Coyote Creek
Watershed Improvement and Education Project

DRAFT Watershed Improvement Plan

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April, 2011

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Submitted to:
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EXECUTIVE SUMMARY

This report provides information that is designed to assist planning for watershed improvements within the Coyote Creek Watershed. This work has been funded by and Arizona Department of Environmental Quality Watershed Improvement and Education Grant. The grant goals were to establish a Watershed Improvement Council (WIC), provide a rapid watershed assessment, develop and prioritize a list of BMPs, and rapidly move into the implementation phase. The goals of the implementation are to reduce the sediment yield of Coyote Creek and consequent sediment impairment of the Little Colorado River and Lyman Lake downstream of Coyote Creek.

Due to the relatively short time frame and the relative abundance of existing data on Coyote Creek a literature review and site visits to lands managed by interested parties were conducted. During site visits and written surveys, landowners were encouraged to express their concerns about sedimentation/erosion on their properties and suggest BMP's that landowners either felt would work or had worked in the past.

The suggested BMP's were analyzed for cost, acreage protected, time frame for sediment reduction benefits, maintenance efforts to maximize the benefits, and sediment reduction potential due to placement within the watershed. The cost per acre of benefit was weighted by these four factors to provide a means of prioritizing BMP types and locations for implementation. This weighed cost benefit allows comparison of projects for sediment reduction. Other factors such as habitat enhancement, producers' requirements and other concerns of the WIC should be considered in the prioritization process as well.

Results of the analysis indicate that specific areas of the Coyote Creek watershed produce relatively more sediment than others. Stream banks and roads are relatively high contributors for their total area. However, gullying and rill erosion are prevalent through much of the watershed. This high sediment contribution has been noted for at least 40 years. Several phases of sediment control have been proposed and partially implemented in the past. Some practices have been successful but are nearing the end of their beneficial life span while others were not implemented due to lack of support from the producers or lack of adequate funding. It is hoped that strong initial landowner participation in the assessment phase as well as BMP selection will improve the chances for successful implementation and sediment reduction.

Analysis of practice cost efficiencies indicated that gully protection through sediment control basins and small grade control efforts were likely the most efficient use of funding to reduce sediment load. Bank sloping and road drainage efforts are worthwhile but did not rate high in efficiency due to the relatively high cost of these operations.

Some refinement of the ranking process could be accomplished by refining the sediment yield model to more accurately include bank and roadway erosion. However, it is not believed that the ranks of the practices will change considerably. The more costly practices have important benefits to habitat, wildlife and channel stability that were not directly incorporated into the prioritization process.

Next steps include the prioritization process, final cost analysis for the chosen practices and application for an implementation grant.

PROJECT DESCRIPTION

Coyote Creek is a major tributary of the Little Colorado River in eastern Arizona. While the major portion of the channel is ephemeral, there is a significant yield of sediment from the watershed to the Little Colorado River. Sediment contributions are significant enough to influence the capacity of Lyman Lake, a major irrigation impoundment on the Little Colorado River, and to cause water quality impairment of the Little Colorado River. Arizona Department of Environmental Quality (ADEQ) has provided a Watershed Education and Training (WET) grant with the objective of establishing a watershed council, identifying specific watershed concerns and best management practices to achieve those funds. This phase of the project should evolve rapidly into specific projects that can be funded and implemented under an ADEQ Nonpoint Source Grant.

This report provides assessment information that can be utilized to plan, cost estimate, prioritize, and fund watershed improvements that are focused on limiting the sediment contribution of Coyote Creek to the Little Colorado River. A review and synthesis of previous studies and programs to reduce sediment was conducted to provide insight into which practices work and which don't. Private landowners and grazing allotment managers within the basin were interviewed and site visits were conducted to discuss locations of specific problems. A descriptive list of BMP's and prioritization criteria were developed to assist the watershed group in deciding the best way to spend limited funding available for water quality improvement.

Coyote Creek has had recognized water quality issues related to sediment yield for several decades. Recommendations from several reports have generally agreed upon the source of sediments and types of practices required to alleviate sediment yield from the watershed. However, many recommendations have not been implemented due to lack of funding or support from public/private land managers. The approach of this report is to have direct input from land owners and managers as to the types of practices they believe will best benefit the land and their interests. This set of practices was evaluated to assess the potential impact on water quality improvement and a decision-making rubric is presented that can be utilized by the watershed improvement group. It is expected that the prioritization process will be somewhat subjective. The decision making process presented here is meant to guide the process and not confine it. The Coyote Creek Watershed Council consists of local landowners and managers. It is anticipated that recommendations develop through this process will be fully supported and implemented by the participants. Consequently, the perceived value of maintaining the projects will be high with a positive water quality response over the long-term.

PROJECT OBJECTIVES

The objectives of the ADEQ grant range from public education on watershed issues, formation of a watershed improvement council to development and implementation of BMPs focused on improving water quality by reducing sediment loads originating from the watershed. This report is meant to aid accomplishment of the grants goals by providing a compilation of watershed assessment data, analysis of which BMP's are most applicable and successful as well as estimated costs and priorities for implementation.
This report contains:

- Assessment of existing resource conditions gathered from available sources and site visits.
- Landowner concerns and needs gathered from site visits and interviews
- Descriptions and costs for BMP's that are focused on sediment reduction and supported by landowners.
- A decision making rubric designed to assist the watershed council in choosing sites and practices which will have the greatest impact on sediment reduction.

LOCATION

Coyote Creek is a 230 square mile sub watershed of the Little Colorado River located in Apache County, Arizona and Cantrell County, New Mexico (Figure 1). Approximately 50 square miles of the watershed are located in New Mexico with the remainder in Arizona. Elevations range from 7,900 feet in the eastern watershed to 6,000 near the confluence with the Little Colorado River. Flows are intermittent along the majority of the 41 miles of Coyote Creek channel.

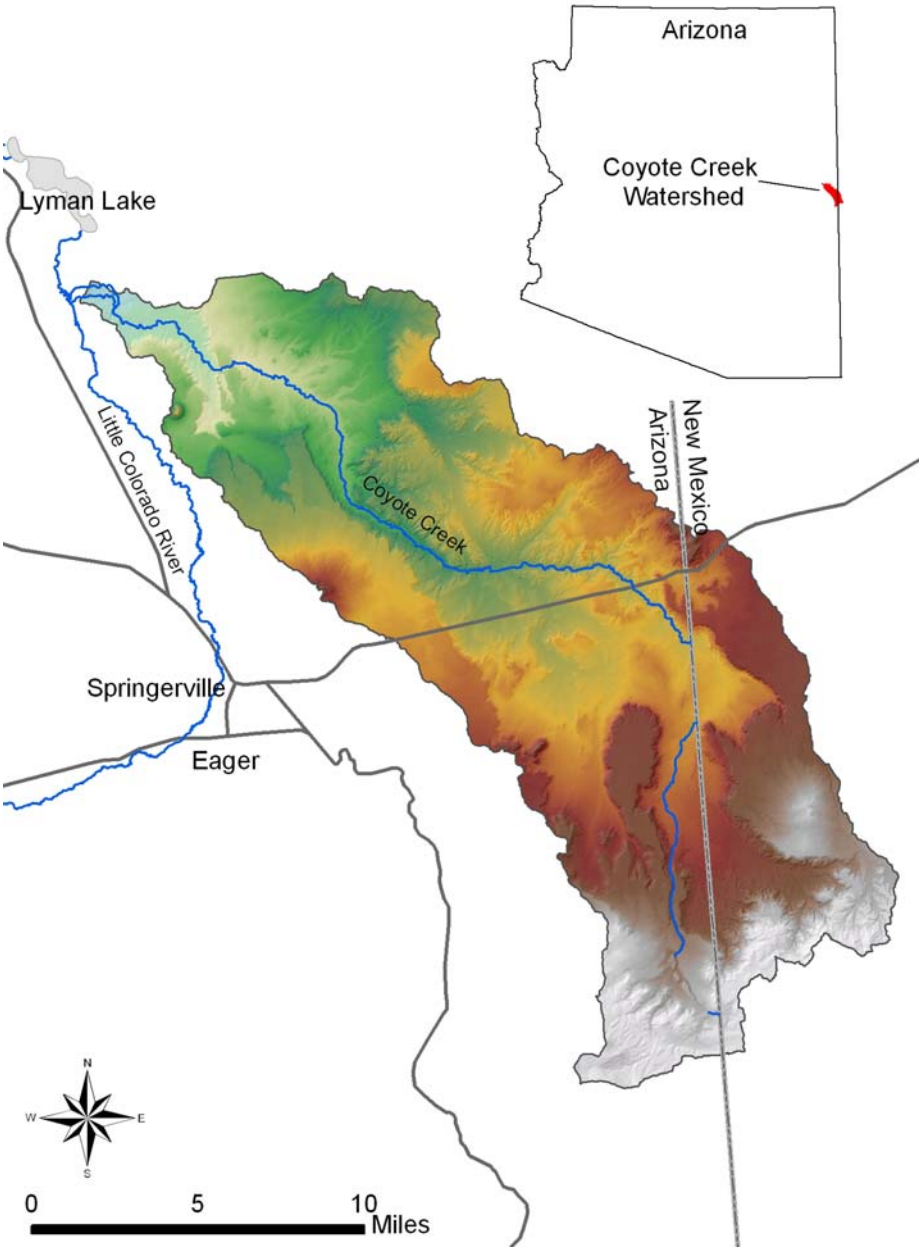

Figure 1 Location map.

EXISTING RESOURCE CONDITIONS AND CONCERNS

OWNERSHIP, CLIMATE, GEOGRAPHY AND SOILS

Background information on the Coyote Creek Watershed environment is covered in detail in a 1982 natural resource inventory conducted by the Arizona State Lands Department. This information is highlighted here.

The majority of land within the watershed is State Trust land that is leased for grazing (Table 1). It is important to note that most of the federal lands are in the upper portion of the watershed while state and private lands are in the lower 2/3's of the watershed where most of the runoff and sediment yield are generated.

Table 1. Land ownership in Coyote Creek Watershed.

Acreages incorporate both Arizona and New Mexico portions of the watershed. Data from AZ State Lands (2009) D.L. Goerndt.

Ownership	Amount (mi^2)	Percentage of watershed
US Forest Service	65.5	28.4%
Bureau of Land Management	13.9	6.0%
Private Land	39.3	17.0%
State Trust	111.7	48.5%
Total	**230.4**	

Precipitation in the watershed ranges from 10 to 14 inches annually. Most precipitation occurs as rain during summer monsoon storms. Winter snows are characteristically light. The higher elevations in the southeastern portion of the watershed receive slightly more precipitation than the rest of the watershed.

The surface geology of the watershed consists of alluvial and sedimentary deposits interspersed with lava flows. The majority of soils on the watershed are loamy sands of the Clovis-Palma-Hubert association formed from eolian deposits on flat or undulating topography. Rudd (basaltic derivation) and Tours-Jocity soil associations are the next most prevalent. All soil associations are well drained.

The topography of the watershed is generally flat, or rolling with volcanic hills. Drainages can create incised canyons.

Vegetation on the watershed consists of mainly grassland savannas or grass mixed with pinyon /juniper.

ASSESSMENT

Assessment of existing conditions was conducted by a review of existing reports and data as well as site visits to see property and interview owners and managers. The goal of the assessment process was to gather information about the general resource condition and issues within the watershed as well as provide owners/managers with specific areas of concern and practices to address those concerns. Previous reports as well as landowner interviews provided valuable information about the resource conditions and practice needs on specific lands.

ANALYSIS OF EXISTING DATA

It has been recognized for at least the last 40 years that the Little Colorado River Basin and specifically the Coyote Creek watershed has high soil loss issues. The characteristic geology and soil type and typical land use of the watershed make it susceptible to rill and sheet erosion as well as gully and channel erosion. Provided below is a brief review of six reports spanning 30 years of study related to the assessment of the Little Colorado River Basin or Coyote Creek specifically.

Little Colorado River Basin Summary Report

In December of 1981 a Cooperative River Basin Study of the Little Colorado River Basin was completed. The Soil Conservation Service, the Forest Service, and the Economic Research Service all participated. The Study was lead by the Arizona Department of Water Resources and the New Mexico State Engineer's Office. The study provides a description of the basin, the socio-economic base, irrigation practices, municipal and industrial water supply, rural domestic and livestock water supply, development of surface water resources, surface water budgets, erosion and sediment, flooding, recreation, fish and wildlife, and timber.

The report presents an analysis of resource data to offer solution to problems and assist decision makers in the development of water and related resource within the Little Colorado River Basin. It should be noted that this was not a basin-wide comprehensive plan. It did however, alternatives were developed which had a good possibility of being implemented with assistance from the USDA. These alternatives include: irrigation, recreation, erosion and sediment, and flooding.

One of the major land resource problems in the basin was identified as soil erosion within the alluvial valleys and on valley slopes. Erosion includes loss of land as a result of streambank and gully erosion, loss of soil nutrients, degradation of water quality by sediment, sediment deposition in streams channels and reservoirs, and the release of soluble salts by the erosion process. Approximately 5,300 miles of channel bank were experiencing moderate to severe erosion. Sheet and rill erosion accounts for the largest amount of erosion in the basin with the highest rates occurring in areas of badland topography, like that found in the Coyote Creek Watershed.
Recommendations to reduce soil erosion, protect water quality and improve productivity include:

- proper grazing use
- deferred grazing
- planned grazing systems
- fencing, water spreading
- brush management
- range seeding
- prescribed burning
- mechanical treatment
- stock water development

U.S. Department of Agriculture, Soil Conservation Service, Economic Research Service, 1981. Little Colorado River Basin, Arizona-New Mexico, Summary Report and Appendix I,II, III, and IV, Phoenix Arizona

Coyote Creek Natural Resource Inventory

A natural resource inventory of the Coyote Creek watershed was conducted by the Arizona State Land Department in 1981. Funding for this work was received from the Four Corners Regional Commission,

Grant # 611-466-050-1. The subsequent report presents an analysis of natural resource data which provides a baseline of natural resource information and data, in an effort to assist in solving range resource management problems specific to the Coyote Creek watershed.

Soil erosion and soil loss studies were conducted focusing on two areas, sheet and rill erosion, and streambed and gully erosion. It was determined that through sheet and rill erosion, approximately 1.8 tons of sediment was being lost per year. Streambed and gully erosion, while more noticeable and damaging was estimated to be less than sheet and rill erosion. Of the 261 miles of tributaries to Coyote Creek it is reported that eighty-nine miles (34%) of the tributaries were experiencing moderate-to-severe bank erosion, with sluffing banks, limited vegetation, and headcutting. The study suggests that 934 erosion-control structures would be needed to stabilize tributary erosion. Treatments would include sloping, mulching, and seeding, gully walls and streambanks. It is also reports that a total of eighteen miles (75%) of Coyote Creek proper is in need of erosion-control measures. The U.S. Soil Conservation Service indentified a potential flood water and sediment-detention dam site on Coyote Creek which would be an effort to prolong the life of Lyman Lake.

The Arizona State Land Department identified the following may resource concerns, listed in the order of priority:

- erosion-control of eighty-nine mile of channels by means of fencing, bank sloping, seeding and mulching, and installing sediment retention structures.
- reduction of soil loss from sheet and rill erosion through the increase of rangeland cover.
- development of grazing systems, improvement of water distribution, long term monitoring, soil erosion studies
- pinyon-juniper invasion control
- Improvement of watering systems with the development of additional wells, pipelines, storage tanks and drinkers, lining ponds, and developing springs.
- development of more recreation activities to reduce impacts to the resource.

Arizona State Land Department, 1988. Coyote Creek Natural Resource Inventory, Phoenix Arizona

Coyote Creek Critical Area Treatment RC&D Measure Plan

A Coyote Creek Watershed Critical Area Treatment Measure was undertaken in August of 1988. This "Measure" was an effort to develop a plan to address the severe soil erosion in the Coyote Creek watershed, a significant concern of the Apache Natural Resource Conservation District. Consistent with previous work, the plan identifies sheet, gully, and streambank erosion as the major contributors of sediment from the watershed.

The plan estimates that 40% of the erosion within the watershed is a result of streambank and gully erosion. It is reported that this type of soil erosion is particularly damaging to range lands due to runoff being rapidly conveyed from the area before it can infiltrate into the soil and promote vegetative cover. These gullies provide a conduit for the rapid transport of sediment to depositional areas such as Lyman Lake. Water quality is impaired by the suspended sediment.

Several alternatives were evaluated in an effort to meet the plans objects which include the protection, preservation and conservation of area water resources, and the improvement of range condition. The selected alternative includes grade control and sediment control structures, road stabilization, critical area planting, fencing, water development, and streambank protection. The estimated cost of these practices in 1988 is $1,780,300. It is believed that these practices would stop accelerating erosion losses, reduce

erosion and sediment yield and maintain or improve productivity, land values, create jobs, and improve wildlife habitat and water quality.

Little Colorado River Plateau Resource Conservation and Development Area Inc., 1988. Coyote Creek Critical Area Treatment RC&D Measure Plan, Apache County, Arizona

Upper Little Colorado River Watershed Partnership, Watershed Based Management and Action Plan

The Upper Little Colorado River Watershed Partnership was formed in 1998 through the assistance of the Arizona Department of Water Resources in an effort to protect, restore, and monitor natural resources of the upper Little Colorado River watershed to enhance quality of life. Participating agencies included the Arizona Department of Environmental Quality, The U.S. Fish and Wildlife Service, The U.S. Forest Services, local town managers, and irrigation users.

The partnership identified more than 20 objectives for the upper little Colorado River Watershed. Of note here is Objective 14 which relates to the feasibility of sediment storage on Coyote Creek in an effort to decrease the sediment yield from the Coyote Creek watershed. The concerning being that Coyote Creek is a major contributor of sediment to Lyman Lake. It was estimated that a large sediment storage structure could capture 85% of the sediment leaving the watershed.

It was also identified that sediment generation within the watershed is a result of bare ground. Grazing management as well as recreation and rock density would need to be managed in order to promote the recovery of ground cover. They suggest that Livestock grazing my need to be suspended, temporarily or even permanently if critical ground cover levels cannot be maintained. The reduction of pinyon and juniper was suggested as a way to increase ground cover in the Coyote Creek watershed.

As of the 2005 report no work had been completed within the Coyote Creek watershed, though it was still desired to evaluate the feasibility of developing sediment storage on Coyote Creek.

Upper Little Colorado River Watershed Partnership, 2005. Watershed Based Management and Action Plan, Rural Watershed Partnership Program, Arizona Department of Water Resources, Phoenix, Arizona.

Little Colorado River Headwaters Watershed, Arizona, Rapid Watershed Assessment

A Rapid Watershed Assessment was completed within the headwaters of the Little Colorado River, hydrologic unit 1502001 by the Natural Resources Conservation Service and the University of Arizona, Water Resources Research Center, in 2008. Coyote Creek is one of the subwatersheds within this study. The Rapid Watershed Assessment is a concise report containing natural resource information related to the condition and concerns with the study area. The assessment is primarily Geographic Information System Based, used to make decisions regarding the condition of the watershed and to help prioritize conservation efforts.

Resource concerns identified by this report include soil erosion, rangeland site stability, rangeland hydrologic cycle, excessive runoff, excessive suspended sediment and turbidity in surface water, threatened or endangered plant and animal species, noxious and invasive plants, wildfire hazard, inadequate water for fish and wildlife, habitat fragmentation, and inadequate stock water for domestic animals.

The report shares that most of the Little Colorado River from the West Fork of the Little Colorado River to Lyman Lake is listed as impaired by sediment. Lyman Lake is also listed as impaired due to mercury in fish tissue. Reaches of the Little Colorado River which Coyote Creek is a tributary of, contain eight species that are either listed, species of concern, or candidate species, under the U.S. Endangered Species Act.

Resource concerns for the watersheds of the Little Colorado River listed in this assessment include the following:

- soil erosion – sheet and rill erosion
- water quality – excessive nutrients and organics in surface water
- water quantity – inefficient water use on irrigated land
- plant condition – productivity, health and vigor
- domestic animals – inadequate quantities and quality of feed and forage

Recommended conservation practices include:

- water development in the form of pipelines and canals
- crop rotation
- pest management
- land leveling
- fencing
- prescribed grazing
- upland wildlife habitat management
- nutrient management

USDA Natural Resource Conservation Service, Arizona and University of Arizona Water Resources Research Center, 2008. Little Colorado River Headwaters Watershed, Arizona, Rapid Watershed Assessment.

NEMO AGUA Model of the Coyote Creek Watershed

In partnership with the Arizona Departments of Environmental Quality and the University of Arizona Water Resources Research Center, the Arizona Cooperative Extension at the University of Arizona has initiated the Arizona Nonpoint Education for Municipal Officials (NEMO) Program. Arizona NEMO helps to develop watershed based plans to address nonpoint source pollution, such as sediment. In October of 2006 Arizona NEMO published the results of a watershed scale modeling using the Automated Geospatial Watershed Assessment tool. This hydrologic analysis system takes into account elevation, slope, soil type, land cover type, and precipitation data to ultimately determine water runoff and sediment yield.

Model results are useful for determining watershed condition at a coarse scale and identifying priority areas for further investigation and the implementation of conservation practices. The purposed of these most recent Coyote Creek Watershed improvement efforts, Arizona NEMO applied the AGWA model to the Coyote Creek watershed. Results of the model are seen the Figures 2 and 3, note that the sediment yield tracks well with the spatial variation of water yield. This correlation indicates that sediment yield from the watershed could be mitigated through the implementation of conservation practices which increase infiltration and decrease runoff.

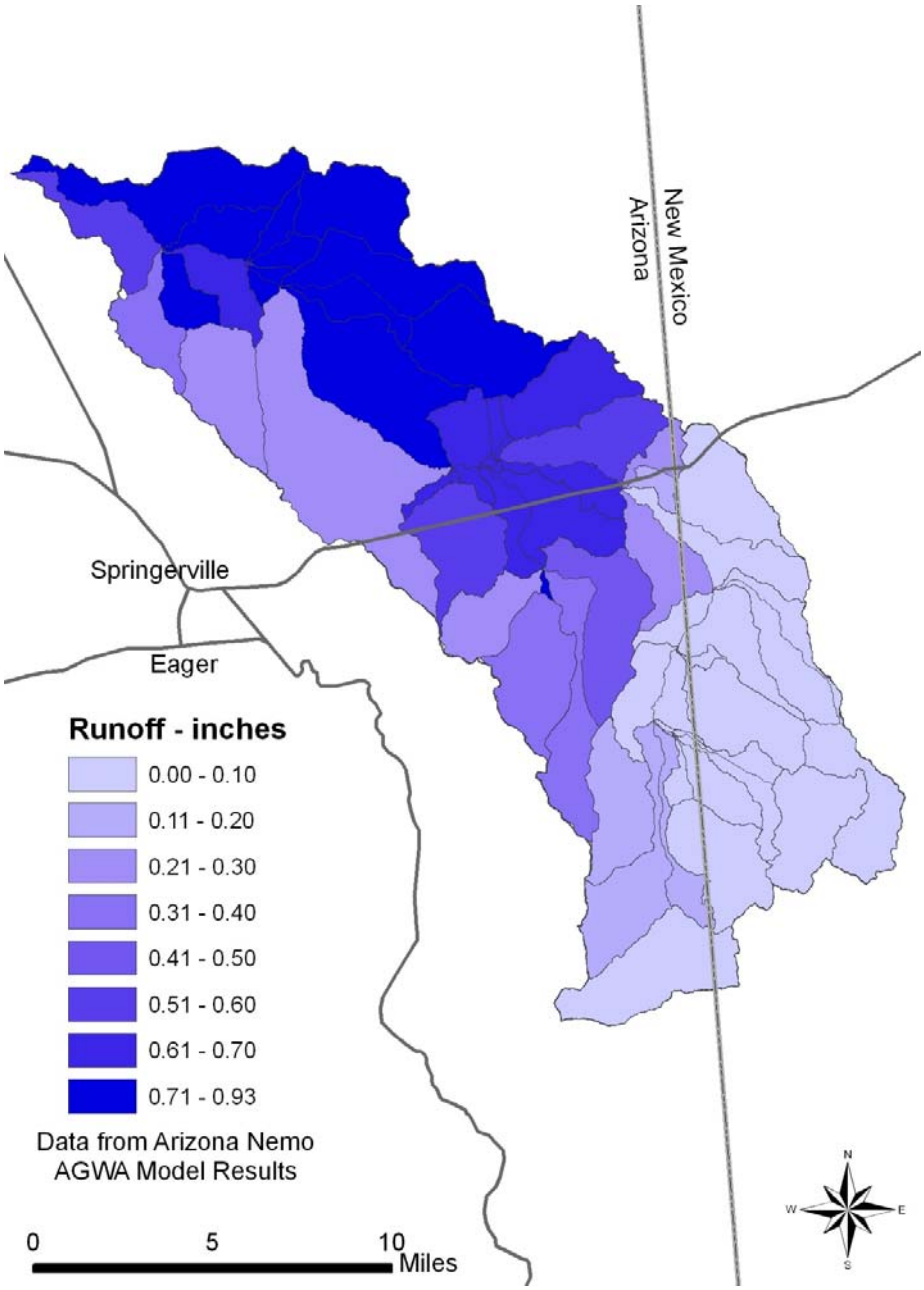

Figure 2. AGWA model results of runoff.

Model results of runoff from a 10-yr rainfall event – 1.3 inches of precipitation in 1 hour.

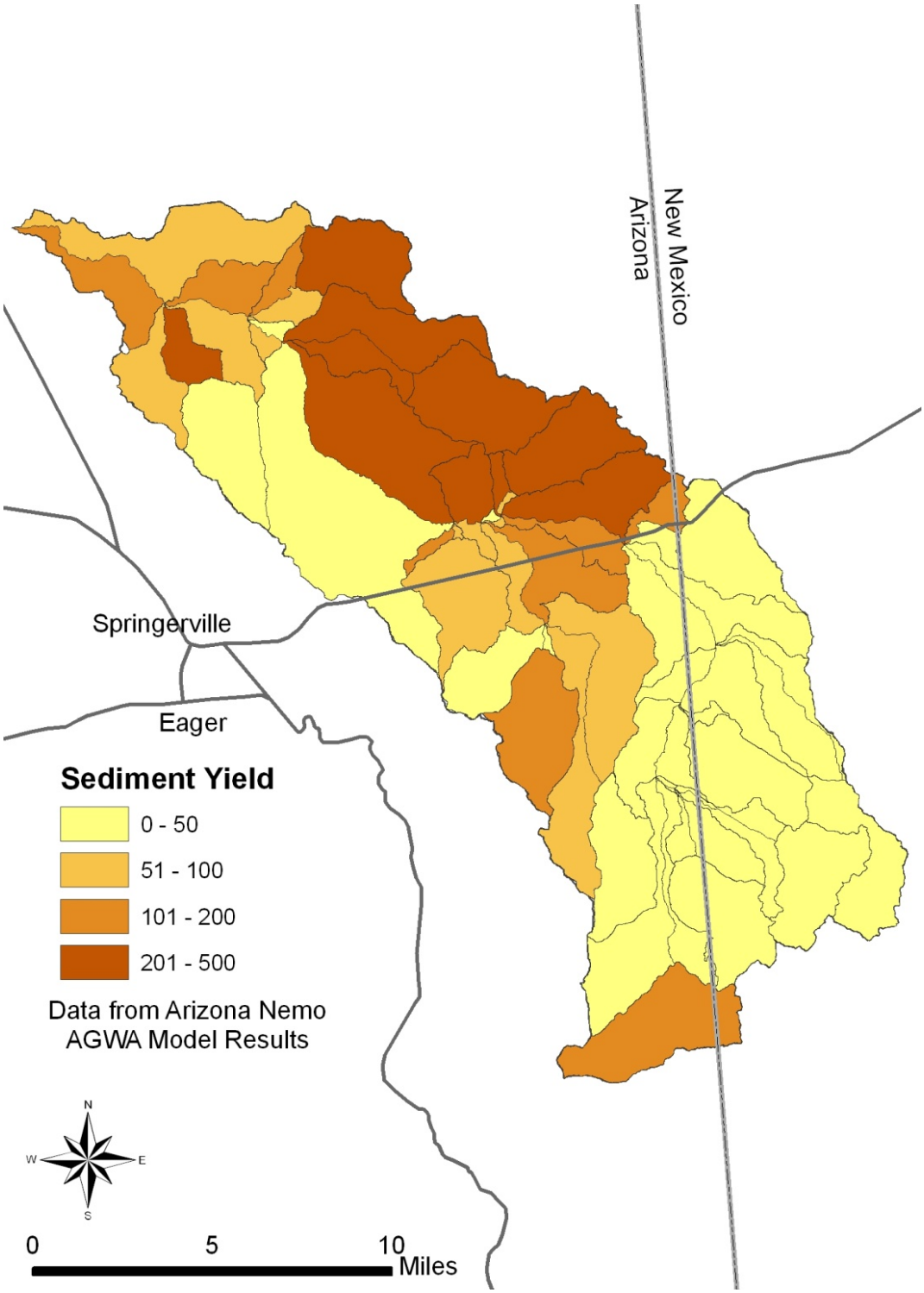

Figure 3. AGWA model results of sediment yield.

Note that the magnitude of sediment yield closely matches the map of runoff.

Common resource concerns in these reports are sheet and rill erosion, as well as gully and stream channel erosion. These concerns have historically been addressed with mixed success through the use of many conservation practices including the following. Many of these practices have reached the end of their service life > 10 years and need replacement or rehabilitation.

- sediment detention basins
- water and sediment control basins
- dikes
- water development – springs, wells, pipeline, and pumps
- fencing
- improved grazing plans
- brush management
- water spreading
- rock and brush grade control

WATER QUALITY

The Arizona Department of Environmental Quality (ADEQ) assesses surface water quality to identify which surface waters are impaired or exceed water quality standards. The current Watershed-scale Education and Training Grant was awarded to begin mitigation of Coyote Creek as it has exceeded water quality standards and is a major tributary to the impaired Little Colorado River and upstream of the impaired Lyman Lake. ADEQ monitors water quality at four sites at the mouth of Coyote Creek, near its confluence with the Little Colorado River. Through these monitoring efforts, ADEQ has identified Coyote Creek to be impaired in both turbidity and suspended sediment, both impairments are considered to be caused by nonpoint source pollution.
The studies outlined in the Analysis of Existing Data section of this report have identified the likely sources of these impairments as, (1) the characteristic geology and soil of the watershed, (2) meteorological changes, causing an acceleration of stream channel erosion, sheet and rill erosion, and gullying, and (3) grazing.

A significant source of eroding sediment are from areas of the watershed made up of deep sandy loam soils. These soils lack cohesion and are easily eroded where there is a void in plant cover and along the banks of Coyote Creek and its tributaries.

Plant cover and precipitation are well correlated within the watershed. The areas lower in the watershed, which are the focus of sediment reduction efforts, receive the least amount of rainfall and have the most severe erosion. It is also believed that recent rainfall events occur less often but with increased intensity. This results in an increase in erosion on the dry plains and desert grassland areas, which are most commonly grazed.

Widespread, heavy grazing decreases plant cover, thus increasing the erodibility of the soil. Runoff events mobilize soil which becomes suspended sediment in streams and increases turbidity. In the 2002 Little Colorado River TMDL report, ADEQ identified grazing practices as contributing 60% of the load for turbidly. This TMDL report is not specific to Coyote Creek alone but to the Little Colorado River and its tributaries. However, the recommendations by ADEQ for decreasing the loading are pertinent to Coyote Creek. ADEQ recommendations are to increase riparian vegetation, stream bank stabilization, the promotion f of floodplain development and the minimization of impacts from cattle through improved grazing strategies and practices.

The objectives of the Coyote Creek Watershed Improvement Council are to decrease suspended sediment and turbidity of Coyote Creek. Strategies include the use of BMPs to, increase plant cover through the improvement of grazing practices, such as water development, and to address streambank erosion, gullying, and sheet and rill erosion.
Continued monitoring by ADEQ will provide a means to measure the success or failure of the BMPs implemented by the Coyote Creek producers. The monitoring scheme may need to be modified to obtain measurements during flows greater than 1 cfs. Measurements taken during these low flows are representative only of very local water quality and not representative of water quality of the Coyote Creek watershed.

SITE VISITS

The Coyote Creek Watershed Improvement and Education Project began with a kick off meeting September 18, 2010, in the Eagar Town Hall. During this and subsequent meetings producers which expressed interest in participating in the watershed improvement project were identified. Staff from Natural Channel Design setup site visits when possible with these producers to discuss resource concerns and solutions. Field notes were made and photographs taken. All data and photographs were organized and site maps were made indicating the location of Best Management Practice (BMP) (Appendix B). A list of participating producers is found in Table 2 and Figure 4 provides the location of their ranch. Summary information from site visits is found in Appendix A. Each summary includes a description of resource concerns, BMPs requested by the producer including typical costs, maps and photographs.

The BMPs listed in Appendix A represent what the producers desired, to solve a resource concern, these BMPs are not necessarily the recommendation of the technical service provider, Natural Channel Design. A rubric is provided in Tables 5 and 6 to assist in the decision making based upon the producer proposed BMPs.

Table 2. List of producers requesting assistance from the Coyote Creek Watershed Improvement and Education Project.

