Court in Pueblo, Colorado. The District's purpose is to develop and administer the Fryingpan-Arkansas Project. The District holds the water rights to the Project. The District has allocated an average of 55,600 acre-feet of water annually to cities, towns, municipalities, and ditch, canal, reservoir and irrigation companies within the District. In addition, the District provides water and return flows for well augmentation.

The District encompasses portions of Bent, Chaffee, Crowley, El Paso, Fremont, Kiowa, Otero, Prowers, and, Pueblo counties within the Arkansas River Basin. The District includes large metropolitan cities, small (Addendum Part A. 3.)

Water Supply Reserve Account – Grant Application Form

Form Revised October 2006

Part B. - Description of the Water Activity – Please Refer to Criteria and Guidance Document for Eligibly Criteria

1. Name of water activity/project:

Application for Grant Funding to Develop a Strategic Plan for the Long-Term Management of Non-native Phreatophyte Trees and a Mapping Project for the Arkansas River Basin.

2. What is the purpose of this grant application? Check one.

[ ] Environmental compliance and feasibility study

[ ] Technical assistance regarding permitting, feasibility studies, and environmental compliance

[X] Studies or analysis of structural, nonstructural, consumptive, nonconsumptive water needs, projects, or activities (Please specify) **(Please see - Addendum Part B. 2.)**

[X] Structural and/or nonstructural water project or activity – **Non-Structural Water Activity**

3. Please provide an overview of water project or activity to be funded including – type of activity, statement of what the activity is intended to accomplish, the need for the activity, the problems and opportunities to be addressed, expectations of the participants, why the activity is important, the service area or geographic location, and any relevant issues etc. Please include any relevant Tabor issues. Please refer to Part 2 of criteria and guidance document for additional detail on information to include. Attach additional sheets as needed.

Southeastern Colorado Water Conservancy District is requesting $50,000 in grant funding to assist in funding the development of a Strategic Plan for the Long-Term Management of Non-Native Phreatophyte Trees and to finish mapping the Basin to inventory the infestation level of these invasive species.

Non-native phreatophytes trees (Tamarisk, Russian olive and Siberian elm), have infested much of the riparian lands and are moving into the upland areas within the Arkansas River Basin. The invasives are causing serious impacts to our limited water resources. The Tamarisk Coalition has estimated on the main stem of the Arkansas River the current water losses, above and beyond what native vegetation would use, is 46,600 acre feet per year. When the water loss from the major tributaries and reservoirs are added an additional 12,000 acre feet per year is being lost. If this problem is not addressed, future water losses from "infilling" only (no expansion from existing infested areas) are estimated to be 86,000 acre-feet per year on the river and 44,000 acre feet on the major tributaries and reservoirs. In addition, dense stands of the non-native trees have restricted recreational accessibility, negatively impacted wildlife habitat, and increased the risk for wildfires and flooding.

The planning and mapping project is designed to develop a comprehensive approach on a basin-wide scale, without which control efforts will be largely ineffective. A specific goal is to develop a strategic long-term management plan to efficiently and effectively implement control, riparian restoration, monitoring, and maintenance measures. To compliment the Plan a comprehensive data base will be developed that will assist property owners and land managers in determining proper control, restoration, monitoring, and long-term maintenance methods for a particular infestation level and land situation. This data base will be available on a website and it will enable the District and agencies to track the progress of the Plan as it is implemented.

The Strategic Plan would assist the Basin in implementing Governor Owens' 2003 Executive Order and the Department of Natural Resource's 2004 10-year Plan to Control Tamarisk and Restore Riparian Plant Communities in Colorado. The Strategic Plan will also assist the Basin in taking advantage of the funding source created by the recently passed Federal legislation H.R. 2720, "The Salt Cedar and Russian Olive Control Demonstration Act". In addition, it will support securing funds from new and existing state and federal programs, foundations, and other sources.

Another extremely important element of the project (Addendum Part B.3.)

4. Please provide a brief narrative of any related or relevant previous studies. Attach additional sheets as needed.

The District has contributed to and utilized the mapping data the National Institute of Invasive Species has developed in regard to levels of Tamarisk infestations in the Arkansas Basin.

As previously stated, the District supported the mapping project on the main-stem of the Arkansas River and the major tributaries performed by CWCB and the Tamarisk Coalition. This data has been very beneficial in determining acres of infestation and average density, estimate of current and future water losses, as well as the costs associated with control, revegetation and long-term management. (Addendum Part B.4.A – Tamarisk Mapping and Inventory, Arkansas and Purgatoire Rivers)

The District is also providing support and in-kind contributions to Dr. Ken Lair's research performed for the Bureau of Reclamation regarding the Evaluation of Invasive Species Management Strategies and Technologies for Protection of Drawdown Zones in Annually Drafted or Drought-Affected Reservoirs. (Addendum Part B.4.B-USBR grant information) The in-kind contribution consists of technical review of experimental approach, assessment of vegetation and hydrologic data gaps and availability and assistance with site selection, sampling design and field data collection. The research project will be completed the end of 2007.

Colorado State University (CSU) and the University of Denver are conducting a research project in the upper basin pertaining to types of control and revegetation methods for Tamarisk. The end results will be a Best Management Practices handbook that is specific to this area. This information will be implemented into the proposed Plan and data base.

The District has financially supported CSU's Lower Arkansas valley research project performed by Dr. Timothy Gates, Dr. Luis Garcia and Dr. John Labadie. The focus of the research is to develop field data and modeling tools (Addendum Part A.4.C.)

5. Please provide a copy of the proposed scope of work. Please refer to Part 2 of the criteria and guidance document for detailed requirements. Attach additional sheets as needed.

The Southeastern Colorado Water Conservancy District requests a grant for $50,000 from the Water Supply Reserve Account for the purpose of developing a strategic plan for the long-term management of non-native phreatophyte trees and a mapping project for the Basin. We believe this project fits the constraints of Senate Bill 06-179 as called out in subparagraph III. The strategic plan development and mapping project complies with items C and D of that Act.

The District's goal is to serve in a leadership position overseeing a basin-wide approach to the Tamarisk problem. The six objectives necessary to fulfill this goal are:

1. Develop a plan that encompasses the entire Basin.
2. Perform an inventory of the extent of infestation within the Basin.
3. Implement various types of control measures to remove the invasive species.
4. Restore the native vegetation.
5. Perform monitoring projects to gauge success and increase knowledge.
6. Oversee the long-term management to ensure the problem doesn't rebound.

To assist in the Plan development a Technical Advisory Committee will be created that will consist of mapping and GIS specialists, federal, state and local agencies, weed managers, university staff, Tamarisk Coalition staff, etc. This Committee will assist with identifying the ecological setting of the Basin and gathering information that will be used in the development of the Plan. This information will include mapping and land uses, community input for water resource protection and development, wildlife enhancement, economic and cultural goals, and health and safety issues.

The Plan will need to define alternatives and select a course of action by defining short and long term goals. The alternatives and goals will be based on federal, state, and local community desires and the existing ecological setting. In addition, ways to provide short, intermediate, and long-term funding alternatives for implemenatatin of the plan will have to be developed and secured. Funding needs to be consistent and may be available from federal, state, local sources, foundations, taxes, user fees, bonds, incentives, and grants.

The Arkansas River Basin Plan for Long-term Management of Nonnative Phreatophytes Trees will provide a broad framework for management of (Addendum Part B.5.A., Addendum Part B.5.B. - budget information and Addendum Part B.5.C.- project schedule.)

6. List the names and addresses of any technical or legal consultants retained to represent the applicant or to conduct investigations for the water activity/project.

Name	Address/Phone Number
Burns, Figa & Will P.C.	6400 S. Fiddlers Green Circle Suite 1030, Greenwood Village, CO 80111 303-796-2626
Tim Carlson, Tamarisk Coalition	PO Box 1907 Grand Junction, CO 81052 970-256-7400

7. Water Availability and Sustainability – this information is needed to assess the viability and effectiveness of the water project or activity. Please provide a description of each water supply source to be utilized for, or the water body to be affected by, the water activity. For water supply sources being utilized, describe its location, yield, extent of development, and water right status. For water bodies being affected, describe its location, extent of development, and the expected effect of the water activity on the water body, in either case, the analysis should take into consideration a reasonable range of hydrologic variation. Attach additional sheets as needed.

Non-native phreatophyte trees have infested much of the riparian lands and are moving into the upland areas within the Arkansas Basin. Dense stands of the non-native trees have restricted recreational accessibility, negatively impacted wildlife habitat, and increased the risk for wildfires and flooding. In addition, these invasives are causing serious impacts to an already limited and over-appropriated water resource. The Tamarisk Coalition has estimated on the main-stem of the Arkansas River the current water losses, above and beyond what native vegetation would use, is 46,600 acre-feet per year. When the water loss from the major tributaries and reservoirs are added in an additional 12,000 acre-feet per year is being lost. If this problem is not addressed, future water losses from "infilling only" (no expansion from existing infested areas) are estimated to be 86,000 acre-feet per year on the river and 44,000 acre feet on the major tributaries and reservoirs. (Addendum Part B. 4. A.- Tamarisk Coalition Mapping & Inventory Summary – Arkansas & Purgatoire River)

8. If you have not specifically and fully addressed the Evaluation Criteria found in Part 3 of the criteria and guidance document please provide additional detail here. Attach additional sheet(s) if needed.

Promoting Collaboration & Cooperation
a. The Plan can become a catalyst for cooperation in the Arkansas Basin by bringing multiple interests together to control an invasive species that is consuming huge amounts of a limited supply of water resources and overtaking riparian and upland areas.
b. There are nineteen counties represented in the Basin and each will be asked to contribute either financially or with in-kind assistance. The collaborative effort will help stop the spreading of trees and will assist with reducing the gap that SWSI has identified in the Basin.
Facilitating Water Activity Implementation
c. Without funding for this project the region will not have a long-term Plan that will(Please see Addendum Part B.8.)

9. Additional Information – If you feel you would like to add any additional pertinent information please feel free to do so here. Attach additional sheets as needed.

The above statements are true to the best of my knowledge:

Signature of Applicant: James W. Broderick

Print Applicant's Name: James W. Broderick

Return this application to:

Mr. Rick Brown
Intrastate Water Management and Development Section
COLORADO WATER CONSERVATION BOARD
1580 Logan Street, Suite 600
Denver, CO 80203

To submit applications by Email, send to: rick.brown@state.co.us

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Reference Information

The following information is available via the internet. The reference information provides additional detail and background information regarding these criteria and guidelines and water policy issues affecting our state.

Colorado Water Conservation Board Policies

Loan and Grant policies and information are available at - http://cwcb.state.co.us/Finance/

Water Supply Reserve Account Criteria and Guidelines –
http://cwcb.state.co.us/IWMD/tools.htm#Water_Supply_Reserve_Account

Interbasin Compact Committee and Basin Roundtables

Interbasin Compact Committee By-laws and Charter –
http://dnr.state.co.us/Home/ColoradoWaterforthe21stCentury/Interbasin+Compact+Committee/IbccHomePage.htm

Basin Roundtable By-laws –
http://dnr.state.co.us/Home/ColoradoWaterforthe21stCentury/IbccHome.htm

Legislation

House Bill 05-1177 - Also known as the Water for the 21st Century Act –
http://cwcb.state.co.us/IWMD/statutes.htm

House Bill 06-1400 – Adopted the Interbasin Compact Committee Charter –
http://cwcb.state.co.us/IWMD/statutes.htm

Senate Bill 06-179 – Created the Water Supply Reserve Account –
http://cwcb.state.co.us/IWMD/statutes.htm

Statewide Water Supply Initiative

General Information - http://cwcb.state.co.us/IWMD/

Phase 1 Report - http://cwcb.state.co.us/IWMD/PhaseIReport.htm

Addendum Part A. 3.
Provide a brief description of your organization

rural towns, and agricultural areas ranging from very small farms to large ranching operations. It truly is representative of "Rural America" where the agricultural sectors are suffering out-migration and the larger metropolitan areas are facing problems common to growing areas.

The District is governed by a 15-member Board of Directors that are appointed by district court judges. The District's daily operations are managed by an Executive Director, with a staff that includes a Manager of Projects, Director of Engineering and Resource Management, Water Conservation Coordinator, Administrative Manager, Engineering Support Specialist, Finance Manager, and an Administrative Associate.

The District has increased significantly in valuation. When formed in 1958, the District had an assessed valuation of slightly less that $400 million. The assessed valuation in 2006 was approximately $6.3 billion.

District activities are supported and financed by ad valorem taxes paid by taxpayers within the District boundaries. Property owners pay up to a 1 percent mill ad valorem tax to support District operations and guarantee the repayment contract with the Federal government.

The overriding priority of the District continues to be the annual fulfillment of its obligations as defined by statute and contract commitments with its water users and the United States. Among these priorities are ongoing commitments to water conservation.

As the largest wholesale water distributor in the area, District operations, to some degree, influence all water and related land resource activities in its service area. Policies established by the Board of Directors consistently have been aimed at yielding maximum possible benefits to its water users through flexibility of operations and adaptability to changing needs. The District Board members and staff encourage policies of wise and efficient use of all available water supplies.

On June19, 2003 the District Board of Directors adopted a resolution authorizing the District to participate in the continued pursuit of a western-wide Tamarisk Control Program using a regional approach. The District Board supported the efforts to pass legislation providing the financial tools for the implementation of regional projects for the control of Tamarisk and other non-native plants impacting western rivers.

Robert Hamilton, Director of Engineering and Resource Management for the District, was appointed to represent the Arkansas River Basin on the Board of Directors of the Tamarisk Coalition. The Coalition is a non-profit alliance working to restore riparian lands. In September 2004, the Board of Directors unanimously supported a resolution to financially contribute to the Tamarisk Coalition

Addendum Part A.4.C.

Please provide a brief narrative of any related or relevant previous studies.

that can be incorporated into decision-making criteria to maximize “liberated” water via reduction in nonbeneficial consumptive use from high water tables under fallow alluvial land and from invasive phreatophyte vegetation along the river corridor.

The District has been active in outreach and education by sponsoring numerous workshops, tours, and seminars pertaining to funding sources and control and restoration methods. The District also contributes technical assistance and participates with organized projects for controlling these invasives within the Basin.

Part B. 2. Addendum

Studies or analysis of structural, nonstructural, consumptive, nonconsumptive water needs, projects, or activities (Please specify)

The purpose is to develop a nonstructural strategic plan for the long-term management of non-native phreatophyte trees and a mapping project for the Arkansas River Basin.

Addendum Part B. 3.

Please provide an overview of water project or activity to be funded.

is to map the entire basin to provide a clear understanding of the extent of the problem. The Tamarisk Coalition, with funding from the Colorado Water Conservation Board, the District and the Purgatoire River Water Conservancy District, recently mapped the lower portion of the main stem of the Arkansas River and several of the major tributaries. Unfortunately, the mapping project is incomplete because it does not include the upper basin from Pueblo Reservoir west to the headwaters, small reservoirs, lakes and ponds, nor the hundreds of miles of creeks, ephemeral streams, canals, ditches, and dry washes that harbor these thirsty invaders. This type of information is invaluable in determining the total acres of infestation and average density, estimate of current and future water losses, as well as the costs associated with control, revegetation and long-term management.

Tamarisk Mapping & Inventory Summary
Arkansas and Purgatoire Rivers

Inventory Background & Objectives – In 2005 and 2006, the Tamarisk Coalition completed an inventory of tamarisk infestations on the Arkansas River and Purgatoire River watersheds and their main tributaries for the Colorado Water Conservation Board (CWCB). The purpose of this work was to establish and implement an inventory protocol that would be economical to perform and would provide a clear understanding of the extent of the tamarisk problem. These inventory/mapping protocols (attached) proved to be successful and were used in 2006 to identify tamarisk throughout the remainder of the state.

Inventory Approach – Inventory and mapping were coordinated with the U.S. Geological Survey's (USGS) efforts to establish a national on-line database conforming to the weed mapping standards developed by the North American Weed Management Association. The basic approach utilized existing aerial photography, satellite imagery, and local knowledge available from counties, river districts, soil and water conservation districts, state agencies, Army Corps of Engineers, National Resources Conservation Service, USGS, CSU, and The Nature Conservancy. This information was then "ground-truthed" by a 2-man team to confirm infestation density, maturity, height, accessibility, presence of native species, and miscellaneous site characteristics. GPS data and digital photo records were taken and shapefiles were developed using GIS. Over 600 miles of main stem river, major tributaries, and major reservoirs were surveyed using this approach. The starting point for the Arkansas River was Pueblo Reservoir dam and for the Purgatoire River it was Trinidad Reservoir dam. This information, in the form of shapefiles and attribute data, has been transformed into a digital GIS database which soon will be available on the USGS invasive species website, www.niiss.org .

Finding – The inventory data for the Arkansas and Purgatoire rivers and their major tributaries are presented in Tables 1 through 4 which are attached for each River. Table 1 presents the general mapping data; whereas, Table 2 provides estimates on current and future water losses associated with the tamarisk infestations and the estimated costs for tamarisk control and revegetation. Tables 3 and 4 provide detailed information on each infested area (shapefiles) and its unique attributes. The water losses and cost estimates are based on the most recent research and statistical analysis available through the USDA, NOAA, USGS, CSU, National Invasive Species Council, Tamarisk Coalition, and others. The following represents the major findings (Note: values presented below are rounded from Tables 1-4:

1. The Arkansas River from the CO/KS state line has approximately 29,000 total acres of tamarisk infestation with an average density (canopy cover) of 54%. Because the Arkansas River tends to be a broad floodplain river, its tamarisk infestations are wide averaging over 1,200 feet with a maximum width of nearly one and a half miles near John Martin Reservoir.

