WPF0212

Cover Page

Fill in all blanks on the cover page. Devise a short descriptive title for the proposal. Your project may fall into more than one of the four primary project types. If so, select all categories that apply. For #12 below, only list other monies that are secured at the time of application submittal. For #13c below, you may list the total of both secured and unsecured money that is committed at the time of application submitt The difference between #13 and #12 should represent the total of unsecured money for your proposal.

RECEIVED
AUG 17 1998
WATER PROTECTION FUND

Cover Page: Application Information

1. Title of Project: Verde River Headwaters Riparian Restoration Demonstration Project

2. Type of Project:
____Water Acquisition
__X__Capital Project or other Consultation_____
____Water Conservation
____Research

3. Stream type
__X__Perennial
_____Intermittent
_____Ephemeral

4. Date submitted 8/14/98
5. a. Date Attended an AWPF Workshop 6/9/98
5. b. Date Attended an AWPF

6. Applicant Name Northern Arizona University

7. Applicant address (city, county, zip code)
Environmental Sciences
P. O. Box 5694
Northern Arizona University
Coconino County
Flagstaff, Arizona 86011-5694

8. Inside AMA
____ Phoenix
____ Tucson
____ Prescott
____ Pinal
____ Santa Cruz

Outside AMA XX

9. Contact person/title: Dr. Diana Anderson
Phone number: [redacted]
Fax number: 520-523-7423

10. Type of application:
New (X) Continuation ( )

11. Project start date: 5/15/99
End date: 5/14/02

12. Other monies obtained and secured:

Grant type	Amount
Total	

13. Estimated funding:
a. AWPF $ 148,429
b. Applicant $ 113,543
c. Other_____
d. Total $ 261,972

14. Tax ID number: [redacted]

15. The undersigned hereby offers and agrees to perform in compliance with all terms, conditions, specifications and scope in the application. Signature certifies understanding and compliance with the attac application. Signature certifies that all information provided by the applicant within this application is true and accurate. The Arizona Water Protection Fund Commission may approve grant award agreements with modifications to scope items, methodology, schedule, final products, and/or budget.

Charles W. Connell
Typed Name of Authorized Representative

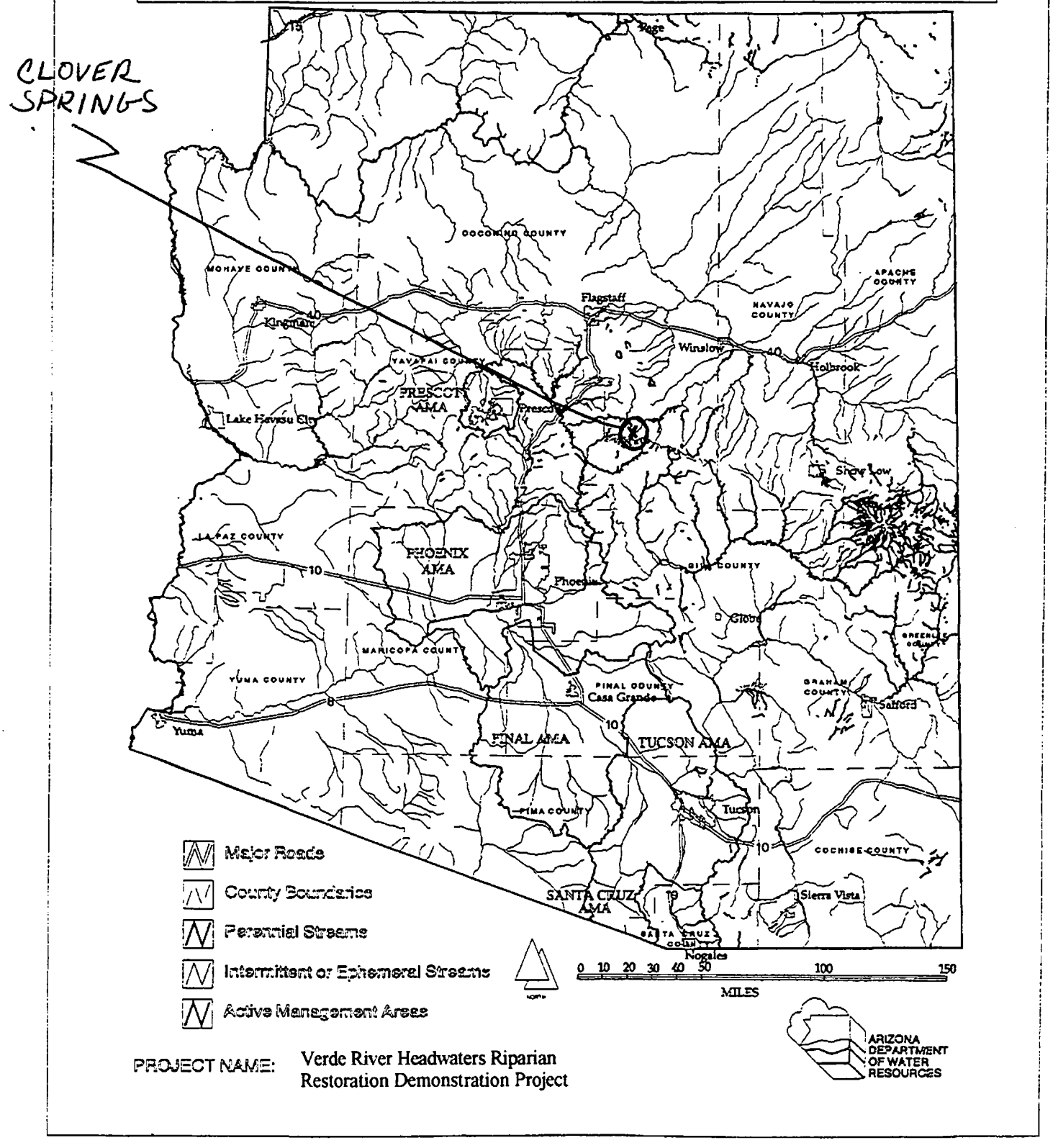
Provost (520) 523-4880
Title and Telephone No.

Charles W. Connell
Signature

8/14/98
Date Signed

Arizona Map Instructions

Indicate on the map the approximate location of your project. Ensure that your markings are clearly visible on all five copies submitted.



PROJECT NAME: Verde River Headwaters Riparian Restoration Demonstration Project

Summary Page

Limit this section to one page!! Begin this summary with a single sentence clearly stating the purpose of the project. List objectives, describe methods to be used, describe all major project features for which funding is being requested (which must also be indicated on the schematic drawing required on the next page) and indicate the significance of the proposed work to the maintenance, enhancement or restoration of Arizona's rivers, streams and associated riparian or aquatic habitats.

Summary:

The purpose of the proposed capitol project is to restore the pre-disturbance morphology and riparian ecosystem of a channelized portion of a perennial stream that flows in the valley of Clover Springs. The 2,600 ft long reach of interest has been severely downcut, with incision initiated by de-stabilization of the local surface due to grazing by domestic livestock or wildlife and human-induced changes in the channel configuration related to road construction. In addition, in-stream log structures have initiated new bank erosion and widening of the channel. Wetland meadows such as the valley of Clover Springs are unique and valuable resources within the dry ponderosa pine forests above the Mogollon Rim in central Arizona. Stream channelization is known to lower the local water table, adversely affecting riparian vegetation in such wetland meadows.

The proposed restoration area is located in the Coconino National Forest approximately 5.5 miles south of Clint's Wells on Hwy 87. Restoration is proposed for the 2,600 feet of channel downstream of Hwy 87 and the channel adjacent to, and immediately upstream of, Clover Springs. The stream flowing through Forty-Mile Canyon, which includes Clover Springs Valley, is a tributary of West Clear Creek, which contributes to the Verde River. The effects of the restoration at Clover Springs will contribute information toward future restoration efforts in the Mogollon Rim Verde River headwaters.

Specific objectives designed to accomplish the stated purpose include:

(1) To develop and implement a channel stabilization and wetland protection plan for the Clover Springs reach downstream from the Highway 87 crossing. Natural channel processes and forms will be the design basis, as determined by extensive field measurements, while projected means of channel and wetland protection include removal of existing structures, reshaping and redirecting of the channel, and use of low impact structures to encourage natural channel stability. Protection of a rare upland riparian wetland meadow and stabilization of a degrading stream channel will be realized by control of downstream headcuts. The springs feeding the wetlands meadow will also be protected by maintaining or improving the channel grade. Moisture storage in the wetlands will be improved by raising the channel grade, improving vegetation and habitat. Protection of the slope stability of the nearby highway may also be effected. Knowledge gained by this project may be used in other areas along the Mogollon Rim that have undergone historic headcut incision.

(2) To determine the causative factors and timing of aggradation and incision in the reach of concern in order to develop a long-term restoration strategy. The chronology of events will be based on physical evidence of past floodplain activity, radiocarbon dating and description of sediments, tree-ring dating, and historic photographs. An accurate determination of the chronology of initial valley fill aggradation and the two subsequent incisional episodes, with attendant climatic and land-use histories, will allow reconstruction of the potential causes for headcut erosion in this reach. This information will be used to establish a mitigation plan that will take into account the long-term (greater than 20 years) variability of the reach. In addition, the geomorphic concepts gained in the project will assist in future NEPA work involving the proposed Highway 87 expansion and the Hackberry/Pivot Rock Allotment analysis.

(3) To develop outreach and public information products to transfer activities of demonstration project to the public. This objective will benefit the public through education about riparian restoration, the role of meadow ecosystems, historic disturbances, current conditions, desired conditions, and restoration techniques.