CLIFFORD JOHNSON
TRAVIS JOHNSON
GALYN KNIGHT
LANCE KNIGHT
SIDNEY MADDOCK
FRED MOORE
BRIAN NICOLL
ELAINE ROGERS
JOHN THOMPSON

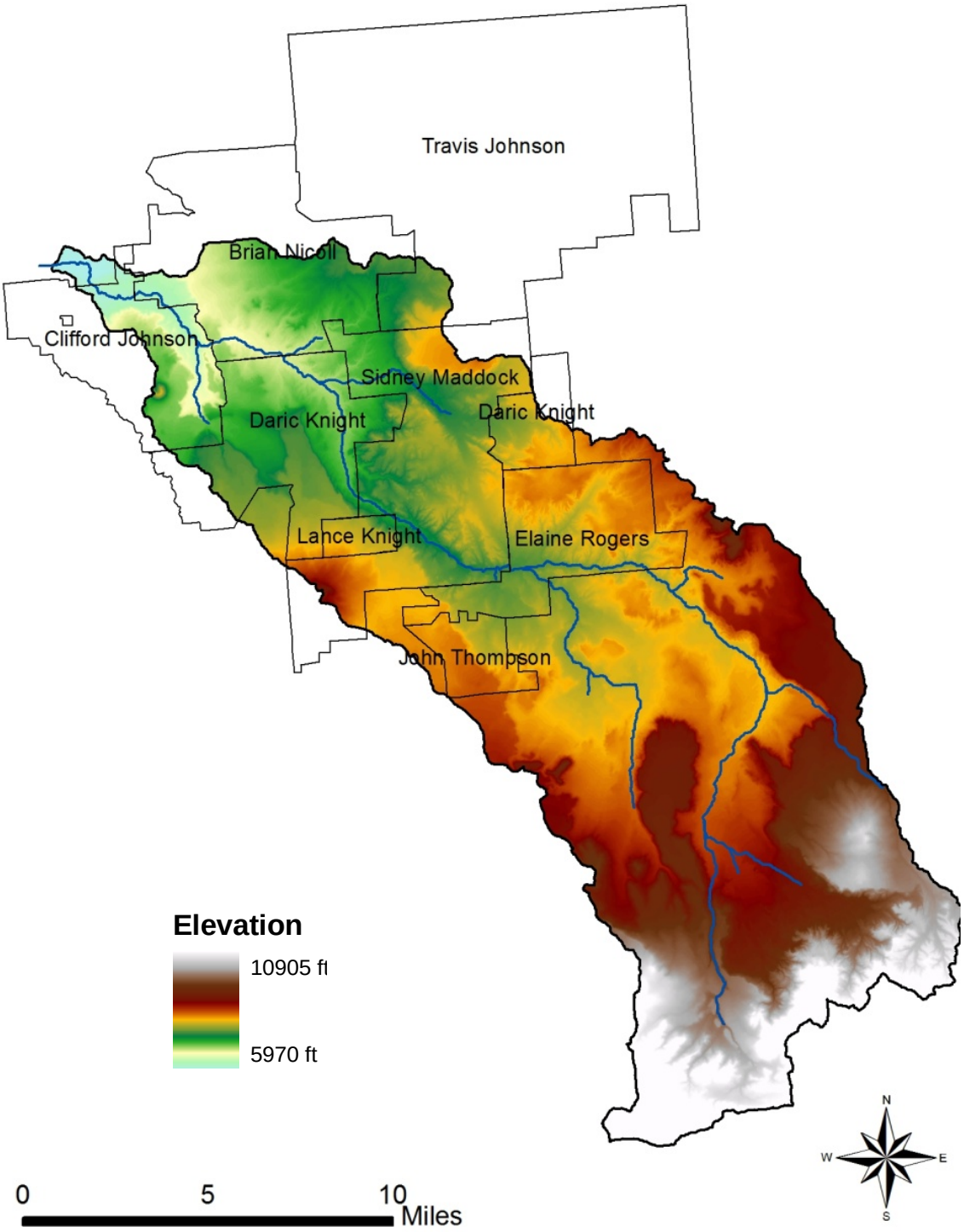

Figure 4. Location of ranches requesting assistance to implement conservation practices.

BEST MANAGEMENT PRACTICES

DEVELOPMENT OF BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) have been developed to address nonpoint source pollution, specific to land uses of the Coyote Creek Watershed. The sediment eroded from uplands and stream banks has been identified as the pollutant causing the loading of turbidity and suspended sediment of Coyote Creek, the Little Colorado River, and ultimately Lyman Lake. The technical service provider met with interested producers and compiled a list of desired BMPs. This list can be broken into two broad categories, vegetative practices and structural practices, Table 3. Information organized by the Natural Resource Conservation Service and Arizona NEMO were used in the Development of practices and in rating their effectiveness at meeting objectives.

Vegetative practices aim to improve plant cover through riparian and upland vegetation management thus decreasing the production of sediment from gullying, and sheet and rill erosion. Presently an invasion of pinyon and juniper has lead to a decrease in understory vegetation. Brush management or the removal of exotic species such as pinyon and juniper has been shown to increase understory abundance in Arizona (Clary and Jameson 1981). Once exotic species are removed it is critical that the disturbed area be reclaimed through range seeding to help compete with the invasive species and improve the seed bank with has been alerted due to grazing.

Planting woody species, such as willows in areas of consistent stream flow or a high water table provides a natural sediment filter and stabilizes stream banks. In some reaches of Coyote Creek Willow and Tamarisk are abundant and are often growing in the middle of the stream. This causes the channel to erode its banks as the stream widens because of the decreased channel capacity caused by the in-stream vegetation. Ideally the woody vegetation would be transplanted to the stream bank and the channel constructed to an appropriate width.

Fencing, an important tool for herd management, it allows for grazing rotation and stream protection. Resting grazed lands allows vegetation to renew energy reserves, rebuild shoot systems, and deepen root systems, with the end result being long-term maximum biomass production which benefits the produces and keeps the plant cover at a maximum.

Structural practices include those that directly stabilize or trap eroding soil and those that provide infrastructure for grazing management in the form of water development. Gully and grade control structures help to arrest headward migration of headcuts and stabilize local stream reaches. These headcuts and stream knick points are significant sources of sediment which contribute to the degradation of water quality. Using water spreading practices helps to redistribute the concentrated flow, allowing for more infiltration and decreasing the flows energy.

Sediment basins are constructed to capture and detain sediment laden runoff. The basins are designed on a individual basis to meet site specific conditions. This practice also provides a means to remove sediment from stream flow, preserving the capacity of a downstream stock pond. Maintenance is required to remove accumulated sediments which decrease the capacity of the basin over time.
Stream bank stabilization in the form of rock and vegetation structures can help reduce the erosion brought upon by the erosive power of stream flood flows. The reconnection of a stream channel with its floodplain through bank sloping can also decrease erosion and promote proper stream channel and riparian function.

Sheet and rill erosion is caused by overland flow from rainfall events. Where vegetation cover is not sufficient to stabilize the soil structural practices can be implemented. Rock barriers and slit fences help

to decrease runoff velocity and promote infiltration. The ultimate solution to sheet and rill erosion is the revegetation of bare soils.

Rainfall runoff commonly concentrates upon roads that run perpendicular to slope. This concentrated flow accelerates erosion of the unpaved dirt roads. By using water bars or rolling dips the water is directed off the road and spread onto adjacent fields.

Water development in the form of wells, springs and pipelines allows for better grazing rotation which allows grazed lands to be rested. As described previously, resting grazed lands allows vegetation to renew energy reserves, rebuild shoot systems, and deepen root systems, with the end result being long-term maximum biomass production which benefits the produces and keeps the plant cover at a maximum.

Details of the BMPs are located in Appendix B, which contains standards and specifications.

Table 3. List of potential BMP's identified by producers.

Vegetative Practices
Brush Management
    Mechanical
Kangaroo Rat Control
Range Seeding
Woody Plantings
    Willow Pole Plantings
    Vertical Willow Bundles
Fencing

Structural Practices
Gully Control Structure
    Headcut Treatment: Smooth-Seed-Fabric/Mulch
    Water Spreader/Dike
    V-Mesh Spreader
Rock and Brush Grade Control
    Rock Wire Sausage Grade Control
    'V' Rock Weir
Sediment Basin
Bank Stabilization
    Bank Sloping-Seeding-Fabric/Mulch
    Stream Barb
    Boulder Dart
    Rock Vane
    Vegetated Toe Extension
    Toe Rock with Brush Trench
Sheet and Rill Erosion
    Rock Barrier
    Silt Fence
Road Stabilization
    Road Water Bar
    Road Rolling Dip
Water Development
    Well Development
    Well Rehabilitation
    Spring Development
    Livestock Pipeline
    Trough
    Pond

INSTITUTIONAL AND JURISDICTIONAL CONSIDERATIONS

Acquisition of required permits for implementation of BMP's may require considerable lead time and planning. Permitting requirements differ between practices and land ownership. Activities within the active channel of Coyote Creek will likely require a Clean Water Act Section 404 permit for discharge into waters of the United States. This permit is administered by the Army Corps of Engineers.

Application for a 404 permit also triggers the need for Clean Water Act Section 401 permits which are administered by Arizona Division of Environmental Quality (ADEQ), the need for a State Historical Preservation Office (SHPO) consultation, and a biological evaluation of effects to protected species. In upland areas, major ground disturbing activities may require SHPO consultation. Minor ground disturbing activities (fencing, gully treatments, etc.) likely do not require permitting. Landowners working directly with NRCS can likely utilize NRCS permitting programs and specialists to accomplish permitting tasks for work on their property. Grazing allotment leases may require review of specific management actions by the state or federal land management agency overseeing the lease. Well drilling requires permits from the Arizona Division of Water Resources (ADWR). Development or enhancement of existing stock ponds or retention basins may require water rights for development. Surface water rights are administered by ADWR. Guidance for permitting requirements for each suggested BMP practice is provided in Table 4.

Table 4. Permitting requirements for suggested BMPs.

Permitting is dependent on location and funding sources for each practice. This table provides general guidelines and specific permitting needs should be considered on an individual project basis.

	ACOE 404	ADEQ 401	SHPO	Biological Evaluation	ADWR well	ADWR water rights
Structural Practices						
Water Development (Pipeline)			X			
Water Development (Trough)						
Water Development (Spring)	X*	X*	X*	X*		
Water Development (Spring Rehabilitation)	X*	X*	X*	X*		
Water Development (Well w/Solar)					X	
Water Development (Well Rehabilitation w/Solar)					X	
Bank Stabilization (Bank Sloping-Seeding-Fabric/Mulch)	X	X	X	X		
Bank Stabilization (Toe Rock)	X	X	X	X		
Bank Stabilization (Toe Rock and Brush Trench)	X	X	X	X		
Road Stabilization (Road Water Bars)						
Gully Control Structure (Rock and Brush Grade Control)						
Gully Control Structure (Sediment Basin Rehabilitation)			X			
Gully Control Structure ("V" Rock Weir)						

Gully Control Structure (Sediment Basin Rehabilitation)	X	X	X	X	X
Gully Control Structure (Sediment Basin with a new Stock Pond)	X	X	X	X	X
Gully Control Structure (Sediment Basin/Dike)	X	X	X	X	X
Sheet and Rill Erosion (V-Mesh Spreaders)					
Vegetative Practices					
Fencing					
Brush Management					
Range Seeding					
Kangaroo Rat Control					

COST ANALYSIS

Estimated Typical Costs were refined using NRCS and ADEQ cost rates, and NCD project experience, as well as other engineering cost estimators. Based on site evaluations and discussions with producers, resource concerns were identified and BMPs were developed to address these concerns.

PRIORITIZATION OF PROJECTS FOR FUNDING

The Watershed Improvement Council faces a challenging task of determining which practices and areas should be prioritized for implementation. While there is merit in all of the practices, limited funding availability necessitates that practices that will have the greatest impact on reducing sediment yield. Local landowners and managers with long experience in the watershed will ultimately provide the best guidance on choosing project areas and practices that best meet the needs of the watershed and stakeholders. However, a quantifiable method of organizing practice effectiveness and cost is a valuable tool for assisting and defending those prioritization decisions.

A prioritization rubric was developed to assist the WIC in planning. This rubric provides a weighted cost/acre-improved as a means of ranking practice effectiveness. The cost/acre is calculated by taking the cost of the practice and dividing by the acres protected or enhanced. For example a sediment basin can protect effectively reduce the sediment yield for the entire watershed upstream of it while fencing and stock management has an effect on the acreage within the fenced area. In some cases several practices are required for an impact on the same acreage, ie brush management and grassland seeding are both required to effectively treat the same acreage. In these cases the total cost of the treatment was divided by the acreage enhanced.

Weighting for four factors are applied to the cost/acre of each practice. The four weighting factors are:

Reduction Potential - The general potential sediment reduction of the practice. Three categories of reduction generally described by Amesbury et al., (2010).

High = 1
Medium = 2
Low = 3

Estimated Time to Load Reduction - The amount of time required to realize full sediment control benefits. . Three categories of reduction generally described by Amesbury et al., (2010).

Immediate = 1
< 2 years = 2
>2 years = 3

Expected maintenance requirements – All practices are expected to have a useful life of at least 10 years. However, this weight factor estimates the amount of maintenance required to realize the full benefit of the practice over that 10-year life span. Three categories of reduction generally described by Amesbury et al., (2010).

Low = 1
Medium = 2
High = 3

Watershed Placement Potential – This factor measures the potential sediment reduction due to the location of the practice within the watershed. This factor is weighted according to sediment yield data estimated by Arizona NEMO AGUA model (Figure 5). Ratings are in six categories:

0 - 50 tons acre = 6
50 -1 00 tons/acre = 5
100 - 200 tons/acre = 4
200 – 300 tons/acre = 3
300 – 400 tons/acre = 2
400 – 500 tons/acre =1
Bank sloping = 1 (based on typical soil loss estimates for unstable banks during bankfull flows)

The first three factors are utilized to rank the effectiveness of the BMPs in general. The weights of the three factors are added together and multiplied by the cost per acre treated to provide a weighted unit cost for ranking purposes. The results are provided in Table 5. The fourth factor is multiplied by the weighted unit cost for proposed BMPs to provide a ranking of the treatment in a specific placement. These rankings are provided for each producer in the site visit results. The most efficient

In general the ranking procedure is instructive. Small rock and brush grade control and sediment detention basins appear to be the most efficient means of controlling sediment throughout the basin. Cost intensive practices that only affect limited areas such as road stabilization and bank sloping are least efficient use of funding for sediment control.

Several steps could be taken to improve the ranking process. Typically, road runoff and bank erosion are high priority projects due to massive amounts of sediment produced by these areas. Our rankings likely underestimate the amount of sediment that could be controlled at these sites. Most estimates of sediment loss from these areas are based on an annual yield or common runoff event. The AGUA estimates for sediment yield from the basin are based on a 10-yr return frequency flood and do not incorporate roads or eroding banks within its estimates. The easiest way to compare the relative yields would be to rerun the model for a more frequent storm event (1.5 – 2 year). However it is doubtful that the relative ranks of bank sloping and road work would change since these practices are considerably more expensive than others.

Table 5. BMP's ranked by weighted unit cost.

Best Management Practice	Total Cost	Area Mitigated (ac)	Cost per Acre Mitigated	Reduction Potential	Time for Reduction	Expected Maintenance	Sum of NEMO Ratings	BMP Rating
Rock and Brush Grade Control ("V" Rock Weir)	$ 11,825.00	2015	6	1	1	1	3	18
Sediment Basin	$ 31,600.00	4202	8	1	1	3	5	38
Rock and Brush Grade Control (Rock and Brush Grade Control)	$ 77,550.00	6033	13	1	1	1	3	39
Water Development	$ 242,895.00	24000	10	2	1	2	5	51
Fencing	$ 168,960.00	4300	39	1	1	1	3	118
Gully Control Structure	$ 8,675.00	415	21	2	1	3	6	125
Kangaroo Rat Control	$ 1,200.00	50	24	3	3	1	7	168
Brush Management and Seeding	$ 925,485.00	7330	126	2	3	1	6	758
Road Stabilization (Road Water Bars)	$ 4,725.00	1	3,267	2	1	3	6	19,602
Bank Sloping-Seeding-Fabric/Mulch	$ 234,975.00	1	235,950	1	1	1	3	707,850

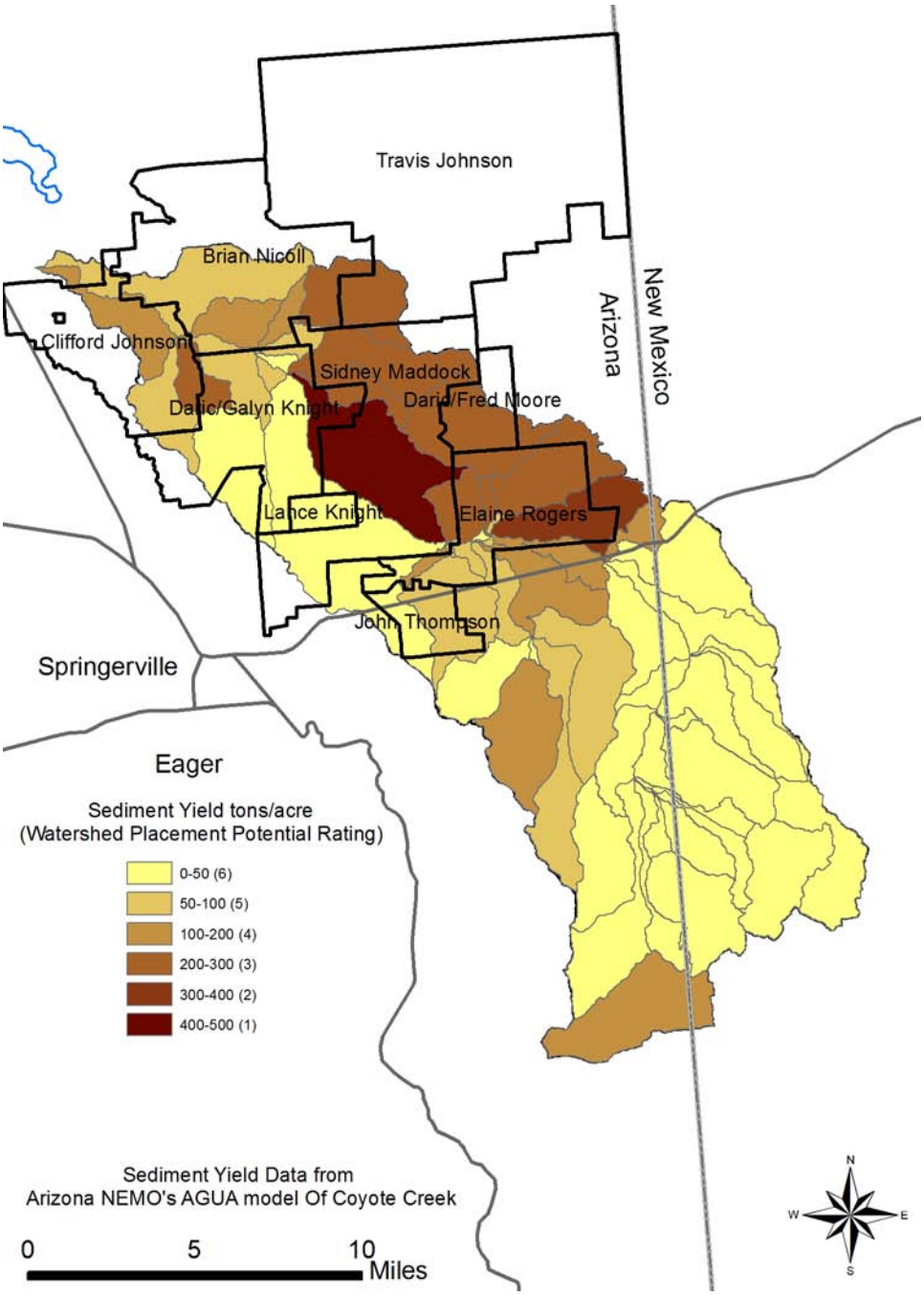

Figure 5. Land ownership and sediment yield in Coyote Creek.

Table 6. Results of BMP ranking by placement within the watershed.

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Brian Nicoll	Fencing	$35.20	3	5	528
Brian Nicoll	Rock and Brush Grade Control	$10.83	3	4	130
Brian Nicoll	Water Development	$13.11	5	5	328
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
Clifford Johnson	Bank Sloping-Seeding-Fabric/Mulch	$235,950.00	3	1	707,850
Clifford Johnson	Range Management	$126.25	6	3	2,273
Clifford Johnson	Rock and Brush Grade Control x4	$11.92	3	1	36
Clifford Johnson	Water Development (Spring)	$0.80	5	3	12
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
Elaine Rogers	Bank Sloping-Seeding-Fabric/Mulch	$235,950.00	3	1	707,850
Elaine Rogers	Rock and Brush Grade Control	$1,191.67	3	1	3,575
Elaine Rogers	Road Stabilization	$588,060.00	6	4	14,113,440
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
Fred Moore (Daric I	Rock and Brush Grade Control x4	$11.92	3	1	36
Fred Moore (Daric I	Sediment Basin	$5.05	5	3	76
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
Galyn Knight (Daric	Gully Control Structure ("V" Rock Weir)	$6.35	3	1	19
Galyn Knight (Daric	Rock and Brush Grade Control x7	$13.10	3	1	39
Galyn Knight (Daric	Water Development	$17.60	5	5	440
Galyn Knight (Daric	Water Development	$12.38	5	6	371
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
John Thompson	Brush Management and Seeding	$126.25	6	5	3,788
John Thompson	Fencing	$42.24	3	5	634
John Thompson	Rock and Brush Grade Control x4	$11.92	3	1	36
John Thompson	Kangaroo Rat Control	$24.00	7	5	840
John Thompson	Water Development (Spring)	$2.04	5	5	51
John Thompson	Water Development (Well Development)	$7.49	5	6	225
John Thompson	Water Development (Well Rehabilitation)	$7.49	5	5	187
John Thompson	Water Development (Well Rehabilitation)	$16.03	5	6	481
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
Lance Knight	Brush Management and Seeding	$0.28	6	6	10
Lance Knight	Rock and Brush Grade Control ("V" Rock W	$0.13	3	1	0.4
Lance Knight	Water Development	$13.49	5	6	405
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
Sidney Maddock	Rock and Brush Grade Control ("V" Rock W	$4.14	3	1	12
Sidney Maddock	Sediment Basin	$14.66	5	3	220
Sidney Maddock	Road Stabilization	$2,273.68	6	3	40,926
Sidney Maddock	Water Development	$2.00	5	3	30
Producer	**Best Management Practice**	**Cost per Acre Mitigated**	**Sum of NEMO Ratings**	**Location Rating**	**Area-Weighted BMP Rating**
Travis Johnson	Brush Management and Seeding	$126.25	6	3	2,273
Travis Johnson	Sediment Basin	$7.41	5	3	111
Travis Johnson	Water Development	$6.62	5	3	99
Travis Johnson	Gully Control Structure	$20.90	6	1	125

RESULTS, CONCLUSIONS, RECOMMENDATIONS

This report provides a review of previous studies, resource concerns, and producer requested BMPs and costs, to address nonpoint source pollution, specific to land uses of the Coyote Creek Watershed. A prioritization rubric is also provided to assist the WIC in planning. This rubric provides a weighted cost/acre-improved as a means of ranking practice effectiveness for decision making purposes.

Within the Coyote Creek watershed, stream banks and roads are relatively high contributors for their total area. However, gullying and rill erosion are prevalent through much of the watershed. Some practices have been successful but are at the end of their service life

Analysis of practice cost efficiencies indicated that gully protection through sediment control basins and small grade control efforts were likely the most efficient use of funding to reduce sediment load. Bank sloping and road drainage efforts are worthwhile but did not rate high in efficiency due to the relatively high cost of these operations. Some refinement of the ranking process could be accomplished by refining the sediment yield model to more accurately include bank and roadway erosion. However, it is not believed that the ranks of the practices will change considerably. The more costly practices have important benefits to habitat, wildlife and channel stability that were not directly incorporated into the prioritization process. Ultimately it will be up to each individual producer to decide what BMPs they are willing to implement upon their land, with their matching funds.

Coyote Creek has historically been the focus of many studies though little implementation of recommend practices has resulted from these efforts. Support provided by the ADEQ to the Coyote Creek WIC offers great promise for the realization of these practices as well as the formation of a partnership between producers and state agencies.

Next steps include the prioritization process, final cost analysis for the chosen practices and application for an implementation grant.

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TECHNICAL APPENDICES

Appendix A - Summary Site Visits

Appendix B - Best Management Practice Details

APPENDIX A - SUMMARY OF SITE VISITS

Clifford Johnson
Travis Johnson
Galyn Knight / Daric Knight
Lance Knight
Sidney Maddock
Fred Moore / Daric Knight
Brian Nicoll
Elaine Rogers
John Thompson

Coyote Creek Watershed Improvement and Education Project

Name: Clifford Johnson

Date of Visit: 11/10/2010

Ranch Name: Scraper Knoll Ranch

Email: cliffordjohnson@q.com

Mailing Address:

Phone Number: 602.920.1155

Site Description:
~3.5 miles of Coyote Creek meander through land owned or leased by the Johnson Cattle Company. Grazing is the primary land use on this ~11,120 acre ranch. Vegetation is typical of the lower Coyote Creek Watershed.

This reach of stream contains numerous tall (> 6 feet) vertical banks. The stream banks consist of weak alluvial soils that are easily eroded. The entire stream appears to be adjusting to a downstream change in base level, evident by the headcuts in tributaries and a narrow stream channel with little to no floodplain.

This ranch contains old dikes (>30 years) on Coyote Creek tributaries that are utilized for erosion control. These structures have largely failed due to overtopping or other problems. Several of the dikes have gullies dissecting them; an old sediment detention basin has a severely eroding downstream channel due to an undersized outlet pipe and lack of spillway provisions. Other drainages contain relatively recent headcuts and gullies. Additionally, the rancher is concerned about decreased capacity of a 4 acre pond due to sedimentation. One particular pasture lacks adequate water due to sedimentation of the existing tank within the pasture. Reduced use of this pasture has increased grazing pressure in other pastures.

Ranch Objectives and Resource Concerns:
Mr. Johnson would like to decrease sediment runoff by restoring grasslands via the removal of junipers and replanting with grasses. He would like to address relatively recent head-cutting and gullies with grade control structures and by rehabilitation the failed dikes.

For herd management he would like help developing or rehabilitating a spring which would allow for better grazing rotation which would increase vegetative cover and decrease sediment runoff.

Mr. Johnson would also like to treat the tall vertical banks of Coyote Creek, which are actively eroding and are a significant source of sediment to the stream.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices
- Bank Stabilization
- Rock and Brush Grade Control
- Water Development

Vegetative Practices
- Brush Management
- Range Seeding

Coyote Creek Watershed Improvement and Education Project

Name: Clifford Johnson **Ranch Name:** Scraper Knoll Ranch

Estimated BMP Cost - Bank Stabilization

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Bank Sloping-Seeding-Fabric/Mulch	ft	2500	$65.00	$162,500
			Total Estimated Cost:	$162,500

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Rock and Brush Grade Control Structure	cy	260	$55.00	$14,300
			Total Estimated Cost:	$14,300

Estimated BMP Cost – Water Development

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Spring Development	ea	1	$1,600.00	$1,600
			Total Estimated Cost:	$1,600

Estimated BMP Cost – Brush Management

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Brush Management	ac	2000	$90.00	$180,000
			Total Estimated Cost:	$180,000

Estimated BMP Cost – Range Seeding

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Range Seeding	ac	500	$145.00	$72,500
			Total Estimated Cost:	$72,500

Total: $430,900

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Clifford Johnson	Bank Sloping-Seeding-Fabric/Mulch	$235,950.00	3	1	707,850
Clifford Johnson	Range Management	$126.25	6	3	2,273
Clifford Johnson	Rock and Brush Grade Control x4	$11.92	3	1	36
Clifford Johnson	Water Development (Spring)	$0.80	5	3	12

Site Photos

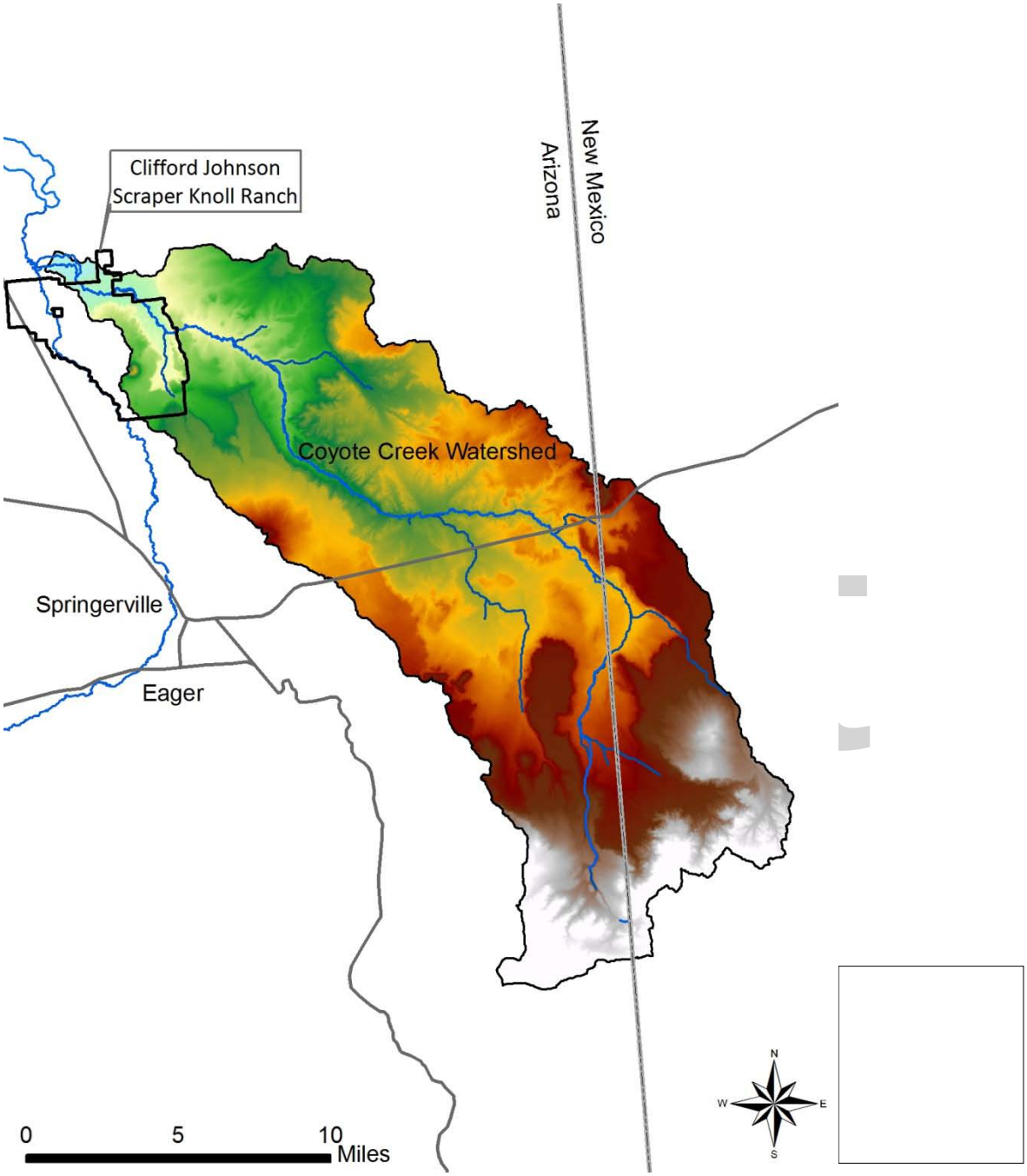
Overview photograph of the Scraper Knoll Ranch, showing a typical dry meander of Coyote Creek with eroding banks and sparse vegetation.

Photograph of an outside meander of Coyote Creek. These eroding vertical banks are a significant source of sediment polluting downstream waters.

Downstream view of a detention basin; the outlet pipe is undersized and causing severe erosion.

Severe gully erosion within the Alfredo pasture of the Scraper Knoll Ranch.