2. The Purgatoire River has both broad floodplains and a narrow canyon section. As a result, it has significant areas of infestation (9,250) but has a relatively low average density of 29%. Purgatoire River tributaries are also lightly infested with 26% average density and approximately 750 acres of total infested area.

3. The major tributaries for the Arkansas River (Huerfano River, Fountain Creek, Big Sandy Creek, and Buffalo Creek) have 4,850 acres of infestation with major reservoirs (Lake Meredith, Adobe Creek, Neeskah, Neenoshe, and Sheridan Lake) having an additional 9,800 acres of infestation. The average density for all of these areas is approximately 28%.

4. Current water losses are based on the amount of water tamarisk is using under observed densities minus the water that would be used by native plants. Figure 1 represents the differences in vegetative cover with and without tamarisk and illustrates tamarisk occupying an area much greater than the riparian zone which typically would support cottonwoods and willows, also phreatophytes. The significant water losses occur as tamarisk occupies upland areas within the floodplain that would normally have dryland xeric vegetation such as grasses, sage, rabbit brush, etc. These uplands of the Arkansas and Purgatoire rivers and their tributaries typically exceed 50% of the tamarisk infested areas. Based on these conditions, the estimates of current water losses above and beyond what native vegetation would use are:

    a. Arkansas River = 46,600 acre-feet per year.
    b. Arkansas River major tributaries and reservoirs = 12,000 acre-feet per year.
    c. Purgatoire River = 8,000 acre-feet per year.
    d. Purgatoire River major tributaries = 600 acre-feet per year.

5. Future water losses assume an infilling of the existing infestation areas that will likely occur over the next several decades based on similar conditions observed in other states (NM, UT, and NV). Future water losses from infilling only (no expansion from existing infested areas) are estimated to be:

    a. Arkansas River = 86,000 acre-feet per year.
    b. Arkansas River major tributaries and reservoirs = 44,000 acre-feet per year.
    c. Purgatoire River = 27,000 acre-feet per year.
    d. Purgatoire River major tributaries = 2,000 acre-feet per year.

6. Costs for tamarisk control and revegetation are based on current work being performed by the National Invasive Species Council on an economic model that incorporates *Integrated Pest Management* practices with planning, design, control, revegetation, monitoring, and maintenance activities. Estimated costs are summarized in Table 5:

Table 5: Economic summary

River	Total Costs*	Average Cost per Acre Treated*	Average Cost per Acre-foot of Water Preserved*	Average Cost per Mile*
Arkansas River	$44,000,000 (±$9,500,000)	$1,500	$950	$220,000
Arkansas R. Tributaries & Reservoirs	$12,000,000 (±$1,700,000)	$850	$1,000	$53,000
Purgatoire River	$8,000,000 (±$1,000,000)	$870	$1,000	$45,000
Purgatoire R. Tributaries	$600,000 (±$80,000)	$810	$1,100	$2,000

* Rounded values from Tables 2

7. If tamarisk control and revegetation occurs on any of these river or tributary sections, the water lost to the atmosphere through evapotranspiration will be preserved within the groundwater and/or surface water regimes. It is unknown at this time, without further research, when and if these waters would be available for beneficial uses.

8. The costs of water retained within the hydrologic system of approximately $1,000 per acre-foot should be compared to the value placed on the purchase of senior water rights because tamarisk is always using water even during a drought.

9. The method used to develop this inventory information is predicted to identify 85 to 90 percent of tamarisk within the watersheds of the Arkansas and Purgatoire rivers. The remaining percentage represents small pockets of infestations that are scattered throughout the region. Because these outlying infestations are not included in the cost development, a contingency of approximately 20% should be added to these cost values to account for their identification and remediation.

Tamarisk Induced Changes *in* Channel Structure *and* Associated Habitats

Tim Carlson[1], Greg Newman[2], Tom Stohlgren[2,3]
[1] The Tamarisk Coalition
[2] Natural Resource Ecology Laboratory, Colorado State University
[3] United States Geological Survey, Fort Collins Science Center

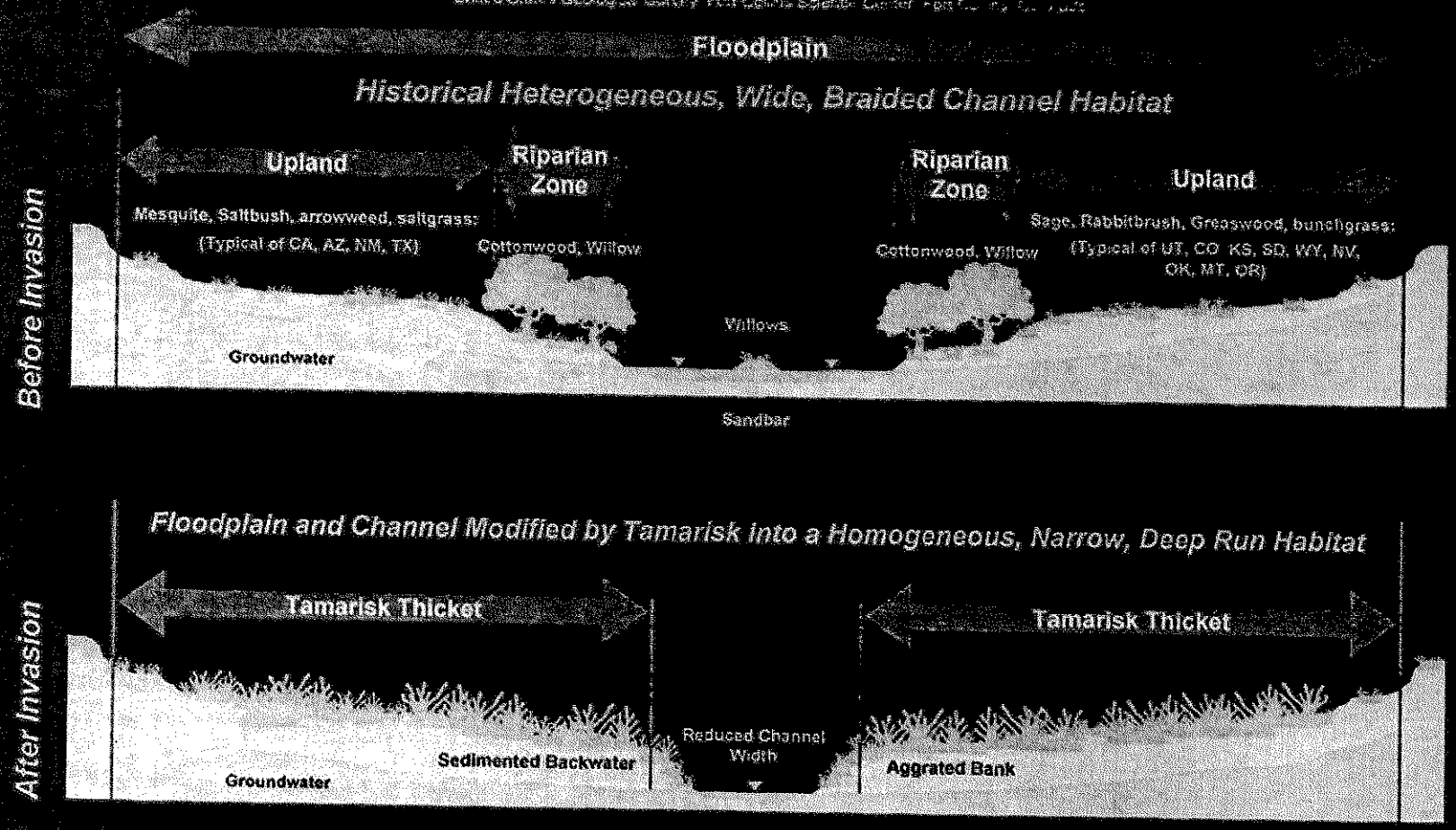

Figure 1

Acknowledgements:
Tim Carlson, Tom Stohlgren, Greg Newman
Jim Graham, Catherine Jarnevich, Tracy Davern, Paul Evangelista, Alycia Waters-Crail, Rick Shory
The Tamarisk Coalition, United States Geological Survey, National Aeronautics and Space Administration, Natural Resource Ecology Laboratory, Colorado State University

Arkansas Table 1: General Tamarisk Inventory Data for Arkansas River and its Related Waterways CO/KS state line to Pueblo Reservoir Dam, CO

Arkansas River Main Stem	Cummulative River Miles	Average Width (ft)	Max Width (ft)	Min Width (ft)	Average Density (%)	Total Acreage	Total Canopy Cover (acres)
CO/KS State Line	0						
Prowers County	49	1,025	3,200	180	59%	6,088	3,609
Bent County	91	1,908	7,000	200	68%	9,714	6,593
Otero County	145	944	4,300	280	49%	6,177	3,018
Pueblo County to Pueblo Dam	197	1,115	5,900	150	36%	7,026	2,545
Totals =	**197**	**1,215**			**54%**	**29,005**	**15,765**

Related Waterways	River Miles	Average Width (ft)	Max Width (ft)	Min Width (ft)	Average Density (%)	Total Acreage	Total Canopy Cover (acres)
Huerfano River	20	759	2,700	30	29%	1,840	529
Fountain Creek	22	732	2,100	30	26%	1,953	514
Arkansas Reservoirs*	N/A	N/A	N/A	N/A	28%	9,790	2,706
Arkansas Tributaries**	40	218	1,060	10	27%	1,058	284
Totals =	**82**				**28%**	**14,641**	**4,033**

***Arkansas Reservoirs include: Lake Meredith, Adobe Creek Res., Neeskah Res., Neenoshe Res., and Sheridan Lake**
****Arkansas Tributaries include: Big Sandy Creek and Buffalo Creek**

Minimum width may exceed average width because some areas of low infestations are not continuous along a river stretch.

Arkansas Table 2: Existing and Future Water Loss Estimates due to Tamarisk Infestations in Arkansas River Watershed and Estimated Control & Revegetation

Arkansas River Main Stem	Cummulative River Miles	Average Density (%)	Total Acreage	Total Canopy Cover (acres)	% Area capable of Supporting Cottonwood/Willow Plant Community	Current Water Loss (acre-feet/year)	Future Water Loss (acre-feet/year)	***Cost estimates for Tamarisk Control & Revegetation
CO/KS State Line	0							
Prowers County	49	59%	6,088	3,609	55%	10,422	17,579	$10,054,330
Bent County	91	68%	9,714	6,593	43%	19,711	29,040	$18,220,239
Otero County	145	49%	6,177	3,018	46%	8,956	18,331	$8,573,169
Pueblo County to Pueblo Dam	197	36%	7,026	2,545	46%	7,542	20,825	$7,276,000
Totals =	**197**	**54%**	**29,005**	**15,765**	**47%**	**46,631**	**85,775**	**$44,123,739**
							High Range =	**$53,732,226**
							Low Range =	**$34,514,769**
							Average cost per acre of infestation =	**$1,521**
							Average cost per acre-foot of water preserved as groundwater and/or surface water =	**$946**
							Average cost per mile =	**$223,978**

Related Waterways	River Miles	Average Density (%)	Total Acreage	Total Canopy Cover (acres)	% Area capable of Supporting Cottonwood/Willow Plant Community	Current Water Loss (acre-feet/year)	Future Water Loss (acre-feet/year)	***Cost estimates for Tamarisk Control & Revegetation
Huerfano River	20	29%	1,840	529	39%	1,598	5,559	$1,917,038
Fountain Creek	22	26%	1,953	514	75%	1,397	5,309	$1,502,806
Arkansas Reservoirs*	N/A	28%	9,790	2,706	41%	8,127	29,404	$7,825,675
Arkansas Tributaries**	40	27%	1,058	284	23%	895	3,338	$930,687
Totals =	**82**	**28%**	**14,641**	**4,033**	**44%**	**12,017**	**43,609**	**$12,176,205**
							High Range =	**$13,814,313**
							Low Range =	**$10,528,098**
							Average cost per acre of infestation =	**$832**
							Average cost per acre-foot of water preserved as groundwater and/or surface water =	**$1,013**
							Average cost per mile (excluding reservoirs) =	**$53,055**

***Arkansas Reservoirs include: Lake Meredith, Adobe Creek Res., Neeskah Res., Neenoshe Res., and Sheridan Lake**
****Arkansas Tributaries include: Big Sandy Creek and Buffalo Creek**

Assumptions:

1. Cottonwood/Willow plant community (CW) will use approximately the same water/year as tamarisk @ 4.35 feet/year
2. Of the area capable of supporting CW vegetation, 25% will actually be occupied based on research evidence.
3. Areas that will not support CW vegetation, plants will be xeric in nature; e.g., dryland grasses, sage, shrubs, which use only water derived through precipitation
4. Dryland vegetation water use within study area is estimated to equal average precipitation of approximately 1.0 feet of water/year per NOAA and USDA-NRCS data (1961-1990).
5. Future water loss assumes infilling of tamarisk at 100% with no expansion of range

Current Water Loss = (Average tamarisk density)(0.75)(CW acreage)(4.35 - 1.0 feet/year)(Total acreage) + (Average tamarisk density)(1.0 - CW acreage)(4.35 - 1.0 feet/year)(Total acreage)

Future Water Loss = (0.75)(CW acreage)(4.35 - 1.0 feet/year)(Total acreage) + (1.0 - CW arerage)(4.35 - 1.0 feet/year)(Total acreage)

***Costs are based on detailed cost information found in *Options for Non-Native Phreatophyte Control,* March 2006, Tamarisk Coalition

Arkansas Table 3: Arkansas River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
Main Stem Arkansas: Kansas/Colorado Border to Prowers/Bent County Line												
a14	1.80	70	1.26	**50**	0.90		good**					
a15	120.69	60	72.41	**50**	60.34		good**					
p1-1	190.87	80	152.70	40	114.52	mature	good		2	p	np	np
p1-2	140.08	80	112.07	30	98.06	mature	good		2	p	np	np
p1-3	128.10	40	51.24	40	76.86	mature	good		3	p	p	np
p1-4	171.08	30	51.32	20	136.86	mature	good		4, 5	p	p	p
a16	436.56	50	218.28	**50**	218.28		good**					
p1-5	158.22	90	142.40	10	142.40	mature	good		6, 7	np	np	np
p1-6	86.42	80	69.13	40	51.85	mature	good		8	np	p	np
p1-7	78.74	80	63.00	**50**	39.37	immature	good		9	np	np	np
p1-9	252.63	80	202.10	60	101.05	mature	good		11, 12	np	np	np
p1-8	169.58	90	152.62	50	84.79	mature	good		10	np	np	np
p1-12	176.76	30	53.03	70	53.03	mature	good		15	np	np	np
p1-10	164.48	50	82.24	60	65.79	mature	good		13	p	np	np
p1-11	105.51	85	89.68	**50**	52.76	mature	good		14	np	np	np
p1-13	97.99	60	58.80	40	58.80	mature	good		16	np	np	np
p1-14	268.45	60	161.07	50	134.23	mature	good		18, 19	p	p	np
a17	557.07	70	389.95	**50**	278.53		good**					
p1-15	148.88	80	119.10	40	89.33	mature	good		20	p	p	np
p1-16	198.48	60	119.09	40	119.09	mature	good		21	p	p	np
p1-17	414.79	50	207.39	40	248.87	mature	good		22, 23	p	p	np
p1-18	197.88	30	59.36	60	79.15	mature	good		24	p	p	np
p1-19	346.52	50	173.26	30	242.56	mature	good		25	p	p	p
p1-20	188.92	10	18.89	20	151.14	mature	good		26	p	p	np
a18	24.41	50	12.21	**50**	12.21		good**					
p1-21	189.27	70	132.49	40	113.56	mature	poor		28	p	p	p
a19	1,073.41	60	644.05	**50**	536.71		good**					
Subtotal	**6,087.60**		**3,609.14**		**3,361.03**							
Main Stem Arkansas: Bent County (including John Martin Reservoir)												
b1-2	227.91	60	136.74	70	68.37	mature	good		52, 53	np	np	p
b1-3	47.09	80	37.67	70	14.13	mature	good		54	np	np	
b1-4	131.47	80	105.18	50	65.74	mature	good		55	np	np	np
a10	27.43	70	19.20	**50**	13.72		good**					
b1-7	193.73	30	58.12	80	38.75	mature	good		59	p	p	np
b1-5	147.95	80	118.36	80	29.59	mature	good		56, 57	np	p	np
b1-6	235.39	10	23.54	100	0.00	mature	good		58	p	np	np
b1-8	229.78	80	183.82	80	45.96	mature	good		60	np	np	np
b1-9	74.47	80	59.58	80	14.89	mature	good		61	np	np	np
b1-10	38.78	50	19.39	80	7.76	mature	good		62, 63	np	np	np
a11	568.42	60	341.05	**50**	284.21		good**					
b1-19	442.21	60	265.33	**50**	221.11		good**					
a12	127.48	80	101.98	**50**	63.74		good**					
b1-18	88.45	80	70.76	50	44.23	mature	poor		70	p	p	p
b1-17	173.36	80	138.68	50	86.68	mature	good		69	p	p	p
a13	145.06	70	101.54	**50**	72.53		good**					
b1-14	262.28	60	157.37	80	52.46	mature	good		66	p	p	np
b1-13	160.38	70	112.26	**50**	80.19	mature	good		65	p	p	np
b1-12	17.40	75	13.05	**50**	8.70	mature	good		64	p	np	np
b1-11	282.45	70	197.71	70	84.73	mature	good		63	p	p	p