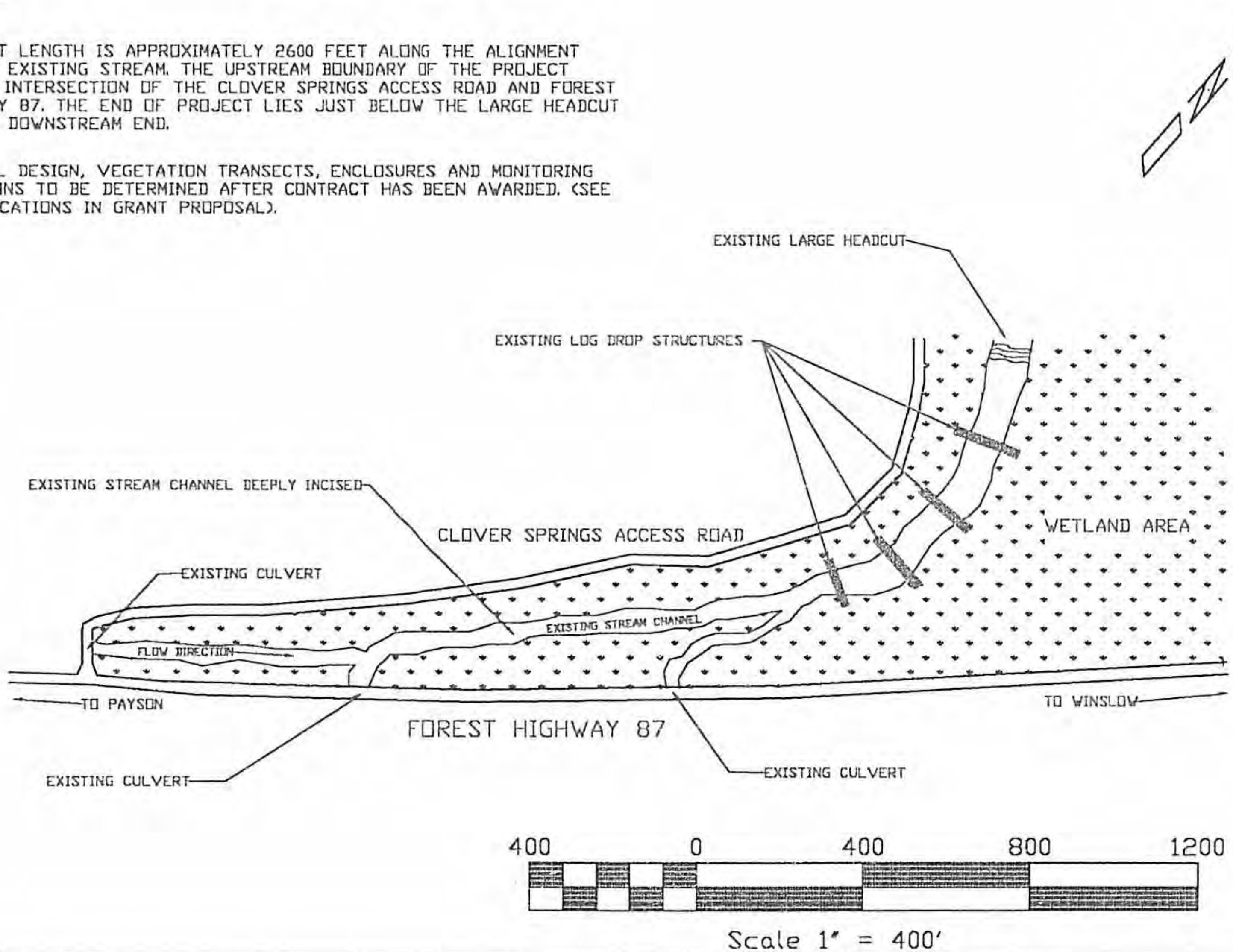
Project Schematic Drawing

PLAN VIEW

NOTES:

PROJECT LENGTH IS APPROXIMATELY 2600 FEET ALONG THE ALIGNMENT OF THE EXISTING STREAM. THE UPSTREAM BOUNDARY OF THE PROJECT IS THE INTERSECTION OF THE CLOVER SPRINGS ACCESS ROAD AND FOREST HIGHWAY 87. THE END OF PROJECT LIES JUST BELOW THE LARGE HEADCUT ON THE DOWNSTREAM END.

CHANNEL DESIGN, VEGETATION TRANSECTS, ENCLOSURES AND MONITORING LOCATIONS TO BE DETERMINED AFTER CONTRACT HAS BEEN AWARDED. (SEE SPECIFICATIONS IN GRANT PROPOSAL).



PLAN & PROFILE
VERDE RIVER HEADWATERS RIPARIAN RESTORATION DEMONSTRATION PROJECT
LONG VALLEY RANGER DISTRICT COCONINO NATIONAL FOREST
NORTHERN AIRZONA UNIVERSITY - COLLEGE OF ENGINEERING

Designed ___ Drawn ___ 2/97 Surveyed ___ 2/97 Checked ___

CAD FILE NO. CLOVE7L.dwg
DRAWING NO.
SHEET 1 OF 1

Project Site Photographs

For all types of applications, include color photographs of the project area and site. Submit one set of standard 3 X 5 inch color photographs of the project area (or color copies) with the 5 copies of your application. Label photographs as to compass direction and describe and indicate on photo the location of the proposed project features.

Photo 1: View east at the culvert under Hwy 87. Near upstream end of project area

Photo 2: View north from upstream end of project area. Note straight channel and deep incision. Hwy 87 visible at right, and dirt road visible at left of photo. This would be the main project area.

Project Site Photographs

For all types of applications, include color photographs of the project area and site. Submit one set of standard 3 X 5 inch color photographs of the project area (or color copies) with the 5 copies of your application. Label photographs as to compass direction and describe and indicate on photo the location of the proposed project features.

Photo 3: View southeast of in-stream log structure. Note lateral extension of incision at left of log structure.

Photo 4: View north at incision in downstream end of project area.

Project Location & Environmental Contaminant Information

This form is to be completed for projects which involve a specific stream reach or watershed area. If the exact extent of the project area is not completely defined at the time this form is completed, please make note of this on line #9 & 10 below, and complete the form with location information which is as accurate as possible. Outline the study area on a 7.5 minute (15 minute if the project area is too large), U.S.G.S. topographic map and include a copy with each copy of the application.. The Arizona Map previously requested is for general public use when reviewing your application summary, while the U.S.G.S. map is for staff use. **All applicants must complete the environmental contaminant questions.**

LOCATION INFORMATION

1. **County:** Coconino **2. Section:** 14, 23, 16 **3. Township:** T13N **4. Range:** R9E

5. **Legislative District:** 2nd

6. **Stream Name:** Clover Creek, Fortyfour Canyon, and Dirtyneck Canyon

7. **Land ownership of project area:** U.S. Forest Service

8. **Current land use of project area:** Multiple use

9. **Length of stream through project area:** 0.5 miles

10. **Size of project area (in acres):** approximately 2800 acres

11. **Area Benefited by Project Implementation:**

Miles of Stream Benefited 0.5 **miles**
Acres of Riparian Habitat (circle one) Enhanced, Maintained, **Restored**, Created: 28 **acres**

12. **Provide directions to the project site from the nearest town. List any special access requirements.**

The project area is approximately 5.5 miles south of Clint's Well on Arizona Highway 87. The project stream crosses the highway in the project site. There are no special access requirements.

ENVIRONMENTAL CONTAMINANT LOCATION INFORMATION

For purposes of this manual, environmental contaminants are substances which pose risk of harm to human health or the environment and include hazardous substances, hazardous wastes, petroleum products or Environmental Protection Agency priority toxic pollutants (defined by CERCLA 42 USC §9601, RCRA 42 USC §6903 and the Environmental Protection Agency). Environmental contaminants do not include wastewater from a wastewater facility permitted by a local, state, or federal authority having jurisdiction over wastewater.

1. **Does your project site contain known environmental contaminants? Yes__ No XX If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants.**

2. **Are there known environmental contaminants in the project vicinity? Yes____ No XX If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants.**

Evidence of Control and Tenure

Proposed capital development plans and research projects shall be located on land and water which the applicant owns or manages. Research projects on sites not controlled by the applicant shall include and attach the access agreement or permit allowing the research. At a minimum, the applicant must include in the application as one of the first tasks obtaining and submitting the appropriate agreements prior to initiation of the remaining project tasks. For water, either surface water, groundwater or effluent, when included as a project feature or benefit, you must include evidence of control and tenure with your application or include in your application a task to obtain control.

1. If you own the land on which the project is located, attach a copy of the appropriate legal document showing title in the name of the Applicant, and including a legal description of the property.

If you manage the land on which the project is located, attach a copy of the lease, special use permit, intergovernmental agreement or other appropriate official instrument.

If you do not own or manage the land on which the project is located, attach documentation verifying ownership (as noted above) and attach a copy of the permit, agreement or letter of intent that allows you access to the site.

Entire project area occurs within the Coconino National Forest and is controlled by the Coconino National Forest. See attached letter to Northern Arizona University granting access to project area.

2. If your project, including the benefits claimed for the Fund, involves surface water flows or use of groundwater withdrawals, demonstrate ownership and tenure by attaching the appropriate documentation .

If you do not own or manage the water that the project uses or that benefits the Fund, attach documentation verifying ownership (as noted above) and attach a copy of the permit, agreement or letter of intent that allows you use of the water.

Water rights to Clover Springs are in the name of the United States of America, Forest Service, Coconino National Forest Certificate #C819, see attached certificate.

Introduction

Give the background of the project. List the problem or problems that you address in your proposal, list the cause or causes of these problems, list the remedies or solutions and state the years of project-related benefit from the project that you will implement. Provide the necessary introductory information which supports your listing of the problem(s), cause(s), and solution(s). Describe the project area's relevant history if applicable. Justify the term your project will provide benefit. For on-going projects, the history and background of the project should be provided: Describe the site prior to project initiation, tasks that have been completed and any site changes that have occurred as a result of these activities.

Background:

Perennial streams occur rarely on upland areas of the Colorado Plateau. Where perennial streams do exist, they are typically supported by ground water discharging through either seeps or springs. Wetland meadows are unique and valuable resources within the dry ponderosa pine forests above the Mogollon Rim in Central Arizona. Many of these meadows have been severely impacted by stream instability caused by both natural and human activities. One such spring and associated perennial reach of stream occurs about 5.5 miles south of Clint's Well at Clover Springs. The springs are one mile upstream from the West Clear Creek Wilderness on Clover Creek. The springs issue from the Coconino Sandstone. Forty-four Canyon and Clover Springs Canyon provide perennial water to a series of meadows along almost two miles of drainage in the Coconino National Forest. This proposal details steps toward the stabilization of the most threatened channel, 2,600 feet of meadow fed by Clover Springs below Highway 87, referred to as the valley of Clover Springs.

Although there are no periodic spring discharge records by the U.S. Geological Survey or the Arizona Department of Water Resources, anecdotal information collected by the U.S. Forest Service indicates that the springs are perennial. The springs issue from the surrounding bedrock into 5 to 15 feet of shallow alluvium in the valley of Clover Springs. This alluvium has been severely downcut (up to 2.5 m) during at least two major incisional events. The first incisional event, responsible for the deepest headcuts, may have been initiated in an 1880's erosional episode that has been recognized throughout the southwestern U.S.. While the exact causes have not been determined, the erosion is postulated to have resulted from climatic change and/or changes in grazing practices. The second event, resulting in new incision, has been anecdotally related to the extreme winter flooding of January and February of 1993. Conditions leading to the extreme flooding of 1993 include a sequence of frontal storms with precipitation falling on existing snowpack (House and Hirschboeck, 1997, Hydroclimatological and paleohydrological context of extreme winter flooding in Arizona, 1993, Geological Society of America Reviews in Engineering Geology, vol. 11).

Downcutting of valley alluvium leading to stream channelization is known to "cause local lowering of the water table depriving subirrigated riparian vegetation of adequate water supply" (Toy and Hadley, 1987, Geomorphology and Reclamation of Disturbed Lands, Academic Press). Channels downcut, or incise, and create headcuts which migrate upstream, in order to re-establish an equilibrium gradient to effectively transport water and sediment supplied to the channel. The local landscape may be driven toward destabilization by reduced vegetation due to grazing by domestic animals and wildlife, and/or human-induced modifications of the channel configuration. Subsequent high magnitude floods may provide the trigger for the initiation of incision (Toy and Hadley, 1987) once de-stabilization has occurred.