Site Maps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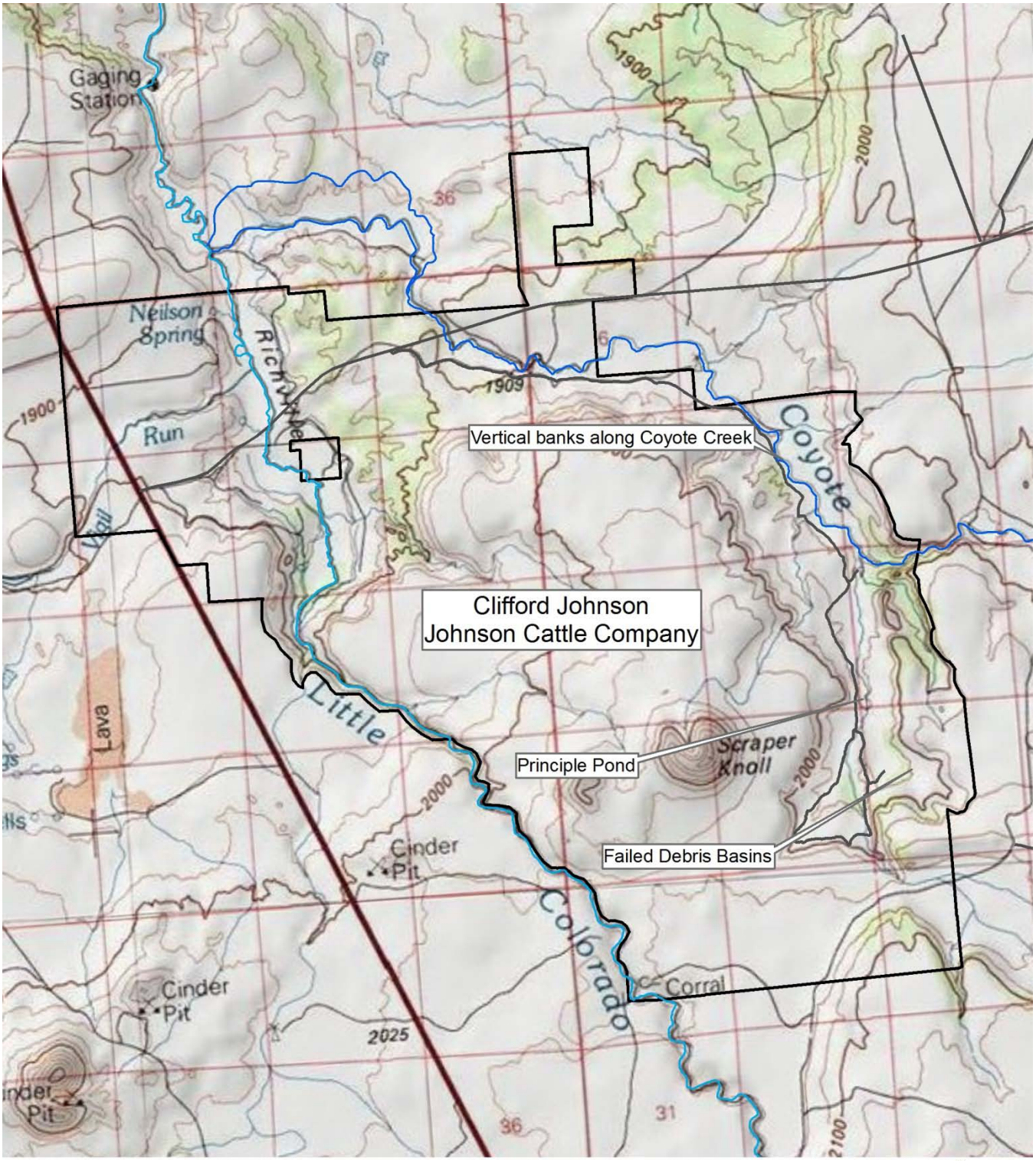
Gaging Station
Neilson Spring
Richville
Run
Vail
Vertical banks along Coyote Creek
Coyote
Clifford Johnson
Johnson Cattle Company
Lava
Little
Principle Pond
Scraper Knoll
Failed Debris Basins
Cinder Pit
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Corral
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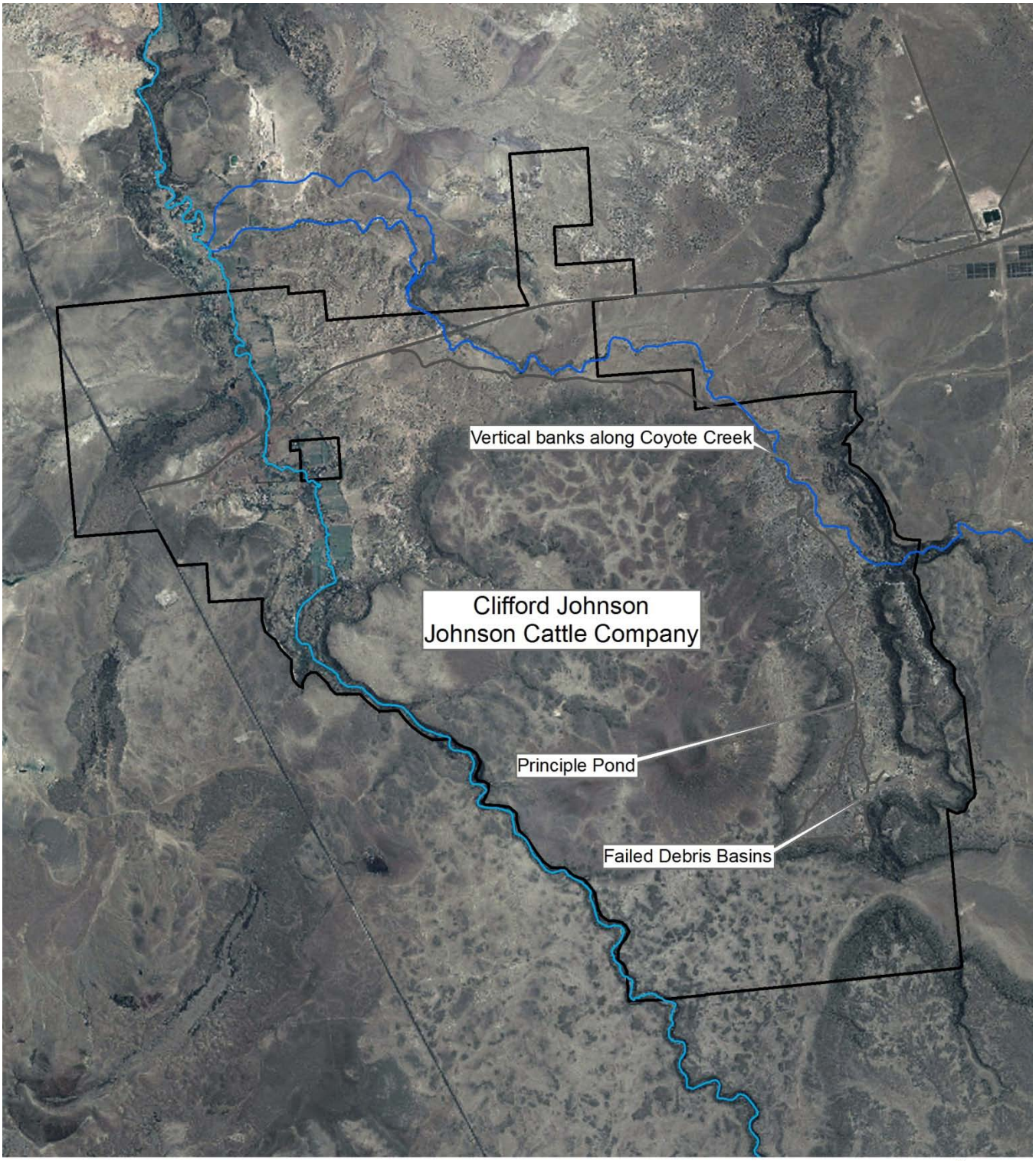
Vertical banks along Coyote Creek
Clifford Johnson
Johnson Cattle Company
Principle Pond
Failed Debris Basins
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Coyote Creek Watershed Improvement and Education Project

Name: Travis Johnson

Date of Visit: 04/14/2011

Ranch Name: Johnson Livestock Inc.

Email: tjohnsonlivestock@yahoo.com

Mailing Address: P.O. Box 1655, St. Johns, AZ 85936

Phone Number: 928.245.3383

Site Description

A portion of this ~35,000 acre ranch is located within the uplands of Coyote Creek. Changes in herd management have led to improvements in vegetative cover and a decrease in gullies and other erosion throughout this portion of the ranch. Many of the active gullies and headcuts have restored and are now covered in grasses and forbs.

Previous conservation practices include sediment basins (dikes) which have been successful at trapping sediment.

Ranch Objectives and Resource Concerns:

A lack of adequate watering sites leads to concentrated grazing and lost opportunities for rotation of stock across the ranch. Existing grazing practices have increased the risk of concentrated runoff and erosion. Development of water lines from existing pumps and stock ponds will enable distribution of livestock across a wider area of the ranch and reduce grazing pressure to improve vegetative cover and reduce soil loss. The combination of sediment basins and stock ponds would be an effective solution for sediment reduction.

Mr. Johnson would like to decrease sediment runoff through the removal of junipers and establishment of grasses. He would like to address headcutting and gullies with a dike and V-mesh spreaders.

Suggested Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices

- Water Development
- Sediment Basin
- Sheet and Rill Erosion Control
- Gully Control Structure

Vegetative Practices

- Brush Management
- Range Seeding

Coyote Creek Watershed Improvement and Education Project

Name: Travis Johnson **Ranch Name:** Johnson Livestock Inc.

Estimated BMP Cost – Water Development

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Pipeline (1 ¼" diameter)	ft	7920	$4.06	$32,155
Trough	gal	1600	$1.34	$2,144
Stock Pond	cu yd	1200	$2.70	$3,240
Stock Pond	cu yd	1200	$2.70	$3,240
			Total Estimated Cost:	$40,779

Estimated BMP Cost – Sediment Basin

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Sediment Basin Rehabilitation	cy	1000	$2.70	$2,700
Sediment Basin	cy	2000	$2.70	$5,400
			Total Estimated Cost:	$8,100

Estimated BMP Cost – Gully Control Structure

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Dike	cu yd	1600	$2.70	$4,320
V-Mesh Spreaders	ft	650	$1.36	$884
			Total Estimated Cost:	$5,204

Estimated BMP Cost – Brush Management

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Brush Management	ac	2560	$66.00	$168,960
			Total Estimated Cost:	$168,960

Estimated BMP Cost – Range Seeding

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Range Seeding	ac	640	$288.00	$184,320
			Total Estimated Cost:	$184,320

Total : $407,363

Coyote Creek Watershed Improvement and Education Project

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Travis Johnson	Brush Management and Seeding	$126.25	6	3	2,273
Travis Johnson	Sediment Basin	$7.41	5	3	111
Travis Johnson	Water Development	$6.62	5	3	99
Travis Johnson	Gully Control Structure	$20.90	6	1	125

Site Photos

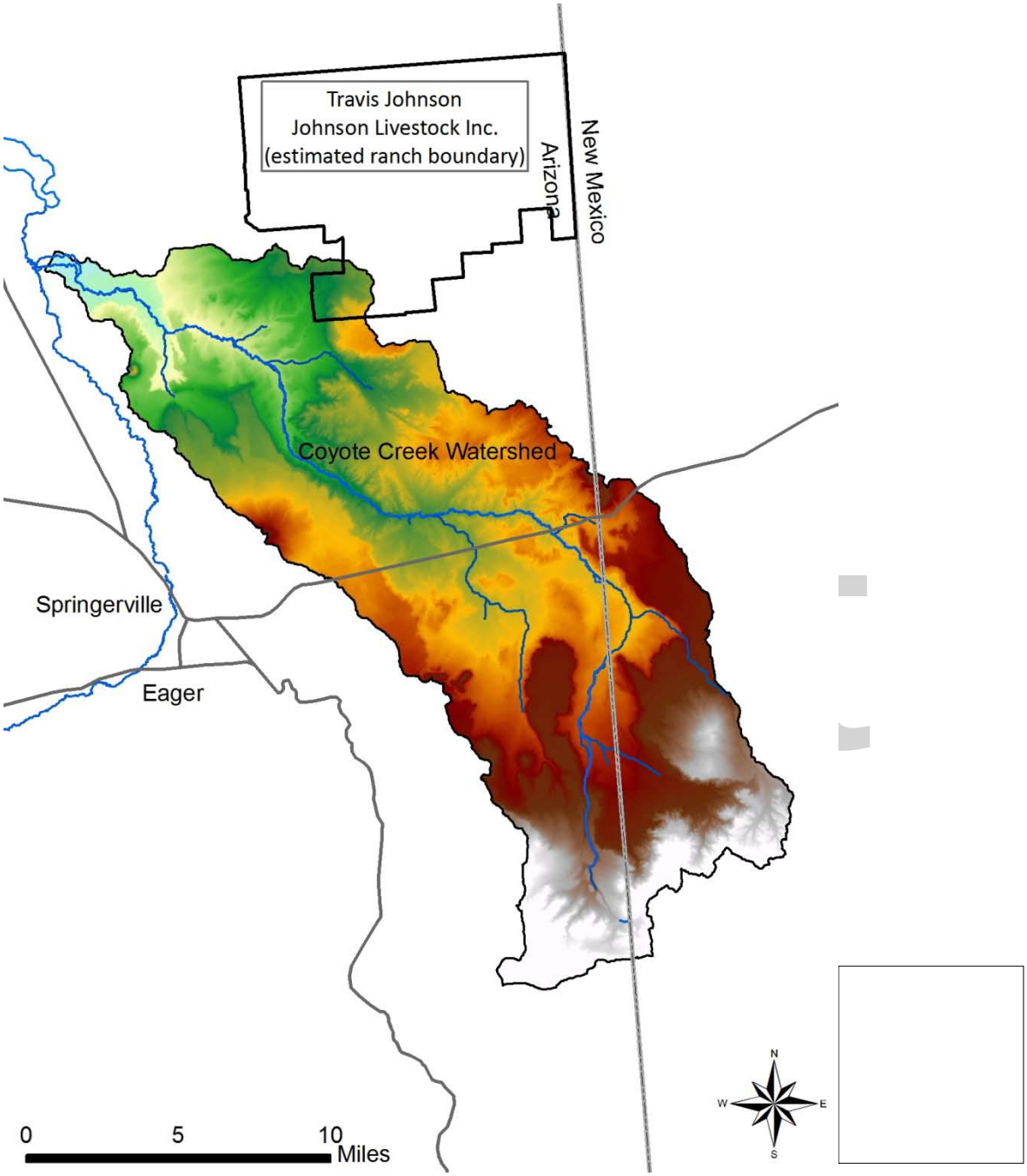
A typical sediment basin found on this ranch. This one in particular has been in service for over 20 years and is still functioning, though it needs some rehabilitation to restore its historic capacity.

View of the area needing brush management and range seeding.

An active gully where Mr. Johnson would like to install a dike and V-mesh spreaders.

Another view of an active gully, and areas in need of brush management and range seeding.

Site Maps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Johnson Livestock Inc.
(estimated ranch boundary)
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New Mexico
Coyote Creek Watershed
Springerville
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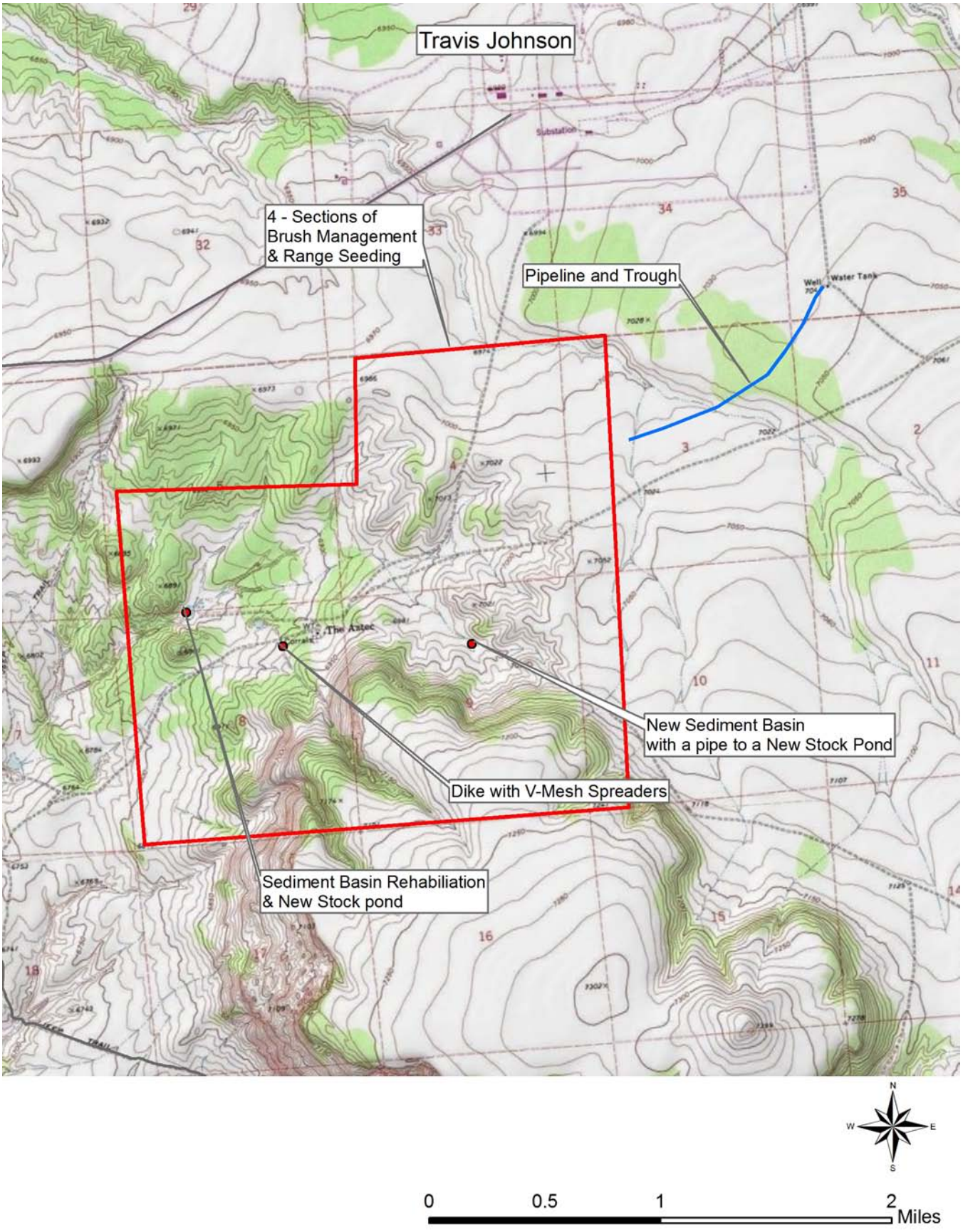
Travis Johnson
4 - Sections of
Brush Management
& Range Seeding
Pipeline and Trough
New Sediment Basin
with a pipe to a New Stock Pond
Dike with V-Mesh Spreaders
Sediment Basin Rehabiliation
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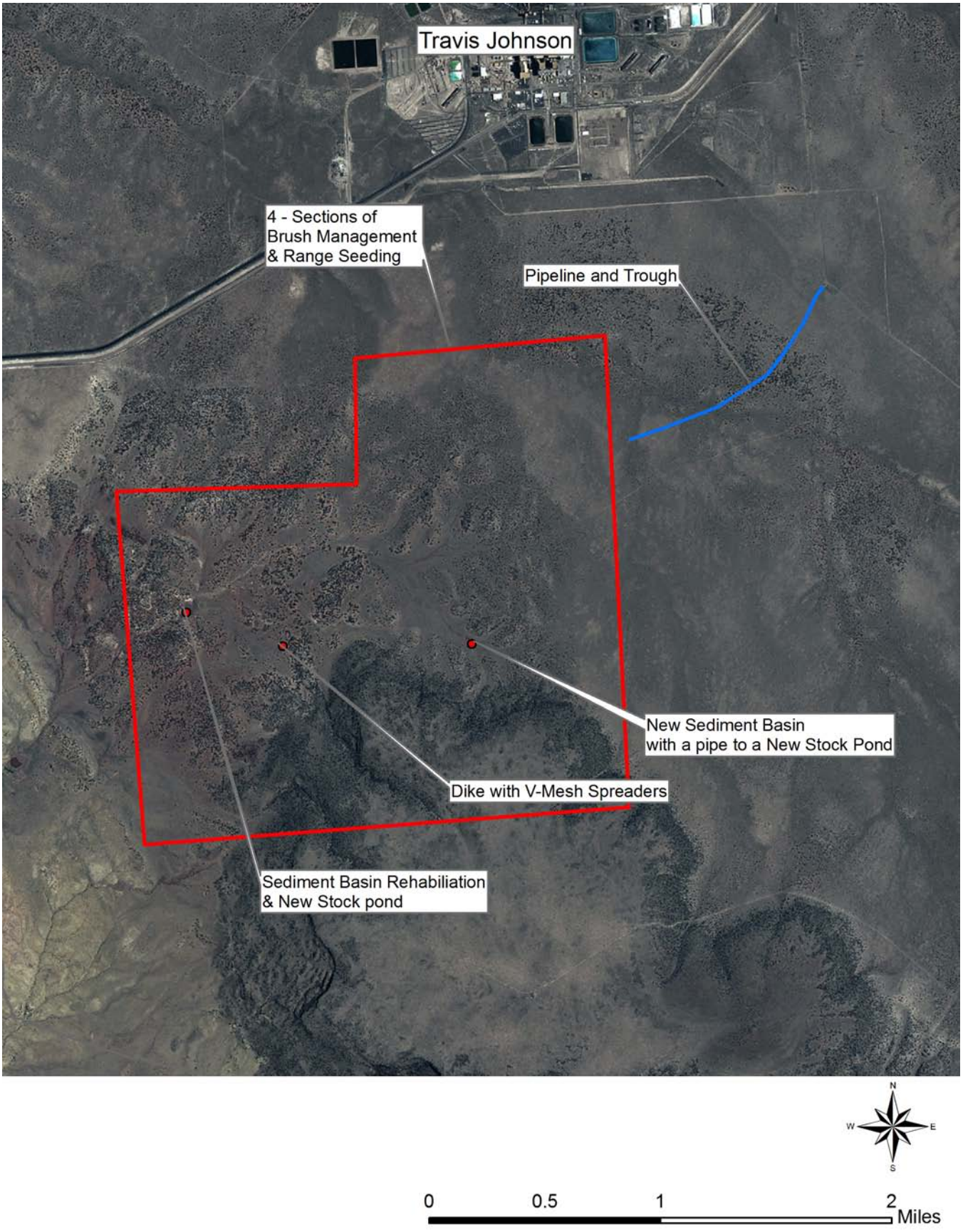
Travis Johnson
4 - Sections of
Brush Management
& Range Seeding
Pipeline and Trough
New Sediment Basin
with a pipe to a New Stock Pond
Dike with V-Mesh Spreaders
Sediment Basin Rehabiliation
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Coyote Creek Watershed Improvement and Education Project

Name: Galyn Knight (Daric Knight)

Date of Visit: 01/27/2010

Ranch Name: Knight Ranch

Email: dknight100@hotmail.com

Mailing Address:

Phone Number: 928.521.9897

Site Description

The Knight Ranch contains ~5.5 miles of Coyote Creek. These reaches of the stream and its tributaries are located in weak alluvial soils that are easily eroded. Grazing is the primary land use on this ~12,965 acre ranch. Vegetation is typical of the lower Coyote Creek watershed.

The entire stream appears to be adjusting to a change in base level, evident by the headcuts in tributaries and the narrow channel with little to no floodplain. Attempts to construct low-water road crossings have had mixed success.

Several pastures lack adequate water due to the failure of wells or the lack a local water source within the pasture. Reduced use of these pastures has increased grazing pressure in other pastures.

Ranch Objectives and Resource Concerns:

The Knights would like to address relatively recent headcutting and gullies with grade control structures. A long-term solution to the eroding banks and stream crossings is desired.

Rehabilitation of a well and addition of a pipeline would allow greater dispersal of grazing that would increase vegetative cover and decrease sediment runoff.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices

- Rock and Brush Grade Control
- Water Development

Coyote Creek Watershed Improvement and Education Project

Name: Galyn Knight (Daric Knight) **Ranch Name:** Knight Ranch

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
"V" Rock Weir	cu yd	45	$55.00	$2,475
Rock and Brush Grade Control Structure	cu yd	500	$55.00	$27,500
			Total Estimated Cost:	$29,975

Estimated BMP Cost – Water Development

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Well Rehabilitation	ft	30	$60.00	$1,800
Pipeline	ft	5800	$3.05	$20,300
Trough	gal	1600	$1.50	$2,400
Well Power Plant - Solar	ea	1	$12,500.00	$12,500
			Total Estimated Cost:	$37,000

Total: $79,475

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Galyn Knight (Daric Knight)	Gully Control Structure ("V" Rock Weir)	$6.35	3	1	19
Galyn Knight (Daric Knight)	Rock and Brush Grade Control x7	$13.10	3	1	39
Galyn Knight (Daric Knight)	Water Development	$17.60	5	5	440
Galyn Knight (Daric Knight)	Water Development	$12.38	5	6	371

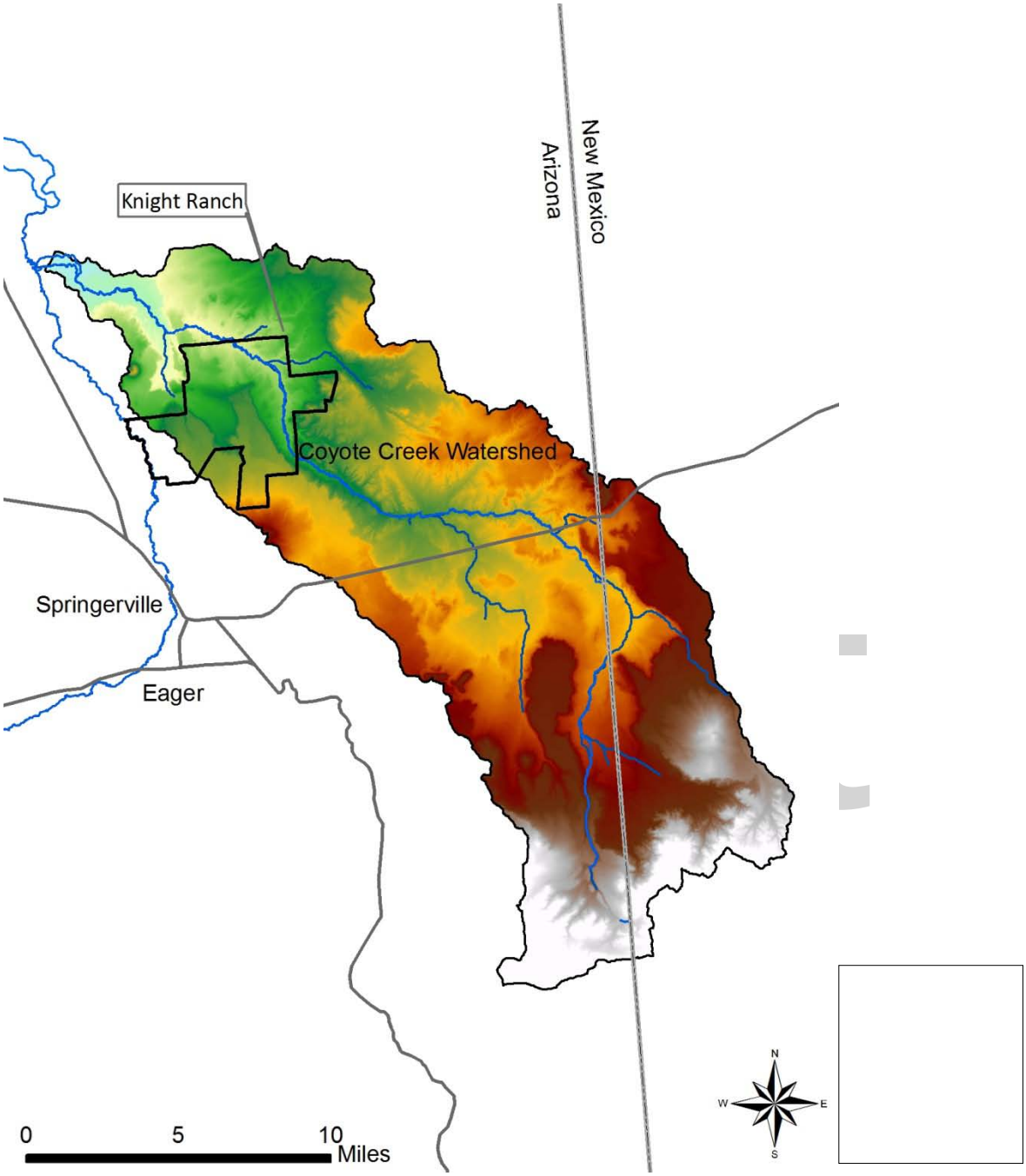
Site Photos

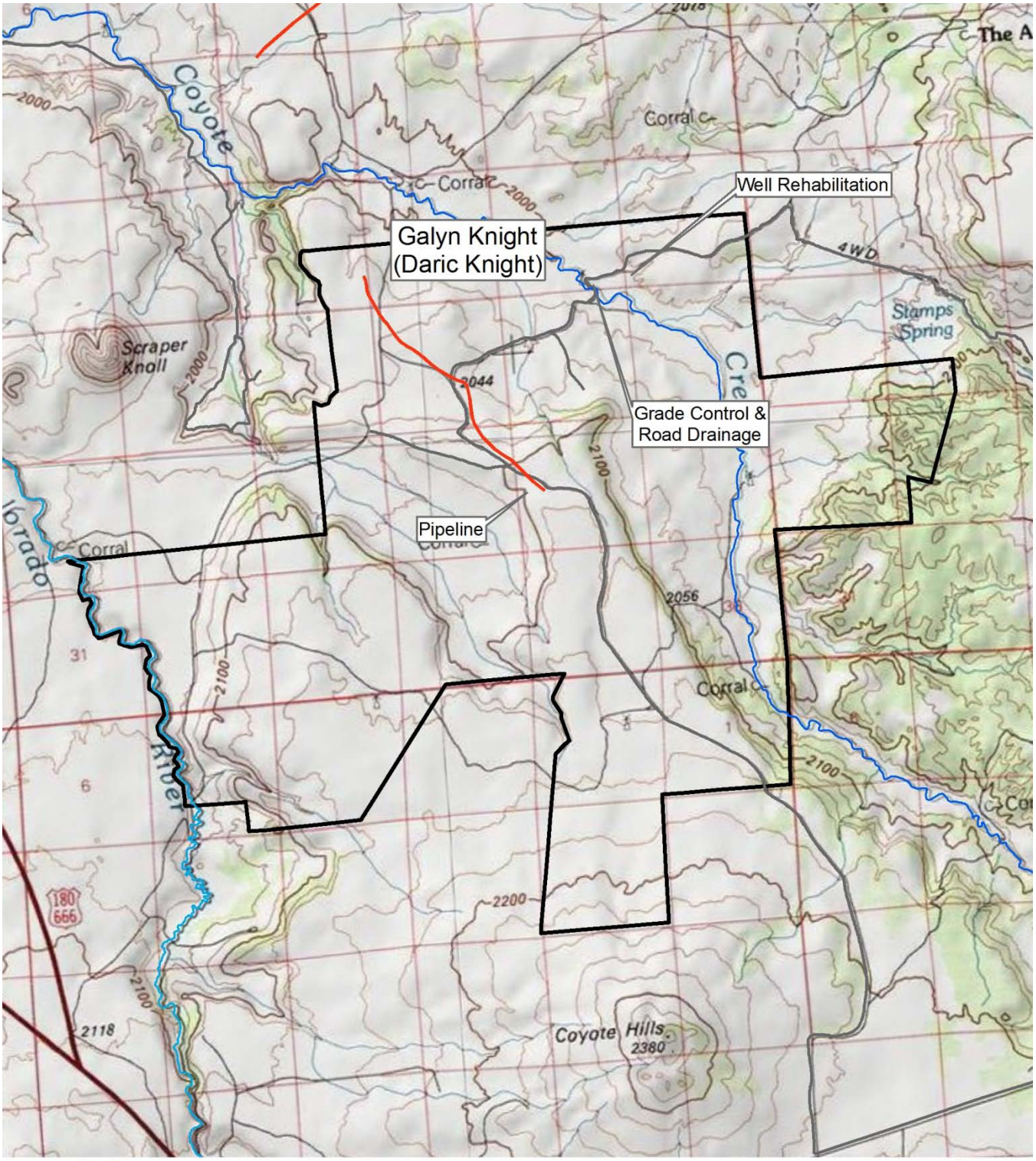
Overview of a portion of the Knight Ranch

View of a failed grade-control structure made of T-posts and tires.

Coyote Creek Watershed Improvement and Education Project

Site Maps




Galyn Knight
(Daric Knight)
Well Rehabilitation
Grade Control &
Road Drainage
Pipeline
Coyote
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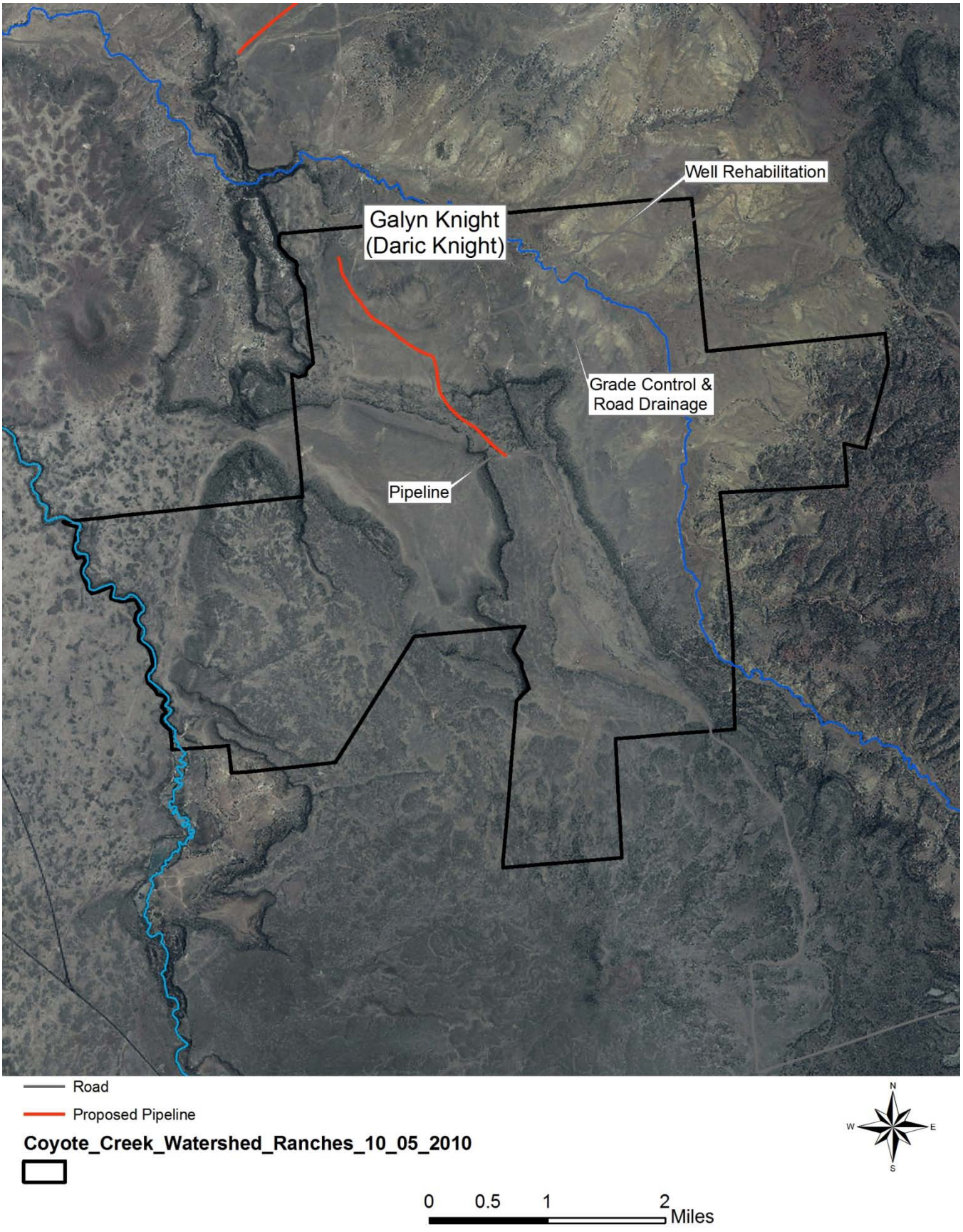
Well Rehabilitation
Galyn Knight
(Daric Knight)
Grade Control &
Road Drainage
Pipeline
Road
Proposed Pipeline
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Coyote Creek Watershed Improvement and Education Project

Name: Lance Knight

Date of Visit: 01/27/2011

Ranch Name: Lance Knight Ranch

Email:

Mailing Address:

Phone Number: 928.521.3353

Site Description

This ~1275 acre ranch is mainly comprised of tributary drainages of Coyote Creek, with ~0.25 miles of Coyote Creek proper, meandering through it. The bulk of the ranch sits atop a mesa above Coyote Creek where there is a high density of Junipers and little water.