Arkansas Table 3: Arkansas River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow	Russian Olive
jm1	500.97	70	350.68	50	250.49		good**					
jm2	422.58	70	295.80	50	211.29		good**					
jm3	81.93	80	65.55	50	40.97		good**					
jm4	229.63	70	160.74	50	114.81		good**					
jm5	54.61	70	38.23	50	27.31		good**					
jm6	11.75	80	9.40	50	5.87		good**					
jm7	69.94	70	48.95	50	34.97		good**					
jm8	68.94	60	41.37	50	34.47		good**					
jm9	76.07	70	53.25	50	38.03		good**					
jm10	87.32	80	69.86	50	43.66		good**					
jm11	346.82	80	277.46	50	173.41		good**					
jm12	464.01	80	371.21	50	232.00		good**					
jm13	114.48	80	91.59	50	57.24		good**					
jm14	133.93	80	107.14	50	66.97		good**					
jm15	466.20	80	372.96	50	233.10		good**					
jm16	48.96	70	34.27	50	24.48		good**					
jm17	208.95	70	146.27	50	104.48		good**					
jm18	135.82	70	95.07	50	67.91		good**					
jm19	249.10	70	174.37	50	124.55		good**					
jm20	184.15	70	128.90	50	92.07		good**					
jm21	98.81	70	69.17	50	49.41		good**					
jm22	321.96	70	225.37	50	160.98		good**					
jm23	25.36	70	17.75	50	12.68		good**					
jm24	115.38	70	80.77	50	57.69		good**					
jm25	75.23	80	60.18	50	37.61		good**					
jm26	22.15	80	17.72	50	11.08		good**					
jm27	213.33	80	170.67	50	106.67		good**					
jm28	47.36	60	28.42	50	23.68		good**					
jm29	7.01	70	4.90	50	3.50		good**					
jm30	10.22	60	6.13	50	5.11		good**					
jm31	669.90	50	334.95	50	334.95		good**					
b1-15	149.26	60	89.56	50	74.63	mature	good		67	p	np	np
b1-15	55.08	60	33.05	50	27.54	mature	good		67	p	np	np
b1-16	325.03	80	260.03	100	0.00	mature	good		68	p	p	p
b1-16	0.21	80	0.17	100	0.00	mature	good		68	p	p	p
Subtotal	**9,713.94**		**6,593.24**		**4,181.06**							
Main Stem Arkansas: Otero County												
o1-1	538.23	60	322.94	70	161.47	mature	good		97	p	np	np
a5	106.85	60	64.11	50	53.42		good**					
o1-3	219.72	50	109.86	50	109.86	mature	good		98	p	p	p
o1-2	207.45	60	124.47	60	82.98	mature	good		98	p	p	np
o1-4	158.94	30	47.68	60	63.58	mature	poor		100	p	p	np
o1-5	119.62	75	89.71	70	35.88	mature	good		101	p	np	np
o1-6	173.31	40	69.32	50	86.66	mature	good		102	p	p	p
o1-7	191.71	25	47.93	50	95.86	mature	good		104	p	p	p
o1-8	215.36	85	183.05	90	21.54	mature	good		105	np	np	np
a6	139.11	70	97.38	50	69.56		good**					
o1-9	155.48	60	93.29	50	77.74	mature	good		106	p	p	p
o1-11	34.95	40	13.98	50	17.47	mature	good		109	np	np	np
o1-10	244.86	65	159.16	60	97.94	mature	good		108	np	np	np

Arkansas Table 3: Arkansas River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
a7	225.38	45	101.42	**50**	112.69		good**					
o1-12	154.11	20	30.82	20	123.29	mature	good		110	p	np	np
o1-13	110.32	10	11.03	50	55.16	immature	good		111	p	p	p
o1-14	151.41	40	60.56	40	90.85	mature	good		113	p	p	p
o1-15	343.90	70	240.73	50	171.95	mature	good		115	p	p	p
o1-16	73.67	50	36.84	50	36.84	mature	good		116	p	p	p
o1-17	276.49	75	207.37	50	138.24	mature	good		117	p	p	p
o1-18	480.43	50	240.21	50	240.21	mature	poor		119	p	p	p
a8	492.51	40	197.00	**50**	246.25		good**					
o1-19	129.65	20	25.93	50	64.82	mature	good		120	p	p	p
o1-20	228.44	40	91.37	50	114.22	mature	good		122	p	p	p
o1-20	261.07	40	104.43	50	130.53	mature	good		122	p	p	p
o1-21	317.86	20	63.57	70	95.36	mature	good		124	p	np	p
o1-22	292.77	40	117.11	50	146.38	mature	good		125	p	p	p
o1-23	133.73	50	66.87	40	80.24	mature	good		126	p	p	np
Subtotal	**6,177.32**		**3,018.14**		**2,821.00**							
Main Stem Arkansas: Otero County Line to Pueblo Reservoir Dam												
pu1-2	6.31	5	0.32	50	3.15	mature	good		31	p	p	p
pu1-3	5.20	20	1.04	40	3.12	immature	good		33	p	p	p
pu1-4	32.59	10	3.26	50	16.30	mature	good		35	p	p	p
pu1-5	13.06	15	1.96	50	6.53	mature	good		36	p	p	p
pu2-20	26.66	10	2.67	70	8.00	mature	good		126	p	p	p
pu2-22	1.70	5	0.09	50	0.85	mature	good		128	p	p	p
pu2-21	3.37	10	0.34	50	1.68	mature	poor		127	p	p	p
pu2-23	1.26	5	0.06	50	0.63	immature	good		129	p	p	p
pu2-24	6.85	20	1.37	50	3.43	mature	good		130	p	p	p
pu2-25	10.26	20	2.05	100	0.00	mature	good		130	p	p	p
pu2-31	94.70	40	37.88	70	28.41	immature	good		143	p	np	np
pu2-30	189.75	15	28.46	30	132.83	mature	good		142	p	np	p
a1	385.13	15	57.77	**50**	192.57		good**			p		
pu2-26	332.11	10	33.21	20	265.69	mature	good		137	p	p	p
pu1-18	176.01	20	35.20	50	88.01	mature	poor		121	p	p	p
pu1-17	490.98	40	196.39	60	196.39	mature	poor		120	p	np	
a2	91.67	40	36.67	**50**	45.83		good**			p		
pu1-16	477.54	40	191.02	50	238.77	mature	good		118	p	p	p
pu1-16	240.35	40	96.14	50	120.18	mature	good		118	p	p	p
pu1-15	1,338.85	20	267.77	50	669.42	mature	good		102	p	p	p
a3	318.95	40	127.58	**50**	159.48		good**			p		
pu1-14	542.63	60	325.58	70	162.79	mature	good		101	p	np	np
pu1-13	382.10	70	267.47	80	76.42	mature	good		100	p	p	np
pu1-14	305.85	60	183.51	70	91.75	mature	good		101	p	np	np
pu1-12	245.89	30	73.77	50	122.95	mature	good		99	p	p	p
pu1-9	353.20	50	176.60	50	176.60	mature	good		96	p	p	p
pu1-10	92.81	40	37.12	70	27.84	mature	good		97	p	p	p
pu1-11	316.78	40	126.71	50	158.39	mature	good		98	p	p	p
a4	238.08	40	95.23	**50**	119.04		good**			p		
pu1-7	154.18	40	61.67	70	46.25	mature	good		93	p	p	p
a9	151.42	50	75.71	**50**	75.71		good**					
Subtotal	**7,026.24**		**2,544.61**		**3,239.00**							

Arkansas Table 3: Arkansas River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
Arkansas River Total	**29,005.09**		**15,765.14**		**13,602.09**							
Arkansas Related Waterways												
Huerfano River												
h1-11	200.80	60	120.48	30	140.56	mature	good		116	p	p	p
a22	122.19	50	61.09	**50**	61.09		good**					
h1-10	34.55	40	13.82	100	0.00	mature	good		115	np	np	
h1-3	174.65	0	0.00	**50**	87.33	immature	good		106	p	np	
h1-5	59.68	20	11.94	75	14.92	mature	good		109	p	p	np
h1-6	125.66	50	62.83	70	37.70	mature	poor		110	p	np	
h1-7	93.97	20	18.79	**50**	46.99	mature	good		111	p	p	p
h1-8	143.54	20	28.71	100	0.00	immature	good		112	np	np	
h1-9	176.45	15	26.47	**50**	88.22	mature	good		113	p	p	p
a23	64.77	20	12.95	**50**	32.38		good**					
h1-4	21.12	1	0.21	75	5.28	immature	good		107	p	p	p
h1-4	3.50	1	0.04	75	0.88	immature	good		107	p	p	p
h1-2	3.08	0	0.00	**50**	1.54	immature	good		105	p	np	
h1-2	272.82	0	0.00	**50**	136.41	immature	good		105	p	np	
h1-1	341.24	50	170.62	80	68.25	mature	good		104	p	np	
h1-1	1.76	50	0.88	80	0.35	mature	good		104	p	np	
Subtotal	**1,839.79**		**528.83**		**721.90**							
Fountain Creek												
f1-1	85.17	40	34.07	**50**	42.58		good					
f1-2	22.64	10	2.26	**50**	11.32		good					
f1-3	52.64	30	15.79	**50**	26.32		good					
f1-4	63.71	15	9.56	**50**	31.86		good					
f1-6	170.00	20	34.00	80	34.00	mature	good		156	p	p	p
f1-7	143.01	20	28.60	0	143.01	immature	good		157	p	p	p
f1-8	230.05	15	34.51	0	230.05	immature	good		158	p	p	p
f1-9	28.62	5	1.43	0	28.62	mature	poor		159	p	p	p
f1-10	177.05	10	17.71	70	53.12	immature	good		160	p	p	p
f1-11	224.52	70	157.16	0	224.52	immature	good		161.162	p	p	p
f1-12	240.62	20	48.12	0	240.62	immature	good		163	p	p	p
a20	183.61	20	36.72	0	183.61	immature	poor		0	np	np	np
f1-13	89.90	25	22.48	70	26.97	mature	good		164	p	np	np
a21	166.21	25	41.55	0	166.21	immature	poor		0	np	np	np
f1-5	51.92	40	20.77	60	20.77	mature	good		151.152	p	p	p
f1-5	23.23	40	9.29	60	9.29	mature	good		151.152	p	p	p
Subtotal	**1,952.89**		**514.02**		**1,472.86**							
Arkansas Reservoirs												
agc1	473.08	40	189.23	50	236.54	mix	good	4	1	p	np	np
ar1	1.01	60	0.61	**50**	0.50		good**					
agc2	66.13	10	6.61	100	0.00	mix	good	2	2	np	np	np
agc3	38.40	40	15.36	30	26.88	mix	good	3	3	p	np	np

Arkansas Table 3: Arkansas River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
agc3b	512.78	60	307.67	50	256.39	mix	poor			np	np	np
agc4	2,290.02	40	916.01	60	916.01	mix	good	2	4	np	np	np
agc5	2,552.37	30	765.71	50	1,276.18	mix	good	2	5	np	np	np
agc6	695.82	10	69.58	100	0.00	mix	good	3		np	np	np
ar2	582.89	10	58.29	100	0.00	mix	poor			np	np	np
ar3	19.26	10	1.93	100	0.00	mix	poor			np	np	np
agc7	271.01	10	27.10	90	27.10	mix	good	3	6	p	np	np
ar4	182.89	10	18.29	**50**	91.45		good**					
agc8	163.82	30	49.15	50	81.91	mix	good	3	7	p	np	np
agc9	863.25	20	172.65	30	604.27	immature	good	3	8	p	np	np
ar5	611.14	10	61.11	**50**	305.57		good**					
ar6	404.03	10	40.40	**50**	202.01		good**					
ar7	61.79	10	6.18	60	24.72	mix	good	3		np	np	np
Subtotal	**9,789.68**		**2,705.87**		**4,049.54**							
Arkansas Tributaries												
agc10	38.46	20	7.69	90	3.85	mature	good	3	9	np	np	np
agc11	30.10	20	6.02	80	6.02	mature	poor	3	10	np	np	np
agc12	204.33	20	40.87	60	81.73	mature	poor	3	11	np	np	np
agc13	51.15	30	15.35	40	30.69	mature	poor	3	13, 14	p	np	p
agc14	93.34	20	18.67	90	9.33	mature	poor	3		np	np	np
agc15	173.80	40	69.52	80	34.76	mature	poor	3	15,16	np	np	np
at1	14.05	40	5.62	**50**	7.03		poor**					p
at2	67.09	30	20.13		33.55		poor**					p
at3	3.56	50	1.78	100	0.00	mature	good	3		np	np	np
at5	299.44	30	89.83	100	0.00		good**	at5				
at4	83.09	10	8.31	**50**	41.54		poor**					
Subtotal	**1,058.42**		**283.78**		**248.50**							
Arkansas Related Waterways Total	**14,640.78**		**4,032.51**		**6,492.80**							
Arkansas Watershed Total	**43,645.87**		**19,797.65**		**20,094.89**							

Where ground truthing was not availabe for estimation of Percent Upland, a conservative value of 50% upland area was assumed (indicated in bold).

****Non ground-truthed**

Arkansas Table 4 -- Arkansas River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
Main Stem Arkansas: Kansas/Colorado Border to Prowers/Bent County Line								
a14	1.80	70	good**	> 50'	B	$3,471	$4,321	$2,622
a15	120.69	60	good**	> 50'	B	$200,937	$244,044	$157,873
p1-1	190.87	80	good	> 50'	B	$419,164	$534,556	$303,894
p1-2	140.08	80	good	> 50'	B	$307,630	$392,318	$223,032
p1-3	128.10	40	good	> 50'	B	$143,713	$165,997	$121,449
p1-4	171.08	30	good	> 50'	B	$144,713	$162,917	$126,524
a16	436.56	50	good**	> 50'	B	$608,957	$721,393	$496,630
p1-5	158.22	90	good	> 50'	B	$388,775	$507,806	$269,873
p1-6	86.42	80	good	> 50'	B	$189,780	$242,025	$137,591
p1-7	78.74	80	good	> 50'	B	$172,930	$220,536	$125,375
p1-9	252.63	80	good	> 50'	B	$554,795	$707,525	$402,227
p1-8	169.58	90	good	> 50'	B	$416,696	$544,275	$289,254
p1-12	176.76	30	good	> 50'	B	$149,520	$168,330	$130,727
p1-10	164.48	50	good	> 50'	B	$229,435	$271,797	$187,114
p1-11	105.51	85	good	> 50'	B	$245,524	$316,895	$174,230
p1-13	97.99	60	good	> 50'	B	$163,154	$198,155	$128,188
p1-14	268.45	60	good	> 50'	B	$446,960	$542,847	$351,170
a17	557.07	70	good**	> 50'	B	$1,076,251	$1,339,659	$813,115
p1-15	148.88	80	good	> 50'	B	$326,955	$416,962	$237,042
p1-16	198.48	60	good	> 50'	B	$330,464	$401,359	$259,641
p1-17	414.79	50	good	> 50'	B	$578,584	$685,412	$471,860
p1-18	197.88	30	good	> 50'	B	$167,382	$188,438	$146,343
p1-19	346.52	50	good	> 50'	B	$483,356	$572,601	$394,197
p1-20	188.92	10	good	> 50'	B	$53,831	$57,502	$50,162
a18	24.41	50	good**	> 50'	B	$34,050	$40,336	$27,769
p1-21	189.27	70	**poor**	> 50'	D	$430,132	$514,433	$344,718
a19	1,073.41	60	good**	> 50'	B	$1,787,171	$2,170,574	$1,404,156
Subtotal	**6,087.60**					**$10,054,330**	**$12,333,013**	**$7,776,776**
Main Stem Arkansas: Bent County (Including John Martin Reservoir)								
b1-2	227.91	60	good	> 50'	B	$379,448	$460,852	$298,127
b1-3	47.09	80	good	> 50'	B	$103,409	$131,877	$74,972
b1-4	131.47	80	good	> 50'	B	$288,721	$368,204	$209,323
a10	27.43	70	good**	> 50'	B	$53,000	$65,972	$40,042
b1-7	193.73	30	good	> 50'	B	$163,874	$184,489	$143,276
b1-5	147.95	80	good	> 50'	B	$324,913	$414,359	$235,563
b1-6	235.39	10	good	> 50'	B	$67,073	$71,646	$62,501
b1-8	229.78	80	good	> 50'	B	$504,610	$643,525	$365,843
b1-9	74.47	80	good	> 50'	B	$163,541	$208,562	$118,567
b1-10	38.78	50	good	> 50'	B	$54,091	$64,078	$44,113
a11	568.42	60	good**	> 50'	B	$946,389	$1,149,418	$743,564
b1-19	442.21	60	good**	> 50'	B	$736,261	$894,211	$578,470
a12	127.48	80	good**	> 50'	B	$279,953	$357,022	$202,966
b1-18	88.45	80	**poor**	> 50'	D	$224,823	$276,231	$173,018
b1-17	173.36	80	good	> 50'	B	$380,704	$485,508	$276,010