Hupp (Hupp, C.R. 1992. Riparian vegetation recovery patterns following stream channelization: a geomorphic perspective. Ecology 73(4) 1209-1226) described stream channelization as affecting hydrogeomorphic and biotic structure (characteristics) and function (interaction of abiotic and biotic factors) of riparian ecosystems. He describes geomorphic and ecologic responses to channelization as being rapid relative to the recovery along the channelized reaches. However, he did not examine the rate of response to *de*channelization and the recovery processes associated with this type of restoration. McBride and Strahan 1984 (McBride, J.R. and J. Strahan. 1984. Establishment and survival of woody riparian species on gravel bars of an intermittent stream. The

American Midland Naturalist. 112(2):235-245) reported that changes in landform associated with natural fluvial geomorphic processes created and destroyed riparian habitats for plant species. They also determined that certain species are better adapted than others to these types of changes. Debano and Schmidt 1990 (Debano, L.F. and L.J. Schmidt. 1990. Potential for enhancing riparian habitats in the southwestern United States with watershed practices) research manipulated the hydrologic regime which provided a more favorable habitat for plant establishment and growth.

Past practices often called for channel manipulations which had typical goals of flood routing or road protection. Standard approaches included channel straightening, channel deepening, and bank armoring. However, undesirable consequences often resulted, including channel incision, bank erosion, and, most importantly, loss of riparian habitat and function. Effective restoration of these types of systems requires that natural channel forms be re-introduced. Determination of a particular stream's geometry, meander patterns, and gradient can provide the basis for creation of a natural channel pattern. The natural channel with an active floodplain can restore riparian function as well as provide conditions for stable banks and effective transport of the watershed's water and sediment, even in flood conditions.

There are clearly documented cases of successful restoration projects of this type. If successful, the benefits of this project will have a long-lasting effect (greater than 20 years). The project aligns with two of the Coconino National Forest goals, namely enhancing riparian health and pursuing collaborative efforts. The project will enhance the current water quality within the West Clear Creek drainage system by reducing sediment production from the historically degraded drainage system. The project will be a demonstration area for riparian area rehabilitation, and knowledge gained can be used to assist in other rehabilitation efforts. The geomorphic concepts gained in the project will have further applications for future NEPA work involving the proposed Highway 87 expansion and the Hackberry/Pivot Rock Allotment analysis.

Statement of problem(s):

The Clover Springs drainage downstream of the Highway 87 crossing and below the confluence of Dirtyneck Canyon drainage and Forty-four Mile Canyon drainage is the focus of this project. The wetlands/riparian meadow is currently in a degrading condition due to channelization resulting from the construction of adjacent roads and large in-stream log structures that are causing bank erosion and widening of the stream that is accelerated during flood events. The meadow is also in danger due to a large headcut at the downstream end of the project reach. Currently, above the springs riparian vegetation and soil moisture have declined due to channel downcutting and bank erosion.

Statement of cause(s) of the problem(s):

The current stream conditions appear to be the result of previous channel straightening activities. The downstream headcut (loss of channel grade with accompanying upstream migration) appears to be caused by past road construction or other activities. Both situations have been exacerbated by historical grazing by both domestic animals and wildlife. Although the roads are still active, sufficient width remains in the valley to restore stable channel pattern, dimension, and profile.

Statement of project-related remedies or solutions:

The primary objectives in the Clover Springs project are channel stabilization and protection and re-establishment of riparian meadow function. Currently, the system can be typified as an upland riparian wetland within the West Clear Creek watershed. The existing failing grade control structures are to be and a new bankfull channel constructed of the appropriate stream type. This will result in a channel design that efficiently transports its sediment load while providing the wetland area with an adequate water supply.

Stabilization will incorporate a variety of natural channel approaches for incised systems (Rosgen, 1997 attached). In the upper section, the channel grade is controlled by the elevation of a culvert under Highway 89. In this section a more sinuous bankfull channel will be constructed along with the appropriate floodplain below the valley floor. Channel bed elevation will gradually rise as it flows downstream. Near Clover Springs, the constructed bankfull channel will be fully connected to the original floodplain. At the end of the reach, a rock structure will drop the channel in a series of steps to meet the elevation of the incised downstream channel.

Channel parameters required for the design will be obtained through a number of methods. A thorough topographic survey will be conducted at the project section of stream to obtain existing channel geometry including dimension, pattern and profile. A viable reference reach section will be reconnoitered and surveyed to define a stable system within the same hydrophysiographic region as the project stream. Other methods such as the development of localized regional curves, hydrologic models, and hydraulic analysis will be employed to aid in the determination of stable channel geometry. Field measurements will include stream gradients, cross sectional and longitudinal profiles, sinuosity, entrenchment ratios, width and depth ratios and bankfull stage. The post design phase of the project involves surveying and construction of the new channel. This includes construction staking, earthwork, seeding, on-site supervision, and contract administration.

Statement of project years of benefit (Demonstrate your level of commitment to maintenance of project benefits and capital improvements; is it < 5 years, 5 - 10 years, 11-15 years, or 16 - 20 years?)

The Clover Springs stabilization project will have a long term (>20 year) benefit by reducing the amount of channel erosion, raising groundwater and base-flow elevations and returning an unstable stream to a natural, stable form. The designed channel together with cooperative land management practices will allow this system to function in a naturally stable condition, support vegetative diversity, and insure an accessible water supply for the wetland area.

Scope of Work: Objectives

Objectives are specific, measurable outcomes of the project. List these objectives in numerical order, with the first objective having the most important outcome.

Objective #1:

Develop and implement a channel stabilization and wetland protection plan for the Clover Springs reach downstream from the Highway 87 crossing. Natural channel processes and forms will be the design basis, as determined by extensive field measurements, while projected means of channel and wetland protection include removal of existing structures, reshaping and redirecting of the channel, and use of low impact structures to encourage natural channel stability.

Benefits: Protection of a rare upland riparian wetland meadow and stabilization of a degrading stream channel will be realized by control of downstream headcuts. The springs feeding the wetlands meadow will also be protected by maintaining or improving the channel grade. Moisture storage in the wetlands will be improved by raising the channel grade, improving vegetation and habitat. Protection of the slope stability of the nearby highway may also be effected. Knowledge gained by this project may be used in other areas along the Mogollon Rim that have undergone historic headcut incision.

Objective #2:

Determine the causative factors and timing of aggradation and incision in the reach of concern in order to develop a long-term mitigation plan. The chronology of events will be based on physical evidence of past floodplain activity, radiocarbon dating and description of sediments, tree-ring dating, and historic photographs.

Benefits: An accurate determination of the chronology of initial valley fill aggradation and the two subsequent incisional episodes, with attendant climatic and land-use histories, will allow reconstruction of the potential causes for headcut erosion in this reach. This information will be used to establish a mitigation plan that will take into account the long-term (greater than 20 years) variability of the reach. In addition, the geomorphic concepts gained in the project will assist in future NEPA work involving the proposed Highway 87 expansion and the Hackberry/Pivot Rock Allotment analysis.

Objective #3:

Develop outreach and public information products to transfer activities of demonstration project to the public.

Benefits: This objective will benefit the public through education about riparian restoration, the role of meadow ecosystems, historic disturbances, current conditions, desired conditions, and restoration techniques.

Describe in detail the tasks you will perform to accomplish your objectives and achieve your desired results. These tasks must be exactly the same as the tasks listed in your task-timetable. Please use the same task numbering on each form.

- A deliverable is a product produced from a task, which is submitted to the Commission and proves that the task was completed. Deliverables are often reports, photos, data, etc. that are submitted along with invoices for materials and labor.
- Obtaining permits and conducting monitoring are potential tasks for all applications. Obtaining access agreements for research projects is also another potential task for all research projects.
- Revegetation and Monitoring Plan development must be a task with an appropriate cost assigned if you do not currently have one(s) prepared. Go to Appendix B for appropriate Plan content outline.
- If appropriate to your project, have your last task be a Final Report and assign a value commensurate with the overall project value (5% - 10% of overall project value).
- As much as possible, make each Task discrete and payable upon completion. A few tasks will continue throughout the contract duration.

Task #1 Description: Obtain permits

The following documents and permits for the project will be provided:

NEPA Documentation
Cultural Resource Clearance
Biological Evaluation and Assessment
401 Certification
404 Permit

Deliverable description: Signed copies of permits and clearances or statement of non-applicability of permit.

Deliverable due date: Prior to any earth moving activity; by end of Project-Year 1.

AWPF task cost: $ 15,000

Task #2 Description: Develop site restoration plan.

Develop a site restoration plan that integrates the geomorphic background of the project area, determination of a design reach, detailed measurements of the 0.5 miles of stream to be restored, and preparation of the design report.

Geomorphic landscape sensitivity plan. Determination of the geomorphic history will be based on physical evidence preserved in the project area and the relationship of the manner and chronology of changes in the stream to climatic or land-use changes. A plan will be developed to establish a mapping procedure for the reach of concern. A sampling strategy will be developed to determine the age of the valley fill using radiocarbon dating and to determine the depositional environment of the valley fill using sedimentologic descriptions and textural analyses. A strategy will be developed for determining the age of the incisional events using historic photographs and dendrochronology. A plan will be developed to utilize sequential aerial photographs, climatic and land use data, and previous studies to determine the potential causative factors leading to the incisional events. (NAU Geomorphology)

Determination of Design Reach. Development of the stream stabilization plan will be based on field measurements, historical photos and maps, and other supporting information. The focus of design work will be approximately 2600 feet of stream below the Highway 87 crossing. Field work will determine the availability and viability of a useable reference reach as the design basis. Critical measurements to characterize the stream include

gradient, cross sectional and longitudinal profiles, sinuosity, entrenchment ratios, bed and bank materials, and width to depth ratios. Bankfull flows will determine cross sectional areas of the design channel. These bankfull flows will be determined by depositional patterns in the field and correlated with appropriate hydrologic models. (NAU Engineering)

Detailed topographic measurements of meadow and stream. A detailed topographic map of the meadow and stream will developed. Quantities of excavation and fill material will be estimated, along with a determination of the necessary materials to provide in-stream structures for grade control if necessary. (NAU Engineering)

Preparation of Design Report. A Draft Design Report will be prepared with all applicable photos, drawings, and maps. A recommended design will be detailed with accompanying cost estimates, plan views, and representative cross sections. A schedule for construction will also be provided. (NAU Engineering)

A plan will be prepared to re-seed any newly exposed soil due to earth moving efforts. Native upland species will be utilized. Newly seeded areas will be covered with hay for stabilization. The plan is described in detail in the "Scope of Work: Sampling, Revegetation and Monitoring Plans" section. The design for building an enclosure to monitor vegetative changes will be described in the site restoration plan.

Deliverable description: Geomorphic sensitivity evaluation plan; detailed stream restoration plan, design report, and cost estimate; photos of site showing problems; detailed drawings of existing and proposed stream channel plan and profiles.