Ranch Objectives and Resource Concerns:

Mr. Knight would like to decrease sediment runoff through the removal of juniper trees and establishment of grasses. He would like to address headcutting and gullies with grade control structures.

For herd management he would like help developing a well. This water development would allow for better grazing rotation which would lead to an increase in vegetative cover and decrease sediment runoff.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices

- Water Development
- Rock and Brush Grade Control

Vegetative Practices

- Brush Management
- Range Seeding

Coyote Creek Watershed Improvement and Education Project

Name: Lance Knight **Ranch Name:** Lance Knight Ranch

Estimated BMP Cost – Water Development

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Well Development	ft	200	$60.00	$12,000
Well Power Plant – Solar	ea	1	$12,500.00	$12,500
Pipeline	ft	20	$3.50	$70
Trough	gal	1600	$1.50	$2,400
			Total Estimated Cost:	$26,970

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
"V" Rock Weir	cu yd	80	$55.00	$4,400
			Total Estimated Cost:	$4,400

Estimated BMP Cost – Brush Management

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Brush Management	ac	850	$90.00	$76,500
			Total Estimated Cost:	$76,500

Estimated BMP Cost – Range Seeding

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Range Seeding	ac	213	$145.00	$30,885
			Total Estimated Cost:	$30,885

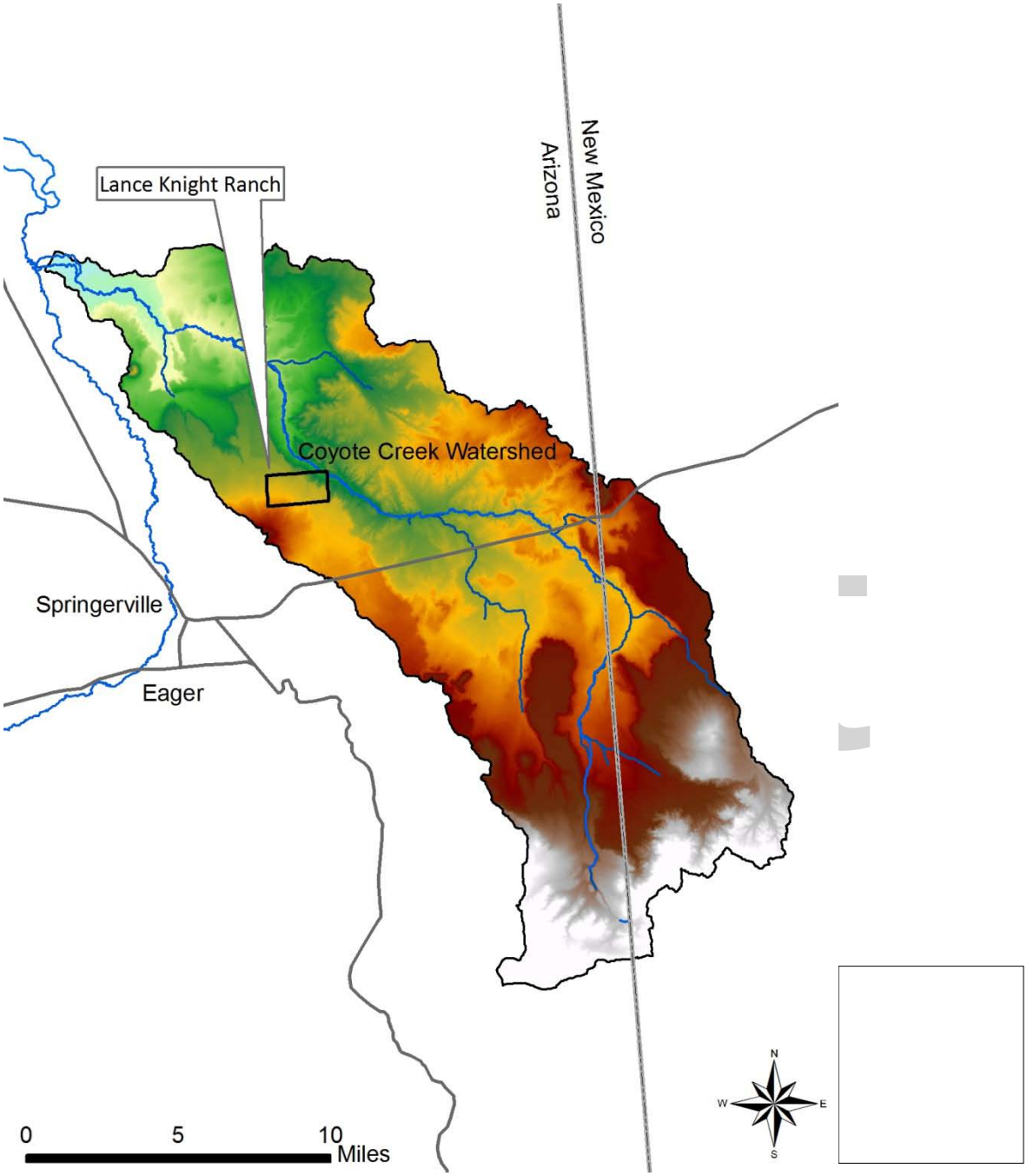
Total: $138,755

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Lance Knight	Brush Management and Seeding	$0.28	6	6	10
Lance Knight	Rock and Brush Grade Control ("V" Rock Weir)	$0.13	3	1	0.4
Lance Knight	Water Development	$13.49	5	6	405

Site Photos

No Photos available

Site Maps


Lance Knight Ranch
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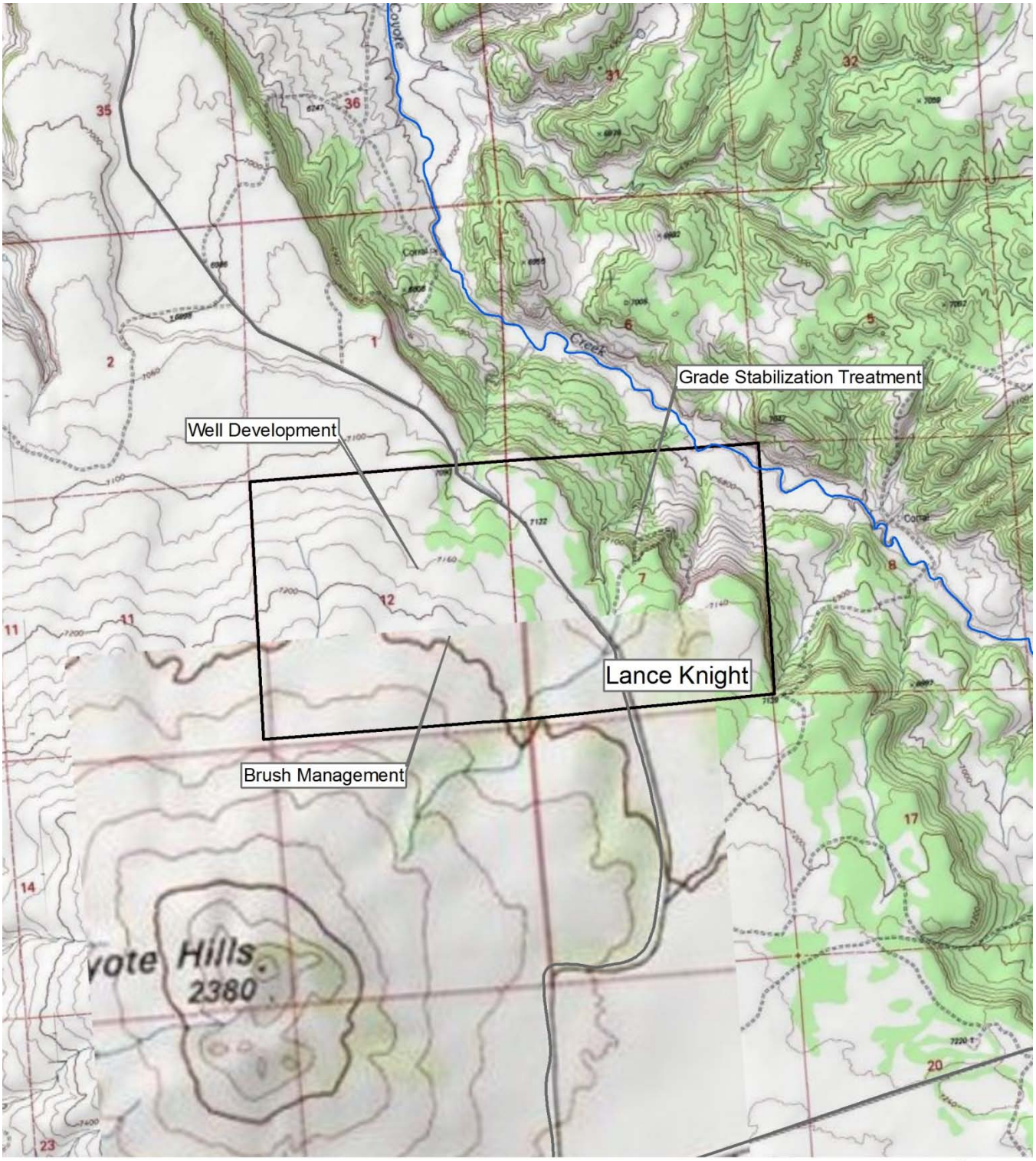
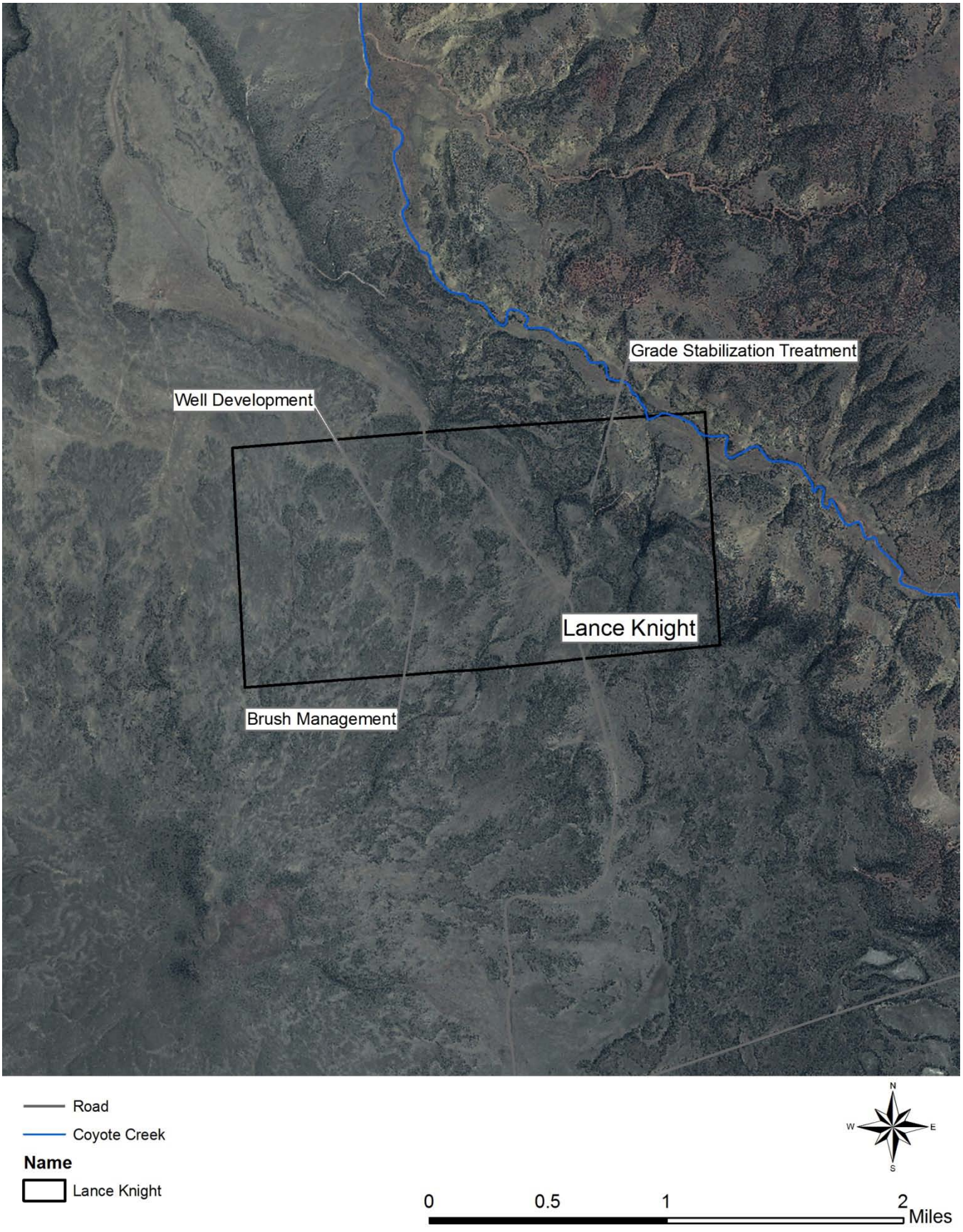
Coyote Creek Watershed Improvement and Education Project




Grade Stabilization Treatment
Well Development
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Coyote Creek Watershed Improvement and Education Project

Name: Fred Moore (Daric Knight)

Date of Visit: 01/27/2011

Ranch Name:

Email: dknight100@hotmail.com

Mailing Address:

Phone Number: 928.521.9897

Site Description

The drainage network across this ranch represents tributaries of Coyote Creek. Historically conservation work on this ranch has included water and sediment control basins (WASCOBs) and Sediment Detention basins to trap sediment and arrest channel incision. Head-cutting and rill erosion continue to be active.

There are breeched sediment/debris basins; it is unclear whether its rehabilitation is an effective solution both with regard to cost and benefit. One sediment basin located in the north-central portion of the ranch does show promise for rehabilitation.

Grazing is the primary land use on this ~3,370 acre ranch.

Ranch Objectives and Resource Concerns:

There are several breached or nearly breached sediment basins and WASCOBs on this ranch. Rehabilitation of the sediment basins would restore the historic capacity and function could be an effective solution for sediment reduction. The design standard for a WASCOB states that they must be built on watersheds with less than 1 square mile of drainage area. Many of these WASCOBs exceed this standard and rehabilitation is not recommended.

Mr. Moore would like to address relatively recent head-cutting and gullies with grade/gully control structures.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices

- Rock and Brush Grade Control
- Sediment Basin

Name: Fred Moore (Daric Knight) **Ranch Name:**

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Rock and Brush Grade Control Structure	cu yd	260	$55.00	$14,300
			Total Estimated Cost:	$14,300

Estimated BMP Cost – Sediment Basin

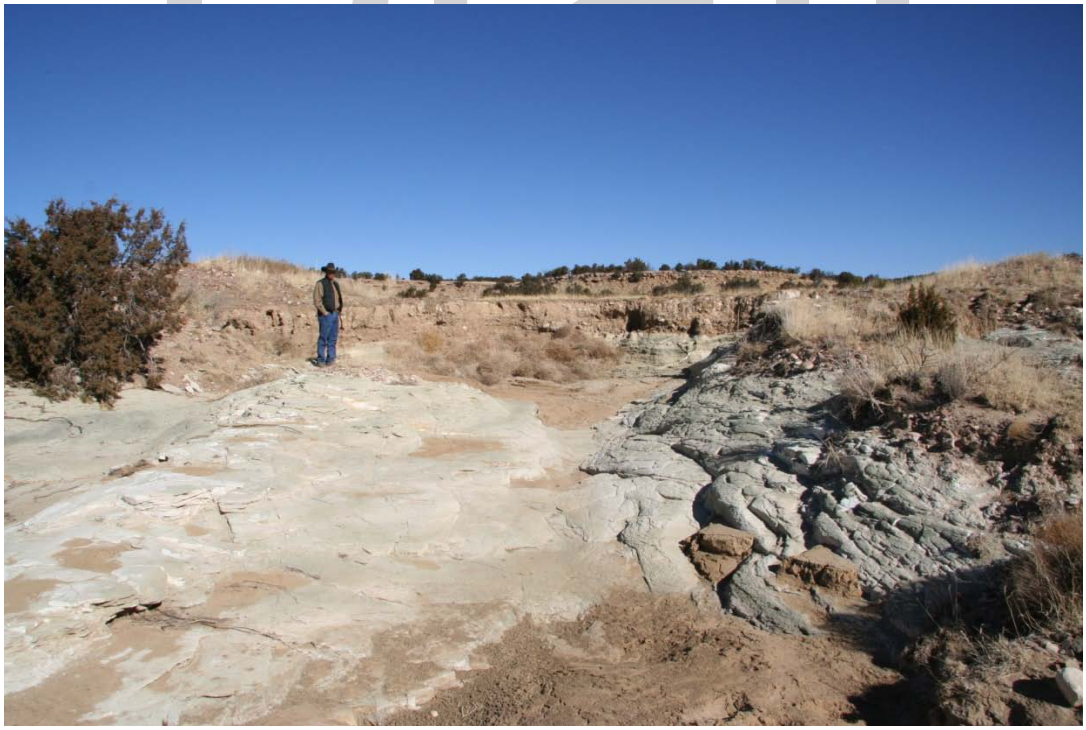
Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Sediment Basin Rehabilitation	cu yd	2,400	$4.00	$9,600
			Total Estimated Cost:	$9,600

Total: $23,900

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Fred Moore (Daric Knight)	Rock and Brush Grade Control x4	$11.92	3	1	36
Fred Moore (Daric Knight)	Sediment Basin	$5.05	5	3	76

Site Photos

Shows actively eroding headcuts.

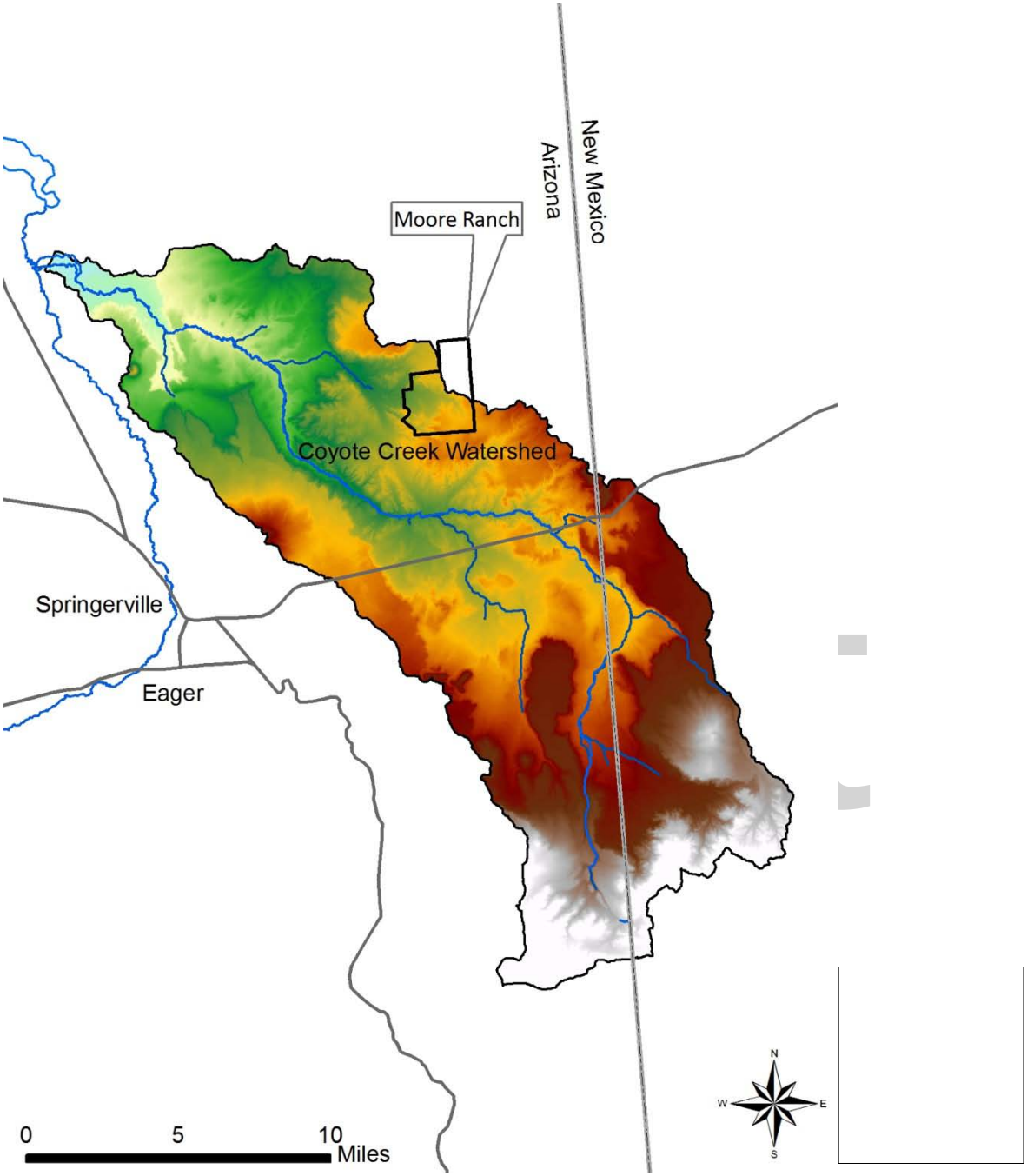


Shows an area of an actively eroding headcut.

Shows another actively eroding headcut.

Shows a failed WASCOB that has reached the end of its service life and is potentially built in a location that has too large of a contributing watershed.

Site Maps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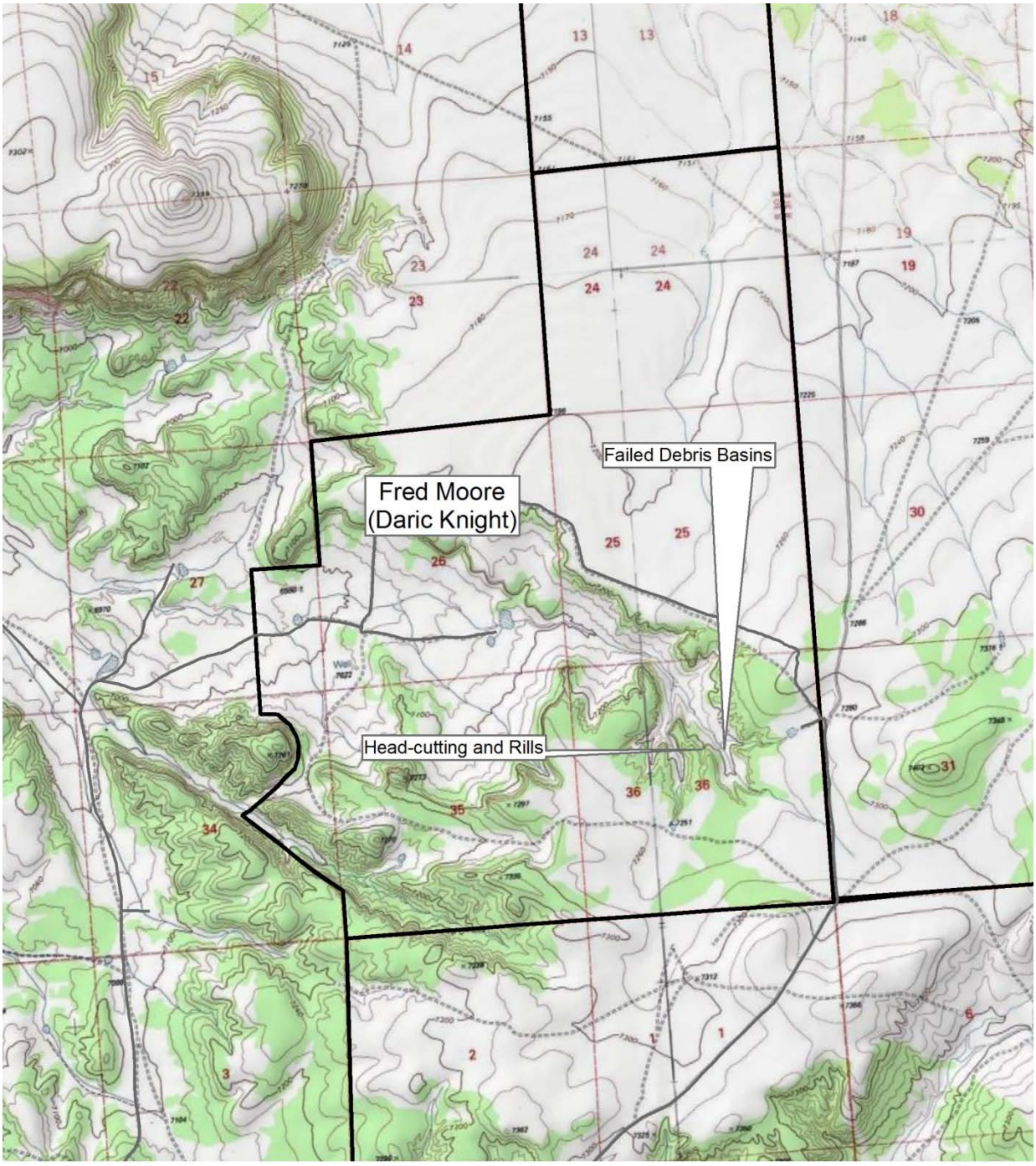
Failed Debris Basins
Fred Moore
(Daric Knight)
Head-cutting and Rills
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Coyote Creek Watershed Improvement and Education Project

Name: Brian Nicoll

Date of Visit: 02/04/2011

Ranch Name: Coyote Creek Ranch

Email: bnicoll01@msn.com

Mailing Address:

Phone Number: 928.245.7353

Site Description:
About 2.2 miles of Coyote Creek meanders through the southeast corner of this ranch; however, approximately half of the ranch drains to the north and directly into the Little Colorado River. The Ranch has extensive groundwater development as part of the Tucson Electric Power operations. These wells can be utilized for ranch management activities. Grazing is the primary land use on this ~18,470 acre ranch. Vegetation cover is typical of the lower Coyote Creek watershed.

Brian Nicoll recently purchased this ranch from Mike Udall. Mr. Udall historically participated in NRCS conservation programs and implemented many conservation practices related to vegetation and stabilization treatments (water bars, water spreaders and revegetation along water courses), as well as grazing management practices aimed at decreasing erosion. These practices are intact and maintained by the new owner and have been effective at reducing erosion from specific areas; however, additional areas need protection.

Headcutting and gully erosion are present on steeper slopes and along reaches of Coyote Creek.

Ranch Objectives and Resource Concerns:
Lack of adequate watering sites has led to concentrated grazing and lost opportunities for rotation of stock across the ranch. Existing grazing practices have increased the risk of concentrated runoff and erosion. Development of water lines from existing pumps and additional fencing will enable distribution of livestock across a wider area of the ranch and reduce grazing pressure to improve vegetative cover and decrease soil loss.

Headcuts and gully erosion are also concerns that could be addressed through grade stabilization treatments. Grade stabilization is required on a wide range of watershed sizes both along the banks of Coyote Creek and along hillslopes.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices
- Water Development
- Rock and Brush Grade Control

Vegetative Practices
- Fencing

Name: Brian Nicoll **Ranch Name:** Coyote Creek Ranch

Estimated BMP Cost – Water Development

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Pipeline (High Density PE 1 1/4" dia)	ft	6805	$3.50	$23,818
Watering Facility (Trough - Pre Fabricated)	gal	1600	$1.50	$2,400
Pipeline (High Density PE 1 1/4" dia)	ft	6805	$3.50	$23,818
Watering Facility (Trough - Pre Fabricated)	gal	1600	$1.50	$2,400
			Total Estimated Cost:	$52,436

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Rock and Brush Grade Control Structure	cu yd	65	$55.00	$3,575
			Total Estimated Cost:	$3,575

Estimated BMP Cost - Fencing

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Standard 4-Strand Barbed Wire	ft	15,840	$4.00	$63,360
			Total Estimated Cost:	$63,360

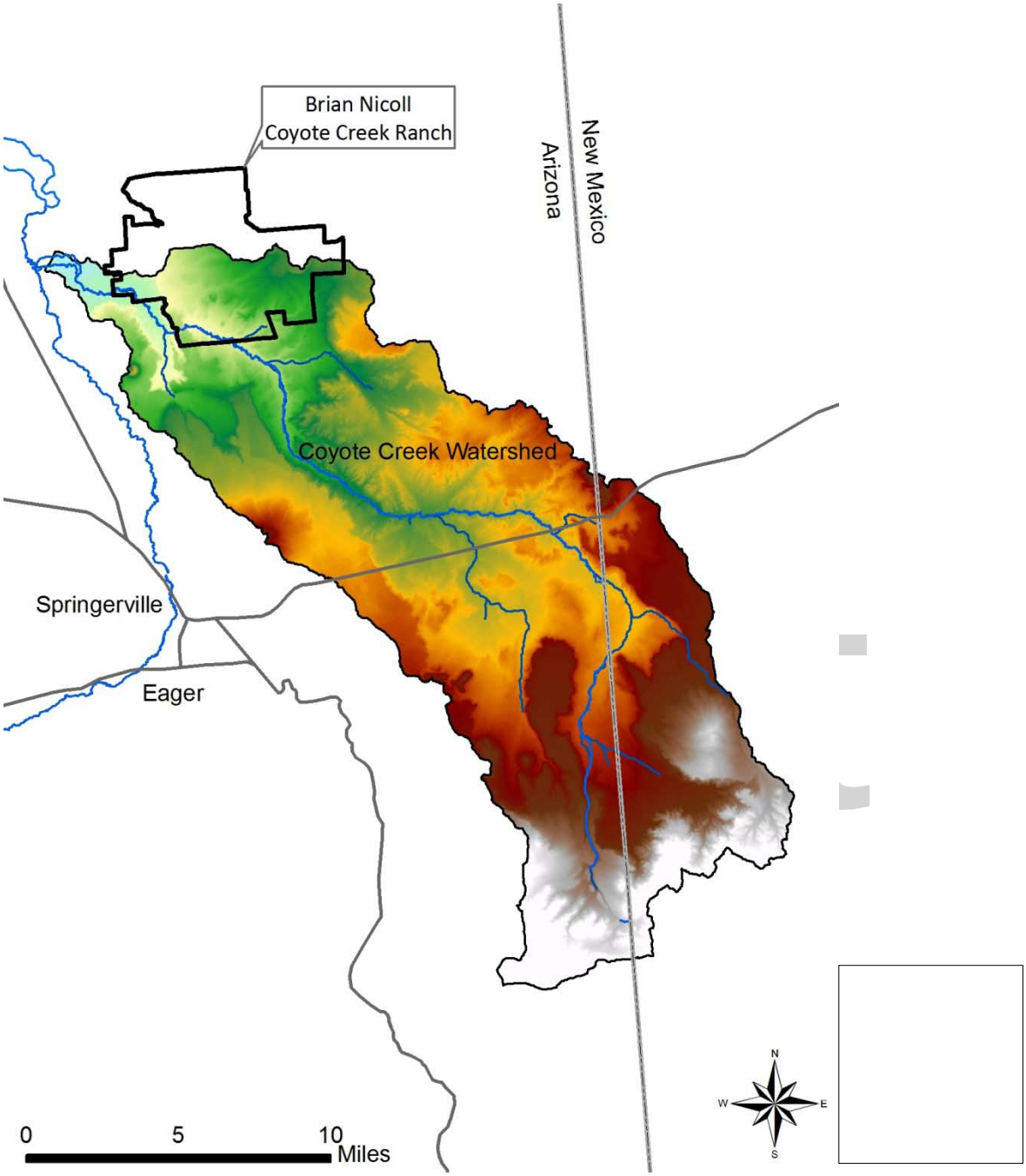
Total: $119,370

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Brian Nicoll	Fencing	$35.20	3	5	528
Brian Nicoll	Rock and Brush Grade Control	$10.83	3	4	130
Brian Nicoll	Water Development	$13.11	5	5	328