Arkansas Table 4 -- Arkansas River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
a13	145.06	70	good**	> 50'	B	$280,251	$348,841	$211,732
b1-14	262.28	60	good	> 50'	B	$436,686	$530,369	$343,098
b1-13	160.38	70	good	> 50'	B	$309,846	$385,680	$234,091
b1-12	17.40	75	good	> 50'	B	$35,923	$45,263	$26,594
b1-11	282.45	70	good	> 50'	B	$545,687	$679,242	$412,271
jm1	500.97	70	good**	> 50'	B	$967,880	$1,204,765	$731,240
jm2	422.58	70	good**	> 50'	B	$816,422	$1,016,238	$616,813
jm3	81.93	80	good**	> 50'	B	$179,931	$229,464	$130,450
jm4	229.63	70	good**	> 50'	B	$443,636	$552,215	$335,171
jm5	54.61	70	good**	> 50'	B	$105,508	$131,331	$79,712
jm6	11.75	80	good**	> 50'	B	$25,799	$32,902	$18,705
jm7	69.94	70	good**	> 50'	B	$135,115	$168,183	$102,080
jm8	68.94	60	good**	> 50'	B	$114,784	$139,409	$90,184
jm9	76.07	70	good**	> 50'	B	$146,965	$182,934	$111,033
jm10	87.32	80	good**	> 50'	B	$191,768	$244,560	$139,032
jm11	346.82	80	good**	> 50'	B	$761,645	$971,318	$552,193
jm12	464.01	80	good**	> 50'	B	$1,019,003	$1,299,525	$738,778
jm13	114.48	80	good**	> 50'	B	$251,413	$320,624	$182,275
jm14	133.93	80	good**	> 50'	B	$294,121	$375,090	$213,238
jm15	466.20	80	good**	> 50'	B	$1,023,812	$1,305,657	$742,264
jm16	48.96	70	good**	> 50'	B	$94,583	$117,732	$71,458
jm17	208.95	70	good**	> 50'	B	$403,697	$502,501	$304,996
jm18	135.82	70	good**	> 50'	B	$262,396	$326,617	$198,242
jm19	249.10	70	good**	> 50'	B	$481,256	$599,042	$363,593
jm20	184.15	70	good**	> 50'	B	$355,773	$442,847	$268,789
jm21	98.81	70	good**	> 50'	B	$190,901	$237,623	$144,227
jm22	321.96	70	good**	> 50'	B	$622,020	$774,257	$469,941
jm23	25.36	70	good**	> 50'	B	$49,003	$60,997	$37,022
jm24	115.38	70	good**	> 50'	B	$222,915	$277,472	$168,414
jm25	75.23	80	good**	> 50'	B	$165,205	$210,685	$119,774
jm26	22.15	80	good**	> 50'	B	$48,647	$62,039	$35,269
jm27	213.33	80	good**	> 50'	B	$468,499	$597,472	$339,662
jm28	47.36	60	good**	> 50'	B	$78,854	$95,771	$61,955
jm29	7.01	70	good**	> 50'	B	$13,535	$16,847	$10,225
jm30	10.22	60	good**	> 50'	B	$17,008	$20,657	$13,363
jm31	669.90	50	good**	> 50'	B	$934,442	$1,106,975	$762,077
b1-15	149.26	60	good	> 50'	B	$248,517	$301,831	$195,256
b1-15	55.08	60	good	> 50'	B	$91,711	$111,386	$72,056
b1-16	325.03	80	good	> 50'	B	$713,799	$910,301	$517,505
b1-16	0.21	80	good	> 50'	B	$471	$600	$341
Subtotal	**9,713.94**					**$18,220,239**	**$22,713,215**	**$13,731,477**
Main Stem Arkansas: Otero County								
o1-1	538.23	60	good	> 50'	B	$896,115	$1,088,359	$704,065
a5	106.85	60	good**	> 50'	B	$177,892	$216,055	$139,767
o1-3	219.72	50	good	> 50'	B	$306,492	$363,081	$249,957

Arkansas Table 4 -- Arkansas River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
o1-2	207.45	60	good	> 50'	B	$345,399	$419,497	$271,375
o1-4	158.94	30	**poor**	> 50'	D	$168,046	$181,183	$153,975
o1-5	119.62	75	good	> 50'	B	$246,938	$311,136	$182,807
o1-6	173.31	40	good	> 50'	B	$194,435	$224,585	$164,314
o1-7	191.71	25	good	> 50'	B	$135,494	$150,573	$120,428
o1-8	215.36	85	good	> 50'	B	$501,134	$646,808	$355,617
a6	139.11	70	good**	> 50'	B	$268,765	$334,544	$203,054
o1-9	155.48	60	good	> 50'	B	$258,863	$314,397	$203,385
o1-11	34.95	40	good	> 50'	B	$39,209	$45,289	$33,135
o1-10	244.86	65	good	> 50'	B	$440,456	$541,583	$339,432
a7	225.38	45	good**	> 50'	B	$283,698	$331,873	$235,569
o1-12	154.11	20	good	> 50'	B	$87,366	$95,827	$78,912
o1-13	110.32	10	good	> 50'	B	$31,434	$33,578	$29,292
o1-14	151.41	40	good	> 50'	B	$169,864	$196,204	$143,549
o1-15	343.90	70	good	> 50'	B	$664,412	$827,025	$501,968
o1-16	73.67	50	good	> 50'	B	$102,768	$121,743	$83,812
o1-17	276.49	75	good	> 50'	B	$570,785	$719,176	$422,549
o1-18	480.43	50	**poor**	> 50'	D	$813,215	$922,728	$700,340
a8	492.51	40	good**	> 50'	B	$552,532	$638,209	$466,935
o1-19	129.65	20	good	> 50'	B	$73,497	$80,614	$66,384
o1-20	228.44	40	good	> 50'	B	$256,278	$296,017	$216,576
o1-20	261.07	40	good	> 50'	B	$292,889	$338,305	$247,515
o1-21	317.86	20	good	> 50'	B	$180,198	$197,648	$162,760
o1-22	292.77	40	good	> 50'	B	$328,452	$379,382	$277,569
o1-23	133.73	50	good	> 50'	B	$186,542	$220,985	$152,133
Subtotal	**6,177.32**					**$8,573,169**	**$10,236,402**	**$6,907,171**
Main Stem Arkansas: Otero County Line to Pueblo Reservoir Dam								
pu1-2	6.31	5	good	> 50'	B	$901	$949	$852
pu1-3	5.20	20	good	> 50'	B	$2,948	$3,233	$2,663
pu1-4	32.59	10	good	> 50'	B	$9,287	$9,920	$8,654
pu1-5	13.06	15	good	> 50'	B	$5,567	$6,026	$5,108
pu2-20	26.66	10	good	> 50'	B	$7,595	$8,113	$7,078
pu2-22	1.70	5	good	> 50'	B	$243	$256	$230
pu2-21	3.37	10	**poor**	> 50'	D	$1,234	$1,266	$1,193
pu2-23	1.26	5	good	> 50'	B	$179	$189	$170
pu2-24	6.85	20	good	> 50'	B	$3,885	$4,261	$3,509
pu2-25	10.26	20	good	> 50'	B	$5,818	$6,381	$5,255
pu2-31	94.70	40	good	> 50'	B	$106,239	$122,712	$89,780
pu2-30	189.75	15	good	> 50'	B	$80,891	$87,563	$74,223
a1	385.13	15	good**	> 50'	B	$164,180	$177,721	$150,647
pu2-26	332.11	10	good	> 50'	B	$94,631	$101,084	$88,181
pu1-18	176.01	20	**poor**	> 50'	D	$126,505	$133,028	$119,194
pu1-17	490.98	40	**poor**	> 50'	D	$678,501	$750,322	$603,381
a2	91.67	40	good**	> 50'	B	$102,839	$118,786	$86,908
pu1-16	477.54	40	good	> 50'	B	$535,741	$618,813	$452,745

Arkansas Table 4 -- Arkansas River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
pu1-16	240.35	40	good	> 50'	B	$269,648	$311,460	$227,875
pu1-15	1,338.85	20	good	> 50'	B	$758,992	$832,495	$685,543
a3	318.95	40	good**	> 50'	B	$357,824	$413,309	$302,390
pu1-14	542.63	60	good	> 50'	B	$903,454	$1,097,272	$709,831
pu1-13	382.10	70	good	> 50'	B	$738,211	$918,885	$557,723
pu1-14	305.85	60	good	> 50'	B	$509,216	$618,458	$400,084
pu1-12	245.89	30	good	> 50'	B	$207,994	$234,159	$181,851
pu1-9	353.20	50	good	> 50'	B	$492,684	$583,652	$401,805
pu1-10	92.81	40	good	> 50'	B	$104,123	$120,268	$87,992
pu1-11	316.78	40	good	> 50'	B	$355,386	$410,492	$300,330
a4	238.08	40	good**	> 50'	B	$267,094	$308,510	$225,717
pu1-7	154.18	40	good	> 50'	B	$172,972	$199,793	$146,176
a9	151.42	50	good**	> 50'	B	$211,220	$250,220	$172,259
Subtotal	**7,026.24**					**$7,276,000**	**$8,449,597**	**$6,099,344**
Totals for Main Stem	**29,005.09**					**$44,123,739**	**$53,732,226**	**$34,514,769**
Arkansas Tributaries								
Huerfano River								
h1-11	200.80	60	good	> 50'	B	$334,317	$406,038	$262,668
a22	122.19	50	good**	> 50'	B	$170,442	$201,911	$139,002
h1-10	34.55	40	good	> 50'	B	$38,761	$44,771	$32,756
h1-3	174.65	30	good	> 50'	B	$147,737	$166,322	$129,168
h1-5	59.68	20	good	> 50'	B	$33,832	$37,109	$30,558
h1-6	125.66	50	**poor**	> 50'	D	$212,710	$241,355	$183,186
h1-7	93.97	20	good	> 50'	B	$53,273	$58,432	$48,118
h1-8	143.54	20	good	> 50'	B	$81,372	$89,252	$73,498
h1-9	176.45	15	good	> 50'	B	$75,218	$81,422	$69,018
a23	64.77	20	good**	> 50'	B	$36,718	$40,274	$33,165
h1-4	21.12	30	good	> 50'	B	$17,865	$20,113	$15,620
h1-4	3.50	30	good	> 50'	B	$2,961	$3,334	$2,589
h1-2	3.08	30	good	> 50'	B	$2,606	$2,934	$2,278
h1-2	272.82	30	good	> 50'	B	$230,775	$259,806	$201,769
h1-1	341.24	50	good	> 50'	B	$475,996	$563,883	$388,195
h1-1	1.76	50	good	> 50'	B	$2,453	$2,906	$2,001
Subtotal	**1,839.79**					**$1,917,038**	**$2,219,863**	**$1,613,588**
Fountain Creek								
f1-1	85.17	40	good	> 50'	B	$95,550	$110,366	$80,748
f1-2	22.64	10	good	> 50'	B	$6,451	$6,890	$6,011
f1-3	52.64	30	good	> 50'	B	$44,524	$50,124	$38,927
f1-4	63.71	15	good	> 50'	B	$27,160	$29,400	$24,921

Arkansas Table 4 -- Arkansas River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
f1-6	170.00	20	good	> 50'	B	$96,373	$105,706	$87,047
f1-7	143.01	20	good	> 50'	B	$81,073	$88,924	$73,227
f1-8	230.05	15	good	> 50'	B	$98,069	$106,158	$89,986
f1-9	28.62	5	**poor**	> 50'	D	$5,291	$5,362	$5,181
f1-10	177.05	10	good	> 50'	B	$50,449	$53,889	$47,011
f1-11	224.52	70	good	> 50'	B	$433,775	$539,939	$327,720
f1-12	240.62	20	good	> 50'	B	$136,405	$149,615	$123,205
a20	183.61	20	**poor**	> 50'	D	$131,965	$138,770	$124,338
f1-13	89.90	25	good	> 50'	B	$63,539	$70,610	$56,474
a21	166.21	25	**poor**	> 50'	D	$147,879	$157,453	$137,433
f1-5	51.92	40	good	> 50'	B	$58,244	$67,276	$49,221
f1-5	23.23	40	good	> 50'	B	$26,060	$30,101	$22,023
Subtotal	**1,952.89**					**$1,502,806**	**$1,710,584**	**$1,293,472**
Arkansas Reservoirs								
agc1	473.08	40	good	> 50'	B	$530,742	$613,040	$448,521
ar1	1.01	60	good**	> 50'	B	$1,681	$2,042	$1,321
agc2	66.13	10	good	> 50'	B	$18,843	$20,128	$17,559
agc3	38.40	40	good	> 50'	B	$43,076	$49,756	$36,403
agc3b	512.78	60	**poor**	> 50'	D	$1,020,218	$1,188,234	$848,756
agc4	2,290.02	40	good	> 50'	B	$2,569,131	$2,967,504	$2,171,125
agc5	2,552.37	30	good	> 50'	B	$2,158,997	$2,430,594	$1,887,629
agc6	695.82	10	good	> 50'	B	$198,268	$211,788	$184,755
ar2	582.89	10	**poor**	> 50'	D	$213,511	$219,054	$206,499
ar3	19.26	10	**poor**	> 50'	D	$7,054	$7,238	$6,823
agc7	271.01	10	good	> 50'	B	$77,223	$82,489	$71,960
ar4	182.89	10	good**	> 50'	B	$52,114	$55,667	$48,562
agc8	163.82	30	good	> 50'	B	$138,574	$156,006	$121,156
agc9	863.25	20	good	> 50'	B	$489,376	$536,768	$442,018
ar5	611.14	10	good**	> 50'	B	$174,137	$186,011	$162,269
ar6	404.03	10	good**	> 50'	B	$115,123	$122,974	$107,277
ar7	61.79	10	good	> 50'	B	$17,607	$18,807	$16,407
Subtotal	**9,789.68**					**$7,825,675**	**$8,868,099**	**$6,779,038**
Arkansas Tributaries								
agc10	38.46	20	good	> 50'	B	$21,801	$23,913	$19,692
agc11	30.10	20	**poor**	> 50'	D	$21,635	$22,750	$20,384
agc12	204.33	20	**poor**	> 50'	D	$146,859	$154,431	$138,371
agc13	51.15	30	**poor**	> 50'	D	$54,083	$58,310	$49,554
agc14	93.34	20	**poor**	> 50'	D	$67,083	$70,542	$63,206
agc15	173.80	40	**poor**	> 50'	D	$240,178	$265,602	$213,587
at1	14.05	40	**poor****	> 50'	D	$19,421	$21,477	$17,271
at2	67.09	30	**poor****	> 50'	D	$70,935	$76,480	$64,995
at3	3.56	50	good	> 50'	B	$4,970	$5,887	$4,053
at5	299.44	30	good**	> 50'	B	$253,287	$285,150	$221,451

Arkansas Table 4 -- Arkansas River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
at4	83.09	10	poor**	> 50'	D	$30,436	$31,226	$29,436
Subtotal	**1,058.42**					**$930,687**	**$1,015,768**	**$841,999**
Total for Tributaries/Reservoirs	**14,640.78**					**$12,176,205**	**$13,814,313**	**$10,528,098**
Arkansas Totals	**43,645.87**					**$56,299,944**	**$67,546,540**	**$45,042,867**

Cost Formula Descriptions	Cost Formula (Most Likely)	Cost Formula (High range)	Cost Formula (Low Range)
A = Narrow Infestations (< 50') with good access	$y = -0.0826X^2 + 26.121X$	$y = -0.0736X^2 + 29.191X$	$y = -0.0916X^2 + 23.051X$
B = Broad Infestations (> 50') with good access	$y = -0.0149X^2 + 28.643X$	$y = 0.0653X^2 + 29.784X$	$y = -0.095X^2 + 27.502X$
C = Narrow Infestations (< 50') with poor access	$y = -0.1379X^2 + 33.961X$	$y = -0.1128X^2 + 35.115X$	$y = -0.1584X^2 + 32.449X$
D = Broad Infestations (> 50') with poor access	$y = -0.0694X^2 + 37.324X$	$y = 0.0208X^2 + 37.373X$	$y = -0.1568X^2 + 36.995X$

y = Cost ($/acre)
X = Percent Cover

* Costs are based on detailed cost information found in *Options for Non-Native Phreatophyte Control,* March 2006, Tamarisk Coalition

**Non ground-truthed

Purgatoire Table 1: General Tamarisk Inventory Data for Purgatoire River and its Related Waterways
Arkansas Confluence to Trinidad Lake Dam

Purgatoire River Main Stem	Cummulative River Miles	Average Width (ft)	Max Width (ft)	Min Width (ft)	Average Density (%)	Total Acreage	Total Canopy Cover (acres)
	0						
Arkansas Confluence to Bent / Otero County Line	38	656	2490	20	34%	3,023	1,042
Otero County	60	777	1,820	15	33%	2,072	675
Otero / Las Animas County Line to Trinidad Lake Dam	179	288	2,000	10	23%	4,155	976
Totals =	**179**	**574**			29%	**9,250**	**2,693**

Related Waterways	River Miles	Average Width (ft)	Max Width (ft)	Min Width (ft)	Average Density (%)	Total Acreage	Total Canopy Cover (acres)
	0						
Powell Arroyo	6	16	375	10	11%	12	1
Raton Creek	3	25	280	10	5%	9	1
Chicosa Arroyo	15	77	315	10	26%	140	37
Frijole Creek	19	23	285	10	35%	52	18
San Francisco Creek	13	6	265	10	49%	9	4
San Isidro Creek	21	71	310	10	25%	182	46
Trinchera Creek	7	20	215	10	20%	17	3
Luning Arroyo	30	16	240	10	45%	56	25
Van Bremer Arroyo	24	16	275	10	23%	45	10
Chacuaco Creek	24	78	465	20	22%	227	51
Bent Canyon	10	11	235	10	20%	14	3
Totals =	**172**	37			26%	**763**	**199**

Purgatoire Table 2: Existing and Future Water Loss Estimates due to Tamarisk Infestations in Purgatoire River Watershed and Estimated Control & Revegetation