Deliverable due date: by end of Project-Year 1

AWPF task cost: $ 22,410.

Task #3 Description: Capitol expenditure for *in situ* pressure transducer and data logger

An *in situ* pressure transducer and data logger will be purchased to be utilized in monitoring task.

Deliverable description: Invoice

Deliverable due date: by end of Project-Year 1

AWPF task cost: $ 2,415.

Task #4 Description: Monitoring

Monitoring plans will be developed and implemented to assess the following parameters:

groundwater
channel stability
vegetation

A ground-water monitoring plan will be developed. The plan will include monitoring of spring discharge from Clover Springs and ground-water levels in the shallow alluvium in the channel of Clover Creek below Clover Springs. After plan is approved NAU will monitor groundwater until the end of Project-Year 3. (NAU Hydrogeology)

A channel stability monitoring plan will be incorporated with the construction of the new channel. After approval of the plan, permanent cross sections will be established at critical points along the new channel. Follow-up measurements at these cross sections will occur on a regular basis until the end of Project-Year 3. (NAU Engineering)

A vegetation monitoring plan will be developed, and then implemented throughout the period until the end f Project-Year 3. This will allow us to assess whether natural regrowth of vegetation along restored reaches of the channel is successful, and will allow us to collect information regarding grazing impacts in the meadow. Species diversity will be quantified in transects running parallel to and across the channel in restored, degraded and non-degraded sites, and species diversity will also be quantified in rectangular grids established inside and outside the enclosure in the meadow. This aspect will further described in the site restoration plan. (NAU Forestry).

In addition, a photographic monitoring plan will be developed to qualitatively document success of riparian restoration and to document changes in the riparian community. The plan will follow the guidelines in Appendix B.3 "Arizona Water Protection Fund Outline for Photographic Monitoring Plan & Forms" in the 1998 application manual. (NAU Hydrogeology and Geomorphology)

Deliverable description: monitoring plans, monitoring reports

Deliverable due date: Monitoring plans will be developed within 6 months after the initiation of the project, after approval of the monitoring plans, monitoring reports will be delivered on a semi-annual basis until the end of Project-Year 3, except for the enclosure monitoring which will be initiated at the end of Project-Year 2 after the construction of the wildlife grazing enclosure in Project-Year 2.

AWPF task cost: $ 56,980

Task #5 Description: Site Restoration

Determine geomorphic landscape sensitivity parameters. Produce geomorphic map, establish chronology of geomorphic events, relate chronology to land-use and climatic variations, rank potential causative factors in headcut initiation.

Channel restoration. Implement plan for stream stabilization and wetland protection of 2600 feet of stream as described in Task 2. Based on results of the Task 2 work and design recommendations, a preferred design will be carried out. Possible activities include removal of existing structures, channel reshaping, and building of small low impact structures. The final design will take advantage of natural stream forms and processes, including use of the floodplain for energy and velocity dissipation. All construction will be performed in a manner that protects the existing meadows and will employ a stringent pollution control plan to minimize sedimentation. (NAU Engineering)

Vegetation monitoring control enclosure construction. A small wildlife grazing enclosure will be constructed in order to monitor species composition and diversity under grazed and ungrazed conditions. Healthy vegetative conditions may be critical to successful restoration efforts. The enclosure will be constructed of pipe and sucker rod to minimize maintenance and to stand up to high flow events. (USFS and NAU Forestry)

Implement plan for seeding to re-vegetate and stabilize any newly exposed surfaces created after implementation of the channel restoration plan. Details of the re-vegetation plan are stated in the "Scope of Work: Sampling, Revegetation and Monitoring Plans" section.

Deliverable description: Geomorphic map, table of geomorphic chronology with landuse and climatic chronologies with associations noted, videotape and photodocumentation of construction and site work and "as built" drawings of project post-construction, photodocumentation of constructed enclosure and photodocumentation and species lists of vegetation monitoring following re-seeding.

Deliverable due date: Products related to geomorphic investigations due in Final Report at the end of Project-Year 3, photodocumentation of channel restoration construction, "as-built" project drawings and photodocumentation of constructed enclosure due at the end of Project Year-2, and vegetative monitoring products will be due semi-annually following implementation in Project-Year 2.

AWPF task cost: $ 40,470.

Task #6 Description: Public Information

Establish information signing to explain the role of meadow ecosystems, historic disturbances, current conditions, desired conditions, and restoration techniques.

Deliverable description: Photodocumentation of signs and text from signs.

Deliverable due date: Public information content progress report showing potential text will be due at end of Project-Year 2 and final product photodocumentation at end of Project-Year 3

AWPF task cost: $ 4,271

Task #7 Description: Attend AWPF Information Transfer Meeting.

Deliverable description: Photograph of poster to be used at annual session or copy of paper given.

Deliverable due date: In Year 2 or Year 3 when meeting is scheduled by AWPF staff/commissioners.

AWPF task cost: $525

Task # 8 Description: Prepare and submit a final report.

Deliverable description: Final project report will summarize all methodologies used, outcome of all tasks, summarize and analyze project data & monitoring data, suggest any further changes needed in the project and evaluate project success measured against the objective.

Deliverable due date: end of Project-Year 3

AWPF task cost: $ 6,357

Sampling Plans, Revegetation Plans, Monitoring Plans (Water Quality, Hydrology, Vegetation, Wildlife, etc.), Photo Monitoring Plans: Some applications may include baseline environmental inventories and most will contain project monitoring. Within your application, describe your monitoring or sampling objective and, in as much detail as possible, describe the monitoring and sampling methodology, and/or study design that will be used to accomplish that objective. Include a description of the equipment you wish the Fund to purchase. For water features include: water level, well schematics, USGS gage station data, well number/location, existing hydrologic reports, recharge or recovery plans. Reference Appendix B for more detailed outlines.

Again, submit as much of the sampling plan, monitoring plan, revegetation plan, etc. information as possible with the application addressing as elements of plan outlines in Appendix B. If you receive a grant award, you must submit detailed plans as deliverables. ***Include in your application*** a task and appropriate budget within the Scope of Work: Sampling, etc. Plans and on budget forms to complete detailed plan(s) after grant award.

Sampling Plans:

Geomorphic sampling

Samples will be collected from representative soil horizons, or depositional units, in the exposed valley fill in the entrenched stream sections. Approximately 20 samples will be taken to correlate depositional units and soils within the project area. Each sample will consist of approximately 50 g of sediment. Approximately three additional 50 g samples will be collected from which to extract non-archeological carbon for radiocarbon dating to determine the age of sediments in the valley. Approximately 10 1/4 " diameter, <12 " long tree-ring cores will be extracted from 10 trees in the floodplain to the project area to determine a minimum age for the sediments on which the tree germinated.

Monitoring Plans:

Ground-water and surface-water monitoring

A shallow, hand-driven well will be installed in the alluvium below the springs. The well will be constructed with a 1 foot long, 1 _ inch diameter stainless steel, wire-wrap screens, attached to black steel casing. "Notice of Intention to Drill Piezometer/Monitoring Well" forms will be files with ADWR with appropriate variances for construction for the well. The well will be instrumented with a InSitu Inc. Troll pressure transducer and data logger. The instrument will record depth to water and temperature of water in the well every 10 minutes for the duration of the project.

Surface-water discharge will be measured in Clover Creek above and below Clover Springs once per month with a Baski portable flume or with a stream velocity meter. Spring discharge will be determined by difference between the two measurements. A stage gage will be constructed in the channel below Clover Springs to measure the peak discharge between each monthly visit to the site.

Channel stability monitoring

Permanent cross sections will be surveyed at representative points along the new channel. These points will include representative riffle and pool segments. A Topcon Total Station will be used to precisely measure the new channel cross sections. Follow-up measurements will be conducted at least twice annually at each of the permanent stations. These follow-up measurements will show whether any changes in cross sectional area have

occurred due to bank erosion or other impacts. Visual monitoring of overall channel and bank stability will also be conducted.

Vegetation monitoring and sampling plan

The vegetation monitoring objectives are twofold. The first objective is to quantify revegetation along restored channel reaches to ensure that herbaceous species coverage is adequate to protect the restored sites and that species composition reflects non-degraded sites along the springs. The second objective is to compare meadow vegetation inside and outside of the enclosure to quantify grazing effects.

The monitoring strategy will be to establish permanent transects and plots in the project area and to quantify species frequency and density with these transects. Transects running parallel to and across the stream channel will be established along non-degraded, degraded and restored reaches of the channel, and rectangular plots will be established inside and outside of the meadow enclosure. The two different types of sampling (line transects versus plots) are being used to accommodate the linearity of vegetation along the stream versus the non-linear nature of the vegetation in the meadow. The transects running across the channel will quantify changing width of the riparian community. The non-degraded and degraded sites will serve as baselines for the restored sites along the channel. Natural regrowth of vegetation in the restored areas will be compared to the non-degraded and degraded sites to quantify how quickly and adequately the vegetation has recolonized the restored sites. Success will be based on how closely the vegetation in the restored sites matches the non-degraded sites. Changes in vegetation inside and outside the meadow enclosure will enable us to quantify effects of grazing at this site and this data can be used to plan for future grazing mitigation at the site.

The data collection methods will involve the use of cloth tapes to establish plant species and abundance along line transects established parallel to and across the stream channel, and will involve visually counting species composition and abundance in "pvc" rectangular grids established inside and outside of the meadow enclosure. Details of the data collection methods will be described more completely in the monitoring plan developed under task 3. These details will include the number of sample sites and length of the line transects, and size of the rectangular grids. The number of sample sites, length of line transects and dimensions of the grids will be based on a preliminary survey of plant and site variability along the stream and in the meadow. Enough replicates will be established so that the data collected can be statistically analyzed using analyses of variance and a 95% confidence interval. Photo monitoring according to the guidelines in the 1998 grant application manual will be conducted at each transect and rectangular grid site.

Revegetation Plan

Commercially available native seed mixtures will be spread on soil exposed by construction at the restoration site. Supplemental watering will not be feasible so the seed will be spread during the time of year immediately after the restoration when precipitation is expected to be most abundant. For example, for any construction in May or June, seed will not be sown until the monsoon rains begin in July. As a measure of added protection, straw will be spread over the seed after it has been sown. If seedling proves to be unsuccessful, plugs of native plants (where commercially available) will be used to initiate revegetation on the exposed sites.

Photographic monitoring

Photographic monitoring will qualitatively document success of riparian restoration and document changes in the riparian community. The plan will follow the guidelines in Appendix B.3 "Arizona Water Protection Fund Outline for Photographic Monitoring Plan & Forms" in the 1998 application manual.

Task - Timetable

Enter the starting and ending dates of the AWPF project, the duration of the AWPF funded project (in number of months), and the years of benefit your project will provide to the riparian or aquatic habitat. Indicate the timing of all tasks from the scope of work. If you perform a task periodically (e.g., taking water level measurements every 3 months), indicate it in this manner rather than as if it is performed every month. Provide the estimated cost to the AWPF for each task (which includes labor, materials, administration, etc.). The total cost for all tasks must add up to the exact amount you are requesting from the AWPF on the application cover page (line 13a), and must agree with the AWPF column total on the budget page. Forms for years 2 and 3 are included for multi-year projects.