Site Photos

Not Available

Site Maps


Brian Nicoll
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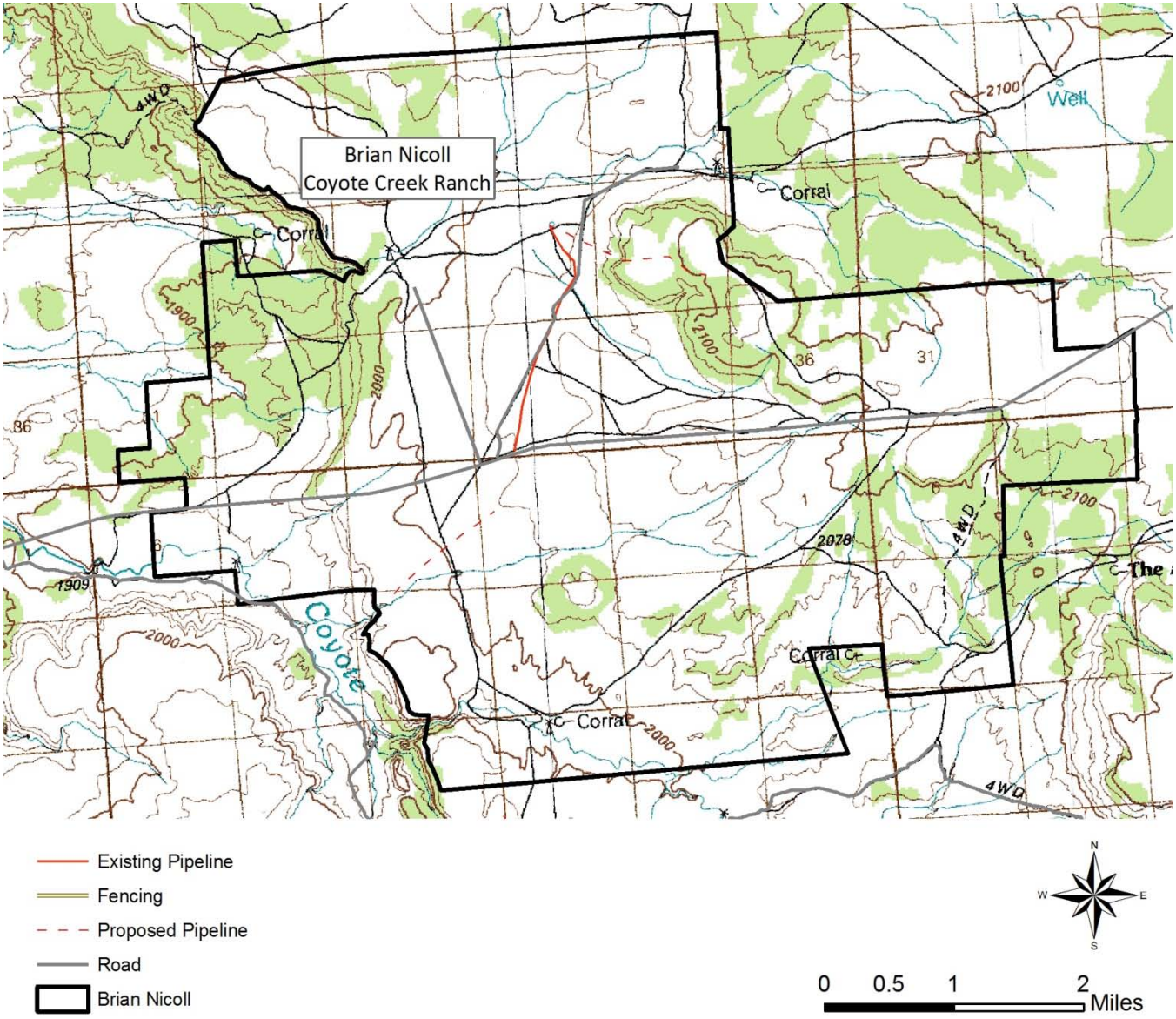
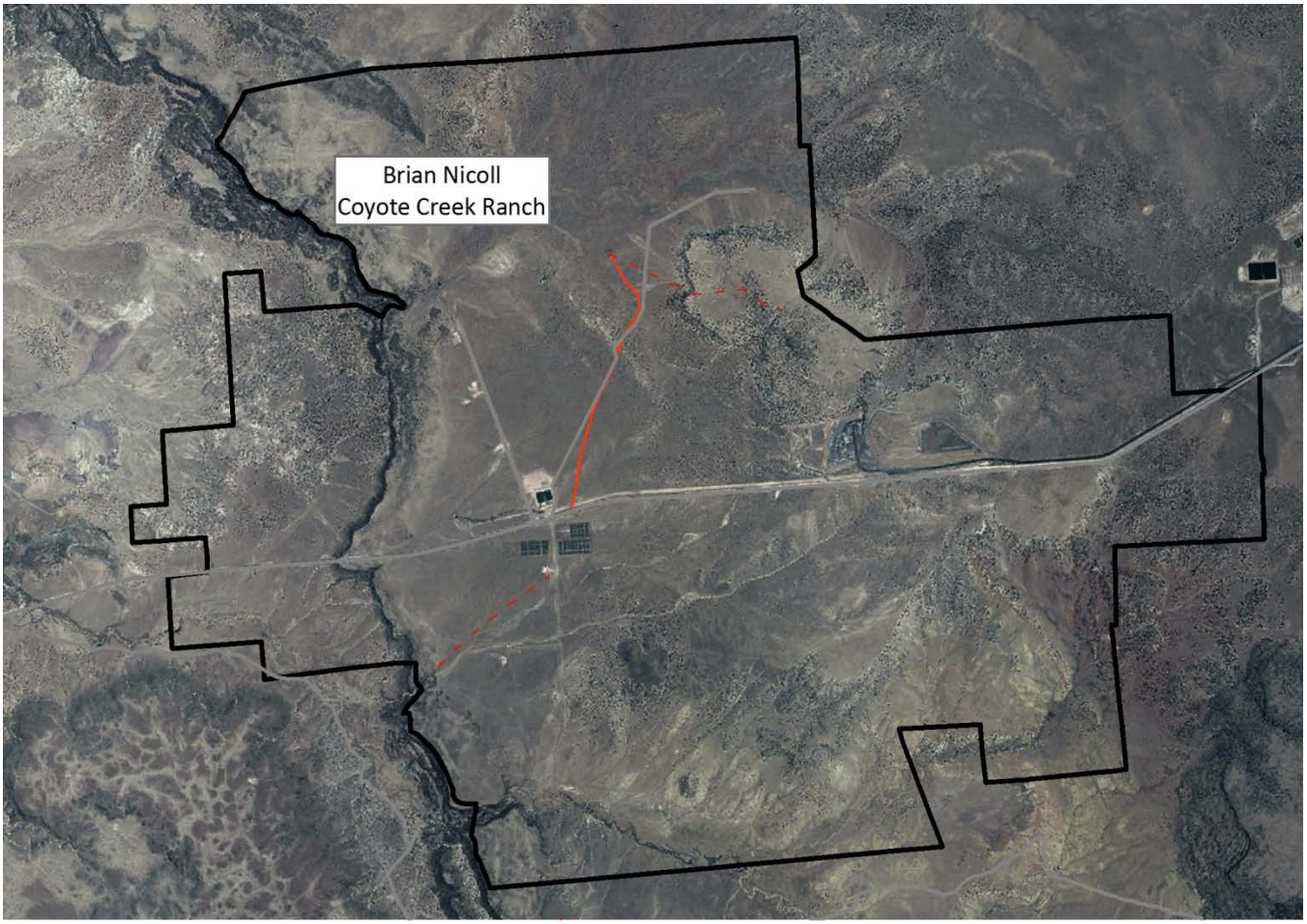
Coyote Creek Watershed Improvement and Education Project




Brian Nicoll
Coyote Creek Ranch
Existing Pipeline
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Coyote Creek Watershed Improvement and Education Project

Name: Elaine Rogers

Date of Visit: 01/19/2011 & 04/13/2011

Ranch Name: Rogers Ranch

Email: elainer.64@gmail.com

Mailing Address: Po Box 1640, Springerville, AZ 85938

Phone Number: 928.245.1572

Site Description

This ranch contains ~4.3 miles of Coyote Creek. These reaches of the stream contain tall (> 6 feet), vertical banks which consist of weak alluvial soils that are easily eroded. The entire stream appears to be adjusting to a change in base level, evident by the headcuts in tributaries and a narrow stream channel with little to no floodplain. Base level change is likely stabilized upstream of a major grade control structure, but the channel and tributary morphology is still adjusting.

A concrete sill has been in place for over 30 years and has effectively controlled the local gradient of Coyote Creek just downstream of a main road used to access several ranches. Lateral movement of Coyote Creek threatens to flank this grade control structure.

Grazing is the primary land use on this ~40,650 acre ranch. Vegetation is typical of the lower Coyote Creek watershed.

Ranch Objectives and Resource Concerns:

Ms. Rogers is concerned that the recent lateral migration of Coyote Creek could flank the Grade-Control Sill, causing the structure to fail. Failure of the structure would lead to incision and headward migration of a large head-cut. This would increase the sediment loading of Coyote Creek from main channel substrate and from tributaries as the base level change migrates throughout the drainage network. There has been a campaign to remove tamarisk (salt cedar) from the channel in an attempt to restore its historic capacity. Further tamarisk removal and bank stabilization would advance these efforts and decrease the production of sediment from streambanks.

Becker Draw has partially adjusted to the base level change and would benefit from bank stabilization to decrease the production of sediment from its banks.

Ms. Rogers would also like to treat a large gully migrating out of Coyote Creek, which is actively eroding and a significant source of sediment to the stream. Other places of active erosion are roads which need water bars to decrease erosion and spread out the water.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices

- Bank Stabilization (Near grade-control sill)
- Bank Stabilization (Becker Draw)
- Bank Stabilization (Coyote Creek)
- Rock and Brush Grade Control
- Road Stabilization

Coyote Creek Watershed Improvement and Education Project

Name: Elaine Rogers **Ranch Name:** Rogers Ranch

Estimated BMP Cost – Bank Stabilization (Near grade-control sill)

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Bank Sloping-Seeding-Fabric/Mulch	ft	100	$65.00	$6,500
			Total Estimated Cost:	$6,500

Estimated BMP Cost – Bank Stabilization (Becker Draw)

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Bank Sloping-Seeding-Fabric/Mulch	ft	470	$65.00	$30,550
			Total Estimated Cost:	$30,550

Estimated BMP Cost – Bank Stabilization (Coyote Creek)

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Bank Sloping-Seeding-Fabric/Mulch	ft	545	$65.00	$35,425
			Total Estimated Cost:	$35,425

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Rock and Brush Grade Control Structure	cy	65	$55.00	$3,575
			Total Estimated Cost:	$3,575

Estimated BMP Cost – Road Stabilization

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Water Bars	ea	9	$135.00	$1,215
			Total Estimated Cost:	$1,215

Total: $77,265

Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Elaine Rogers	Bank Sloping-Seeding-Fabric/Mulch	$235,950.00	3	1	707,850
Elaine Rogers	Rock and Brush Grade Control	$1,191.67	3	1	3,575
Elaine Rogers	Road Stabilization	$588,060.00	6	4	14,113,440

Site Photos

Grade-control sill has effectively controlled the course of Coyote Creek and maintained the local grade.

Vertical banks of Coyote Creek, downstream of the grade-control sill. The grade-control sill has been constructed upon the natural bedrock rock seen in the foreground.

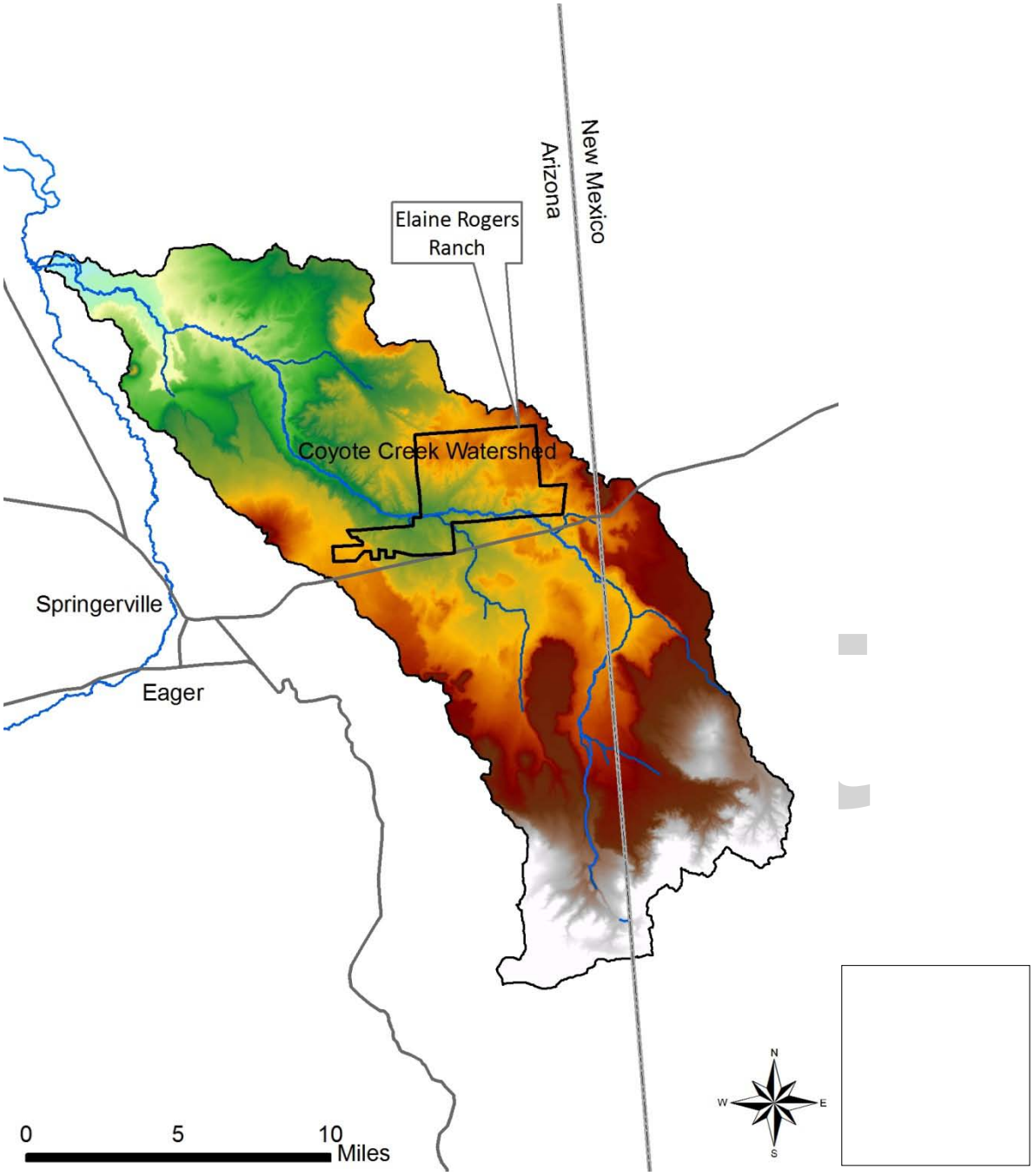
Gully migrating out of Coyote Creek with unsuccessful mitigation in the form of brush.

This reach of Coyote Creek has undergone tamarisk removal in an attempt to restore the hydraulic capacity of the channel.

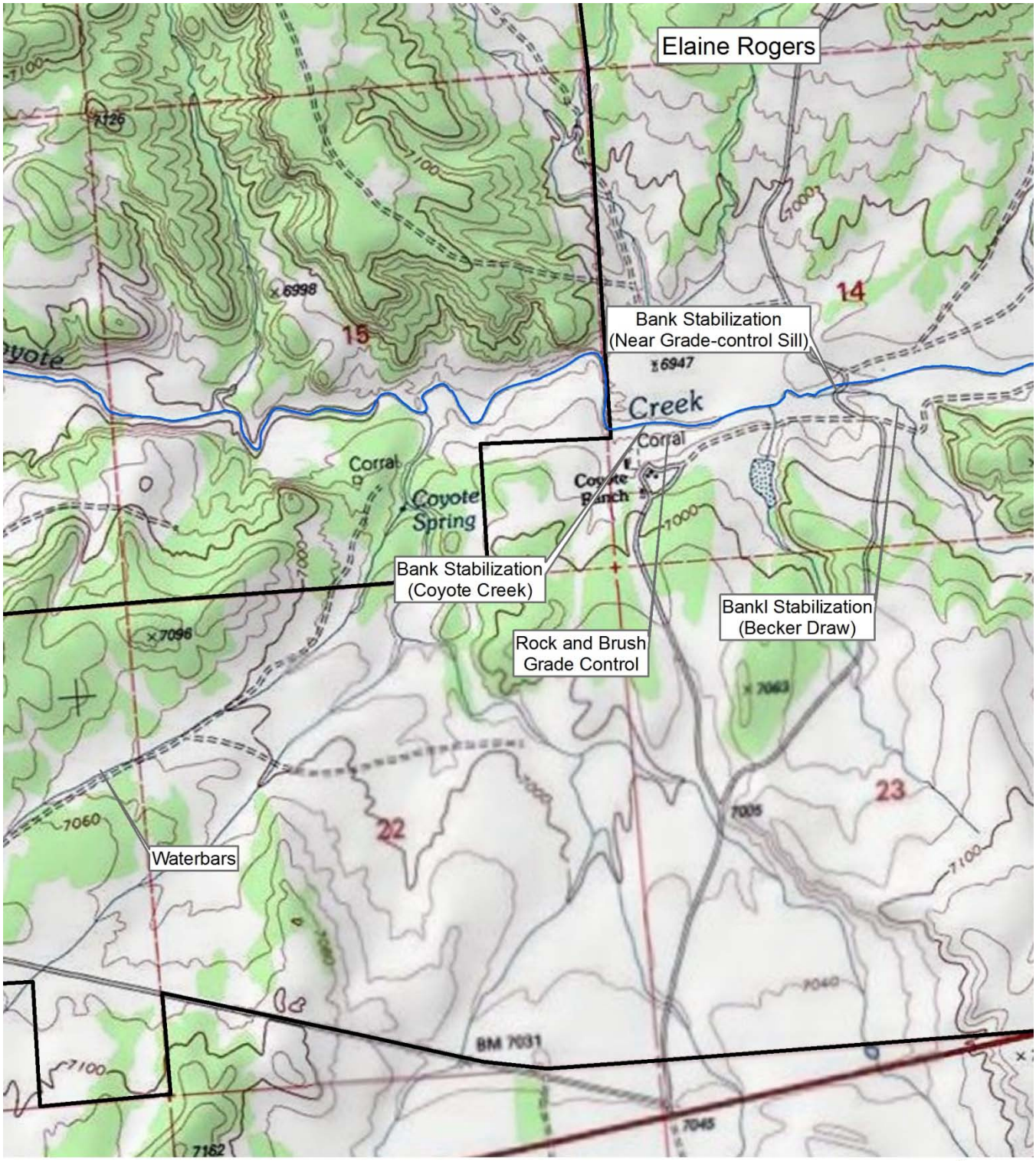
The lower reach of Becker Draw is actively eroding. This reach is evolving toward a stable condition and is a good candidate for bank stabilization.

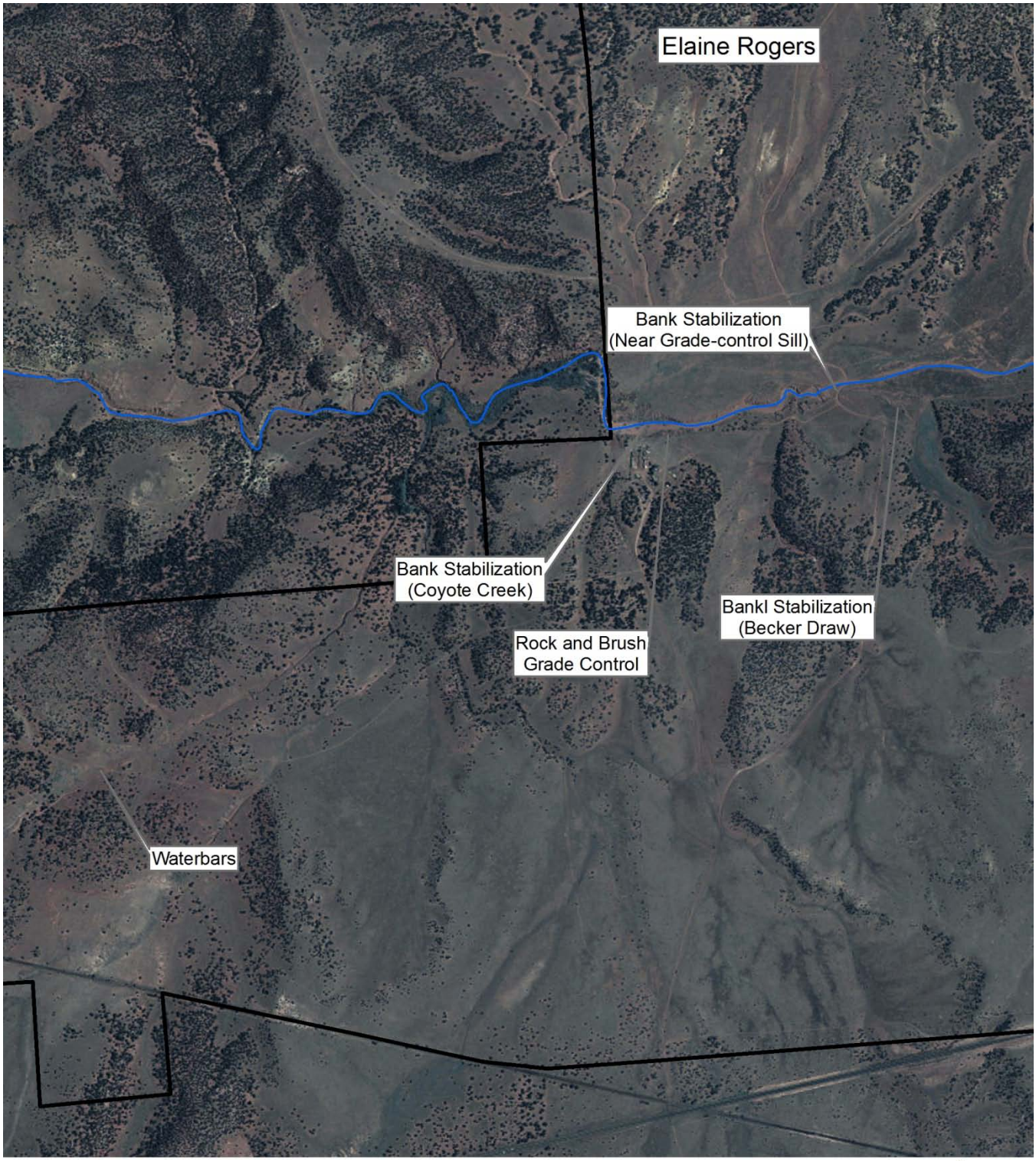
Coyote Creek Watershed Improvement and Education Project

Site Maps



Coyote Creek Watershed Improvement and Education Project




Elaine Rogers
Bank Stabilization
(Near Grade-control Sill)
Bank Stabilization
(Coyote Creek)
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Rock and Brush
Grade Control
Waterbars
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Coyote Creek Watershed Improvement and Education Project

Name: Sidney Maddock

Date of Visit: 01/06/2011

Ranch Name: The Maddock Ranch

Email: sporandomcattle@hotmail.com

Mailing Address:

Phone Number: 602.686.1590

Site Description

This ranch contains ~5.8 miles of Coyote Creek. Grazing is the primary land use on this ~20,400 acre ranch. Historically, conservation work on this ranch has included sediment/debris basins that are currently silted in or are in danger of being flanked. As these structures fail, base level changes in Coyote Creek may lead to channel incision in both the stream and its tributaries.

Road drainage and stream crossings are associated with numerous gullies and headcuts.

Brush management is being undertaken by the USFWS on portions of this ranch.

Ranch Objectives and Resource Concerns:

There are several breeched, or nearly breeched, sediment basins and water and sediment control basins (WASCOB) on this ranch. Rehabilitation of the sediment basins, which would restore the historic capacity and function, could be an effective solution for sediment reduction. The design standard for a WASCOB states that they must be built on watersheds with less than 1 square mile of drainage area. Many of these WASCOBs exceed this standard and rehabilitation is not recommended.

For herd management, Ms. Maddock would like help developing a spring to allow better grazing rotation which would increase vegetative cover and decrease sediment runoff.

The road network on this ranch is paralleled by gullies and headcuts. The installation of waterbars would reduce erosion and thus the amount of sediment reaching downstream waters. Grade stabilization of actively incising channels through the use of rock and brush structures could reduce the amount of sediment reaching the downstream waters by reduce.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices

- Road Stabilization
- Rock and Brush Grade Control
- Water Development

Coyote Creek Watershed Improvement and Education Project

Name: Sidney Maddock **Ranch Name:** The Maddock Ranch

Estimated BMP Cost - Road Stabilization

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Road Water Bars	ft	16	$135.00	$2,160
			Total Estimated Cost:	$2,160

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Sediment Basin Rehabilitation	cu yd	2500	$4.00	$10,000
"V" Rock Weir	cu yd	90	$55.00	$4,950
			Total Estimated Cost:	$14,950

Estimated BMP Cost - Water Development

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Spring	ea	1	$1,600.00	$1,600
Pipeline	ft	45	$3.50	$158
Trough	gal	1600	$1.5	$2,400
			Total Estimated Cost:	$4,158

Total: $58,268

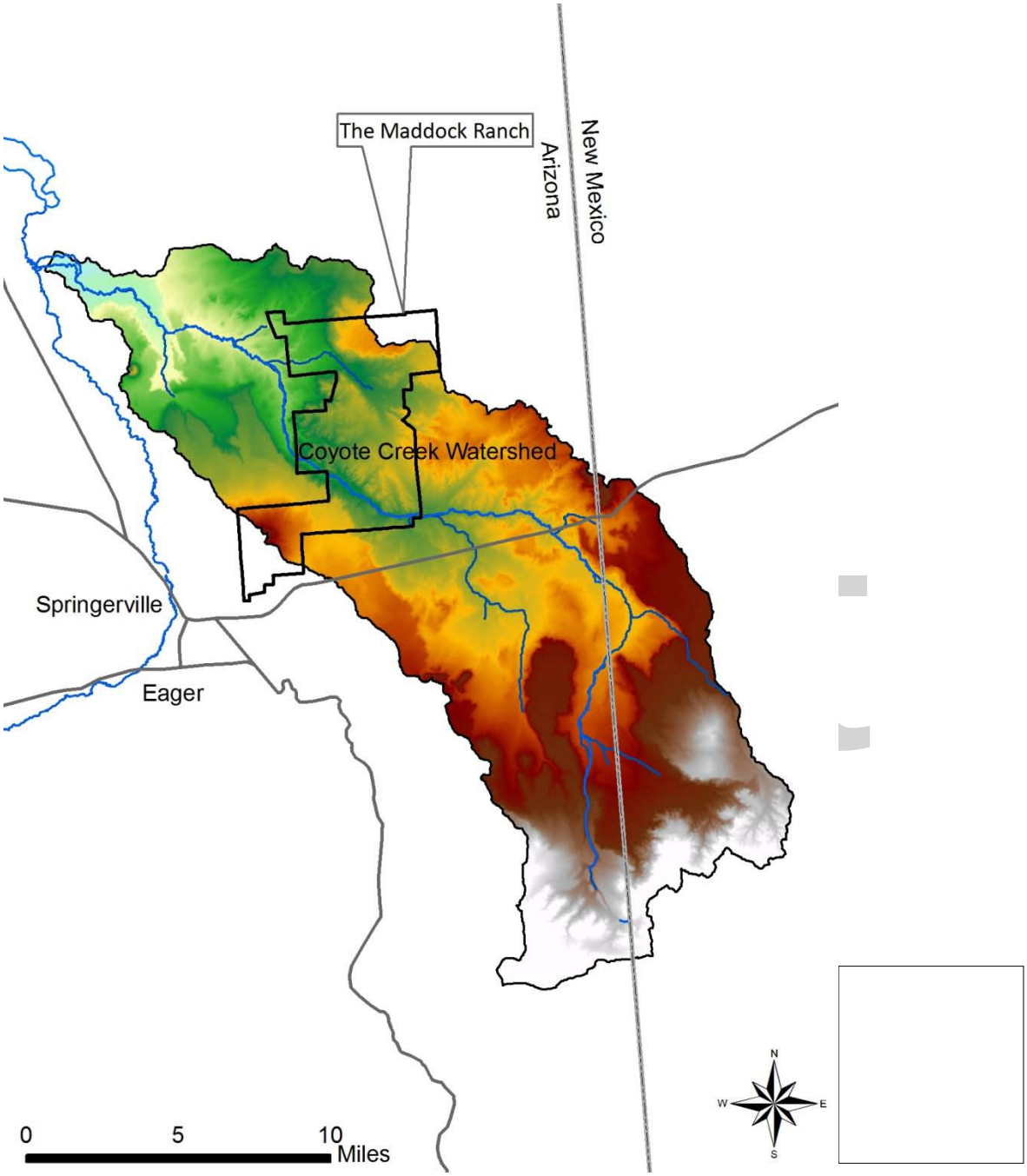
Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
Sidney Maddock	Rock and Brush Grade Control ("V" Rock Weir)	$4.14	3	1	12
Sidney Maddock	Sediment Basin	$14.66	5	3	220
Sidney Maddock	Road Stabilization	$2,273.68	6	3	40,926
Sidney Maddock	Water Development	$2.00	5	3	30

Site Photos

A failing grade-control structure at a road crossing on a tributary to Coyote Creek.

A typical road on this ranch with an actively eroding parallel gully.

Site Maps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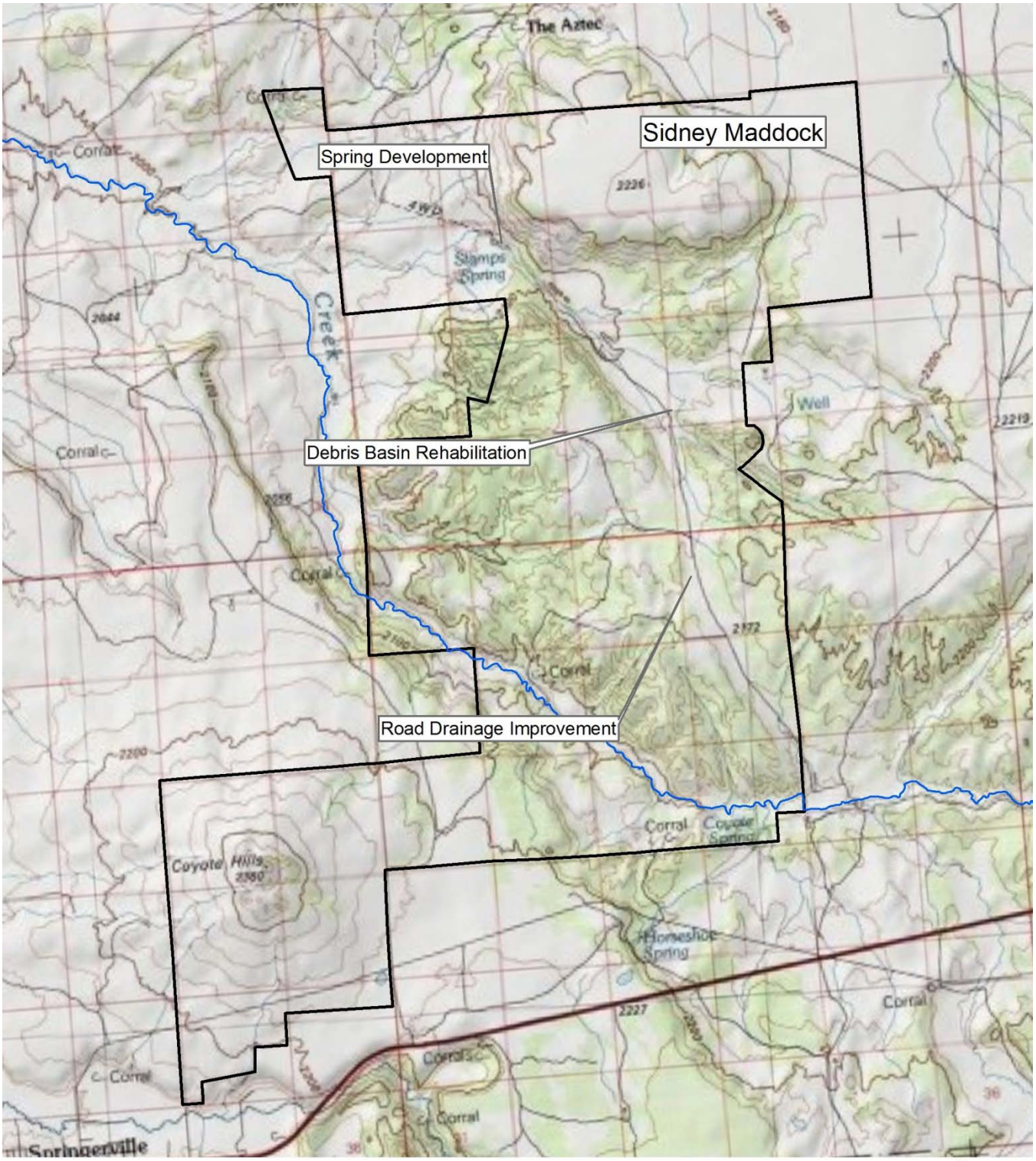
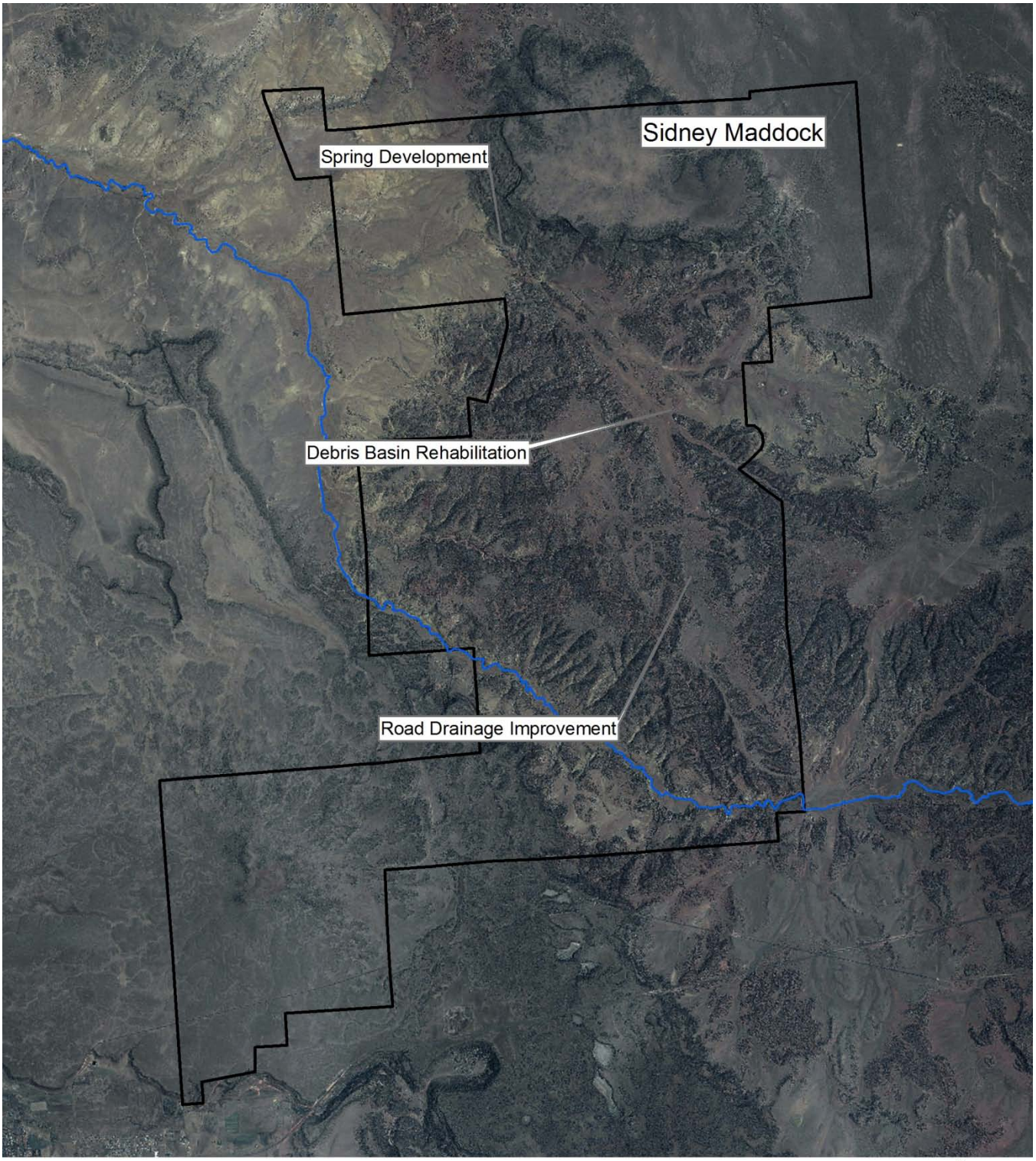
Coyote Creek Watershed Improvement and Education Project




Sidney Maddock
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Coyote Creek Watershed Improvement and Education Project

Name: John Thompson

Date of Visit: 12/12/2010

Ranch Name: Horseshoe Springs

Email:

Mailing Address: 985 W. School Bus Road, Eagar

Phone Number: 928.245.2162

Site Description:
This property contains tributaries of Coyote Creek. Grazing is the primary land use on this ~3,000 acre ranch. Historically, conservation work on this ranch has included sediment/debris basins, V-mesh fencing spreaders to retard sheet erosion and rill development. These practices have been at least partially successful; however, head-cutting and rill erosion are still active on the ranch.