Purgatoire River Main Stem	Cummulative River Miles	Average Density (%)	Total Acreage	Total Canopy Cover (acres)	% Area capable of Supporting Cottonwood/Willow Plant Community	Current Water Loss (acre-feet/year)	Future Water Loss (acre-feet/year)	***Cost estimates for Tamarisk Control & Revegetation
Arkansas Confluence to Bent / Otero County Line	38	34%	3,023	1041.54	47%	3,075	8,926	$2,926,850
Otero County	60	33%	2,072	675	38%	2,049	6,289	$1,900,062
Otero / Las Animas County Line to Trinidad Lake Dam	179	23%	4,155	976	52%	2,841	12,099	$3,213,320
Totals =	**179**	29%	**9,250**	**2,693**	**47%**	**7,966**	**27,314**	**$8,040,233**
							High Range =	**$9,017,959**
							Low Range =	**$7,050,208**
							Average cost per acre of infestation =	**$869**
							Average cost per acre-foot of water preserved as groundwater and/or surface water =	**$1,009**
							Average cost per mile =	**$44,918**

Related Waterways	River Miles	Average Density (%)	Total Acreage	Total Canopy Cover (acres)	% Area capable of Supporting Cottonwood/Willow Plant Community	Current Water Loss (acre-feet/year)	Future Water Loss (acre-feet/year)	***Cost estimates for Tamarisk Control & Revegetation
Powell Arroyo	6	11%	12	1	11%	4	39	$3,511
Raton Creek	3	5%	9	1	90%	1	24	$1,422
Chicosa Arroyo	15	26%	140	37	65%	103	393	$102,740
Frijole Creek	19	35%	52	18	59%	52	149	$50,559
San Francisco Creek	13	49%	9	4	51%	12	26	$14,286
San Isidro Creek	21	25%	182	46	48%	134	535	$128,416
Trinchera Creek	7	20%	17	3	50%	10	50	$9,834
Luning Arroyo	30	45%	56	25	50%	74	165	$84,958
Van Bremer Arroyo	24	23%	45	10	50%	31	133	$37,131
Chacuaco Creek	24	22%	227	51	59%	145	648	$178,612
Bent Canyon	10	20%	14	3	50%	8	40	$7,734
Totals =	**64**	26%	**763**	**199**	**55%**	**575**	**2,203**	**$619,204**
							High Range =	**$694,131**
							Low Range =	**$542,705**
							Average cost per acre of infestation =	**$811**
							Average cost per acre-foot of water preserved as groundwater and/or surface water =	**$1,078**
							Average cost per mile (excluding reservoirs) =	**$2,028**

Purgatoire Table 3: Purgatoire River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
Mainstem Purgatoire: Arkansas Confluence to Bent / Otero County Line												
tpb1	525.71	30	157.71	80	105.14	mature	good	3	2	p	np	np
pi19	70.82	30	21.25	**50**	35.41		good**	0	0			
tpb2	167.19	30	50.16	30	117.04	mature	good	3	3	p	p	np
pi45	162.00	20	32.40	**50**	81.00		good**					
pi46	3.63	20	0.73	**50**	1.81		good**					
pi47	45.81	20	9.16	**50**	22.91		good**					
pi48	0.05	20	0.01	**50**	0.02		good**					
tpb3	45.77	30	13.73	30	32.04	mature	good	3	5	np	p	np
tpb3	189.50	30	56.85	30	132.65	mature	good	3	5	np	p	np
pi49	140.97	40	56.39	**50**	70.49		good**					
pi50	119.97	40	47.99	**50**	59.98		good**					
pi51	69.61	30	20.88	**50**	34.80		good**					
pi52	136.25	30	40.87	**50**	68.12		good**					
tpb4	136.41	60	81.84	50	68.20	mature	good	3	6	p	np	np
pi53	177.86	40	71.14	**50**	88.93		good**					
pi54	166.67	40	66.67	**50**	83.34		good**					
pi55	308.51	40	123.40	**50**	154.26		good**					
pi56	148.69	30	44.61	**50**	74.35		good**					
pi57	234.99	40	94.00	**50**	117.49		good**					
pi58	172.48	30	51.74	**50**	86.24		good**					
Subtotal	**3,022.90**		**1,041.54**		**1,434.23**							
Mainstem Purgatoire: Otero County												
tpo1	334.44	30	100.33	70	100.33	mature	good	3	7	p	p	np
tpo2	390.50	45	175.72	60	156.20	mature	good	3	9	p	p	np
tpo3	199.30	30	59.79	60	79.72	mature	good	3	10	p	p	np
tpo4	283.54	30	85.06	70	85.06	mature	good	3	11	p	p	np
tpo5	285.67	30	85.70	60	114.27	mature	good	3	12	p	p	np
tpo6	75.74	40	30.30	50	37.87	mature	good	3	13	p	p	np
tpo7	221.26	20	44.25	70	66.38	mature	good	3	14	p	p	np
pi59	185.68	30	55.70	**50**	92.84		good**					
pi60	96.35	40	38.54	**50**	48.17		good**					
Subtotal	**2,072.47**		**675.40**		**780.84**							
Mainstem Purgatoire: Otero / Las Animas County Line to Trinidad Lake Dam												
pi1	7.32	5	0.37	**50**	3.66		good**					
tp2	73.97	5	3.70	60	29.59	mature	good	4	50	p	p	p
tp3	53.89	5	2.69	50	26.95	mature	good	3	53	p	p	p
tp4	99.41	10	9.94	50	49.70	mature	good	3	56	p	p	p
pi2	115.99	5	5.80	**50**	58.00		good**					
pi3	76.28	10	7.63	**50**	38.14		good**					
pi4	138.15	10	13.82	**50**	69.08		good**					
tp5	97.60	10	9.76	50	48.80	mature	good	3	58	p	p	p
tp6	116.50	10	11.65	50	58.25	mature	good	3	59	p	p	p
tp7	62.06	60	37.24	50	31.03	mature	good	4	61	p	p	p
pi5	71.71	30	21.51	**50**	35.86		good**					
pi6	93.00	10	9.30	**50**	46.50		good**					
tp8	31.88	40	12.75	50	15.94	mature	good	3	64	p	p	p
tp9	34.66	15	5.20	20	27.73	mature	good	4	74	p	p	p
tp10	3.97	70	2.78	20	3.17	mature	poor	3	75	np	p	p
tp11	108.02	25	27.01	50	54.01	mature	good	4	76	p	p	p
tp12	203.30	40	81.32	50	101.65	mature	good	3	77	p	p	p
tp13	69.50	30	20.85	50	34.75	mature	good	4	78	p	p	p
pi10	1.95	30	0.59	**50**	0.98		good**					

Purgatoire Table 3: Purgatoire River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
pi11	64.16	20	12.83	50	32.08		poor**					
pi12	196.20	20	39.24	50	98.10		poor**					
pi13	81.65	20	16.33	50	40.83		poor**					
pi14	90.95	20	18.19	50	45.47		poor**					
pi15	77.92	15	11.69	50	38.96		poor**					
pi16	104.96	10	10.50	50	52.48		poor**					
pi17	105.10	20	21.02	50	52.55		poor**					
pi18	95.07	20	19.01	50	47.53		poor**					
pi28	25.56	30	7.67	50	12.78		poor**					
pi29	28.80	20	5.76	50	14.40		poor**					
pi30	16.45	20	3.29	50	8.22		poor**					
pi31	32.31	20	6.46	50	16.15		poor**					
pi32	13.04	20	2.61	50	6.52		poor**					
pi33	34.25	30	10.28	50	17.13		poor**					
pi34	16.26	20	3.25	50	8.13		poor**					
pi39	54.32	20	10.86	50	27.16		poor**					
pi40	10.14	30	3.04	50	5.07		poor**					
pi41	17.82	30	5.35	50	8.91		poor**					
pi42	50.99	30	15.30	50	25.50		poor**					
pi43	34.86	30	10.46	50	17.43		poor**					
pi44	27.15	30	8.14	50	13.57		poor**					
tp2-1	31.31	30	9.39	70	9.39	mature	good	3	15	p	p	np
pi67	14.75	20	2.95	50	7.38		poor**					
pi68	29.34	30	8.80	50	14.67		poor**					
pi69	26.77	30	8.03	50	13.39		poor**					
tp15	37.84	70	26.49	40	22.71	mature	good	3	98	np	p	np
tp16	35.79	70	25.05	40	21.47	mature	poor	3	100	np	p	np
pi76	22.30	40	8.92	50	11.15		poor**					
pi77	61.01	20	12.20	50	30.50		poor**					
pi78	40.65	30	12.20	50	20.33		poor**					
pi79	33.51	20	6.70	50	16.75		poor**					
pi81	90.68	30	27.20	50	45.34		poor**					
pi82	137.93	30	41.38	50	68.96		poor**					
pi83	65.82	30	19.75	50	32.91		poor**					
pi84	74.53	30	22.36	50	37.27		poor**					
pi85	87.34	20	17.47	50	43.67		poor**					
tp3-1	302.12	30	90.64	20	241.70	mature	poor	3	25	p	p	np
pi86	151.85	30	45.55	50	75.92		poor**					
pi87	83.52	30	25.05	50	41.76		poor**					
pi88	98.21	20	19.64	50	49.10		poor**					
pi89	22.98	30	6.89	50	11.49		poor**					
tp14	69.70	20	13.94	50	34.85	mature	good	2	93	p	p	np
Subtotal	**4,155.08**		**975.78**		**2,173.47**							
Mainstem Purgatoire Totals	**9,250.45**		**2,692.72**		**4,388.54**							
Purgatoire Related Waterways												
Raton Creek												
trc1	9.09	5	0.45	10	8.18	mature	good	2	42	p	p	np
trc2	0.02	100	0.02	0	0.02	mature	good	3	43	p	p	np
pi98	0.02	100	0.02	50	0.01		good**					
tp1	0.01	100	0.01	100	0.00	mature	good	3	41	p	p	np
Subtotal	**9.13**		**0.50**		**8.21**							

Purgatoire Table 3: Purgatoire River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
Powell Arroyo												
tpa1	9.27	5	0.46	100	0.00	mature	good	2	51	p	p	np
pi38	2.24	30	0.67	**50**	1.12		good**					
tpa2	0.43	50	0.21	50	0.21	mature	good	3	52	p	p	np
Subtotal	**11.94**		**1.35**		**1.34**							
Chicosa Arroyo												
tcc1	18.52	20	3.70	50	9.26	mature	good	2	63	np	p	p
pi104	2.11	30	0.63	**50**	1.06		good**					
tcc2	12.53	10	1.25	10	11.27	mature	good	3	66	np	p	p
tcc3	6.63	5	0.33	20	5.30	mature	good	3	67	np	p	np
tcc4	39.12	5	1.96	20	31.29	mature	good	2	68	p	p	np
tcc5	24.72	70	17.30	40	14.83	mature	good	3	72	np	p	np
pi105	34.14	30	10.24	**50**	17.07		good**					
pi106	1.98	50	0.99	**50**	0.99		good**					
pi107	0.44	80	0.35	50	0.22		good**					
Subtotal	**140.17**		**36.76**		**91.29**							
Frijole Creek												
pi99	2.11	30	0.63	**50**	1.06		good**					
pi100	0.67	40	0.27	**50**	0.33		good**					
tfc1	7.66	40	3.06	30	5.36	mature	good	3	80	np	np	np
pi101	4.86	50	2.43	**50**	2.43		good**					
pi102	7.61	30	2.28	**50**	3.80		good**					
pi103	4.07	30	1.22	**50**	2.03		good**					
tfc1	7.44	40	2.98	30	5.21	mature	good	3	80	np	np	np
tfc2	9.32	40	3.73	20	7.46	mature	good	2	0	np	np	np
tfc3	2.29	50	1.14	20	1.83	mature	good	3	81	p	p	np
tfc4	5.26	5	0.26	80	1.05	mature	good	2	82	p	p	np
tfc4	0.85	5	0.04	80	0.17	mature	good	2	82	p	p	np
Subtotal	**52.13**		**18.05**		**30.73**							
San Francisco Creek												
tsf2	2.94	50	1.47	40	1.76	mature	poor	2	86	np	p	np
pi20	0.51	50	0.26	**50**	0.26		poor**					
pi21	1.37	50	0.68	**50**	0.68		poor**					
pi22	2.29	50	1.14	**50**	1.14		poor**					
pi23	1.02	50	0.51	**50**	0.51		poor**					
tsf1	0.63	30	0.19	80	0.13	mature	good	2	83	p	p	np
Subtotal	**8.75**		**4.25**		**4.48**							
San Isidro Creek												
tsf3	27.31	50	13.65	50	13.65	mature	good	2	87	p	p	np
tsi1	4.56	50	2.28	50	2.28	mature	good	2	87	p	p	np
tsi2	39.42	10	3.94	70	11.83	mature	good	2	90	p	p	np
pi24	28.04	20	5.61	**50**	14.02		good**					
pi25	5.59	30	1.68	**50**	2.79		good**					
tsi3	7.37	30	2.21	20	5.90	mature	good	2	91	p	p	np
tsi4	23.45	30	7.04	40	14.07	mature	good	3	92	p	p	np
pi27	8.60	20	1.72	**50**	4.30		good**					
tp14	37.32	20	7.46	50	18.66	mature	good	2	93	p	p	np
Subtotal	**181.66**		**45.59**		**87.50**							

Purgatoire Table 3: Purgatoire River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow present (p)/not present (np)	Russian Olive present (p)/not present (np)
Trinchera Creek												
pi35	11.19	20	2.24	50	5.59		good**					
pi36	5.98	20	1.20	50	2.99		good**					
pi37	0.05	80	0.04	50	0.02		good**					
Subtotal	**17.21**		**3.47**		**8.61**							
Luning Arroyo												
pi61	2.97	20	0.59	50	1.49		poor**					
pi62	11.77	40	4.71	50	5.89		poor**					
pi63	4.51	20	0.90	50	2.25		poor**					
pi64	9.63	20	1.93	50	4.82		poor**					
pi65	16.82	70	11.77	50	8.41		poor**					
pi66	10.74	50	5.37	50	5.37		poor**					
Subtotal	**56.44**		**25.27**		**28.22**							
Van Bremer Arroyo												
pi35	11.19	20	2.24	50	5.59		poor**					
pi36	5.98	20	1.20	50	2.99		poor**					
pi37	0.05	80	0.04	50	0.02		poor**					
pi70	1.07	30	0.32	50	0.53		poor**					
pi71	5.84	30	1.75	50	2.92		poor**					
pi72	6.32	30	1.90	50	3.16		poor**					
pi73	5.54	20	1.11	50	2.77		poor**					
pi74	3.49	20	0.70	50	1.74		poor**					
pi75	5.86	20	1.17	50	2.93		poor**					
Subtotal	**45.32**		**10.41**		**22.66**							
Chacuaco Creek												
pi35	11.19	20	2.24	50	5.59		poor**					
pi36	5.98	20	1.20	50	2.99		poor**					
pi37	0.05	80	0.04	50	0.02		poor**					
pi70	1.07	30	0.32	50	0.53		poor**					
pi71	5.84	30	1.75	50	2.92		poor**					
pi72	6.32	30	1.90	50	3.16		poor**					
pi73	5.54	20	1.11	50	2.77		poor**					
pi74	3.49	20	0.70	50	1.74		poor**					
pi75	5.86	20	1.17	50	2.93		poor**					
pi92	25.76	30	7.73	50	12.88		poor**					
cha1	65.01	5	3.25	20	52.01	mature	good	2	28	p	p	np
pi93	30.89	40	12.36	50	15.44		poor**					
pi94	48.86	30	14.66	50	24.43		poor**					
pi95	6.67	20	1.33	50	3.34		poor**					
pi97	4.30	20	0.86	50	2.15		poor**					
Subtotal	**226.80**		**50.60**		**132.90**							
Bent Canyon												
pi91	13.64	20	2.73	50	6.82		good**					
Subtotal	**13.64**		**2.73**		**6.82**							

Purgatoire Table 3: Purgatoire River & Tributaries - Tamarisk Infestation Attribute Data

Reference Name	Acreage	Percent Cover	Canopy Coverage Acreage	Percent Upland	Riparian Acreage	Age Status	Access	Avg Height (m)	Photo Reference Number	Cottonwood present (p)/not present (np)	Willow	Russian Olive
Purgatoire Related Waterways Total	763.21		198.99		422.77							
Purgatoire River Totals	10,013.66		2,891.71		4,811.31							

Where ground truthing was not availabe for estimation of Percent Upland, a conservative value of 50% upland area was assumed (indicated in bold).

**Non ground-truthed

NOTE: Reference Name "pi__" refers to areas interpreted from high resolution aerial imagery. These areas were inaccessible due to either land ownership or topography issues.