Start Date: 5/15/99
Yrs of Benefit: > 20 years
End Date: 5/14/02
Duration: 3 years

Project Name: **Verde River Headwaters Riparian Restoration Demonstration Project**

Project Categories and Tasks			**Months Since Project Initiated (Year 1)**											
Task No.	Task Cost	Task Description	1	2	3	4	5	6	7	8	9	10	11	12
1	$ 15,000	Permits	X	X	X	X	X	X	X	X	X	X	X	Permit
2	$ 22,410	Restoration Plans	X	X	X	X	X	X	X	X	X	X	X	Plans
3	$ 2,415	Capitol Expenditure	X	X	X	X	Pur-chase							
4	$ 19,777	Monitoring	X	X	X	X	X	Plans/ Report	X	X	X	X	X	Report
5	-----	Site Restoration												
6	-----	Public Information												
7	-----	Info. Transfer Meeting												
8	-----	Final Report												

Project Categories and Tasks			Project Name: **Verde River Headwaters Riparian Restoration Demonstration Project**											
			Months Since Project Initiated (Year 2)											
Task No.	Task Cost	Task Description	13	14	15	16	17	18	19	20	21	22	23	24
1	-----	Permits												
2	-----	Restoration Plans												
3	-----	Capitol Expenditure												
4	$ 19,347	Monitoring	X	X	X	X	X	Report	X	X	X	X	X	Report
5	$ 23,110	Site Restoration	X	X	X	X	X	X	X	X	X	X	X	Report
6	$ 1,000	Public Information	X	X	X	X	X	X	X	X	X	X	X	Report
7	-----	Info. Transfer Meeting												
8	-----	Final Report												

Project Categories and Tasks			Project Name: **Verde River Headwaters Riparian Restoration Demonstration Project**										
			Months Since Project Initiated (Year 3)										
Task No.	Task Cost	Task Description	25	26	27	28	29	30	31	32	33	34	35	36
1	-----	Permits												
2	-----	Restoration Plans												
3	-----	Capitol Expenditure												
4	$ 17,856	Monitoring	X	X	X	X	X	Report	X	X	X	X	X	Report
5	$ 17,361	Site Restoration	X	X	X	X	X	X	X	X	X	X	X	Report
6	$ 3,271	Public Information	X	X	X	X	X	X	X	X	X	X	X	Report
7	$ 525	Info. Transfer Meeting												X
8	$ 6,357	Final Report								X	X	X	X	Report

Project Budget Forms

On the project budget form, break down your budget into Administrative costs, Direct Labor costs, Other Direct costs, Outside Services costs, and Capital Outlay costs. It is most helpful to identify all costs by Task number. Identify requested AWPF funding on the first form and other matching funds on the next form.
Administrative costs are management and overhead costs and by statute the total administrative costs charged to the AWPFC cannot exceed 5% of the total amount requested from the AWPF.
Direct Labor costs include the labor costs directly involved with the project. Break down these costs by: Job classification (e.g., laborer, project scientist, hydrologist, etc.); average cost/hour for that job classification; number of hours for that job classification; and total cost [Total cost = (Job classification cost/hour) x (number of hours)].
Other Direct cost include supplies and materials, paper, pencils, computer time, per diem, printing, public relations, etc.
Outside Services are consultants or subcontractors.
Outlay Capital costs include any equipment costs greater than $1000.00.

TASK: Number and short description	AWPF FUNDS REQUESTED					
	ADMIN COSTS (1)	DIRECT LABOR COSTS (2) *	OTHER DIRECT COSTS	OUTSIDE SERVICES	CAPITAL OUTLAY (3)	TOTAL
1: Permits				$ 15,000		$ 15,000
2: Restoration Plans	$ 1,067	DA: .1 FTE $4563 WO: .05 FTE $3358 Grad student: 6 m $6787 UG student: 300 hr $3240	$ 3,395	—	—	$ 22,410
3: Capitol Expenditure	$ 115	—	—	—	$ 2,300	$ 2,415
4: Monitoring	$ 2,713	AS: .14 FTE $8,224 LD: .14 FTE $7,072 Grad student: 18 m $20,978 UG student: 800 hr $8,885	$ 9,108	—	—	$ 56,980
5: Site Restoration	$ 1,927	DA: .125 FTE $5,910 WO: .088 FTE $ 6,131 Grad student: 12 m $14,191 UG student: 500 hr $5,645	$ 6,666	—	—	$ 40,470
6: Public Information	$ 61	DA: .025 FTE $1,210	—	$ 3,000	—	$ 4,271
7: Info. Transfer Meeting	$ 25	—	$ 500	—	—	$ 525
8: Final Report	$ 303	DA: .05 FTE $2,421 AS: .0125 FTE $772 WO: .0125 FTE $890 LD: .0125 FTE $663	$ 1,308	—	—	$ 6,357
						$ 148,428

(1) Administration costs are limited to 5% of the total dollars requested for a project.
(2) Include wages, salaries, and fringe benefits.
(3) Attach list of capital equipment expenditures over $1,000.00, Water (CAP/Effluent), etc.
*** FTE is full time equivalent, .05 FTE is approximately equal to 2 weeks. DA=Diana Anderson AS=Abe Springer; WO=Willie Odem; LD=Laura DeWald; Graduate student time in months; undergraduate student time in hours.**

Budget Forms Continued

TASK: Number and short description	OTHER FUNDS (MATCHING) (4)					
	ADMIN COSTS (1)	DIRECT LABOR COSTS (2)*	OTHER DIRECT COSTS	OUTSIDE SERVICES	CAPITAL OUTLAY (3)	TOTAL
1: Permits	—	—	$ 250	$ 2,250(6)	—	$ 2,250
2: Restoration Plans	$ 10,167 (7)	$ 7,921 (5)	—	$ 200(6)	—	$ 18,288
3: Capitol Expenditure	$ -115 (7)	—	—	—	—	$ -115
4: Monitoring	$ 23,921 (7)	$ 15,295(5)	—	—	—	$ 39,216
5: Site Restoration	$ 17,324 (7)	$ 12,041(5)	—	$ 9,550(6)	—	$ 38,915
6: Public Information	$ 938 (7)	$ 1,210(5)	—	$ 4,000(6)	—	$ 6, 148
7: Info. Transfer Meeting	$ -25 (7)	—	—	—	—	$ -25
8: Final Report	$ 3,616 (7)	$ 4,747(5)	—	$ 500(6)	—	$ 8,863
						$ 113,540

(1) Administration costs are limited to 5% of the total dollars requested for a project.
(2) Include wages, salaries, and fringe benefits.
(3) Attach list of capital equipment expenditures over $1,000.00, Water (CAP/Effluent), etc.
(4) Use the value of volunteer labor based on current minimum wage; technical volunteer labor can be based on an hourly fee comparable to a consultant's fee.
(5) NAU salaries and wages and fringe benefit in-kind match of faculty time.
(6) Forest Service in-kind match (from "secured support")
(7) overhead on NAU in-kind salaries and wages plus contributed overhead

Forest Service vehicle and assoc. costs $ 1,500
Fence $ 5,000
GIS support $ 1,000
Public info. support and design $ 2,000
Admin. support above the 5% limit $7,000

Matching Information

Provide written evidence of all secured funds (in-hand or committed in writing) that you are listing on the cover page. For unsecured funds, list their amount and describe their status. If you were to obtain them, list when this would occur. The value of volunteer labor is based on current minimum wage; technical volunteer labor can be based on an hourly fee comparable to a consultant's fee. An explanation of any in-kind contributions listed in your application is recommended.

Secured Support:

See attached letters of secured support for Drs. Anderson, Springer, DeWald, and Odem and the USFS Blue Ridge and Long Valley Ranger Districts.

Existing Plans

Discuss any existing plans, reports or information that are relevant to the project and that the Commission should be aware of when evaluating your proposal. This might include other projects that are being performed or being planned in the area that may affect your project, or local planning/zoning changes that could impact the project area. Emphasize any institutional partnerships and collaborative planning being used in your project.

Existing Plans:

1) Hackberry/Pivot Rock Range Allotment (1990-NEPA)
2) Coconino National Forest Riparian Action Plan (1988)
3) Coconino National Forest Land and Resource Management Plan (1987-NEPA)
4) Clover Creek Watershed Improvement Project (1996-NEPA)
5) Forest Service Natural Resource Agenda

See attached descriptions of past and current activity in the project area.

Community Support

Indicate the community support for your project from within the project impact area. Include signed copies of letters from community organizations or groups that support your project. Please be aware that for public support to affect your proposal's criteria rating score, it must be included with your application. If pertinent, describe your commitment to work jointly with affected cities, towns, counties, NRCDs, special districts, and/or Indian tribes. If you are a federal or state agency, you should attach evidence of support from those citizens who lease or hold use-permits for the lands to be impacted by your project. Indications of public support for your proposal that are received after your application is submitted will be forwarded to the Commission and may affect their decisions on which proposals to fund, but will not affect the criteria rating score.

Community Support:

The project area falls within the Verde River Watershed Association. A letter regarding the Association's support is scheduled to be completed by mid-September, and will be forwarded directly to the AWPF office.

Personnel

Indicate the key personnel associated with this project. Include a brief biographical sketch that describes relevant qualifications.

PLEASE SEE ATTACHED CURRICULUM VITAE FOR THE FOLLOWING PERSONNEL

Project Manager and Lead Geomorphologist: Diana Anderson, Northern Arizona University

Lead Hydrogeologist: Abe Springer, Northern Arizona University

Lead Botanist: Laura DeWald, Northern Arizona University

Lead Engineer: Willie Odem, Northern Arizona University

Agency Leads: Jeff Hink and Dick Fleishman, U.S. Forest Service, Coconino National Forest

Dick Fleishman, US Forest Service, Coconino National Forest, Long Valley and Blue Ridge Ranger Districts. Watershed Specialist. BS Forest Management Northern Arizona University (1980), MPA Public Administration Northern Arizona University (1990). Eighteen years of experience with the Forest Service, five years in land management planning (1980-85), nine years of experience in timber management (1985-1994), four years of experience in soil and watershed (1994-present).

Jeff Hink, US Forest Service, Coconino National Forest, Mormon Lake and Peaks Ranger Districts. Hydrologist. BS Natural Resources Management, Humboldt State University, 1975. Twenty-two years of experience with the Forest Service in timber management with eight years in the field of watershed management.