Dispersal of grazing pressure is limited by water sources on the property. Wells on the property need new pumps and a sustainable source of power (i.e. solar or windmill). The upper well needs a storage tank, pipe, and drinkers. Pasture fences are in need of repair to effectively manage grazing pressure and vegetation density. Grassland cover is limited by both juniper tree encroachment and wind erosion. Wind erosion has been a persistent problem leading to the denudation of fertile soil from some pastures.

Sediment retention on one tributary is limited by a breached water and sediment control basin (WASCOB); however, the effectiveness of this structure is questionable.

Dense populations of kangaroo rats are a perceived barrier to reestablishment of grasslands and other vegetative cover.

Ranch Objectives and Resource Concerns:
Mr. Thompson would like to decrease sediment runoff through the removal of junipers and reestablishment of grass ground cover. He would like to address relatively recent head-cutting and gullies with grade control structures. Establishment of vegetation and stabilization of wind-eroded pasture is also a goal.

Grazing and vegetation management would be enhanced by developing a new well and rehabilitating two wells. These water developments and additional fencing would allow for better grazing rotation which would increase vegetative cover and decrease sediment runoff.

Proposed Best Management Practices (BMPs) to Achieve Ranch Objectives:

Structural Practices

- Water Development
- Rock and Brush Grade Control

Vegetative Practices

- Fencing
- Brush Management
- Range Seeding
- Kangaroo Rat Control

Coyote Creek Watershed Improvement and Education Project

Name: John Thompson **Ranch Name:** Horseshoe Springs

Estimated BMP Cost – Water Development

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Well Development	ft	40	$60.00	$2,400
Well Power Plant – Solar	ea	1	$12,500.00	$12,500
Well Rehabilitation	ft	40	$60.00	$2,400
Well Power Plant – Solar	ea	1	$12,500.00	$12,500
Trough x 2	gal	3200	$1.50	$4,800
Pipeline	ft	100	$3.50	$350
Well Rehabilitation	ft	320	$60.00	$19,200
Well Power Plant – Solar	ea	1	$12,500.00	$12,500
Spring Development	ea	1	$1,600.00	$1,600
			Total Estimated Cost:	$68,250

Estimated BMP Cost – Rock and Brush Grade Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Rock and Brush Grade Control Structure	cu yd	260	$55.00	$14,300
			Total Estimated Cost:	$14,300

Estimated BMP Cost - Fencing

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Fencing	ft	26,400	$2.75	$72,600
			Total Estimated Cost:	$72,600

Estimated BMP Cost – Brush Management

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Brush Management	ac	1920	$66.00	$126,720
			Total Estimated Cost:	$126,720

Estimated BMP Cost – Range Seeding

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Range Seeding	ac	480	$288.00	$138,240
			Total Estimated Cost:	$138,240

Estimated BMP Cost – Kangaroo Rat Control

Description	Unit	Quantity	Typical Unit Cost	Estimated Cost
Kangaroo Rat Control	ac	50	$24.00	$1,200
			Total Estimated Cost:	$1,200

Total: $432,013

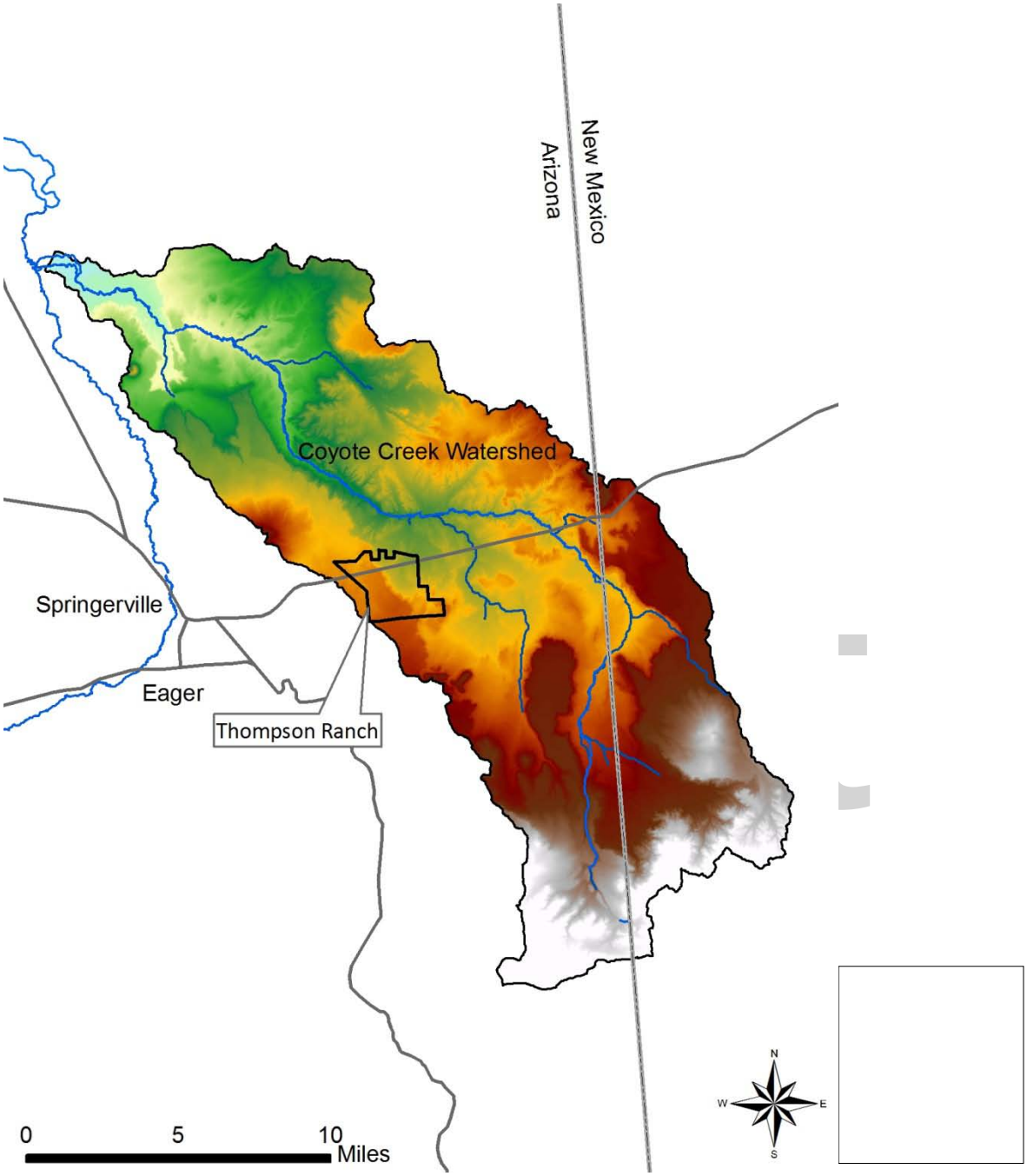
Producer	Best Management Practice	Cost per Acre Mitigated	Sum of NEMO Ratings	Location Rating	Area-Weighted BMP Rating
John Thompson	Brush Management and Seeding	$126.25	6	5	3,788
John Thompson	Fencing	$42.24	3	5	634
John Thompson	Rock and Brush Grade Control x4	$11.92	3	1	36
John Thompson	Kangaroo Rat Control	$24.00	7	5	840
John Thompson	Water Development (Spring)	$2.04	5	5	51
John Thompson	Water Development (Well Development)	$7.49	5	6	225
John Thompson	Water Development (Well Rehabilitation)	$7.49	5	5	187
John Thompson	Water Development (Well Rehabilitation)	$16.03	5	6	481

Site Photos

View of an area in need of brush management and wind erosion treatment.

Picture of a damaged windmill and well in need of rehabilitation.

Site Maps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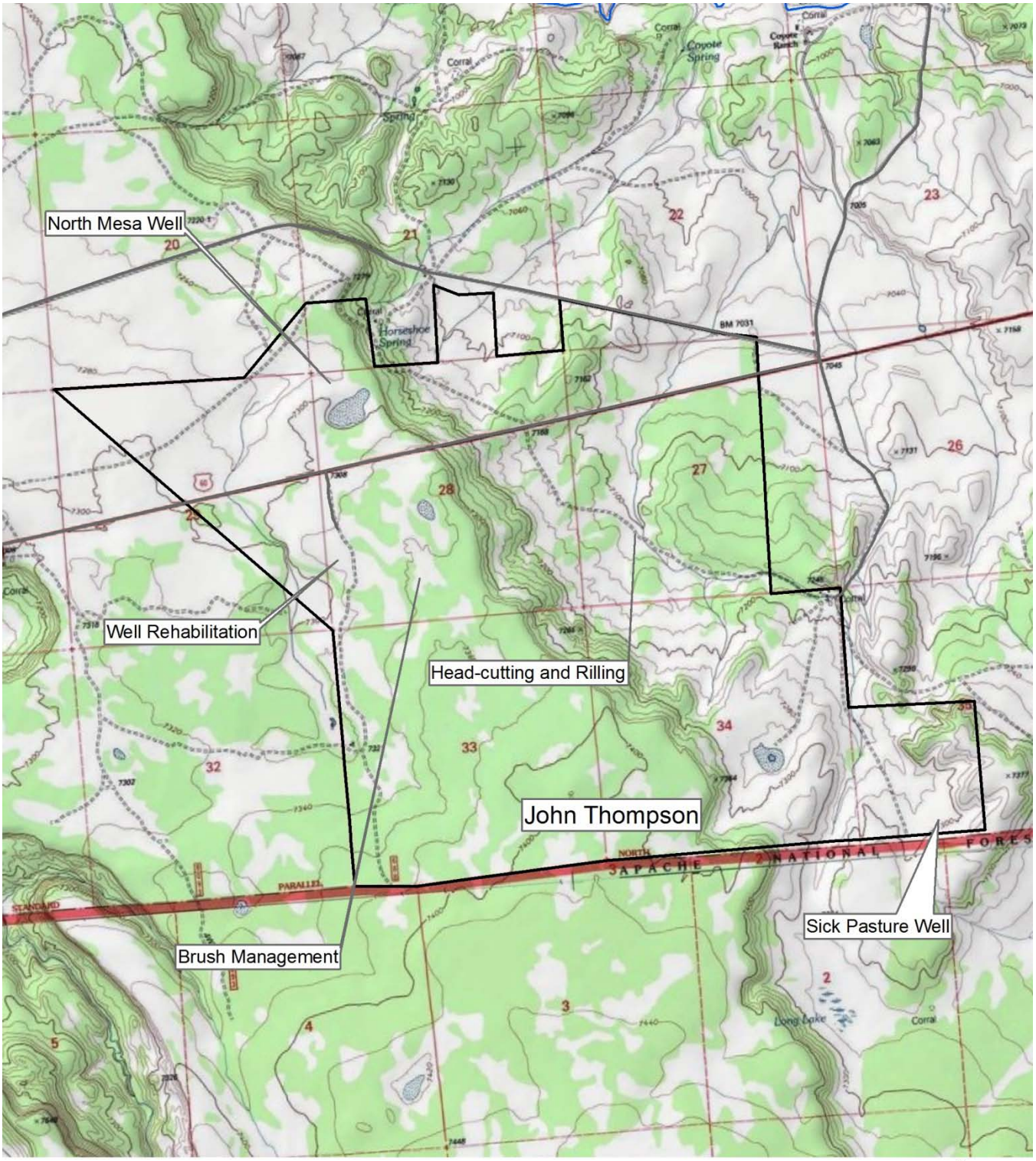
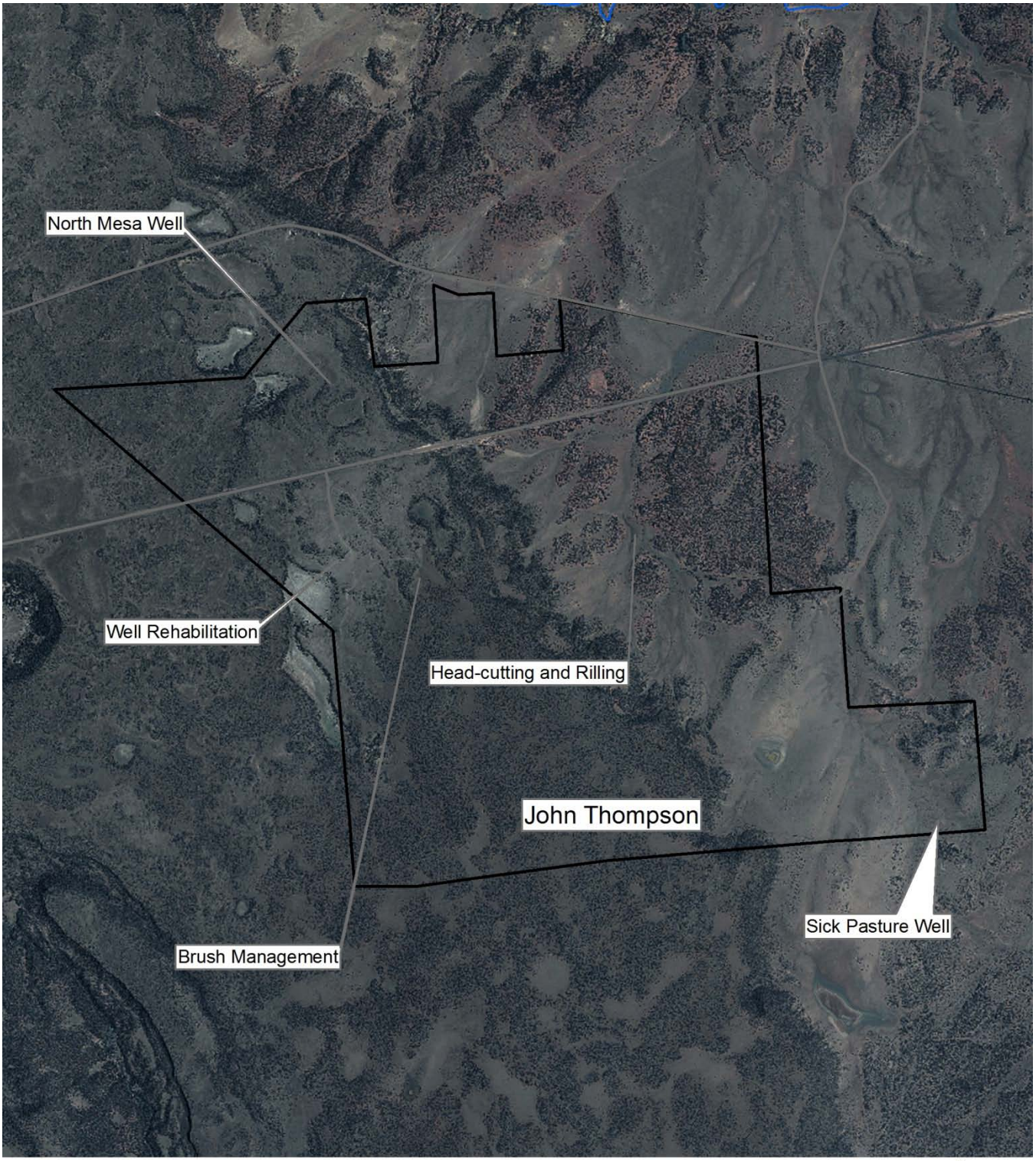
Arizona
Coyote Creek Watershed
Springerville
Eager
Thompson Ranch
0
5
10
Miles
N
W
E
S

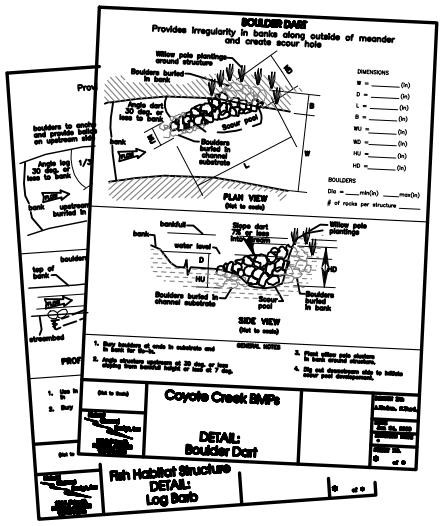

North Mesa Well
Well Rehabilitation
Head-cutting and Rilling
John Thompson
Brush Management
Sick Pasture Well
Coyote Spring
Horseshoe Spring
Long Lake
Corral
NORTH APACHE NATIONAL FOREST
PARALLEL
STANDARD
BM 7031
Road
Coyote_Creek_Watershed_Ranches_10_05_2010
N
W
E
S
0
0.5
1
2
Miles


North Mesa Well
Well Rehabilitation
Head-cutting and Rilling
John Thompson
Sick Pasture Well
Brush Management
Road
Coyote_Creek_Watershed_Ranches_10_05_2010
N
W
E
S
0
0.5
1
2
Miles

APPENDIX B - BEST MANAGEMENT PRACTICE DETAILS

COYOTE CREEK
Best Management Practices DETAILS

INDEX OF DRAWINGS



Formatted for
8–1/2 in x 11 in. Sheet Size

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

Cover Sheet

Preliminary
Not For
Construction

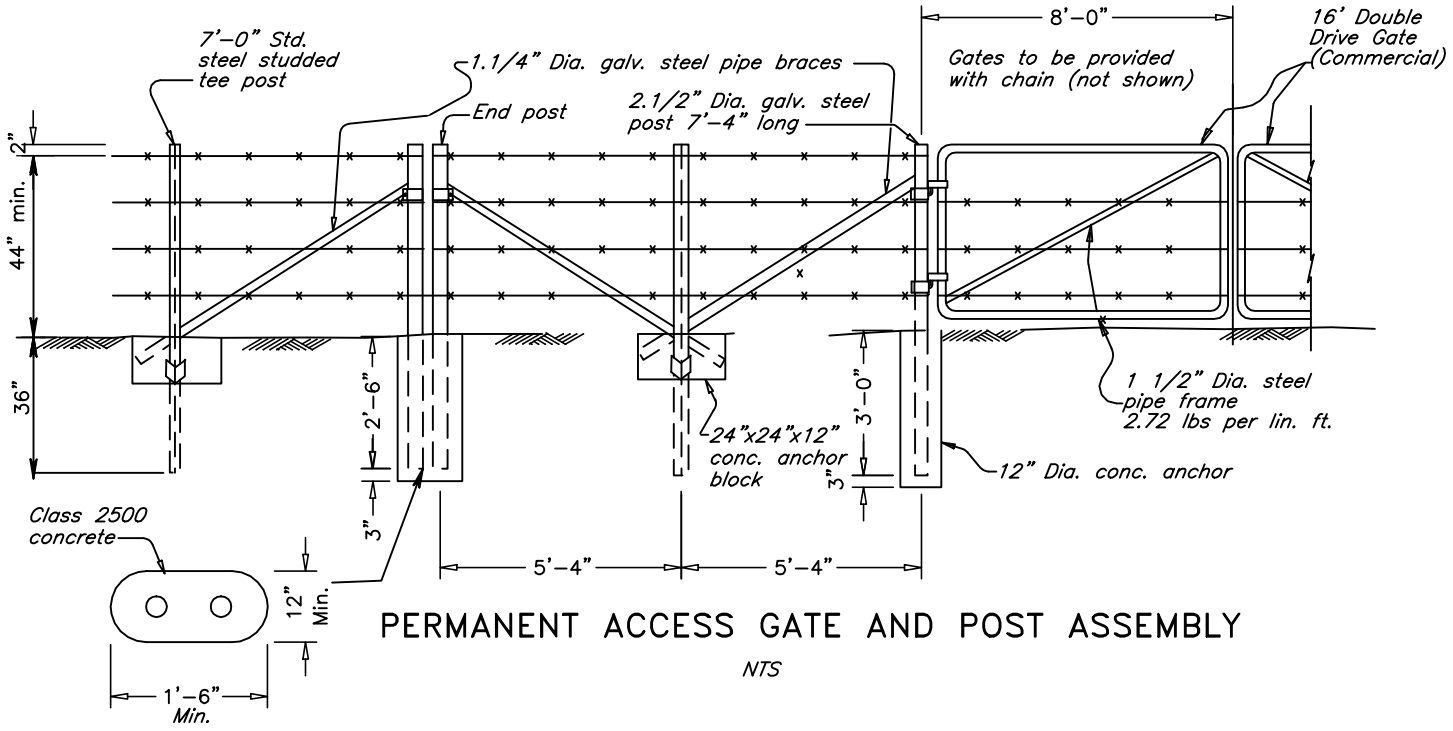
DESIGN BY:
S.Yard

DATE
April 2011

REVISION DATE

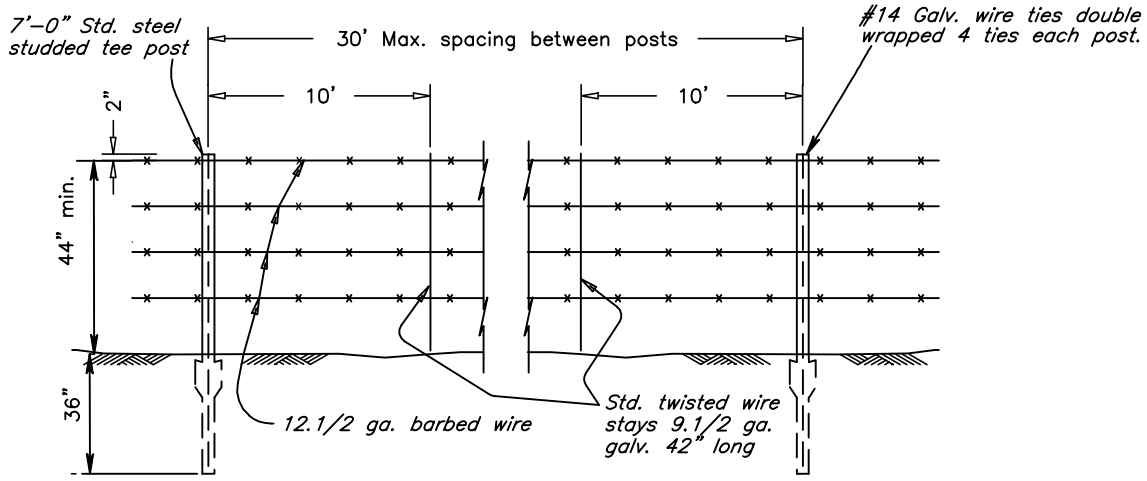
Cover

Fencing Management



PERMANENT ACCESS GATE AND POST ASSEMBLY

NTS

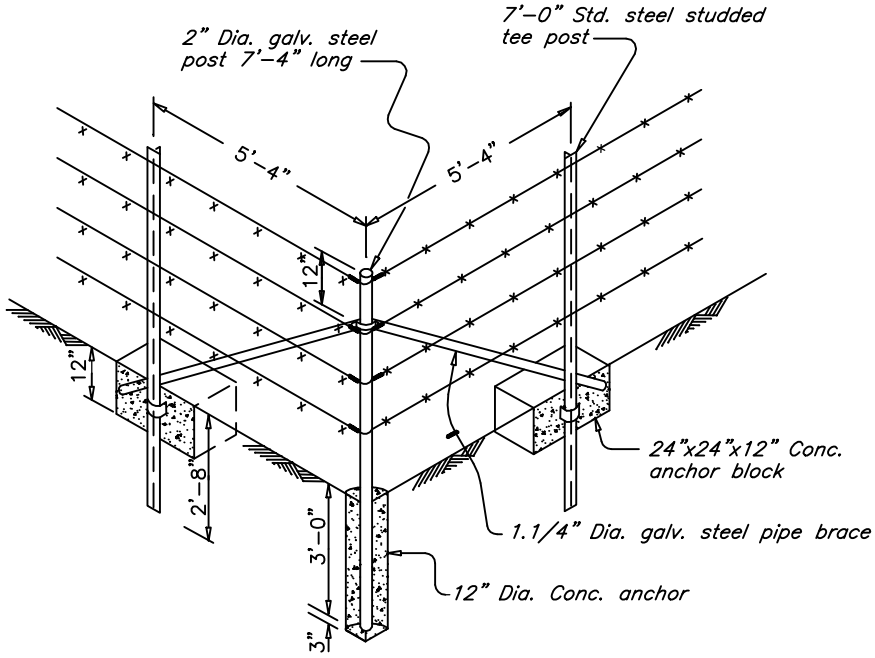


LINE POST ASSEMBLY

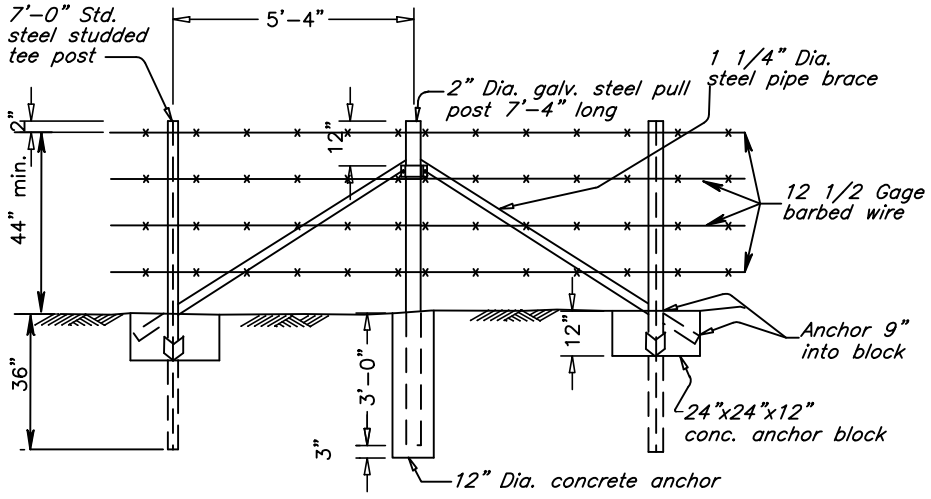
NTS

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Fencing - Access Gate & Line Post Assembly		DATE April 2011 REVISION DATE BMP NO. 1A

FENCING MANAGEMENT (continued)



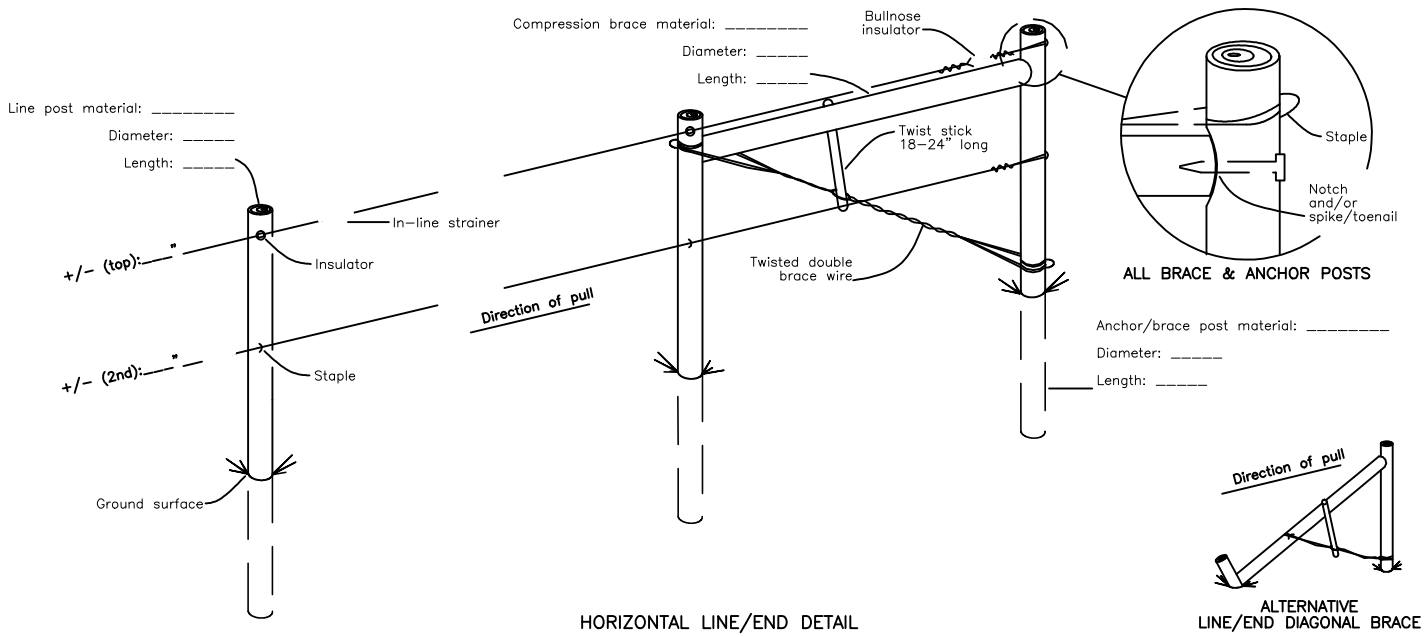
END OR CORNER POST ASSEMBLY



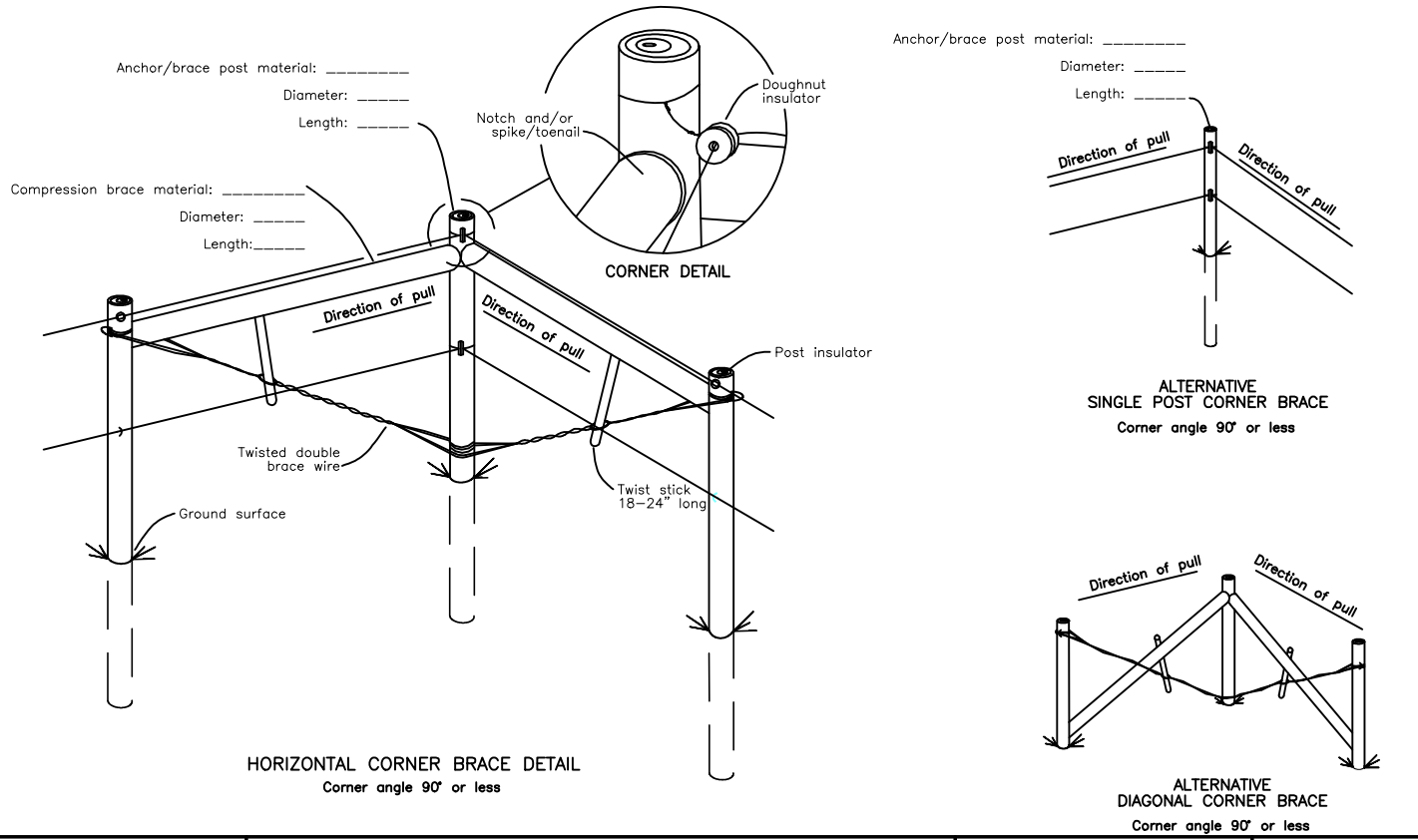
PULL POST OR CHANGE IN GRADE ASSEMBLY

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Fencing - End or Corner Post & Grade Change Assembly		DATE April 2011 REVISION DATE BMP NO. 1B

ELECTRICAL FENCING



HORIZONTAL LINE/END DETAIL



HORIZONTAL CORNER BRACE DETAIL
Corner angle 90° or less

(Not to Scale)
Adapted From NRCS Drawings

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL: Fencing - Electrical

Preliminary Not For Construction

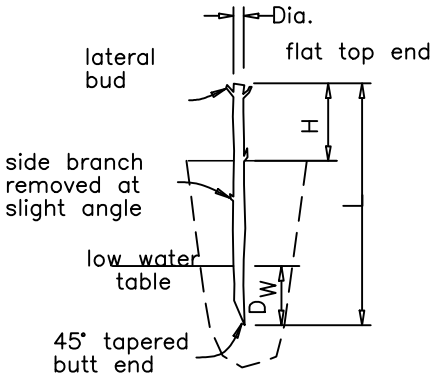
DESIGN BY: S.Yard

DATE April 2011

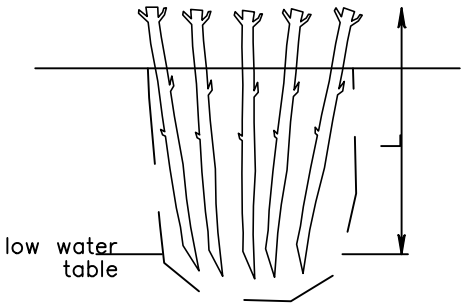
REVISION DATE

BMP NO. 2

WILLOW POLE PLANTINGS



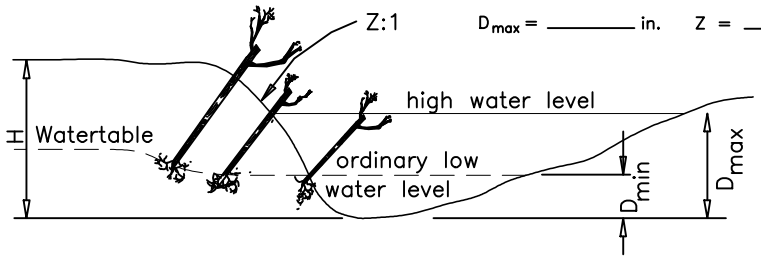
POLE PLANTING DETAIL
(Not to scale)



POLE CLUSTER DETAIL
(Not to scale)

DIMENSIONS

WATER DEPTH		BANK	
D_{min} = _____	in.	H = _____	ft.
D_{max} = _____	in.	Z = _____	



SECTION VIEW
(Not to scale)

GENERAL NOTES

PLANT MATERIAL PROCUREMENT and HANDLING

All woody species shall be native and collected from designated local sources.