Purgatoire Table 4 -- Purgatoire River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
Mainstem Purgatoire: Arkansas Confluence to Bent / Otero County Line								
tpb1	525.71	30	good	> 50'	B	$444,690	$500,631	$388,796
pi19	70.82	30	good**	> 50'	B	$59,904	$67,440	$52,375
tpb2	167.19	30	good	> 50'	B	$141,427	$159,218	$123,650
pi45	162.00	20	good**	> 50'	B	$91,837	$100,731	$82,950
pi46	3.63	20	good**	> 50'	B	$2,056	$2,255	$1,857
pi47	45.81	20	good**	> 50'	B	$25,972	$28,488	$23,459
pi48	0.05	20	good**	> 50'	B	$27	$30	$24
tpb3	45.77	30	good	> 50'	B	$38,718	$43,588	$33,851
tpb3	189.50	30	good	> 50'	B	$160,297	$180,462	$140,149
pi49	140.97	40	good**	> 50'	B	$158,156	$182,680	$133,655
pi50	119.97	40	good**	> 50'	B	$134,589	$155,459	$113,739
pi51	69.61	30	good**	> 50'	B	$58,881	$66,288	$51,480
pi52	136.25	30	good**	> 50'	B	$115,250	$129,749	$100,764
tpb4	136.41	60	good	> 50'	B	$227,111	$275,833	$178,438
pi53	177.86	40	good**	> 50'	B	$199,533	$230,473	$168,622
pi54	166.67	40	good**	> 50'	B	$186,988	$215,982	$158,020
pi55	308.51	40	good**	> 50'	B	$346,111	$399,780	$292,492
pi56	148.69	30	good**	> 50'	B	$125,776	$141,599	$109,967
pi57	234.99	40	good**	> 50'	B	$263,629	$304,508	$222,788
pi58	172.48	30	good**	> 50'	B	$145,896	$164,249	$127,558
Subtotal	**3,022.90**					**$2,926,850**	**$3,349,443**	**$2,504,636**
Mainstem Purgatoire: Otero County								
tpo1	334.44	30	good	> 50'	B	$282,895	$318,482	$247,337
tpo2	390.50	45	good	> 50'	B	$491,543	$575,012	$408,154
tpo3	199.30	30	good	> 50'	B	$168,584	$189,792	$147,395
tpo4	283.54	30	good	> 50'	B	$239,839	$270,010	$209,693
tpo5	285.67	30	good	> 50'	B	$241,643	$272,041	$211,270
tpo6	75.74	40	good	> 50'	B	$84,975	$98,151	$71,811
tpo7	221.26	20	good	> 50'	B	$125,433	$137,581	$113,295
pi59	185.68	30	good**	> 50'	B	$157,061	$176,819	$137,319
pi60	96.35	40	good**	> 50'	B	$108,089	$124,849	$91,344
Subtotal	**2,072.47**					**$1,900,062**	**$2,162,738**	**$1,637,618**
Mainstem Purgatoire: Otero / Las Animas County Line to Trinidad Lake Dam								
pi1	7.32	5	good**	> 50'	B	$1,046	$1,102	$990
tp2	73.97	5	good	> 50'	B	$10,566	$11,136	$9,996
tp3	53.89	5	good	> 50'	B	$7,698	$8,113	$7,283
tp4	99.41	10	good	> 50'	B	$28,325	$30,257	$26,395
pi2	115.99	5	good**	> 50'	B	$16,568	$17,463	$15,674
pi3	76.28	10	good**	> 50'	B	$21,736	$23,219	$20,255
pi4	138.15	10	good**	> 50'	B	$39,365	$42,049	$36,682
tp5	97.60	10	good	> 50'	B	$27,809	$29,706	$25,914
tp6	116.50	10	good	> 50'	B	$33,197	$35,461	$30,934

Purgatoire Table 4 -- Purgatoire River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
tp7	62.06	60	good	> 50'	B	$103,328	$125,495	$81,183
pi5	71.71	30	good**	> 50'	B	$60,658	$68,289	$53,034
pi6	93.00	10	good**	> 50'	B	$26,500	$28,307	$24,694
tp8	31.88	40	good	> 50'	B	$35,766	$41,312	$30,225
tp9	34.66	15	good	> 50'	B	$14,776	$15,995	$13,558
tp10	3.97	70	poor	> 50'	D	$9,016	$10,784	$7,226
tp11	108.02	25	good	> 50'	B	$76,345	$84,841	$67,856
tp12	203.30	40	good	> 50'	B	$228,073	$263,438	$192,740
tp13	69.50	30	good	> 50'	B	$58,791	$66,187	$51,401
pi10	1.95	30	good**	> 50'	B	$1,650	$1,858	$1,443
pi11	64.16	20	poor**	> 50'	D	$46,113	$48,491	$43,448
pi12	196.20	20	poor**	> 50'	D	$141,011	$148,282	$132,861
pi13	81.65	20	poor**	> 50'	D	$58,685	$61,711	$55,294
pi14	90.95	20	poor**	> 50'	D	$65,367	$68,737	$61,589
pi15	77.92	15	poor**	> 50'	D	$42,409	$44,048	$40,492
pi16	104.96	10	poor**	> 50'	D	$38,448	$39,446	$37,185
pi17	105.10	20	poor**	> 50'	D	$75,535	$79,430	$71,169
pi18	95.07	20	poor**	> 50'	D	$68,328	$71,851	$64,379
pi28	25.56	30	poor**	> 50'	D	$27,022	$29,134	$24,759
pi29	28.80	20	poor**	> 50'	D	$20,702	$21,770	$19,506
pi30	16.45	20	poor**	> 50'	D	$11,819	$12,429	$11,136
pi31	32.31	20	poor**	> 50'	D	$23,221	$24,418	$21,879
pi32	13.04	20	poor**	> 50'	D	$9,372	$9,855	$8,830
pi33	34.25	30	poor**	> 50'	D	$36,212	$39,043	$33,180
pi34	16.26	20	poor**	> 50'	D	$11,689	$12,292	$11,013
pi39	54.32	20	poor**	> 50'	D	$39,040	$41,053	$36,784
pi40	10.14	30	poor**	> 50'	D	$10,721	$11,559	$9,823
pi41	17.82	30	poor**	> 50'	D	$18,840	$20,313	$17,263
pi42	50.99	30	poor**	> 50'	D	$53,910	$58,124	$49,396
pi43	34.86	30	poor**	> 50'	D	$36,861	$39,743	$33,775
pi44	27.15	30	poor**	> 50'	D	$28,702	$30,946	$26,299
tp2-1	31.31	30	good	> 50'	B	$26,484	$29,815	$23,155
pi67	14.75	20	poor**	> 50'	D	$10,602	$11,148	$9,989
pi68	29.34	30	poor**	> 50'	D	$31,017	$33,442	$28,420
pi69	26.77	30	poor**	> 50'	D	$28,306	$30,519	$25,936
tp15	37.84	70	good	> 50'	B	$73,115	$91,010	$55,239
tp16	35.79	70	poor	> 50'	D	$81,330	$97,269	$65,179
pi76	22.30	40	poor**	> 50'	D	$30,811	$34,073	$27,400
pi77	61.01	20	poor**	> 50'	D	$43,847	$46,108	$41,313
pi78	40.65	30	poor**	> 50'	D	$42,980	$46,340	$39,381
pi79	33.51	20	poor**	> 50'	D	$24,081	$25,323	$22,690
pi81	90.68	30	poor**	> 50'	D	$95,873	$103,368	$87,845
pi82	137.93	30	poor**	> 50'	D	$145,828	$157,228	$133,617
pi83	65.82	30	poor**	> 50'	D	$69,589	$75,029	$63,762
pi84	74.53	30	poor**	> 50'	D	$78,800	$84,960	$72,202
pi85	87.34	20	poor**	> 50'	D	$62,775	$66,012	$59,147
tp3-1	302.12	30	poor	> 50'	D	$319,424	$344,395	$292,677
pi86	151.85	30	poor**	> 50'	D	$160,544	$173,094	$147,101

Purgatoire Table 4 -- Purgatoire River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
pi87	83.52	30	poor**	> 50'	D	$88,298	$95,200	$80,904
pi88	98.21	20	poor**	> 50'	D	$70,583	$74,223	$66,504
pi89	22.98	30	poor**	> 50'	D	$24,298	$26,197	$22,263
tp14	69.70	20	good	> 50'	B	$39,511	$43,338	$35,688
Subtotal	**4,155.08**					**$3,213,320**	**$3,505,778**	**$2,907,953**
Mainstem Purgatoire Totals	**9,250.45**					**$8,040,233**	**$9,017,959**	**$7,050,208**
Purgatoire Related Waterways								
Raton Creek								
trc1	9.09	5	good	> 50'	B	$1,298	$1,368	$1,228
trc2	0.02	100	good	> 50'	B	$50	$67	$33
pi98	0.02	100	good**	> 50'	B	$51	$68	$34
tp1	0.01	100	good	> 50'	B	$22	$30	$15
Subtotal	**9.13**					**$1,422**	**$1,534**	**$1,310**
Powell Arroyo								
tpa1	9.27	5	good	> 50'	B	$1,324	$1,396	$1,253
pi38	2.24	30	good**	**< 50'**	A	$1,591	$1,816	$1,366
tpa2	0.43	50	good	> 50'	B	$596	$706	$486
Subtotal	**11.94**					**$3,511**	**$3,918**	**$3,105**
Chicosa Arroyo								
tcc1	18.52	20	good	> 50'	B	$10,499	$11,515	$9,483
pi104	2.11	30	good**	> 50'	B	$1,786	$2,011	$1,561
tcc2	12.53	10	good	> 50'	B	$3,569	$3,813	$3,326
tcc3	6.63	5	good	> 50'	B	$946	$998	$895
tcc4	39.12	5	good	> 50'	B	$5,587	$5,889	$5,286
tcc5	24.72	70	good	> 50'	B	$47,759	$59,448	$36,082
pi105	34.14	30	good**	> 50'	B	$28,876	$32,508	$25,246
pi106	1.98	50	good**	> 50'	B	$2,756	$3,265	$2,248
pi107	0.44	80	good**	> 50'	B	$962	$1,226	$697
Subtotal	**140.17**					**$102,740**	**$120,672**	**$84,825**
Frijole Creek								
pi99	2.11	30	good**	> 50'	B	$1,786	$2,011	$1,562
pi100	0.67	40	good**	> 50'	B	$749	$865	$633
tfc1	7.66	40	good	> 50'	B	$8,592	$9,924	$7,261
pi101	4.86	50	good**	> 50'	B	$6,776	$8,028	$5,526
pi102	7.61	30	good**	> 50'	B	$6,433	$7,243	$5,625
pi103	4.07	30	good**	> 50'	B	$3,442	$3,875	$3,010

Purgatoire Table 4 -- Purgatoire River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
tfc1	7.44	40	good	> 50'	B	$8,348	$9,642	$7,054
tfc2	9.32	40	good	> 50'	B	$10,457	$12,079	$8,837
tfc3	2.29	50	good	> 50'	B	$3,189	$3,778	$2,601
tfc4	5.26	5	good	**< 50'**	A	$676	$758	$594
tfc4	0.85	5	good	**< 50'**	A	$110	$123	$97
Subtotal	**52.13**					**$50,559**	**$58,326**	**$42,800**
San Francisco Creek								
tsf2	2.94	50	**poor**	> 50'	D	$4,975	$5,645	$4,285
pi20	0.51	50	**poor****	> 50'	D	$869	$986	$748
pi21	1.37	50	**poor****	> 50'	D	$2,311	$2,622	$1,990
pi22	2.29	50	**poor****	> 50'	D	$3,870	$4,391	$3,333
pi23	1.02	50	**poor****	> 50'	D	$1,731	$1,964	$1,490
tsf1	0.63	30	good	> 50'	B	$531	$598	$465
Subtotal	**8.75**					**$14,286**	**$16,206**	**$12,310**
San Isidro Creek								
tsf3	27.31	50	good	> 50'	B	$38,090	$45,123	$31,064
tsi1	4.56	50	good	> 50'	B	$6,363	$7,538	$5,190
tsi2	39.42	10	good	> 50'	B	$11,232	$11,998	$10,467
pi24	28.04	20	good**	> 50'	B	$15,898	$17,437	$14,359
pi25	5.59	30	good**	> 50'	B	$4,728	$5,323	$4,134
tsi3	7.37	30	good	> 50'	B	$6,235	$7,019	$5,451
tsi4	23.45	30	good	> 50'	B	$19,839	$22,335	$17,346
pi27	8.60	20	good**	> 50'	B	$4,875	$5,347	$4,403
tp14	37.32	20	good	> 50'	B	$21,156	$23,205	$19,109
Subtotal	**181.66**					**$128,416**	**$145,325**	**$111,522**
Trinchera Creek								
pi35	11.19	20	good**	> 50'	B	$6,342	$6,956	$5,729
pi36	5.98	20	good**	> 50'	B	$3,390	$3,718	$3,062
pi37	0.05	80	good**	> 50'	B	$101	$129	$74
Subtotal	**17.21**					**$9,834**	**$10,804**	**$8,864**
Luning Arroyo								
pi61	2.97	20	**poor****	> 50'	D	$2,137	$2,247	$2,013
pi62	11.77	40	**poor****	> 50'	D	$16,267	$17,989	$14,466
pi63	4.51	20	**poor****	> 50'	D	$3,240	$3,407	$3,053
pi64	9.63	20	**poor****	> 50'	D	$6,924	$7,281	$6,524
pi65	16.82	70	**poor****	> 50'	D	$38,215	$45,705	$30,626
pi66	10.74	50	**poor****	> 50'	D	$18,174	$20,622	$15,652
Subtotal	**56.44**					**$84,958**	**$97,251**	**$72,334**

Purgatoire Table 4 -- Purgatoire River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
Van Bremer Arroyo								
pi35	11.19	20	poor**	> 50'	D	$8,041	$8,455	$7,576
pi36	5.98	20	poor**	> 50'	D	$4,298	$4,520	$4,050
pi37	0.05	80	poor**	> 50'	D	$117	$144	$90
pi70	1.07	30	poor**	> 50'	D	$1,128	$1,216	$1,033
pi71	5.84	30	poor**	> 50'	D	$6,170	$6,652	$5,653
pi72	6.32	30	poor**	> 50'	D	$6,681	$7,204	$6,122
pi73	5.54	20	poor**	> 50'	D	$3,980	$4,186	$3,750
pi74	3.49	20	poor**	> 50'	D	$2,506	$2,635	$2,361
pi75	5.86	20	poor**	> 50'	D	$4,211	$4,428	$3,968
Subtotal	**45.32**					**$37,131**	**$39,439**	**$34,602**
Chacuaco Creek								
pi35	11.19	20	poor**	> 50'	D	$8,041	$8,455	$7,576
pi36	5.98	20	poor**	> 50'	D	$4,298	$4,520	$4,050
pi37	0.05	80	poor**	> 50'	D	$117	$144	$90
pi70	1.07	30	poor**	> 50'	D	$1,128	$1,216	$1,033
pi71	5.84	30	poor**	> 50'	D	$6,170	$6,652	$5,653
pi72	6.32	30	poor**	> 50'	D	$6,681	$7,204	$6,122
pi73	5.54	20	poor**	> 50'	D	$3,980	$4,186	$3,750
pi74	3.49	20	poor**	> 50'	D	$2,506	$2,635	$2,361
pi75	5.86	20	poor**	> 50'	D	$4,211	$4,428	$3,968
pi92	25.76	30	poor**	> 50'	D	$27,238	$29,368	$24,958
cha1	65.01	5	poor**	> 50'	D	$12,019	$12,181	$11,770
pi93	30.89	40	poor**	> 50'	D	$42,686	$47,205	$37,960
pi94	48.86	30	poor**	> 50'	D	$51,654	$55,692	$47,329
pi95	6.67	20	poor**	> 50'	D	$4,796	$5,043	$4,519
pi97	4.30	20	poor**	> 50'	D	$3,087	$3,246	$2,909
Subtotal	**226.80**					**$178,612**	**$192,174**	**$164,046**
Bent Canyon								
pi91	13.64	20	good**	> 50'	B	$7,734	$8,483	$6,985
Subtotal	**13.64**					**$7,734**	**$8,483**	**$6,985**
Purgatoire Related Waterways Total	**763.21**					**$619,204**	**$694,131**	**$542,705**
Purgatoire River Totals	**10,013.66**					**$8,659,436**	**$9,712,090**	**$7,592,913**

Cost Formula Descriptions

Cost Formula (Most Likely)	Cost Formula (High range)	Cost Formula (Low Range)

Purgatoire Table 4 -- Purgatoire River & Tributaries - Tamarisk Infestation Inventory & Costs Data

Reference Name	Acreage	Percent Cover	Access	Width > or < 50'	Cost Formula*	Most Likely Total Cost	Range High	Range Low
			A = Narrow Infestations (< 50') with good access			$y = -0.0826X^2 + 26.121X$	$y = -0.0736X^2 + 29.191X$	$y = -0.0916X^2 + 23.051X$
			B = Broad Infestations (> 50') with good access			$y = -0.0149X^2 + 28.643X$	$y = 0.0653X^2 + 29.784X$	$y = -0.095X^2 + 27.502X$
			C = Narrow Infestations (< 50') with poor access			$y = -0.1379X^2 + 33.961X$	$y = -0.1128X^2 + 35.115X$	$y = -0.1584X^2 + 32.449X$
			D = Broad Infestations (> 50') with poor access			$y = -0.0694X^2 + 37.324X$	$y = 0.0208X^2 + 37.373X$	$y = -0.1568X^2 + 36.995X$

y = Cost ($/acre)
X = Percent Cover

* Costs are based on detailed cost information found in *Options for Non-Native Phreatophyte Control,* March 2006, Tamarisk Coalition

**Non ground-truthed

Colorado Tamarisk Mapping & Inventory Project
Objectives, Protocols, and Guidelines

Purpose: The purpose of this study was to establish and implement an inventory protocol that provides a clear understanding of the extent of the tamarisk problem but is also economical to perform. Quantifying and characterizing the tamarisk infestations on each major river system provides a wealth of information for many diverse users. The data produced provides planning level information that can support policy; and state, federal, and local decision-making concerning tamarisk control and riparian restoration efforts. Land managers, however, must take into consideration the site specific conditions of each land parcel and the desires/preferences of the landowner to select the appropriate tamarisk control and revegetation approach to implement.

Goal: The goal of these mapping and inventory protocols was to identify 85 to 90 percent of the tamarisk infestations in Colorado. This goal is achieved through the efficient inventory approach described below. The remaining 10 to 15 percent of infestations are scattered among minor tributaries and headwaters which can cost more to find than to control. These small scattered infestations are best identified as a component of larger-scale control projects.