SHPO Certification

(must be submitted)

This certification is required by regulations implementing the State Preservation Act (A.R.S. 41-861 through 41-864), effective July 24, 1982. It is understood that **recipients of state funds are required to comply with this law** throughout the project period. The State Historic Preservation Act mandates that all State agencies consider the potential of activities or projects to impact significant cultural resources. Each State agency is required to consult with the State Historic Preservation Officer with regard to those activities or projects that may impact cultural resources. All projects that affect the ground-surface that are funded by AWPF require SHPO clearance **including those on private lands.**

PROJECT TITLE: Verde River Headwaters Riparian Restoration Demonstration Project

Please answer the following questions which provide information about the potential of the project to impact cultural resources:

1. Does the project have the potential to disturb the surface and/or subsurface of the ground?
   YES:_XX_____ NO:_____

2. Are there any buildings or structures (including mines, bridges, dams, canals, etc.) which are 50 years or older within the project area that have the potential to be disturbed by the proposed activity?
   YES:_XX_____ NO:_____

3. Are there any known prehistoric and/or historic archaeological sites within the project area?
   YES:_____ NO:__XX____

4. Are you aware of any archeological investigations that have been performed within one (1) mile of the project area?
   YES:_XX_____ NO:_____

If you have answered "**NO**" to all of the above questions, please sign on the line below certifying that the activity or project is in compliance (and will remain in compliance throughout the project period) with the State Historic Preservation Act. **YOU MUST SUBMIT THIS FORM WITH YOUR COMPLETED APPLICATION.**

_____

Authorized Signature

_____

Date

If you have answered "**YES**" to any of the questions above, please answer the following questions.

SHPO Certification

If you answered yes to question #1, specifically identify any surface or subsurface impacts that are expected. Attach extra sheets if more space is needed.

Re-establishment of the natural channel may require earth moving, including some filling of the current incised channel. Earth moving will be confined to the current channel alignment and are immediately adjacent to the new channel.

If you answered yes to question #1, describe the current ground surface condition within the entire project area boundary (i.e., is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, used for agriculture, etc.). Attach extra sheets if more space is needed.

Project area is in a disturbed state with extensive downcutting and other channel degradation.

If you answered yes to question #2, list the sites, their names, and provide a brief description of the site.

There is a historic road in the area that was established prior to AD 1912. One feature of this road is a historic culvert, but it has not been determined as a site.

Has the project area been previously surveyed for cultural resources by a qualified Archaeologist?

YES:__XX_____ NO:_____

DON'T KNOW:_____

If yes, submit a copy of the Archaeologist's report with your application.
No known archaeological sites in project area (question #3, page 31). No copy of archaeologist's report on file with D. Anderson at time of submittal. Please contact D. Anderson for further information.

YOU MUST SUBMIT THIS FORM WITH YOUR COMPLETED APPLICATION

06/16/89

STATEMENT OF CLAIMANT
FOR
OTHER USES

U.S.D.A. FOREST SERVICE

NATIONAL FOREST NAME: COCONINO
SUPERVISORS OFFICE - ADDRESS: 2323 E. GREENLAW LAN FLAGSTAFF,AZ 86001

STATE FILE NO.: C219

PRIORITY DATE: 19390213

USE NAME: CLOVER SPRING

PURPOSE OF USE: STOCKWATER

SOURCE OF WATER: SPRING

LEGAL DESCRIPTION OF POINT OF DIVERSION:
SUBDIVISION NWNE SEC 23 TWP-RGE 013CN009CE

LEGAL DESCRIPTION OF THE POINT OF USE:
SUBDIVISION NWNE SEC 23 TWP-RGE 013CN009CE

ANNUAL VOLUME OF WATER USE: 2.790 ACRE-FT

MAP NUMBER AND QUARTER: 203SE

39-391363

D4

STATE OF ARIZONA

WATER DISTRICT NO. COUNTY OF COCONINO

CERTIFICATE OF WATER RIGHT

(For rights perfected under original, enlargement or secondary permits)

This is to Certify, *That* UNITED STATES FOREST SERVICE, COCONINO NATIONAL FOREST, of FLAGSTAFF, *State of* ARIZONA, *has made proof to the satisfaction of the STATE WATER COMMISSIONER of Arizona of a right to the use of the waters of* CLOVER CREEK, TRIBUTARY OF WEST CLEAR CREEK, TRIBUTARY OF VERDE RIVER, *for* DOMESTIC AND STOCK WATERING PURPOSES, *under Application No.* A-2136, *Permit No.* A-1271 *of the State Water Commissioner, and that said right to the use of said waters has been perfected in accordance with the laws of Arizona, and made and entered of record in the Records of the State Water Commissioner at Phoenix, Arizona, in Volume* 3 *at page* 819, *on the* 8th *day of* October, 1940; *that the priority of the right hereby confirmed dates from* FEBRUARY 13, 1939; *that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed* ONE THOUSAND (1,000) GALLONS PER DAY FOR DOMESTIC USE AND FIFTEEN HUNDRED (1500) GALLONS PER DAY FOR STOCK WATERING USE.

A description of the lands under such right, and to which the water hereby confirmed is appurtenant, or if for other purposes, the place where such water is put to beneficial use, is as follows:

WITHIN THE SOUTHWEST QUARTER OF THE SOUTHEAST QUARTER ($SW\frac{1}{4}SE\frac{1}{4}$) OF SECTION FOURTEEN (14), TOWNSHIP THIRTEEN (13) NORTH, RANGE NINE (9) EAST, GILA AND SALT RIVER BASE AND MERIDIAN, COCONINO COUNTY, ARIZONA, AND THE POINT OF DIVERSION UNDER THIS APPROPRIATION AND RIGHT TO THE USE OF WATER IS LOCATED S. 59° - 13' E. 10.49 CHAINS FROM THE SOUTH QUARTER CORNER OF SAID SECTION FOURTEEN (14), WITHIN THE NORTHWEST QUARTER OF THE NORTHEAST QUARTER ($NW\frac{1}{4}NE\frac{1}{4}$) OF SECTION TWENTY THREE (23), SAID TOWNSHIP AND RANGE, AT WHAT IS KNOWN AS CLOVER SPRING.

The right to the use of the water aforesaid hereby confirmed is restricted to the lands or place of use herein described, and subject to all prior existing rights.

Rights to the use of water for power purposes are limited to a period of forty years from the date of priority of the right, as herein set forth, subject to a preference right of renewal under the laws existing at the date of the expiration of the right for power purposes, as hereby confirmed and limited.

Witness *the seal and signature of the STATE WATER COMMISSIONER affixed this* 8th *day of* October 19 40

to the use of said waters has been perfected in accordance with the laws of Arizona, and made and entered of record in the Records of the State Water Commissioner at Phoenix, Arizona, in Volume 3 *at page* 819 *on the* 8th *day of* October, 1940; *that the priority of the right hereby confirmed dates from* FEBRUARY 13, 1939; *that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed* ONE THOUSAND (1,000) GALLONS PER DAY FOR DOMESTIC USE AND FIFTEEN HUNDRED (1500) GALLONS PER DAY FOR STOCK WATERING USE.

A description of the lands under such right, and to which the water hereby confirmed is appurtenant, or if for other purposes, the place where such water is put to beneficial use, is as follows:

WITHIN THE SOUTHWEST QUARTER OF THE SOUTHEAST QUARTER ($SW\frac{1}{4}SE\frac{1}{4}$) OF SECTION FOURTEEN (14), TOWNSHIP THIRTEEN (13) NORTH, RANGE NINE (9) EAST, GILA AND SALT RIVER BASE AND MERIDIAN, COCONINO COUNTY, ARIZONA, AND THE POINT OF DIVERSION UNDER THIS APPROPRIATION AND RIGHT TO THE USE OF WATER IS LOCATED S. 59° - 13' E. 10.49 CHAINS FROM THE SOUTH QUARTER CORNER OF SAID SECTION FOURTEEN (14), WITHIN THE NORTHWEST QUARTER OF THE NORTHEAST QUARTER ($NW\frac{1}{4}NE\frac{1}{4}$) OF SECTION TWENTY THREE (23), SAID TOWNSHIP AND RANGE, AT WHAT IS KNOWN AS CLOVER SPRING.

The right to the use of the water aforesaid hereby confirmed is restricted to the lands or place of use herein described, and subject to all prior existing rights.

Rights to the use of water for power purposes are limited to a period of forty years from the date of priority of the right, as herein set forth, subject to a preference right of renewal under the laws existing at the date of the expiration of the right for power purposes, as hereby confirmed and limited.

Witness *the seal and signature of the STATE WATER COMMISSIONER affixed this* 8th *day of* October 19 40.

By Jesse D. Wandell
State Water Commissioner.

Attest: Frances B. Trimble
Acting *Secretary.*

Recorded in State Record of Water Right Certificates, Volume 3 *Page* 819

NORTHERN
ARIZONA
UNIVERSITY

TRADITION • INNOVATION

CENTER FOR
ENVIRONMENTAL
SCIENCES AND
EDUCATION

12 August 1998

Arizona Water Protection Fund Commission
Arizona Department of Water Resources
500 N. Third St.
Phoenix, AZ 85004

Dear Commissioners:

This letter is to acknowledge my support of Dr. Diana Anderson's 1998 application to the Arizona Water Protection Fund entitled "Verde River Headwaters Riparian Restoration Demonstration Project." This letter serves as notice of matching funds from the Center for Environmental Sciences and Education (CESE). CESE will donate 4 weeks of Dr. Anderson's nine-month academic year time to this project, each year of the project.

If you have any questions regarding this matter please contact me at 520-523-9333. CESE looks forward to this potential opportunity.

Sincerely,

Dr. Scott Anderson, Chair

cc: D. E. Anderson

PO Box 5694
Flagstaff, AZ 86011-5694
(520) 523-9333 fax (520) 523-7423

NORTHERN ARIZONA UNIVERSITY
DEPARTMENT OF GEOLOGY

August 13, 1998

Arizona Water Protection Fund Commission
Arizona Department of Water Resources
500 N Third St
Phoenix AZ 85004

Dear Commissioners:

This letter is to acknowledge my support of Dr. Abe Springer's 1998 application to the Arizona Water Protection Fund entitled "Verde River Headwaters Riparian Restoration Demonstration Project". This letter serves as notice of matching funds from the Department of Geology. The Department of Geology will donate 2 weeks of Dr. Springer's nine-month academic year time to this project, each year of the project.

If you have any questions regarding this matter, please feel free to call me at 520-523-3329. The Department of Geology looks forward to this potential opportunity.

Sincerely,

Roderic A Parnell, Chair

copy to: Abe Springer

RAP:ssf

PO Box 4099 Flagstaff, AZ 86011-4099 (520) 523-4561 fax (520) 523-9220

NORTHERN ARIZONA UNIVERSITY
SCHOOL OF FORESTRY
Office of the Dean

August 12, 1998

Arizona Water Protection Fund Commission
Arizona Department of Water Resources
500 N. Third Street
Phoenix, AZ 85004

Dear Water Protection Fund Commission:

This letter is to acknowledge my support of Dr. Laura E. DeWald's application to the Arizona Water Protection Fund titled "Verde River Headwaters Riparian Restoration Demonstration Project". I am pleased to certify that Northern Arizona University School of Forestry is willing to donate 2 weeks of Dr. Laura E. DeWald's nine-month academic year time to this project, each year of the project.