Dormant unrooted hardwood cuttings can be taken after leaf fall and before bud burst in the spring. Never remove more than 1/3 of any single donor plant during harvesting. The best rooting success is from cuttings that are disease–free, green plants that are 2–10 years old. The best diameters for pole planting, vertical bundles, and trenches are 1/2 to 1 inch and 2 to 3 inches for post plantings. Cutting length varies depending on the application. It shall be long enough to reach 6 to 8 inches into the lowest water level of the year and high enough to expose at least two to three buds.

Cuts shall be made with clean, sharp tools. The bottom end of the stem cutting shall be cut to a 45–degree angle and the top end shall be cut square across or horizontal to the stem. Trim off all side branches and the terminal bud (bud at the growing tip) so energy will be rerouted to the lateral buds for more efficient root and stem sprouting. Do not trim terminal bud from cuttings for vertical bundles and willow trench until after planted. Trimmed tip ends shall be sealed by dipping in light–colored latex, water–based paint.

Submerge cuttings in water for 3 to 7 days prior to planting to maximize water retention. Do not allow the roots to emerge from the bark.

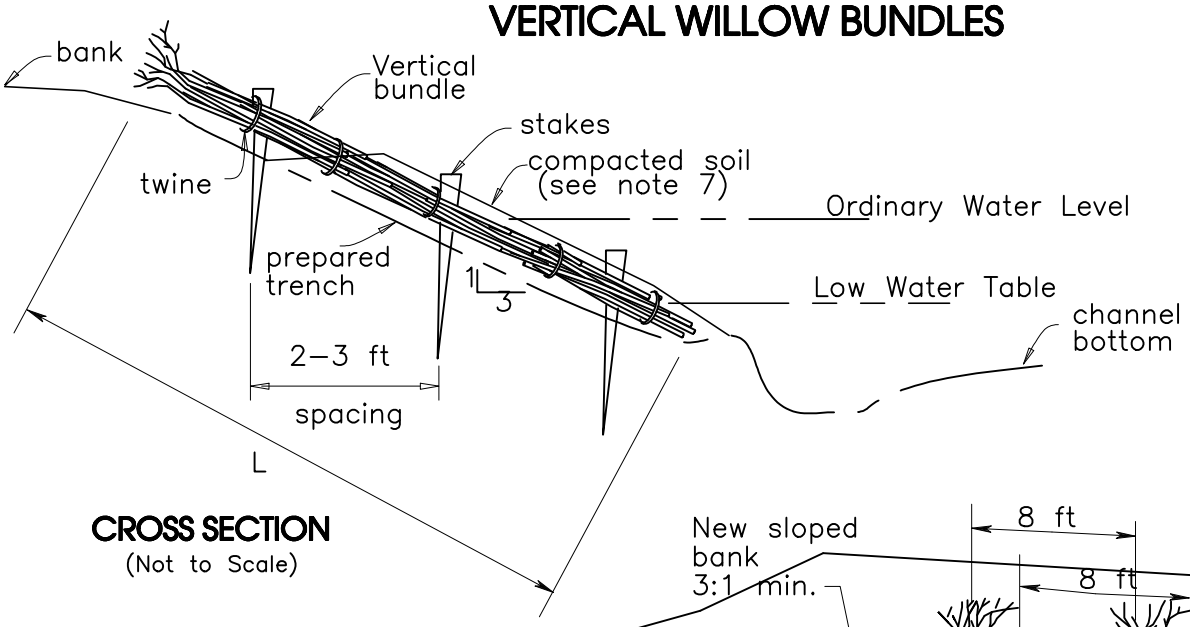
POLE PLANTINGS and POLE CLUSTERS:

Pole cuttings are placed in the ground deep enough to reach the lowest water table of the year and high enough to expose at least two to three buds. Root primordia will develop when good soil–to–stem contact is made and exposed sections of the cutting will sprout stems and leaves. Dormant cuttings can be planted with a digging bar, auger, water–jet, or if the soil is saturated, they may be pushed into the soil. Pole Plantingsare planted in the Bank and Overbank Zone and shall be spaced 2–4 feet apart in the row. In multiple row plantings, spacing between rows shall be staggered with respect to those in adjacent rows.

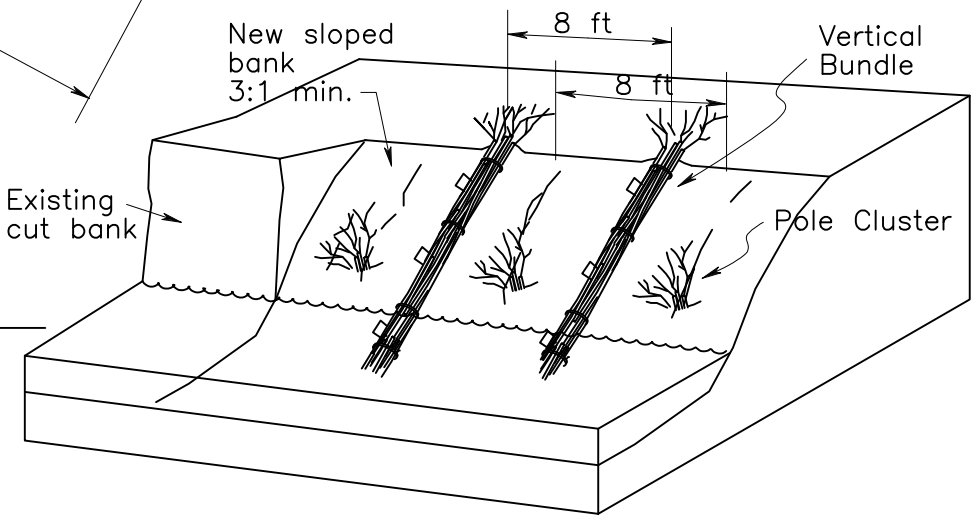
Pole Clusters require four to six inch holes augered into the bank, down to the water table with the use of a hydraulic auger attached to an excavator or tractor. Four willow poles are placed into the hole, backfilled and watered in. A Willow Trench uses pole clusters at 1 foot spacings behind the toe rock that creates a "fence" to filter runoff before it enters the stream and provide dense vegetation to stabilize the eroding bank.

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Willow Pole Plantings		DATE April 2011
			REVISION DATE
			BMP NO. 3

VERTICAL WILLOW BUNDLES



CROSS SECTION
(Not to Scale)



ISOMETRIC VIEW
(Not to Scale)

VERTICAL BUNDLES

Dormant native poles placed in shallow trenches at 8 ft spacings with clusters in between.

Species _____

Dia _____ in.

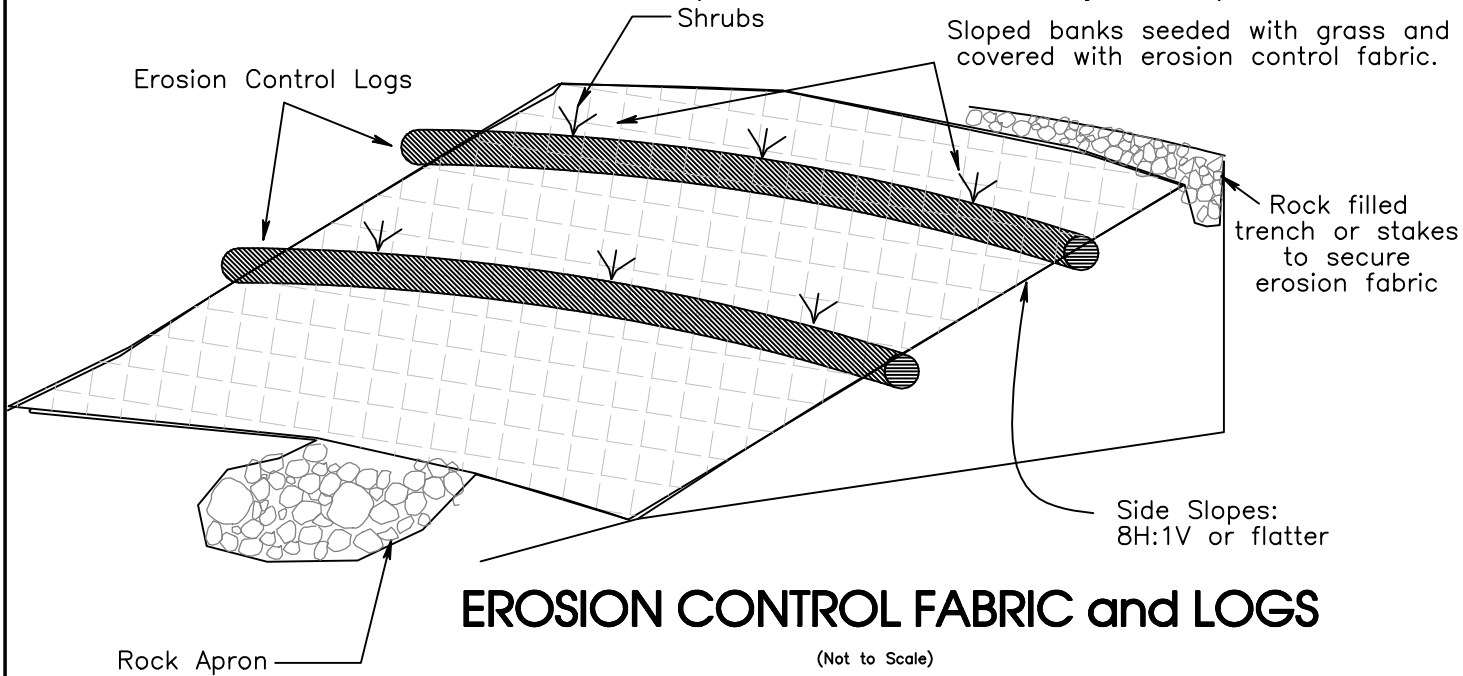
Length _____ ft.

VERTICAL BUNDLE NOTES

1. Cuttings shall be dormant, stripped of side branches, and soaked 3 to 7 days.
2. Cuttings shall be 3/4 to 2 inches in diameter and typically 3 stems per bundle or cluster.
3. Bundles shall be tied with untreated twine about every 2 feet.
4. Excavate a vertical trench with a slope of 2:1 or more in the streambank.
5. Make sure the bottom of the trench will still be under water during low flows.
6. The trenches should be excavated on 4 foot centers alternating with willow clusters to ensure adequate protection and to encourage rapid growth to fill in the bank.
7. Place bundle in the trench with the cut ends in the water.
8. Secure bundles to back of trench with wooden stakes at about 3 foot spacings.
9. "Muddy" in bundles with water and soil (covering the bundles 1 to 2 inches deep)
10. Leave approximately 30 percent of upper branches exposed.
11. Tops of cuttings are cut off after placement.

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Vertical Willow Bundles		DATE April 2011
			REVISION DATE
			BMP NO. 4

HEADCUT TREATMENT (Smooth-Seed-Fabric/Mulch)



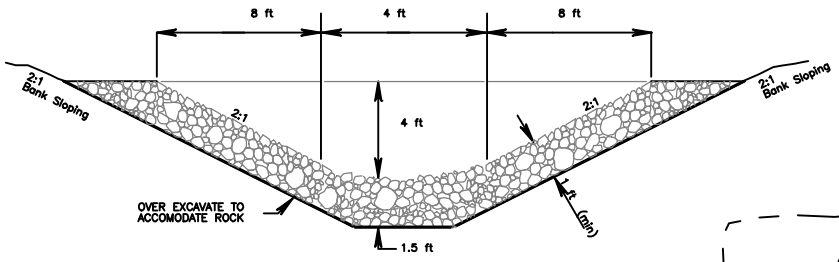
EROSION CONTROL FABRIC and LOGS

(Not to Scale)

Disturbed soils shall be revegetated as shown on drawings

Excess material shall be transported to designated spoil areas, fill material shall be smoothed and reseeded with upland grass mix.

Install erosion control fabric over seeding as specified.

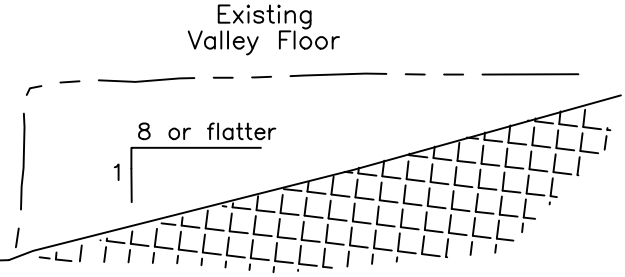


ROCK APRON

ROCK APRON SPECIFICATIONS

Use well-graded, angular fractured quarry spalls with bulk specific gravity greater than 2.0

Rock Apron:
Dmin = 3 in.
D50 = 9 in.
Dmax = 14 in.

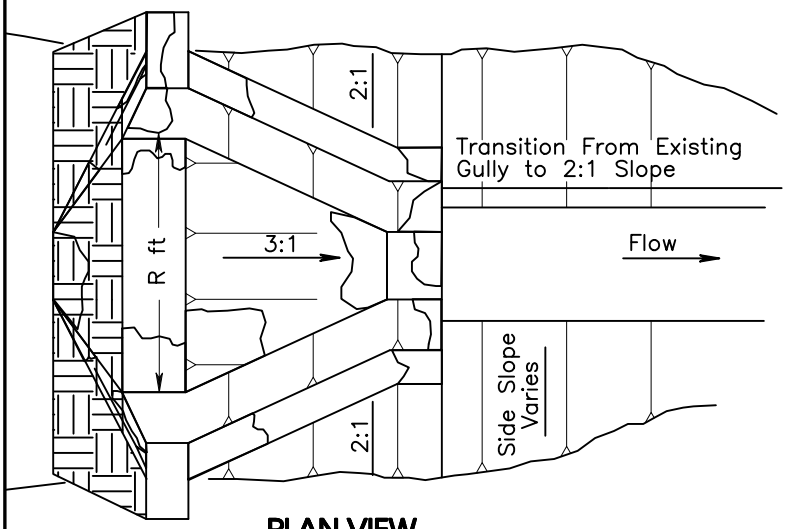


BANK SLOPING at HEADCUT

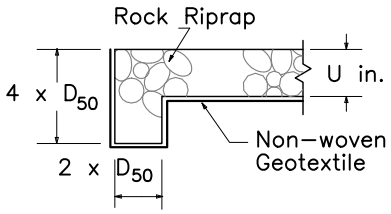
(Not to Scale)

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Headcut Treatment (Smooth-Seed-Fabric/Mulch)		DATE April 2011
			REVISION DATE
			BMP NO. 5

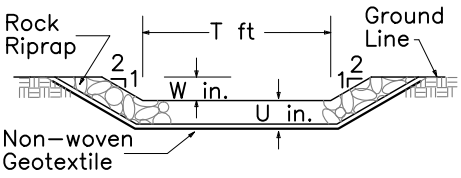
ROCK and BRUSH GRADE CONTROL STRUCTURE



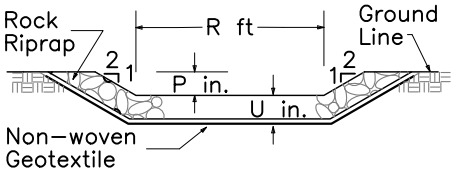
PLAN VIEW



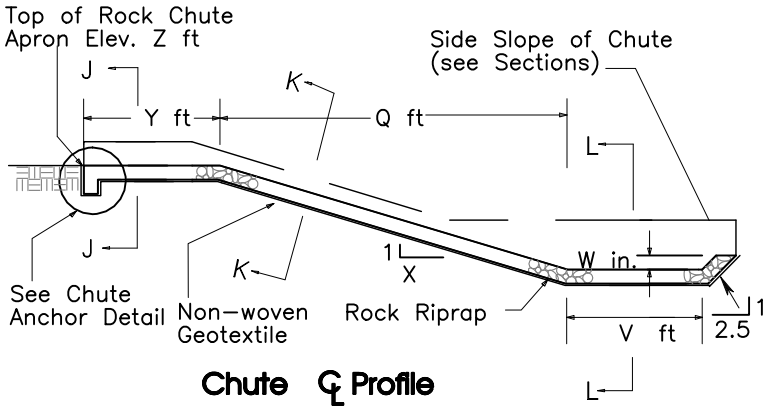
Chute Anchor Detail



Typical Section L-L



Typical Section J-J & K-K



Chute $\mathcal{L}$ Profile

Dimensions

Z _____ ft
Y _____ ft
X _____
W _____ in.
V _____ ft
U _____ in.
T _____ ft
R _____ ft
Q _____ ft
P _____ in.
D_{50} _____ in.

NOTES

1. Site Preparation: the surface between the channel and the structure shall be prepared by excavating vertical or overhanging banks, sloping and shaping to provide a uniform surface.
2. Geotextile shall be non–woven fabric with a minimum grab tensile strength of 90 lb, greater than 50% elongation at failure, a minimum of 40 lb puncture strength, and UV resistance of 70% strength retained. Geotextile shall be joined by overlapping a minimum of 18 inches and secured against the underlying foundation material.
3. Structure to be built of either rock or alternate layers of rock and brush (first layer shall be brush) or atop geotextile.
4. Rock and/or brush shall not be dropped more than 3 ft onto geotextile to prevent puncture of material.
5. The brush shall be from fresh cut, live conifers juniper is preferred). The maximum diameter of the stem shall be 1–1/2 in., placed on top of geotextile, not exceeding 4 inch compressed thickness, and completely covering the structure base. The butt ends shall be placed upstream, the brush will be repositioned within the keyways as needed to minimize voids.
6. Rock shall be blocky or angular in shape, durable, and well–graded according to the Rock Gradation table. If rounded stones must be used, increase the size by 40%.
7. Rock shall be selected and hand–placed in horizontal layers, beginning at the bottom, to form a dense, interlocking mass.
8. The minimum depth of keyway shall be 2 feet into the channel bank and 1 foot into the channel bottom.
9. All structures shall be finished in a workmanlike manner.

(Not to Scale)
Adapted From NRCS Drawings

Coyote Creek Best Management Practices

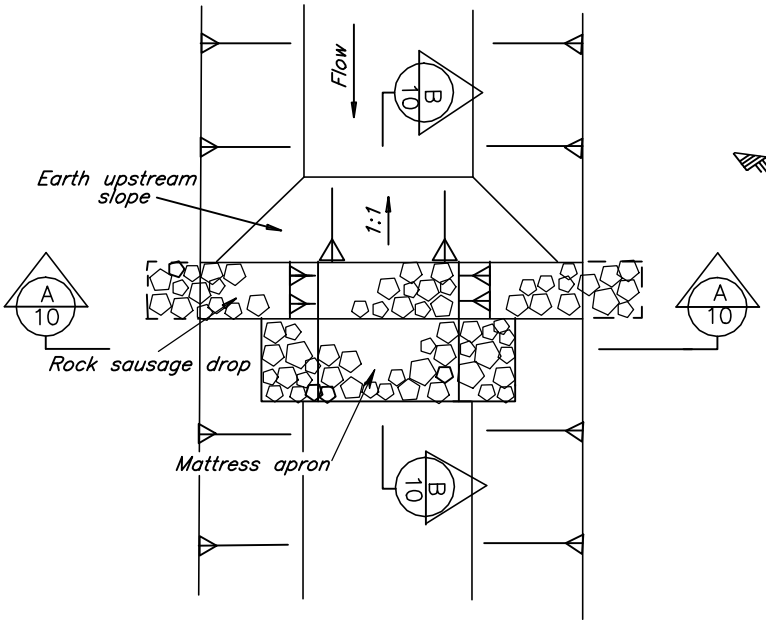
Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL:
Rock and Brush Structure

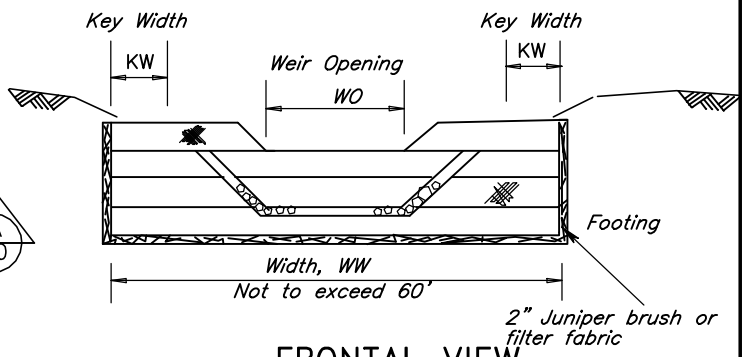
Preliminary
Not For
Construction

DESIGN BY: S.Yard
DATE April 2011
REVISION DATE
BMP NO. 6

ROCK WIRE SAUSAGE GRADE CONTROL STRUCTURE

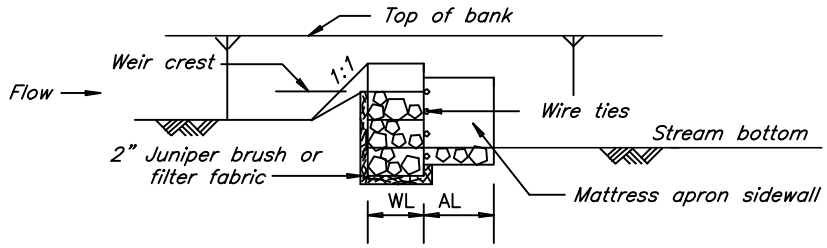


PLAN VIEW



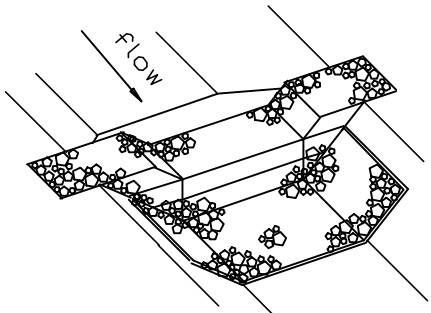
FRONTAL VIEW

Section A 10



SIDE VIEW

SECTION B 10



ISOMETRIC VIEW

DIMENSIONS

KW _____ ft

WO _____ ft

WW _____ ft

WL _____ ft

AL _____ ft

NOTES

1. Spillway width (w) to be based on Q for 10 year 24 hour storm.
2. Wire mesh shall be welded 2 in. by 4 in. and 14 gauge minimum with a width not less than 72 in.
3. Rock shall be sound and no smaller than 2 in. in size.
4. Tie wire shall be galvanized 14 gauge minimum.
5. Seams shall be overlapped 4 in. minimum and be tied by tie wire at 6 in. maximum width. Seams shall be placed upstream.
6. Rock wire sausages shall be connected together at all edges and down the centerline of the rock sausage drop at 1 ft by 1 ft spacing maximum.
7. Mattress apron shall be seamed and doubled wire tied at 6 in. widths to the sausage drop structure.
8. A single sausage drop structure can be used up to 1 ft drop max. Multiple sausage drops can be used up to 2 ft drop max.

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Rock Wire Sausage Structure		DATE April 2011
			REVISION DATE
			BMP NO. 7

MODIFIED HEEDE GRADE CONTROL STRUCTURE

DIMENSIONS

___ CW = Channel Width

___ L_U = Length Upstream

___ L_D = Length Downstream

___ L_A = Length Apron

___ L_F = Length Fence

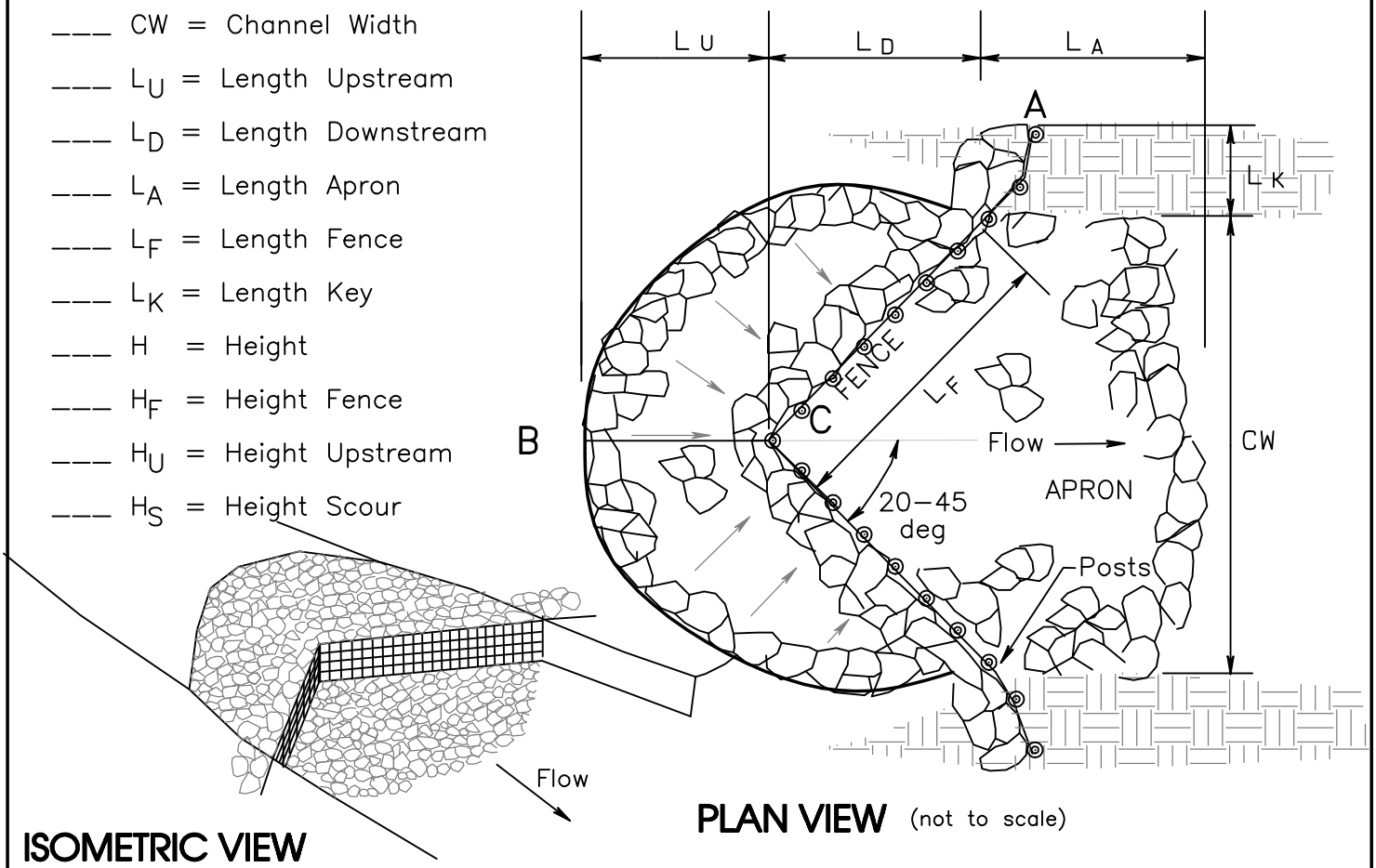
___ L_K = Length Key

___ H = Height

___ H_F = Height Fence

___ H_U = Height Upstream

___ H_S = Height Scour



ISOMETRIC VIEW

(not to scale)

PLAN VIEW (not to scale)

MIN. ROCK THICKNESS

A = D_{50} = __ in.

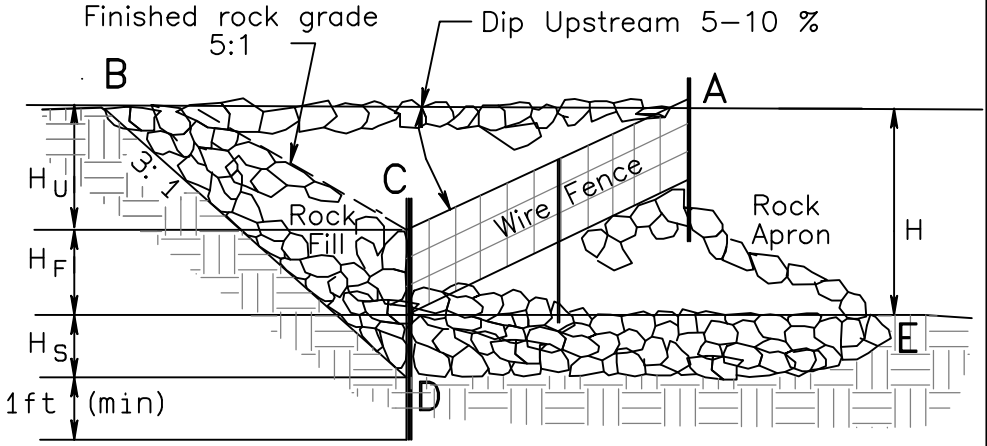
C–D = $4D_{50}$ = __ in.

E = $2D_{50}$ = __ in.