Inventory Approach: To provide a thorough understanding of tamarisk infestations, a comprehensive data set was collected. This data provides essential information for developing effective cost estimates for control and revegetation, and to better understand impacts such as water losses and wildlife habitat effects. Tamarisk infestations were mapped by the Tamarisk Coalition on the Arkansas, Colorado, Purgatoire, White, Gunnison, Uncompahgre, Dolores, San Juan, Republican, and South Platte watersheds including major tributaries of each. The Yampa River watershed was mapped under an agreement with the National Park Service at Dinosaur National Monument. The North Platte and Rio Grande watersheds have minimum infestations that were assessed based on local weed managers' input but were not directly surveyed. The mapping and inventory process had five basic components.

1) High resolution aerial and satellite photos that are ortho-rectified (usually at 2 meter resolution or better) were acquired from available sources at no cost. These include photography from Mesa County GIS, U.S. Department of Agriculture – Farm Service Agency, and TerraServer. Utilization of National Agricultural Imagery Program (NAIP-2005) aerial photographs were, in most cases, the most current, consistent source of imagery for mapping purposes (available at http://datagateway.nrcs.usda.gov/NextPage.asp).

2) A basic understanding of infestation locations was gleaned from county weed managers, the state weed coordinator, state agriculture specialists, the water conservancy district staff, federal weed managers, university researchers, private land owners, and/or others. Photo interpretation of high-resolution aerial photography proved to be valuable in determining the potential infestation extent where prior knowledge was not available.

3) A consultation with the US Geological Survey (USGS) and National Institute of Invasive Species Science was performed for technical assistance and data standardization to ensure database compatibility with the national database system (www.niss.org)

4) On-the-ground surveys were then performed by a two-person crew to verify the following attributes of the tamarisk infestation:

   - ✓ GPS coordinates of tamarisk stand (Universal Transverse Mercator-UTM)
   - ✓ Percent cover (canopy)
   - ✓ Average height (added at the request of USGS partway through the field work on the Arkansas River)
   - ✓ Percent riparian area: defined as the portion of area currently occupied by tamarisk found in the floodplain corridor where native phreatophytes such as cottonwoods and willows could exist in the future.
   - ✓ Percent upland area: defined as the remaining land within the floodplain where dryland plant species would be more prevalent after tamarisk control is achieved is classified as upland.
   - ✓ Maturity (mature or immature)
   - ✓ Accessibility (good or poor for mechanized removal)
   - ✓ Presence other significant species (Russian olive, willow, cottonwood). Note that for some rivers such as the White, South Platte, Republican, and Purgatoire that Russian olive was the dominant invasive species and additional mapping was performed to inventory these infestations.

These attributes were initially recorded on a Personal Data Assistant (PDA) system with standardized data collection software (EcoNab) integrated with a GPS unit. As the mapping work progressed, a rugged quality field laptop computer with ArcView 9 and preloaded NAIP imagery was used to allow for on-site data entry. Digital photos representing each data point were also taken to visually display the infestations. Additionally, a field notebook documenting other significant observations (i.e. access issues, land use, etc.) was recorded at every data point.

5) The field imagery data was transferred into shapefiles using ArcGIS software and attached to the tabular data listed above. These shapefiles were subsequently utilized to calculate the total areas of infestation in any specific region.

Deliverables:

1) Shape files characterizing each infestation with an attribute table including the following fields: acreage, percent cover, average height, percent riparian, maturity, accessibility, and other significant species presence. These shapefiles have added value in that they can be overlaid with other GIS referenced information; e.g., county property boundaries and ownership maps.

2) Digital photo album of the infested areas corresponding to each data point.

3) Auxiliary notebook describing significant observations.

4) PDFs of river segments showing shapefiles overlaid onto aerial photos and Excel spreadsheet tables are provided as user-friendly formats to present usable information for people without GIS expertise.

5) Excel spreadsheets provide individual details for each shapefile as well as watershed summaries. The summaries contain infestation acreage, percent cover, estimates of existing and future water losses, and estimates of total restoration costs including planning, control, revegetation, monitoring, and maintenance. These cost estimates are based on algorithms developed in *Options for Non-Native Phreatophyte Control* (March 2006, Tamarisk Coalition). The cost equations incorporate best management practices coupled with an Integrated Pest Management approach based on three variables – percent tamarisk cover, accessibility, and average width of infestation.

System Requirements:

System requirements to use the inventory and mapping data require the following computer and software capability.

1) The minimum requirement for viewing the shapefiles is a free program called ArcExplorer, available at **http://www.esri.com/software/arcexplorer/**.

2) Computer specs: Access the ESRI site at www.esri.com for specific system requirements.

3) Microsoft Word and Excel software are used for viewing reports and spreadsheets. Adobe Reader is required for PDFs of river segments showing shapefiles overlaid onto aerial photos.

4) Digital photos: Any software capable of viewing JPEGs is sufficient.

ID: 9116 - Evaluation of Invasive Species Management Strategies and Technologies for Protection of Drawdown Zones in Annually Drafted or Drought-Affected Reservoirs

Submitted by: Ken Lair, Ecological Research and Investigations, 86-68220, 303.445.2005, klair@do.usbr.gov
Show me the history of this proposal. Previous versions include: 2006

I. General Information

A. Title (250 character limit including spaces) Help. Update Title
Enter a title and then click "Update Title".

Evaluation of Invasive Species Management Strategies and Technologies for Protection of Drawdown

B. State the question your R&D would answer. Help
(Please do not disclose any potential intellectual property in this section. See Section I.F below. 1000 character limit including spaces) Click Add or Edit Text to begin.

Exposed drawdown zones of numerous reservoirs throughout the Western United States are adversely impacted by encroachment and establishment of invasive plant species during periods of seasonal or annual drafting or recedence during extended drought, particularly saltcedar (Tamarix spp.). What are the best management strategies and technologies for control of invasive species in light of a) prescribed reservoir hydrographic protocols; b) invasive species colonization and infestation dynamics; c) exposed soils, geologic substrates and site predisposition to invasion; and d) semi-aquatic environmental constraints on use of weed control measures? This proposal addresses activities to develop partnerships and increase involvement of water users and suppliers to: 1) expedite application of research on drawdown zone stabilization; and 2) coordinate research across agency, commercial and private stakeholders in cost-effective pursuit of site protection during extended drawdown events.

C. R&D Focus and Output Areas Help Detailed Description of Output Areas
Update Output Area

WD3-Reduce Invasive Species Impacts on Water Delivery
WD3

D. Proposed Start and Completion Years Help Update Years
Select proposed start and completion years, then click "Update Years".

Proposed Start Year FY: 2007

Proposed Completion FY: 2007

E. Type of Proposal (pick one) Help Update Type
It is VERY IMPORTANT that you read all the instructions for this section. Once you have read the instructions, select the type of proposal you are submitting, then click "Update Type".

(•) Scoping or Formulation (Should not exceed $10,000 to $15,000)

( ) Conducting research and development.

F. Security and Intellectual Property Alert: If Sections II and/or III below contain information that could be considered propriety or potentially patentable please check "yes" below.
Be sure to note that if you check "yes", reviewers of your proposal will sign a non-disclosure agreement. The Title and R&D Question, Sections I.A and I.B, will not be protected and should be worded such that potential intellectual property is not disclosed. Help Update Alert
Make a choice below, then click "Update Alert".

( ) Yes

(•) No

If you answered Yes, reviewers of your proposal will sign a non-disclosure agreement. The information in Section I will not be protected and should be worded such that potential intellectual property is not disclosed.

II. Proposed Research End Products, Completion Dates, Need, and Benefit

A. No.	R&D End Product Category	How will your end product (s) be documented	Scheduled Completion Date	Add New End Product
1	Tools to measure effects of water operations on ecosystems Evaluation and selection of representative reservoirs significantly impacted by weed encroachment in drawdown zones.	Results of this outcome will be included in Report for Output No. 2.	01/31/2007	Edit Delete
2	Tools to offset or reduce impacts on water projects due to environmental constraints Inventory and assessment of BOR drawdown zone	Report	08/30/2007	Edit Delete

	characteristics, invasion predisposition factors, and reservoir impacts from drawdown zone exposure and weed encroachment for selected reservoirs.			
3	Tools to measure effects of water operations on ecosystems Development of partnerships, including advocates and research collaborators with commitment of funds or IKS.	Results of this outcome will be included in Report for Output No. 4.	09/30/2007	Edit Delete
4	Tools to measure effects of water operations on ecosystems Development of plans, strategies, and draft experimental designs for continuing collaborative research.	Report	09/30/2007	Edit Delete

B. Need and Benefit
Describe existing capabilities available to Reclamation from both internal and external sources. Explain why they are insufficient to adequately serve Reclamation's needs. (4000 character limit including spaces) Help Add or Edit Text

The Bureau of Reclamation (BOR) operates and maintains numerous multi-purpose reservoirs throughout the Southwestern United States. Many of these reservoirs are currently experiencing adverse environmental and ecological impacts to shoreline drawdown zones as a result of extended drought progressively and perennially lowering water levels. Exposure of bare shoreline soils below high-water line (BHWL) during these drawdown events greatly increases frequency and severity of weed infestation problems, particularly from aggressive, perennial species such as saltcedar (Tamarix spp.), Canada thistle (Cirsium arvense), and knapweeds (Centaurea spp.). Prescribed annual or seasonal drafting protocols for hydroelectric generation, flood storage, maintenance of downstream fisheries minimum flows or conservation pools, and other purposes also exacerbate these problems. Invasive species growth on exposed shorelines poses severe risk for new or increased dissemination of weed seed and other reproductive propagules to surrounding landscapes and ecosystems, including ecologically sensitive riparian sites along reservoir tributaries. Lacustrine fisheries habitat within littoral zones is also adversely impacted by erosion loss or wave-induced diffusion of shoreline substrate fines, thereby favoring or shifting plant establishment and composition during drawdown events toward aggressive annual (ruderal) or perennial invasive species with germination and dormancy strategies highly adapted to such altered soil environments. Subsequent increase of dead, decomposing weed biomass contributes to aquatic eutrophication in littoral (shallows) shoreline habitat.

Effective strategies for addressing these invasive species management concerns have not been developed or refined to-date, in part because of the perceived ephemeral nature of reservoir drawdown events. In light of longer-term impacts resulting from recent extended drought and/or longer drafting periods, these strategies are particularly needed in terms of: a) scientific soundness of treatment approaches; b) correlation to reservoir hydrologic dynamics (i.e., treatment windows, treatment residuals in soils, etc.); c) development of rapid-response shoreline revegetation protocols for use during drawdown events, utilizing inundation-tolerant desirable species to stabilize the site and minimize weed colonization; and d) assessment of predisposition of certain reservoir locations or soils to weed infestation in relation to regional weed population pressure, topographically influenced micro-climate, and transportation vectors. Evaluation of herbicide chemistry in relation to physical leaching or retention properties in exposed shoreline soils altered by long-term inundation and wave action has not been studied. Similarly, uncertainty as to site classification in reservoir drawdown zones by

State agencies responsible for implementation and monitoring of aquatic vs. non-aquatic labeled application of herbicides also suggests the need for research that will not only determine best management practices in light of environmental constraints, but also refine and codify permissable herbicide products within these zones. Involvement and commitment of resources from these state agencies with other agencies, cooperators and research collaborators to address this lack of appropriate strategies and technologies is a prime thrust of this scoping proposal.

C. Why is this the responsibility of Reclamation and not another government agency or the private sector. (3000 character limit including spaces) Help Add or Edit Text

Reclamation is responsible for environmental health and safety of physical facilities that the agency operates or controls, including ecological health and sustainability of associated, supporting land forms. Reclamation is a member agency of the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), with lead responsibilities for management and research for aquatic and riparian invasives. Reclamation is also responsible for the identification and proper management of pests on Reclamation lands and at Reclamation-owned facilities in accordance with the national policies set out in FIFRA, Federal Noxious Weed Act, Carlson-Foley Act, and applicable State and local laws and standards. [Authority: Federal Insecticide Fungicide and Rodenticide Act (FIFRA), as amended; Federal Noxious Weed Act of 1974 (Public Law 93-629 as amended, see Public Law 101-624 for Section 15); Carlson-Foley Act of 1968 (Public Law 90-583, 82 Stat. 1146) concerning Control of Noxious Plants on Federal Lands; 517 DM 1. Pesticide Use Policy].

These responsibilities include prevention or control of the introduction or dispersal of noxious weeds into previously uninfested areas by vectors such as vehicle/equipment transport, project activities, or reservoir operation and maintenance. Reclamation manages pests and the environment so as to balance cost, benefits, public health, and environmental quality, coordinating with other land management agencies to ensure that the appropriate best management practices are implemented. The State Departments of Agriculture and/or Natural Resources, adjoining land management agencies, and county agricultural commissions are incorporated into development of measures to avoid the dispersal of noxious weeds.

Because of these responsibilities, and through the research capabilities and resources of the Ecological Research and Investigations Group, Reclamation is in best position to lead in developing partnerships and coordinating research efforts on these reservoir drawdown sites to determine needed prescriptions for prevention measures; timeliness of weed management; when management should be initiated; at what frequency treatments should be applied; what physical, cultural, biological, or chemical strategies should be employed; and the effect of the treatment(s).

III. Proposed Steps to Produce the R&D End Products Listed in Section II

A. Briefly Describe: i. The methods and approaches you will use to answer your research question and
ii. How you will share your research end product with peers and stakeholders. (4000 character limit including spaces) Help Add or Edit Text

i. For this scoping proposal, sample reservoirs (n <= 6) will be selected for further examination of study

feasibility and development of contributing partnerships and research collaboration based on an initial survey of reservoir hydrology / hydrography; history, nature and severity of weed infestation attributable to periodic drawdown; suitability for experimental treatment application (including equipment access); proximity and degree of weed dissemination threat to downstream land uses, reservoir tributaries, sensitive riparian / wetland areas, and other natural resources; and suitability for extrapolation of data and findings to similar reservoir systems.

Upon completion of initial sample reservoir selection, existing resource attribute data will be augmented by limited field sampling and data collection for specific a) soil parameters (texture / structure, salinity / SAR, pH, organic matter, nutrient status, soil microbial communities); b) vegetation parameters (invasive species composition, diversity / richness, canopy structure / cover, density / frequency, associated/adjacent plant communities, including weed populations); c) climate parameters (long-term means and seasonal / annual patterns for precipitation, evapotranspiration, wind, soil temperature and moisture regimes); and d) hydrologic parameters (reservoir hydrographic protocols (fill and drawdown patterns / duration / history), groundwater depth / quality, proximity and hydrologic relationship to tributary streams (perennila and ephemeral).

From these parameter evaluations, a subset of sample reservoirs will be chosen as most appropriate and utilitarian for potential design and installation of experimental trials, pending final partnership commitment, approval of scoping proposal results and provision of ongoing research support funding.

ii. Diverse partnerships with other BOR office, agency (e.g., USACOE) and private sector researchers will comprise a significant component of this work, enhancing dissemination and deployment of results. Results of partnership development and interest in the project will be reported via USBR Report (e.g., Technical Memorandum). Future research results from an expanded project will be jointly published with cooperators in peer reviewed journal publications and additional Reclamation technical reports. Progress reports, and links to outside publications, will be posted on Reclamations IPM web site. Recommendations and guidelines (decision support criteria, including self-assessment form) for evaluating site-specific weed management protocols and restoration potential will be issued in technical Reclamation reports.

List the sequential steps that you will take to conduct your R&D and share the results with end users and peers to promote adoption of your research end product.

B. No.	Proposed Steps To Produce the Research End Products Outputs listed in Section II (Each Task description is limited to 400 characters but there is no limit on the number of tasks you can enter.)	Requested S&T Budget for Each Step	Scheduled Completion Date	Add New Step
1	Evaluation and selection of representative reservoirs significantly impacted by weed encroachment in drawdown zones.	$2,500.00	01/31/2007	Edit Delete
2	Inventory and assessment of biotic and abiotic drawdown zone characteristics, invasion predisposition factors, and reservoir impacts from drawdown zone exposure and weed encroachment for selected reservoirs.	$7,500.00	08/30/2007	Edit Delete
3	Development of partnerships, including advocates and research collaborators with commitment of funds or IKS.	$2,500.00	09/30/2007	Edit Delete
4	Development of plans, strategies, and draft experimental designs for continuing collaborative research.	$2,500.00	09/30/2007	Edit Delete
Total Funding		$15,000.00		

IV. Fiscal Year S&T Program Funding Request

Fiscal Year	Funding Requested	Add New Fiscal Year
2007	$15,000.00	Edit Delete
Total Requested S&T Funding	$15,000.00	

V. Partners - Cost-Sharing With Others Who Have A Stake in This Effort

No.	Partner First Name	Partner Last Name	Organization	Phone	E-mail	Firm or Potential	Inside or Outside	Add New Partner
1	Michael	Delvaux	NK-300	308-389-5314	mdelvaux@gp.usbr.gov	Firm	Inside	Edit
2	Jaci	Gould	EC-1300	970-962-4338	jgould@gp.usbr.gov	Potential	Inside	Edit
3	Stephen	Grabowski	PN-6540	209-727-5319	sgrabowski@pn.usbr.gov	Firm	Inside	Edit
4	Jean	Van Pelt	Southeastern Colorado Water Conservancy District	719-948-2023	jean@secwcd.com	Potential	Outside	Edit

You must add the partner above before you describe the contribution below.