If you have any questions regarding this matter please feel free to call me at 520-523-6692. The School of Forestry in the College of Ecosystem Science and Management is pleased to have the opportunity to work with the agency in cooperation with Northern Arizona University's Departments of Geology, Environmental Science and Engineering on this interdisciplinary project.

Sincerely,

David R Patton
David R. Patton, Dean

Cc: L.E. DeWald

PO Box 15018 Flagstaff, AZ 86011-5018 (602) 523-3031 Fax (602)523-1080

NORTHERN ARIZONA UNIVERSITY

COLLEGE OF ENGINEERING AND TECHNOLOGY

August 7, 1998

Arizona Water Protection Fund Commission
Arizona Department of Water Resources
500 N. Third St.
Phoenix, AZ 85004

Dear Commissioners:

This letter is to acknowledge our department's support of Dr. Wilbert Odem's participation in the 1998 application to the Arizona Water Protection Fund entitled "Watershed restoration of a high-elevation riparian community". This letter serves as notice of matching funds from the Department of Civil and Environmental Engineering. The Department of Civil and Environmental Engineering will donate two weeks of Dr. Odem's nine-month academic year time to this project, each year of the project.

If you have any questions regarding this matter please call me at 520-523-4339.

Sincerely,

Wilbert D. Odem

Wilbert I. Odem, Acting Chair

Cc: S. J. Nix

PO Box 15600 Flagstaff, AZ 86011-1560 (520) 523-5251 FAX (520) 523-2300

United States Department of Agriculture | Forest Service | Blue Ridge and Long Valley Ranger Districts | HC 31 Box 300 Happy Jack, AZ 86024 (520) 477-2255

File Code: 1580

Date: August 11, 1998

Mr. Abe Springer
Department of Geology
Northern Arizona University
Flagataff, AZ 86004

Dear Abe,

I fully support the effort between the Forest Service and Northern Arizona University on the Verde River Headwaters Riparain Restoration Demonstration Project. The proposed project aligns perfectly with two of the goals of the Coconino National Forest, restoring riparian health and using collaborative efforts, respectively. The proposed project will also present an excellent teaching opportunity on the function and the value of riparian ecosystems.

The project occurs entirely on National Forest System lands, and as such, I am giving the University access to conduct the necessary research on the project. As we agreed to, the Forest Service will be responsible for all necessary permits before any ground disturbing activities can take place. If you have any further questions on this matter, please feel free to contact myself or Dick Fleishman at (520) 477-2255.

Sincerely,

Erin Connelly

Erin Connelly
Acting District Ranger

A Summary of Current Activities Within the Clover Creek SubWatershed

Currently, permitted activities that occur within the Clover Creek SubWatershed include seasonal grazing on the Hackberry/Pivot Rock allotment and 2 special use recreation residence cabins that occur in 44 canyon. The Hackberry/Pivot Rock allotment is currently permitted for 735 head of cattle under the 1998 Annual Operating Plan (see attachment). Graze periods within the allotment are generally short (approximately 15 days per pasture in the Clover Creek area). The recreation residence cabins term expires on December 31, 1999. At this time, it is anticipated that the cabins will move to Forest Service ownership.

Other activities that occur within the Clover Creek subwatershed are recreation related. In the summer, recreationist use the area for a variety of recreational activites, including camping, hiking, driving for pleasure, and birdwatching. In the fall, recreationists use the area for hunting and gathering fuelwood, as well as other recreational uses. The sub watershed lies within two Arizona Game and Fish game management units, Units 5A and 6A, respectively. In the winter, the Huffer Burn area receives extensive winter recreation use consisting of snowplay, cross-country skiing and snowmobile use.

Watershed improvement structures were placed in the Clover Springs area in 1990 and 1994. Two wood structures were placed in Clover Spring in 1990 and are still functioning. The structures placed in Clover Springs and 44 Canyon in 1994 were built to re-water the meadow area, but instead have further excacerbated a grade problem. The structures were all wood log structures. In the fall of 1997, a vehicular closure was put in place in Clover Springs.

Past Activities Within the Clover Creek Sub-Watershed

A variety of activities have occurred within the Clover Creek Sub-Watershed. This document will summarize the known activities for approximately the last 20 years. The first major event that occurred within the haedwaters of Clover Creek was the Huffer Burn, which burned approximately 2,000 acres in the summer of 1977. The burn area was subsequently planted with ponderosa pine seedlings in the summer of 1978. The area in Dirtyneck and 44 canyons has been logged several times since 1977. The area was pupled in the early 1980_s as part of the Colorado Plateau Pulpwood Contract. The same area was logged for sawlogs under the Poverty Timber Sale in 1987-89. Slash treatment for the sawlog sale was machine piling for a majority of the area. The piles were burned in the early 1990_s, and were allowed to _creep_, in effect performing a broadcast burn. Roads that were used for the timber sale were maintained durng the sale period, but have not been maintained since.

Permitted activities that have occurred within the Clover Creek SubWatershed include seasonal grazing on the Hackberry/Pivot Rock allotment. The allotment was managed with summer long grazes in large pastures up until the early 1990_s when the allotment was subdivided into smaller pastures and graze periods were reduced to 10-20 days. Currently, the Hackberry/Pivot Rock allotment is currently permitted for 735 head of cattle under the 1998 Annual Operating Plan. Graze periods within the allotment are generally short (approximately 15 days per pasture in the Clover Creek area). Two recreation residences are in the 44 Canyon area. The recreation residence cabins term expires on December 31, 1999. At this time, it is anticipated that the cabins will move to Forest Service ownership.

Other activities that have occurred within the Clover Creek subwatershed are recreation related. In the summer, recreationist use the area for a variety of recreational activites, including camping, hiking, driving for pleasure, and birdwatching. In the fall, recreationists use the area for hunting and gathering fuelwood, as well as other recreational uses. The sub watershed lies within two Arizona Game and Fish game management units, Units 5A and 6A, respectively. In the winter, the Huffer Burn area receives extensive winter recreation use consisting of snowplay, cross-country skiing and snowmobile use.

ANDERSON, DIANA ELDER

Education

Ph.D., 1998, Geological Sciences, University of California, Riverside, CA
M.S., 1991, Quaternary Studies, Northern Arizona University, Flagstaff, AZ
B.S., 1991, Physical Science (Atmospheric) *Magna Cum Laude*, Northern Arizona University, Flagstaff, AZ
B.S., 1985, Geology, Northern Arizona University, Flagstaff, Arizona

Professional Experience

August 1998 - present: Assistant Professor of Geomorphology, Northern Arizona University, Flagstaff, AZ
October 1995 - August 1998: Geomorphologist/Research Assistant, Quaternary Sciences Center, Desert Research Institute, Reno, NV
January 1994 - September 1995: Graduate Research Assistant, Geology Department, University of California at Riverside, Riverside, CA
September 1993 - December 1993: Teaching Assistant, Geology Department, University of California at Riverside, Riverside, California.
July 1992 - September 1994: Graduate Research Assistant, Earth and Environmental Sciences Group 1, Los Alamos National Laboratory, Los Alamos, New Mexico
July 1989 - December 1991: Geologist, Branch of Western Regional Geology, USGS, Flagstaff, Arizona

Professional Affiliations

American Geophysical Union
Geological Society of America

Grants

While enrolled in a graduate program at the University of California at Riverside, grants authored or co-authored by D. Anderson generated a total of $ 181,500. Funding agencies included the National Science Foundation's Hydrological Sciences Program, and the Geological Society of America. D. Anderson also held a University of California Distinguished Scholar Fellowship from January 1991 to December 1992 and a Switzer Environmental Fellowship from August 1994 to June 1995.

Publications (Diana Elder Anderson née Diana Frances Elder)

Anderson, D.E., Wells, S.G., Balling, Jr., R., and Vose, R. (1997). "Modern Hydroclimatology and Late Holocene Fluvial History of the Amargosa River near Tecopa, CA." *IN* Death Valley: The Amargosa Route, R.E. Reynolds and J. Reynolds, Eds, *San Bernardino County Museum Association Quarterly*, 44(2):43-48.

Anderson, D.E. and Wells, S.G. (1997). "Late Pleistocene Death Valley lakes: subsurface records of changing paleoenvironments." *IN* Death Valley: The Amargosa Route, R.E. Reynolds and J. Reynolds, Eds, *San Bernardino County Museum Association Quarterly*, 44(2):89-92.

MacKinnon, David J., Elder, Diana F., Helm, Paula J., Tuesink, Marlene F., Nist, Catherine A. (1990). A method of evaluating effects of antecedent precipitation on dust storms at Yuma, Arizona. (NASA IRPESLSCP Project 1974-IRP-45, S-5647ID.) *Climatic Change* 17:331-360.

Agenbroad, L., Mead, J., Mead, E., Elder, D. (1989). Archaeology, alluvium and cave stratigraphy: The record from Bechan Cave, Utah. *Kiva,* 54, no. 4.

SPRINGER, ABRAHAM E.

Education

Ph.D. 1994. Hydrogeology, The Ohio State University, Columbus, Ohio.
M.S. 1990. Hydrogeology, The Ohio State University, Columbus, Ohio.
B.A. 1987. Geology with Departmental Honors, The College of Wooster, Wooster, Ohio.

Professional Experience

1994-present: Assistant Professor, Northern Arizona University, Department of Geology
Teaching classes in Hydrogeology, Advanced Hydrogeology, Ground-Water Flow Modeling, Contaminant Hydrogeology, Environmental Geology.
1995-present, Instructor, Environmental Education Enterprises, 3-day professional short course, "Introduction to Physical Processes in Contaminant Hydrogeology" 3-day professional short course.
1993-present, Instructor, Environmental Education Enterprises, 4-day professional short course, "Modeling Techniques for Delineating Capture Zones".
1990, Instructor, The Ohio State University - Department of Geological Sciences, taught Geological Sciences 204, Water Resources.
1989-1994, Graduate Research Associate, The Ohio State University, Department of Geological Sciences, Conducted research on wellhead protection, agricultural water quality, and tracer tests.
1987-1989, Graduate Teaching Associate, The Ohio State University, Department of Geological Sciences.

Professional Affiliations

1995-present, Arizona Riparian Council
1994-present, Arizona Hydrological Society
1994-present, Geological Society of America
1990-present, American Geophysical Union
1987-present, Assoc. of Ground Water Scientists and Engineers, National Ground Water Assoc.
1987-present, Sigma Xi

Grants

Since arriving at NAU in 1994, proposals authored or coauthored by PI Springer have generated a total of $467,000. Funding agencies include the U.S. Bureau of Reclamation, U.S. Geological Survey, U.S. Department of Energy, Arizona Water Protection Fund, U.S. Forest Service, Phelps Dodge, Inc., Arizona Department of Water Resources, and Northern Arizona University.

SPRINGER, ABRAHAM E.

Publication Summary

A total of 9 peer reviewed papers, books, and field trip guides (2 others in review) and 26 non-refereed paper/abstracts (3 in press) have been published. Peer-reviewed papers have been published in the following journals: *Ground Water, Journal of Environmental Quality, Environmental and Engineering Geoscience*. Books/reports/field guides have been published by the International Ground Water Modeling Centers, Geological Society of America and the U.S. Geological Survey (Water Resources Investigation Report).

Recent Publications (related to proposal)

Stevens, L.E., T.J. Ayers, K. Christiansen, M.J.C. Kearsley, V.J. Meretsky, A.M. Phillips, R.A. Parnell, J. Spence, M.K. Sogge, A.E. Springer, D.L. Wegner, in review, Planned flooding and riparian resource trade-offs: the 1996 Colorado River experimental flood. *Ecological Applications*.

Springer, A.E., W.D. Petroutson, B. Gilbert, in review, Spatial and temporal variability of hydraulic conductivity in active reattachment bars of the Colorado River, Grand Canyon, *Ground Water*.

Springer, A.E. and D. Bills, 1988. Exploration for and ecological importance of shallow and deep ground-water around San Francisco Mountain, Field trip guidebook for the 1998 Geological Society of America, Rocky Mountain Section meeting, Flagstaff, Arizona.

Springer, A.E. and E.S. Bair, in press. Natural-gradient tracer test using bromide, atrazine, and alachlor in a high-organic carbon aquifer, *J. of Environmental Quality*

Springer, A.E., E.S. Bair, and D. Beak, 1996. Natural gradient, surface-applied tracer test at the Ohio Management Systems Evaluation Area, *Environmental and Engineering Geoscience*, v. 2, no. 4. pp. 453-464.

Jagucki, M.L., C.D. Finton, A.E. Springer, and E.S. Bair, 1995. *Hydrogeology and water quality at the Management Systems Evaluation Area near Piketon, Ohio*, U.S. Geological Survey Water Resources Investigation Report 95-4139, 117 p.

Bair, E.S., A.E. Springer, and G.S. Roadcap, 1992. *CAPZONE - An Analytical Flow Model for Simulating Confined, Leaky Confined, and Unconfined Flow to Wells with Superposition of Regional Water Levels*: International Ground Water Modeling Centers, Colorado School of Mines, Golden, Colorado; TNO Institute of Applied Geoscience, Delft, The Netherlands, 193 p.

DeWALD, LAURA E.

Education

Ph.D., 1986, Forestry (genetics/physiology), Virginia Polytech. Instit. & State Univ., Blacksburg, VA
M.S., 1982, Forest Resources (genetics), Pennsylvania State University, University Park, PA
B.S., 1980, Forestry, Michigan Technological University, Houghton, MI

Professional Experience

Aug. 1994 - present: Assistant Professor of Genetics and Conservation Biology, School of Forestry, Northern Arizona University, Flagstaff, AZ
Teaching responsibilities include: graduate and undergraduate courses in forest biology, ecological genetics, conservation biology.

Sept. 1992 - June 1994: Forest Resources Technology Faculty, Green River Community College, Auburn, WA. Teaching responsibilities included: wildlife habitat management, dendrology, stream and wetland ecology, silviculture, wildland recreation, forest measurements, general biology, plant biology.

July 1989 - July 1992: Forest Supervisor and Forest Biology Faculty, Warren Wilson College, Swannanoa, NC. Teaching responsibilities included: forest biology, genetics, biochemistry, plant physiology, ecology, natural resource conservation, soil science, geology, silviculture, measurements, forest management. Research responsibilities included: supervision of undergraduate research projects and participation in the North Carolina Academy of Science.

Nov. 1987 - July 1989: Post-Doctoral Research Associate, Department of Forestry, University of Florida, Gainesville, FL. Research responsibilities: evaluation of nitrogen-use efficiency as an early selection tool for slash pine.

July 1986 - Nov. 1987: Post-Doctoral Research Associate, Forest Resources Department, University of Minnesota, St. Paul MN. Research responsibilities: effects of soil aluminum on the growth and water relations of red spruce, northern red oak and white spruce seedlings.

Sept. 1982 - June 1986: Research Assistant, Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, VA. Research responsibilities: Fraser fir genetics, grafting, and pollination; water relations and ozone research, loblolly pine seedling quality and genetics.

Sept. 1980 - May 1982: Research Assistant, School of Forest Resources, Pennsylvania State University, University Park, PA. Research responsibilities: data collection from a variety of provenance plantations, evaluation of black alder provenances in Pennsylvania.

Professional Affiliations

Arizona Riparian Council
Society of American Foresters
Society for Conservation Biology
Society for Ecological Restoration
Xi Sigma Pi
Sigma Xi

Grants

Since arriving at NAU in 1994, proposals authored or coauthored by DeWald have generated a total of $460,365. Funding agencies include the U.S. Department of Agriculture, U.S. Forest Service, Northern Arizona University, Arizona Bureau of Forestry and the Arizona Water Protection Fund.

Publications

Zimmerman, J.A.C., L.E. DeWald, and P.G. Rowlands. 1998. Vegetation diversity in an interconnected ephemeral riparian system of North-central Arizona, USA. Biological Conservation (accepted pending revision).

Naumburg, E., L.E. DeWald, and T.E. Kolb. 1998. Shade responses of five grasses native to southwestern *Pinus ponderosa* forests. New Phytologist (in review).

Naumburg, E., and L.E. DeWald. 1998. Influence of *Pinus ponderosa* forest structural and light characteristics on graminoid species presence and abundance. Forest Ecology and Management (in review).

DeWald, L.E. and L.P. Moser. 1998. Genetic variation within and among different generations of pondersoa pine: implications for restoration. Restoration Ecology (in review).

Fox, B.E., L.E. DeWald, T.E. Kolb, M.E. Lee, and D.B. Wood. 1998. Assessing a forestry education: The Northern Arizona University Experience. Pages 81-86 In: Proceedings of the Second Biennial Conference on University Education in Natural Resources, March 7-10, 1998, Utah State University, Logan,UT.

DeWald, L.E. 1997. Role of genetics in restoration of southwest forest ecosystems. In: Society of American Foresters National Convention, Albuquerque NM, Nov. 9-13, 1996.

DeWald, L.E. and M.F. Mahalovich. 1997. The role of forest genetics in managing ecosystems. Journal of Forestry 95:12-16.

DeWald, L.E. and B.E. Philips. 1996. Morphological variation among and within four populations of *Cimicifuga arizonica*. Pages 53-59 In: Proceedings 2nd Southwest Rare and Endangered Plant Conf., Flagstaff, AZ USDA FS Gen. Tech. Rep. RM-GTR-283.

DeWald, L.E., T. White and M.L. Duryea. 1992. Performance of four slash pine families grown in different nitrogen regimes. Tree Physiology 11:255-269.

Brown, M., and L.E. DeWald. 1991. Autotoxicity in four woody tree species and implications for seed size and seed dispersion strategy. North Carolina Academy of Science CANCUS Journal.

DeWald, L.E., E.I. Sucoff, and T. Ohno. 1990. Response of northern red oak seedlings to soil solution aluminum. Can. J. For. Res. 20:331-336.

DeWald, L.E. and P.P. Feret. 1988. Changes in loblolly pine seedlings during cold storage. For. Sci. 34:41-54.

DeWald, L.E. and P.P. Feret. 1987. Changes in loblolly pine seedling root growth potential from September to April. Can. J. For. Res 17:635-643.

DeWald, L.E. and K.C. Steiner. 1986. Phenology, height increment and cold tolerance of *Alnus glutinosa* populations in a common environment. Silvae Genetica 35:205-211.

Wilbert I. Odem, Jr., Ph.D., P.E.

Northern Arizona University
College of Engineering and Technology
Dept. of Civil and Environmental Engineering and Construction Management

Education

1991	Ph.D., University of Arizona, Tucson, Az. Civil Engineering, Environmental Engineering Emphasis. Minor in Hydrology and Water Resources.
1985	M.S., University of Arizona, Tucson, Az. Civil Engineering , Environmental Engineering Emphasis.
1981	B.A., University of Texas, Austin, Tx. Geosciences and Geography.

Experience

1998 – Pres.	Associate Professor, Dept. of Civil and Environmental Engineering Northern Arizona University.
1992 - 1998	Assistant Professor, Dept. of Civil and Environmental Engineering and Construction Management, Northern Arizona University.
Summer 1993	Research Fellow, Los Alamos National Laboratory, Environmental Sciences Group.
1991- 92	Research Associate, University of Colorado, Boulder, Co.
1988 - 91	Research Associate, University of Arizona, Tucson, Az.
1987 - 88	Environmental Engineer, Culp, Wesner, and Culp, Cameron Park, Ca. Experience included design of drinking water, wastewater, and hazardous waste treatment facilities; underground storage tank removal; community hazardous waste planning; environmental audits; regulatory analyses.
1986 - 87	Environmental Engineer/Hydrogeologist, Radian Corp., Sacramento, Ca. Experience included remedial investigations and feasibility studies at hazardous waste sites; design review of hazardous waste treatment

facility; air toxics inventories; permitting for waste-to-energy plants; waste generation surveys and audits.

1984 - 85 Research Assistant. University of Arizona, Tucson, Az.

Publications

Trotta, Paul D., **Wilbert I. Odem,** 1997. Water Quality Monitoring at Great Basin National Park. Draft Final Report submitted to National Park Service, Grant # CA 8000-8-0002.

Foust, Richard D., and **Wilbert Odem**, 1996. *Environmental Site Characterization: A Senior Capstone Experience for Environmental Chemistry and Environmental Engineering Students.* Proceedings of 212th American Chemical Society National Meeting, Orlando, Fla., 1996.

Odem, Wilbert I., 1996. *Verde Watershed Watch Network - Incorporating Water Quality Monitoring in Science Curricula.* Proceedings of Fifth National Volunteer Monitoring Conference. Madison, Wi., 1996.

Odem, Wilbert I., 1995. Nanofiltration of a High Salinity Groundwater on the Hopi Reservation. Water Treatment Technology Program Report No. 3, U.S. Bureau of Reclamation, 1995.

Amy, G. et al (incl. **W. Odem**), 1995. Integrated Ozone-Biotreatment System vs. Membrane Separation of DBP Precursors. EPA Report CR 818846-01-0, 1995.

Amy, G.; M. Siddiqui, W. Zhai, J. DeBroux, **W. Odem**, 1994. Survey of Bromide in Drinking Water and Impacts on DBP Formation, AWWARF Final Report, 1994.

Odem, Wilbert I.; G. Amy, M. Conklin, 1993. *Subsurface Interactions of Cu(II) with Humic Substances in Saturated Media*, Environmental Science and Technology, June, 1993.

Amy, G.; M. Siddiqui, W. Zhai, J. DeBroux, **W. Odem**, 1993. "National Survey of Bromide in Drinking Waters. Proceedings of 1993 AWWA Annual Conference, San Antonio, Texas.

Odem, Wilbert Irwin, Jr., 1991. Natural Organic Matter Interactions with Cu(II) in Groundwater. Ph.D. Dissertation, University of Arizona, Tucson, AZ., 1991.