No.	Partner Last Name	Description of Partner Contribution	Cash / IKS	Year	Projected Contribution Value	Add New Cntrb
1	Delvaux	Technical review of experimental approach; assessment of vegetation and hydrologic data gaps and availability; assistance with site selection, sampling design and field data collection.	IKS	2007	$5,000.00	Edit Delete
2	Gould	Technical review of experimental approach; assessment of vegetation and hydrologic data gaps and availability; assistance with site selection, sampling design and field data collection.	IKS	2007	$2,500.00	Edit Delete
3	Grabowski	Technical review of experimental approach; assessment of vegetation and hydrologic data gaps and availability; assistance with site selection, sampling design and field data collection.	IKS	2007	$2,500.00	Edit Delete

4	Van Pelt	Technical review of experimental approach; assessment of vegetation and hydrologic data gaps and availability; assistance with site selection, sampling design and field data collection.	IKS	2007	$2,000.00	Edit Delete

VI. Advocates - List Reclamation Managers, Other Stakeholders, and Project Output Beneficiaries That Advocate this Proposed Effort

First Name	Last Name	Title	Organization	Phone	Email	Add New Advocate
Michael	Delvaux	Natural Resource Specialist	NK-300	308-389-5314	mdelvaux@gp.usbr.gov	Edit Delete
Jaci	Gould	Resource Manager	EC-1300	970-962-4338	jgould@gp.usbr.gov	Edit Delete
Stephen	Grabowski	Research Fisheries Biologist	PN-6540	208-378-5030	sgrabowski@pn.usbr.gov	Edit Delete
Chris	Holdren	Group Manager	D-8220	303-445-2178	choldren@do.usbr.gov	Edit Delete
Eric	Lane	State Weed Management Coordinator	Colorado Department of Agriculture	303-239-4182	eric.lane@ag.state.co.us	Edit Delete
Jean	Van Pelt	Conservation Outreach Coordinator	Southeastern Colorado Water Conservancy District	719-948-2023	jean@secwcd.com	Edit Delete

VII. Research Beneficiaries and R&D Locations

A. Primary Research Beneficiaries

Region 1	Region 2	Region 3
BOR-WIDE	GP	PN

Update Region

B. R&D Location

Field/Office/Lab Based	Area Office	Primary Field Contact	Add New Location
Field based	Nebraska-Kansas	Michael Delvaux, mdelvaux@gp.usbr.gov NK-300	Edit Delete
Field based	Eastern Colorado	Jaci Gould, jgould@gp.usbr.gov EC-1300	Edit Delete
Field based	Upper Columbia	Stephen Grabowski, sgrabowski@pn.usbr.gov PN-6540	Edit Delete

C. NEPA Compliance Contact

First Name	Last Name	Organization	E-mail	Location of NEPA Document	Enter NEPA Compliance Contact Information
Gregory	Reed	D-8210	greed@do.usbr.gov	Denver TSC (D-8220/8210) and at jurisdictional Area Offices.	Edit Delete

VIII. Project Team

First Name	Last Name	Discipline/Speciality	Organization	Phone	E-mail	PI	Add New Member
Kenneth	Lair	Restoration Ecologist / Research Botanist	D-8220	303-445-2005	klair@do.usbr.gov	Yes	Edit Delete
Michael	Delvaux	Natural Resource Specialist	NK-300	308-389-5314	mdelvaux@gp.usbr.gov	No	Edit Delete
David	Sisneros	Research Botanist / Aquatic Weed Management Specialist	D-8220	303-445-2228	dsisneros@do.usbr.gov	Yes	Edit Delete
Stephen	Grabowski	Research Fisheries Biologist	PN-6540	208-378-5030	sgrabowski@pn.usbr.gov	No	Edit Delete
Scott	O'Meara	Research Botanist	D-8220	303-	someara@do.usbr.gov	Yes	Edit

				445-2016			Delete

IX. Potential Technical Reviewers

Enter the names and contact information for three technical reviewers outside of Reclamation that are qualified to review your research proposal. Please enter a list of keywords that describe the expertise of the potential technical reviewer. To add rows for additional potential technical reviewers, click the Add New Reviewer link. Help

First Name	Last Name	Field of Technical Expertise	Key Words Associated with Potential Reviewer's Expertise	Affiliation	Phone	E-mail	Add New Review
Dr. George	Beck	Weed Scientist; Extension Weed Management Specialist, Colorado	No key words yet	Department of Bioagricultural Sciences, Colorado State University	970-491-7568	K.George.Beck@colostate.edu	Edit Delete
Eric	Lane	Weed Management; State Weed Management Policy and Regulation Formulation	No key words yet	Colorado Department of Agriculture	303-239-4182	eric.lane@ag.state.co.us	Edit Delete

X. Comments and Additional Information

Comments and Additional Information Help Add or Edit Text
Use this space to provide any additional inforamtion regrading this proposed effort (4000 characters limit including spaces)

RESUBMITTED FOR FY2007; NOT FUNDED IN FY2006.

This project still has GREAT merit and timeliness in light of continuing, worsening drought conditions throughout the Western US. This climatic trend will continue to exacerbate invasion and infestation in reservoir drawdown zones through a) further reduction of reservoir storage pools, exposing additional acres to infestation and resultant seed dispersal to neighboring lands; and b) reduction in vigor of native species due to drought stress, enabling invasive species (particularly annual grasses and depp, tap-rooted perennials) to gain a competitive advantage on shoreline sites.

Addendum Part B. 5. A.
Please provide a copy of the proposed scope of work.

nonnative, phreatophyte trees throughout the Arkansas River watershed. The framework will include a plan and a data base that can be used as management tools. The plan and data base will incorporate templates and protocols. The term *template* defines what actions that needs to be taken, and the term *protocol* defines how the actions will be performed. The templates and protocols will offer guidelines and criteria for decision making while carrying out the activities associated with various aspects of the nonnative phreatophyte tree control, revegetation and rehabilitation, monitoring, and long-term management. Thus, the intent is to ensure that selected approaches are consistent, effective, efficient, and decisions and actions are well documented. The plan will encourage public land managers and private landowners to undertake coordinated control and restoration measures. It will identify long-term objectives to address infestations and define measures of success. As the project matures, the templates and protocols will be continuously updated to improve the efficiency and effectiveness of the control, revegetation and rehabilitation, monitoring, and long-term management and maintenance.

The purpose of the Plan is to provide valuable leadership and tools to initiate a basin-wide effort for long-term management of nonnative phreatophyte trees. Currently, there are a few projects being undertaken in the Basin, but they are small and fragmented in their efforts and work is not well documented. The need for a well-thought out plan that outlines the steps for control, revegetation, and restoration, and monitoring techniques for various situations will provide consistent, effective and efficient decisions and actions that will be well documented. The District is supported by most of these groups and others in its quest to develop the much needed plan and data base that will assist in the challenge of attaining long-term management of nonnative phreatophyte trees in the basin.

The Arkansas River watershed encompasses twenty two counties in southeastern Colorado. They are Lake, Chaffee, Park, Saguache, Teller, Fremont, Custer, Huerfano, Costilla, Las Animas, Pueblo, El Paso, Elbert, Lincoln, Crowley, Otero, Baca, Prowers, Bent, Kiowa, Cheyenne, and Kit Carson. Within the watershed there are 13 water districts defined by the Colorado Department of Natural Resources (DNR). The 13 districts are located in Department of Water Resources (DWR) Division 2 (See Addendum Part B. 5. A. – Map) The Districts are: District 10 – Fountain Creek basin, District 11 - Arkansas River from the headwaters to the Town of Salida, District 12 - Arkansas River from the Town of Salida to Dept. of Natural Resources stream flow gage at Portland, District 13 - Wet Mountain Valley basin, District 14 - Arkansas River Portland gage to the town of Fowler, District 15 - Saint Charles River basin, District 17 - Cucharas River basin, District 17 - Arkansas River from Fowler to the city of Las Animas, District 18 - Apishapa River basin, District 19 - Purgatoire River basin, District 66 - Cimmaron River basin, District 67 - Arkansas River from Las Animas to the Kansas state line, and District 79 - Huerfano River basin.

Addendum Part B. 5. A. (Page 2)
Please provide a copy of the proposed scope of work.

The constraints of the size of this project will necessitate a multi-pronged approach. Management efforts will have two focuses and both approaches will be addressed at the same time. One focus will be on the upper reaches of the water district and work downstream toward the main-stem. The Plan will divide the watershed into segments utilizing the existing boundaries of the 13 water districts. The systematic approach to long-term management will begin in the headwater areas of each watershed or water district within the Basin and will continue downstream. Each water district within the Basin will be further subdivided into the main stem, tributaries, perennial streams, intermittent streams, ephemeral streams, dry washes, canals and ditches. Each subdivision will be further divided into subsets of smaller denominations to properly define areas for management activities.

The other multi-pronged approach will focus on certain health and safety situations when a headwater approach may not be the ideal method, particularly in areas of special concern. This additional approach will focus on monotypic areas of heavy infestation and/or with health, safety, and environmental concerns .These areas will be appropriately prioritized and acted upon in a timely manner. In addition, local jurisdiction may have restrictions or constraints that require different priorities and approaches. The strategy for control and management must be designed to result in a progressive reduction of the overall infestation.

Once the Plan is completed, a data base will be developed to assist land managers and owners in determining proper control, revegetation, monitoring and maintenance strategies. This will be available on an easy to access interactive web site. These will serve as valuable resource tools to assist landowners and land managers in selecting the appropriate control, restoration, and management method for a particular level of infestation and land use. The data base will also assist in tracking progress and evaluating management practices within the Basin.

The Plan development will cost approximately $200,000. Twenty thousand dollars will be used for District staff and a Technical Advisory Committee to develop the Strategic Basin Plan. Approximately $75,000 will be needed to develop the interactive data base, web site, and publication costs. The mapping and engineering cost will be approximately $100,000. This will include costs for mapping and GIS specialists, County Planning & Engineering Departments and Tamarisk Coalition consultations. An additional, $5,000 will be needed to meet travel, meeting and office expenses. (Please see Addendum Part B. 5. B. – Budget)

The District is also applying for funds from a Department of Local Affairs grant proposal to develop the Strategic Plan and complete the mapping. Bent County has graciously

Addendum Part B. 5. A. (Page 3)
Please provide a copy of the proposed scope of work.

agreed to be the lead county on this proposal, because DOLA requires a government entity to be the applicant. The District will provide technical and managerial support for the grant and plan development. The grant request from DOLA will be for $50,000. The deadline for supporting entities to report is March 15, 2007 and the DOLA grant will be submitted before the April 1, 2007 deadline.

Please, see Addendum Part B. 5. B. for detailed budget.
Please, see Addendum Part B. 5. C. for a project schedule.

Addendum Part B.5.B. – Budget Summary

BUDGET		
Expenses	**$200,000**	
	Cash	**In-Kind**
Plan Development SECWCD Staff Conservation Outreach Coordinator 400 hrs @ $32.63 hr. Executive Director 20 hrs. @ $112.32 hr. Director of Finance 50 hrs. @ $50.75 hr. Admin. Associate 15 hrs @ $22.11 hr. Admin. Manager 5 hrs. @ $40.24 hr Technical Advisory Committee	**$20,000** $13,052 $2,246 $2,537 $332 $201	 $1,622
Office Expenses Misc., blueprints, photos, GIS maps Copier Postage	**$1,500** $1,000 $100 $400	
Public Education Expenses Publication of Plan for Distribution and Promotion Website Development Development of Data Base	**$75,000** $7,000 $18,000 $50,000	
Meeting Expenses Organizational Meetings Outreach/Educational Meetings	**$2,000** $1,000 $1,000	
Travel 3,000 miles @ $0.485/mile 10 - 300 miles round trips	**$1,500** $1,500	
Mapping/Engineering Expenses Contract for GIS Mapping SECWCD Director of Water & Engineering 100 hrs @ $57.08 hr. SECWCD Engineering Support Staff 160 hrs @ $28.05 hr.	**$100,000** $40,000	 $5,700 $4,300

Addendum Part B.5.B. – Budget Summary

COMMITTED INKIND $ AMOUNTS FROM VARIOUS COUNTIES		
County GIS Specialists		$25,000
County Planning Departments		$10,000
County Engineering support		$5,000
Tamarisk Coalition Consultations		$10,000
Income	**$153,340**	
Arkansas Basin Roundtable Grant	**$50,000**	
Department of Local Affairs Grant	**$50,000**	
Committed Cash Contributions	**$17,000**	
Pueblo County		
Otero County		
Crowley County		
Bent County	$7,000	
Prowers County	$5,000	
Fremont County		
El Paso County		
Huerfano County		
Las Animas County		
Baca County		
Custer County		
Chafee county		
Lincoln County		
Kiowa County		
Cheyenne County		
Elbert County		
Teller County		
Energy Companies		
The Nature Conservancy		
Purgatoire River WCD	$5000	
Lower Arkansas WCD		
Upper Arkansas WCD		
Soil Conservation Districts		
Committed In-kind Contributions		**$36,340**
Bent County		$5,000
Crowley County		
Fremont County		
El Paso County		
Prowers County		$5,240
Pueblo County		
Otero County		

Addendum Part B.5.B. – Budget Summary

Huerfano County		
Las Animas County		
Baca County		
Custer County		
Chaffee County		
Lincoln County		
Kiowa County		
Cheyenne County		
Elbert County		
Teller County		
Purgatoire River WCD		
Southeastern Colo. WCD		$10,000
Lower Arkansas WCD		
Upper Arkansas WCD		
The Nature Conservancy		
CO State Forest Service		$1,200
CSU Cooperative Extension		$1,000
Soil Conservation Districts		
USDA - NRCS offices		$1,950
Southeast RC & D		$1,950
Sangre de Cristo RC & D		
Tamarisk Coalition		$10,000

Addendum Part B. 5 C. Project Schedule

Tasks	Completion Date
Submit DOLA grant	April 2007
Develop Technical Advisory Committee	May - June 2007
GIS Mapping Project Development	June - December 2007
Plan Development	June - December 2007
Data Base Development	August 2007 – February 2008
Publish & Distribute Plan	January 2008
Website development to house data base	January – February 2008
Outreach Programs	December 2007 – March 2008

Addendum Part B. 8.
Evaluation Criteria

encompass the entire Basin. This funding will not only support plan development, but it will also enable the Basin to qualify for other sources of funding to implement the Plan.

d. The "window of opportunity" that is offered is to have the Basin Plan in place and ready to go when the newly passed Federal Legislation HR 2720 "The Salt Cedar and Russian Olive Control Demonstration Act" is appropriated. By having a Plan already in place will increase the Basin's chances of being funded under HR 2720.

e. The Plan mapping project and data base will be completed in its entirety by February 2008.

f. The Southeastern District has shown our commitment to this problem since passing a Resolution in June 2003 to take the lead for the implementation of regional projects. In addition, District staff has been appointed to represent the Arkansas Basin on the Board of Directors of the Tamarisk Coalition. Other staff members have actively participated with groups throughout the Basin in support of their projects.

g. The District is providing in-kind contributions as well as many of the counties and entities in the Basin to support the Plan. Cash contributions will come from the counties, municipalities, and entities and grant funding from the Department of Local Affairs.

h. There is a need for financial assistance in the Arkansas Basin. Many of the counties and municipalities are struggling financially, but they recognize the importance of this project and have agreed to support it with in-kind contributions of staff time and expertise.

Meeting Water Management Goals and Objectives and Identified Water Needs

i. By completing the mapping project for the entire Basin it will enable us to evaluate the water loss and savings that is possible by implementing the Plan.

j. The Plan development meets many of the SWSI objectives: Optimize existing and future water supplies, enhance recreational opportunities, and provide for environmental enhancements.

k. The plan development will promote water conservation by providing landowners and managers the tools for eliminating phreatophytes.

l. The Southeastern District has a Five year Water Management and Conservation Plan which has been approved by the Bureau of Reclamation. One of the conservation measures is a Tamarisk Control Program.

m. According to the research the Tamarisk Coalition has performed the phreatophytes along the main stem of the Arkansas are stealing 46,600 acre-feet per year. When the

water loss from the major tributaries and reservoirs are added in an additional 12,000 acre feet per year is being lost. This amount is above and beyond what native vegetation would use. If this problem is not addressed, future water losses from "infilling only (no expansion from existing infested areas) are estimated to be 86,000 acre-feet per year on the river and 44,000 acre feet on the major tributaries and reservoirs.

n. The Plan incorporates a riparian and upland restoration component that will restore native plants and habitats once control measures have been implemented. In addition, the Plan will incorporate long-term management options to ensure the invasives do not rebound.

The Water Activity Addresses Issues of Statewide Value

o. The Plan will provide tools for long-term management which will help to sustain agriculture land, open space, increase accessibility to the river for recreation and livestock and wildlife access, reduce channelization that causes flooding, and will reduce the risk of wildfires.

p. By developing and implementing the Plan the water that will be saved can assist in providing necessary water to meet the State's obligation for the Arkansas Compact requirements.

q. By developing and implementing the Plan the riparian health of the Arkansas River Basin will be enhanced for all species by restoring the native plant and animal communities.

r. The proposed Plan, mapping project, monitoring programs and the interactive data base can be used as model for other Basins in the state to utilize. The benefits that will come from the development of this Plan will far out weigh the costs of development.

s. CWCB has already invested time, energy, and dollars in mapping the main-stem of the Arkansas and the major tributaries and reservoirs. It is clear that the long-term management of the non-native phreatophytes in Colorado is in the best interest of the Board and the State.

t. The development of a Basin Plan will greatly increase the chances for the Arkansas Basin to receive funding to implement the Plan through the federal legislation HR 2720. The legislation states to qualify for funding there needs to be regional and state plans in place.