ROCK GRADATION*1

	Angular Rock (inches)	Rounded Rock (inches)
D_{max}	_____	_____
D_{50}	_____	_____
D_{min}	_____	_____

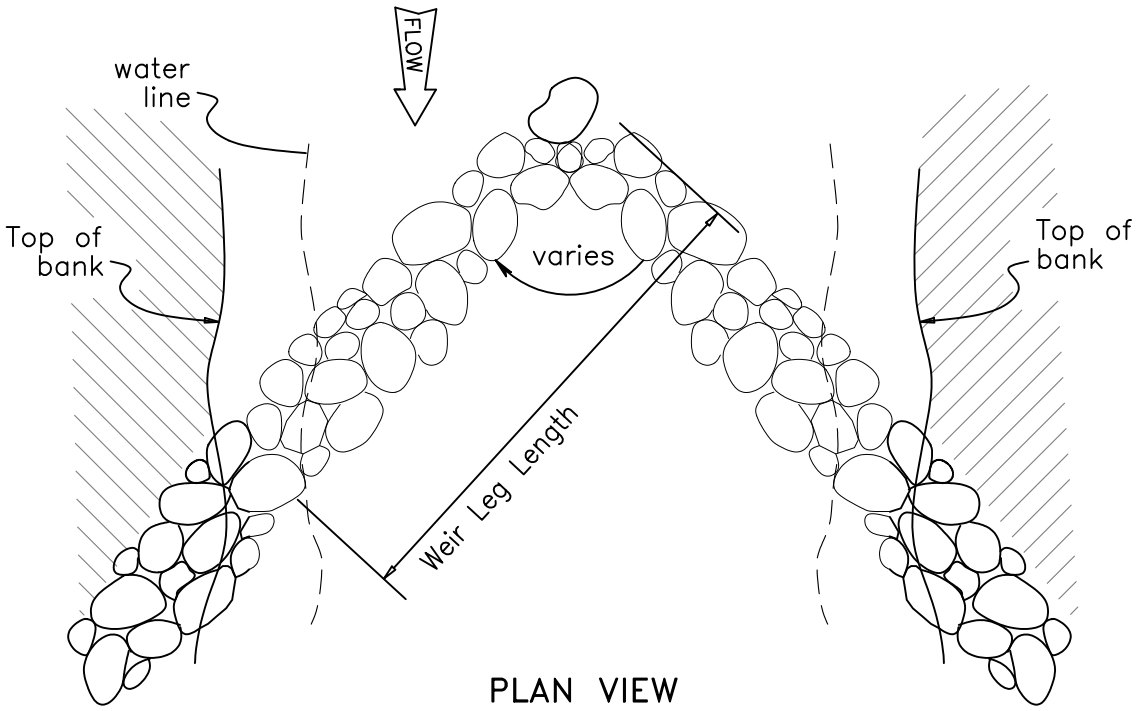
*1 Design Storm, Q10 = ___ cfs



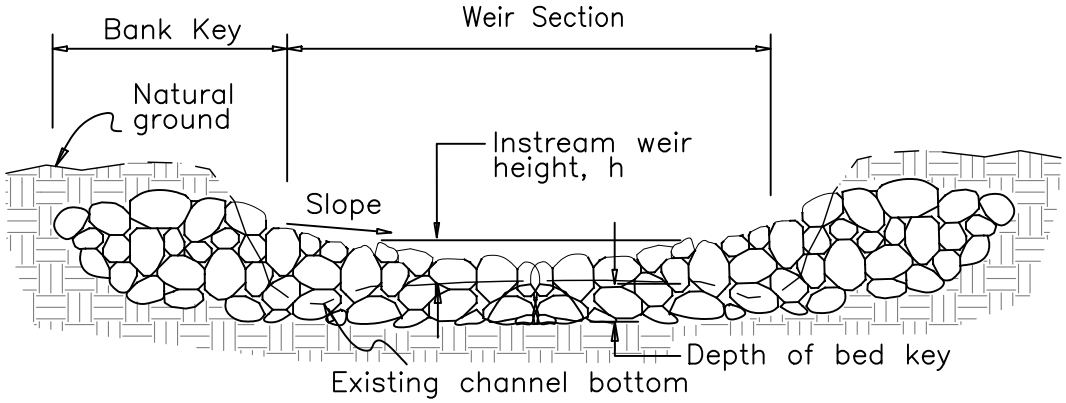
PROFILE VIEW (not to scale)

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Modified Heede Structure		DATE April 2011 REVISION DATE BMP NO. 8

V ROCK WEIR GRADE CONTROL STRUCTURE



PLAN VIEW
(Not to scale)



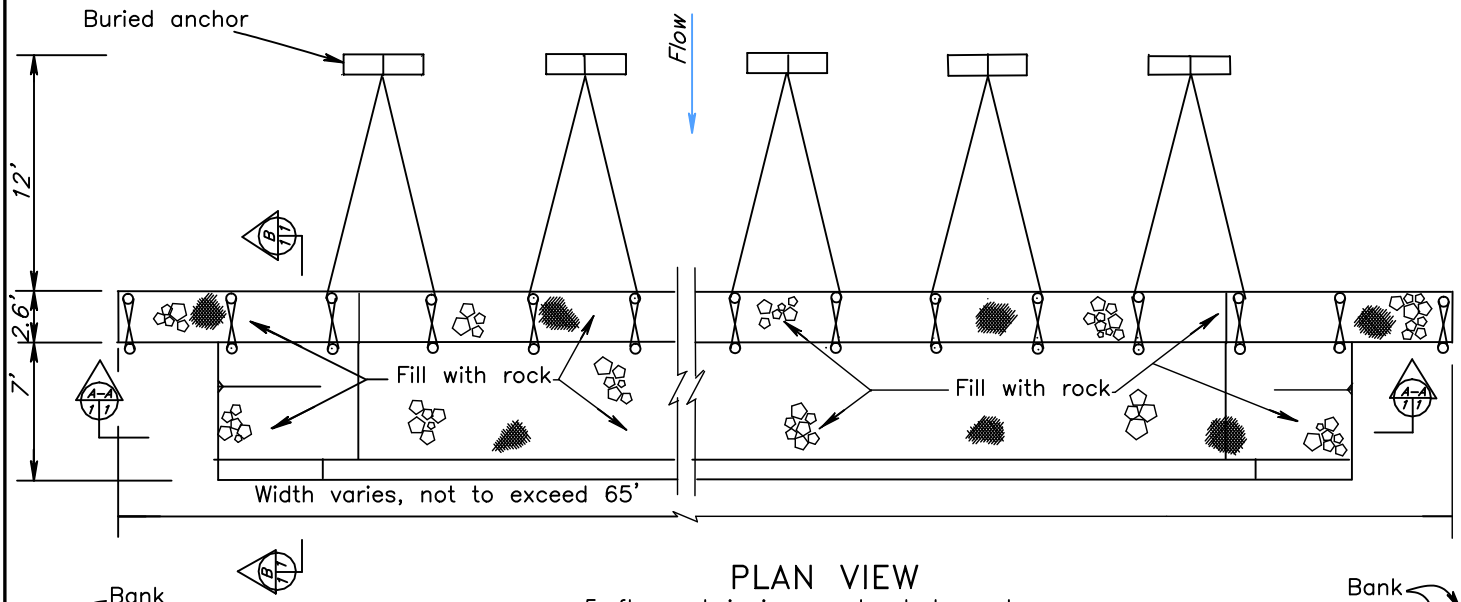
SIDE VIEW
(Not to scale)

GENERAL NOTES

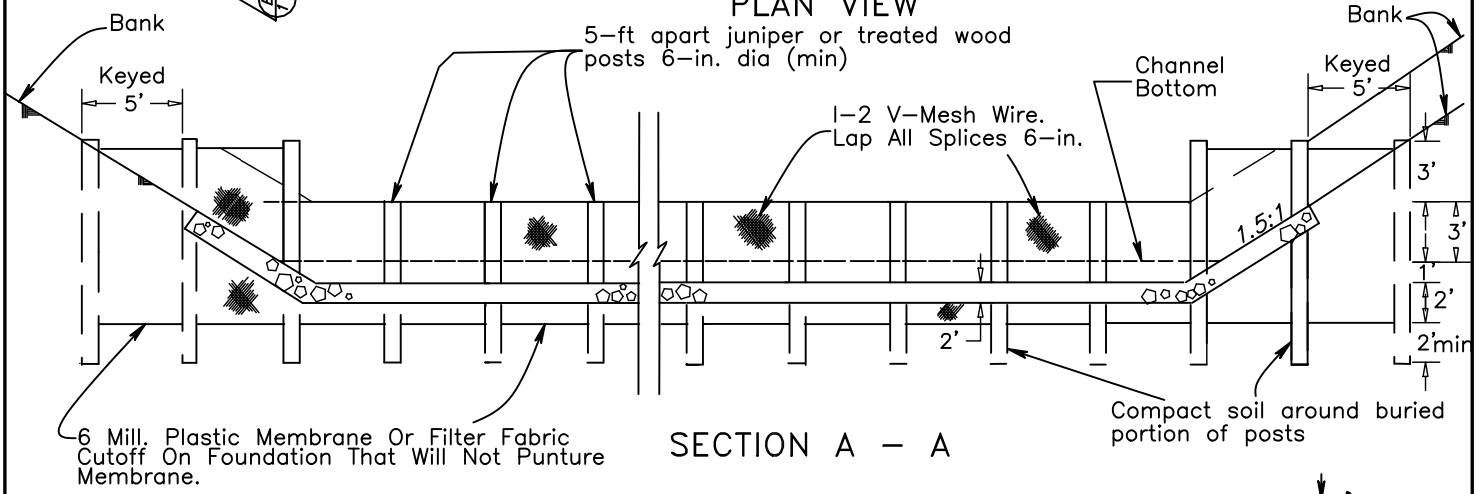
1. Feature provides backwater to increase localized water table for hydric vegetation recovery on floodplain.
2. Weir crest invert set at ordinary high water elevation.
3. Constructed of rock & gravels, providing both fish passage and habitat.
4. This standard drawing requires supporting technical documentation prior to use and must be adapted to the specific site.

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: V Weir Structure		DATE April 2011 REVISION DATE BMP NO. 9

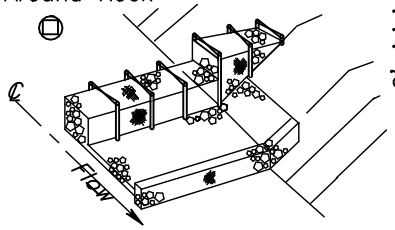
ROCK WIRE CRIB GRADE CONTROL STRUCTURE



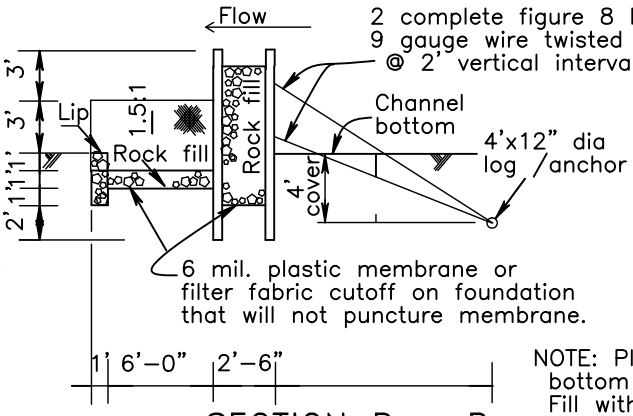
PLAN VIEW



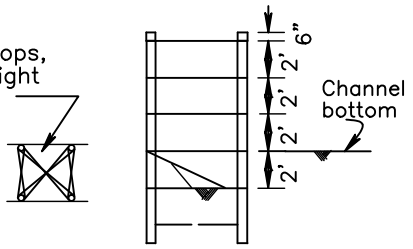
SECTION A – A



ISOMETRIC HALF SECTION



SECTION B – B



PLAN ELEVATION

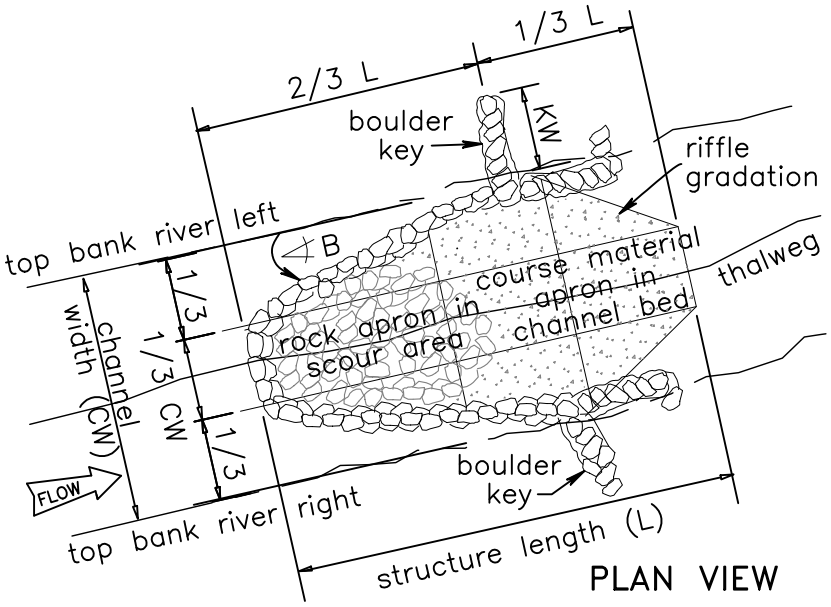
BRACE DETAIL

NOTE: Place woven wire so that top and bottom wrap under and behind brace wire Fill with rock in layers before attaching brace wire

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Rock Wire Crib		DATE April 2011
			REVISION DATE
			BMP NO. 10

CROSS-VANE WEIR GRADE CONTROL STRUCTURE

Channel pool conversion, grade control, floodplain backwatering and fish habitat enhancement.



PLAN VIEW (Not to scale)

DIMENSIONS

CW = _____ (ft) H = _____ (ft)

W = _____ (ft) HA = _____ (ft)

KW = _____ (ft) HW = _____ (ft)

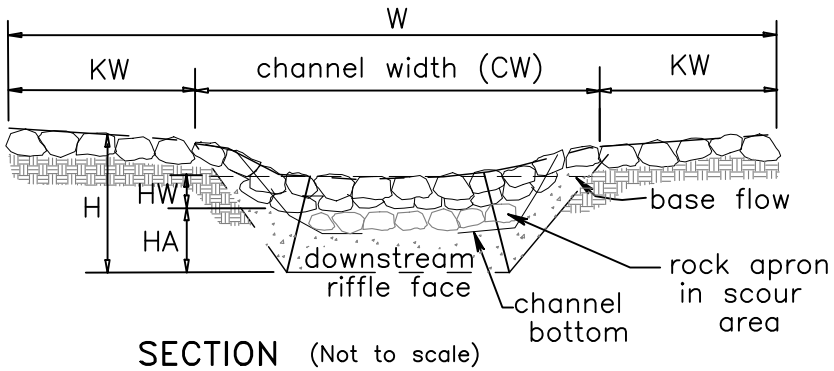
L = _____ (ft) ∠B = _____ (deg)

∠H = _____ (deg)

BOULDERS

Dia = _____ min(in) _____ max(in)

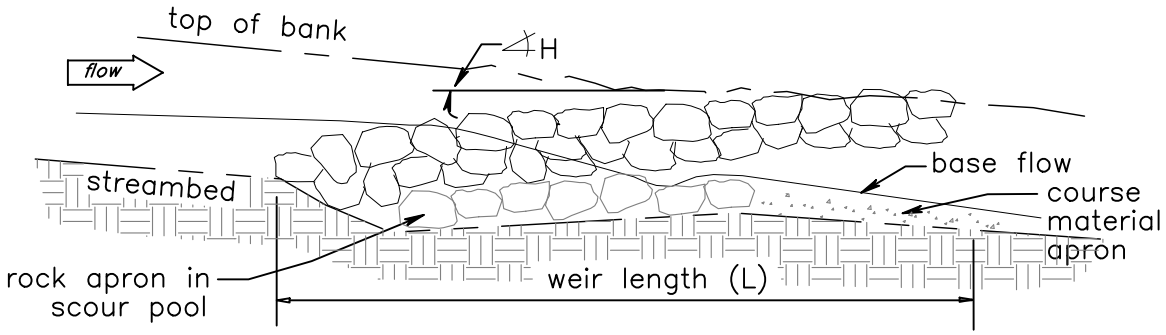
# of rocks per structure _____



SECTION (Not to scale)

GENERAL NOTES

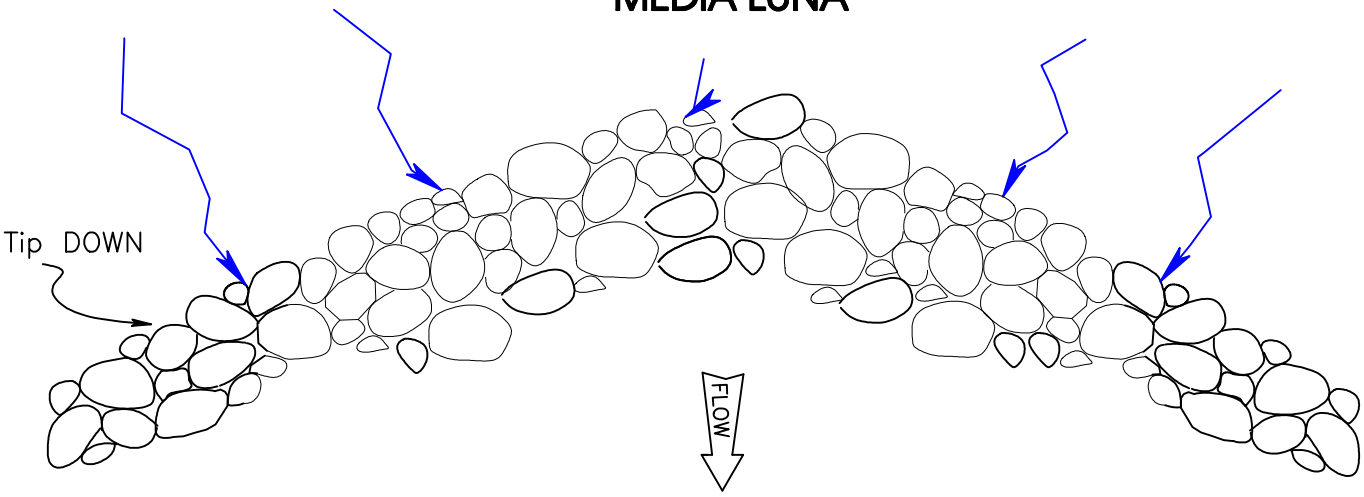
1. Feature provides backwater to increase localized water table for hydric vegetation recovery on floodplain.
2. Weir crest invert set at ordinary high water elevation.
3. Constructed of rock & gravels, providing both fish passage and habitat.
4. This standard drawing requires supporting technical documentation prior to use and must be adapted to the specific site.



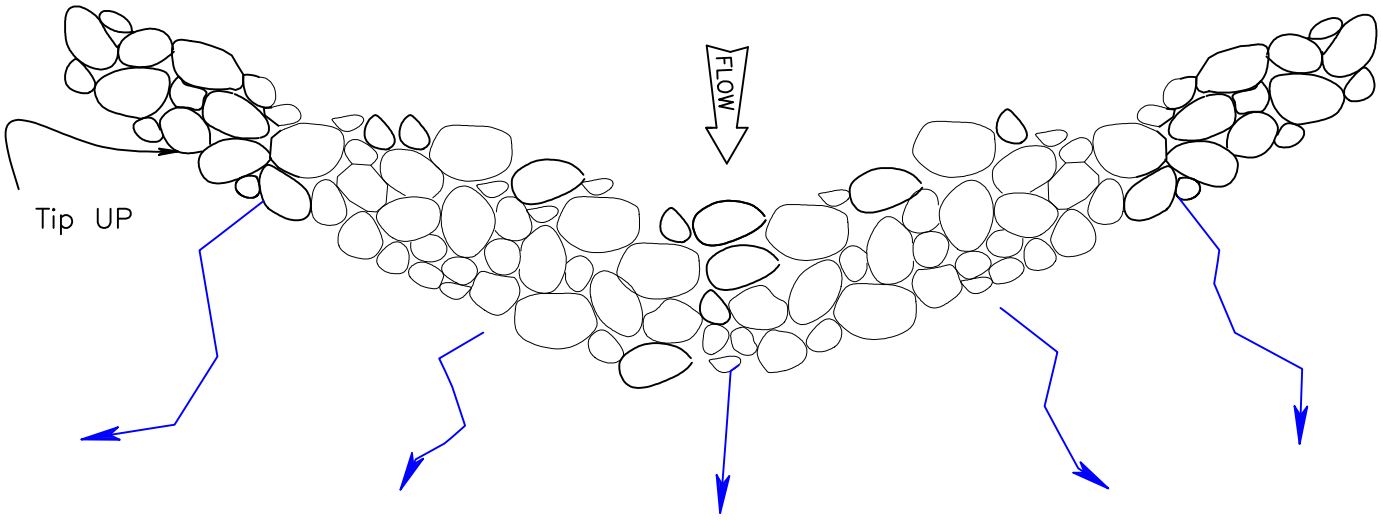
PROFILE VIEW (Not to scale)

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
			DATE April 2011
			REVISION DATE
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Cross-Vane Weir		BMP NO. 11

MEDIA LUNA



SHEET FLOW COLLECTOR PLAN VIEW



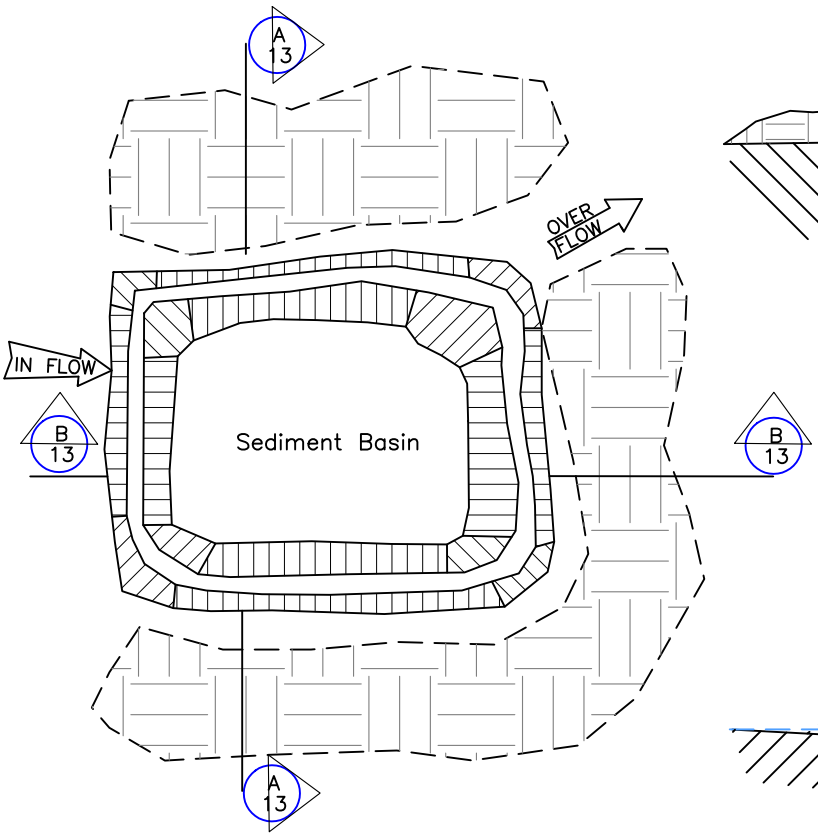
SHEET FLOW SPREADER PLAN VIEW

GENERAL NOTES

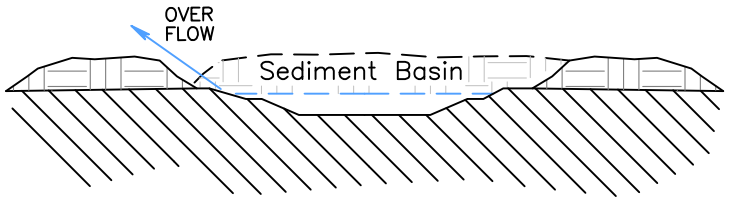
1. Identify which type of Media Luna (ie 'tips UP' or 'tips DOWN') is appropriate for the treatment site.
2. If the treatment site is at the collection point of a network of rills or small gullies, then use a Sheet Flow Collector (tips DOWN). Select two points 6 in. above the bed on each bank of the main channel immediately downslope of where the rills collect. Lay out an arc from bank to bank so that the tips point downslope.
3. If the treatment site is located where runoff from a shallow channel (<1 ft deep) can easily be spread across relatively flat ground, then use a Sheet Flow Spreader (tips UP). Lay out an arc across the flat area with the tips at the same elevation (ie use a leveling tool) and the center slightly lower.
4. Lay out the upslope edge of the structure by tracing an arc parallel to the lower edge to create a band that is at least 4 ft wide. Media Lunas composed of wider bands of cobble mulch offer more protection from erosion, improved infiltration, and increased plant recruitment.
5. Start by digging a shallow trench from tip to tip along the downslope side. Fill the trench with 1 or 2 rows of rock so that no rock protrudes more than 2 in. above ground level. This will serve as the Splash Apron.
6. Scatter native grass and wildflower seed in the area where the Media Luna is to be built.
7. For both types of Media Luna, cover the ground with a single layer of cobble mulch to form a band at least 4 ft wide.

(Not to Scale) Adapted From Dryland Solutions	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Media Luna		DATE April 2011
			REVISION DATE
			BMP NO. 12

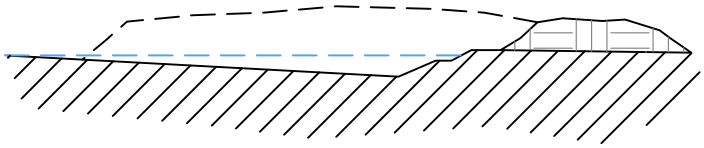
SEDIMENT BASIN



SEDIMENT BASIN PLAN VIEW



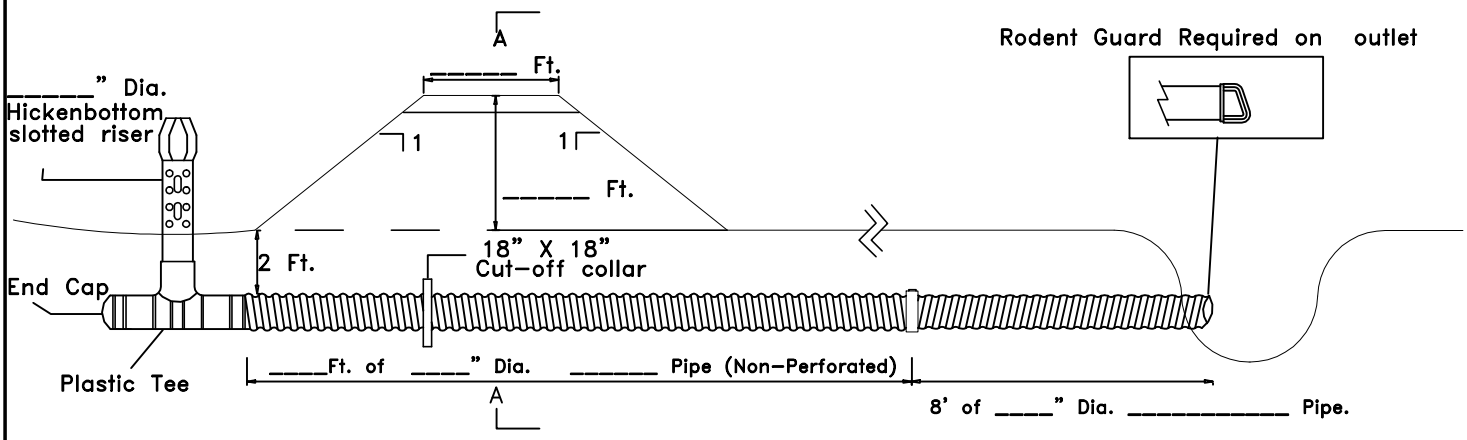
SECTION A 13



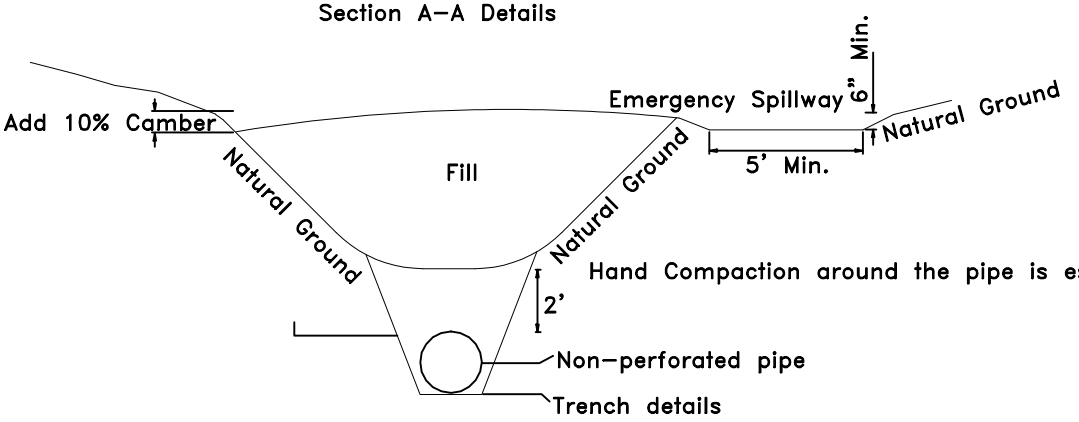
SECTION B 13

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Sediment Basin		DATE April 2011
			REVISION DATE
			BMP NO. 13

WATER & SEDIMENT CONTROL BASIN (WASCOB)



Section A–A Details

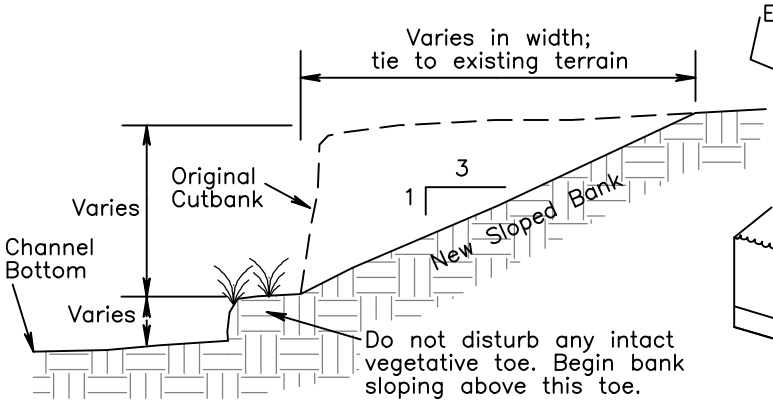


Hand Compaction around the pipe is essential through the fill.

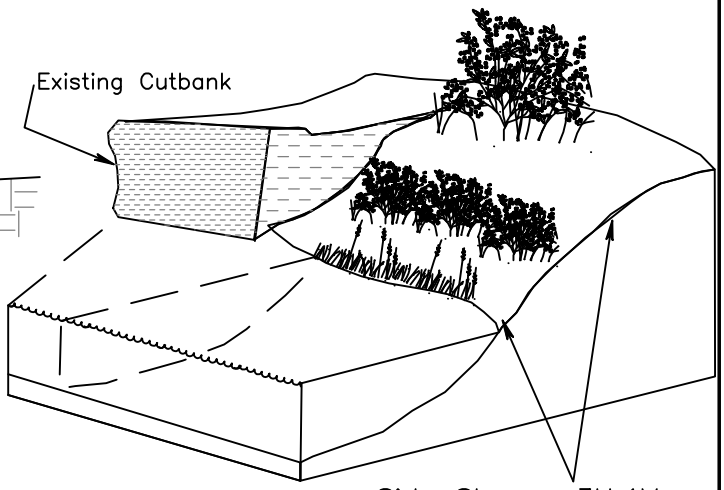
Required Storage Volume: _____ Cu. Ft.

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: WASCOB		DATE April 2011
			REVISION DATE
			BMP NO. 14

BANK SLOPING - SEEDING - FABRIC OR MULCH

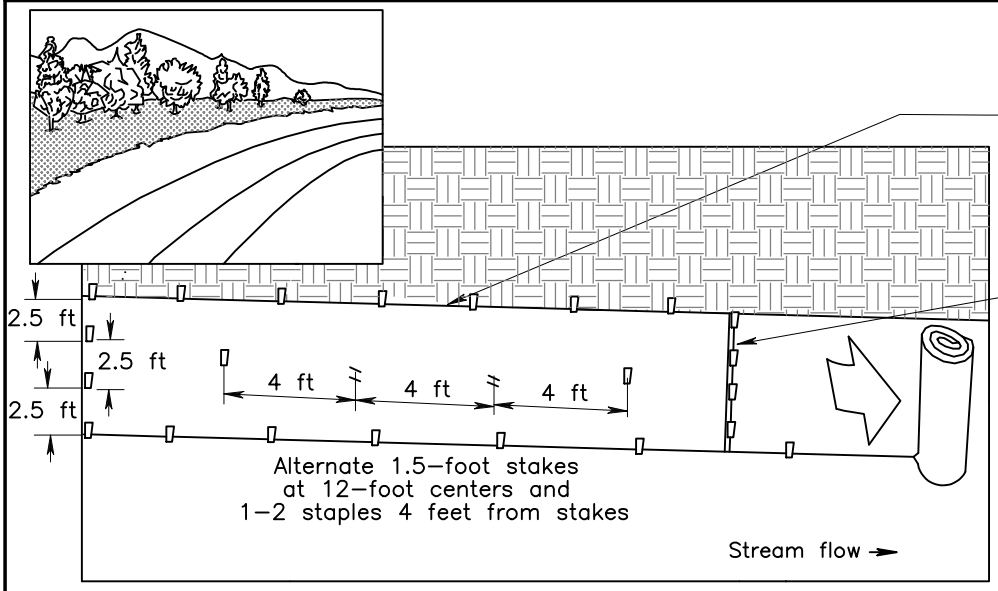


SECTION VIEW OF TOE
(Not to Scale)

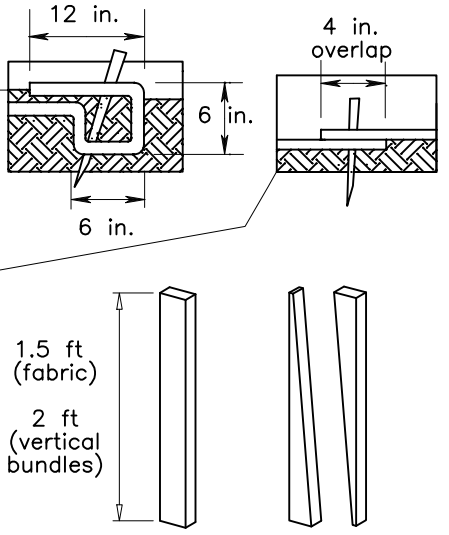


ISOMETRIC VIEW
(Not to Scale)

Side Slopes: 3H:1V
(Optimim slope angle
for vegetative growth:
2H:1V to 10H:1V)



EROSION CONTROL FABRIC: SLOPE INSTALLATION DETAIL
(NOT TO SCALE)



DEAD STOUT STAKES

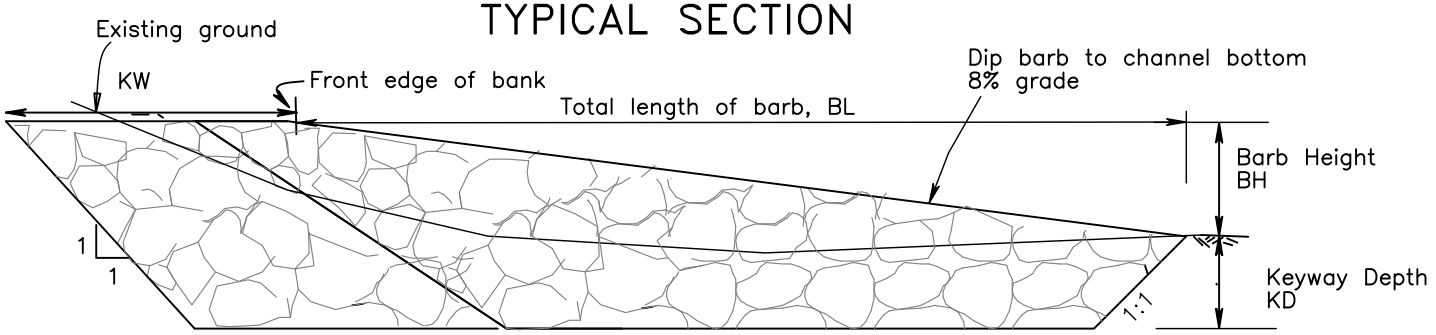
BANK SLOPING NOTES

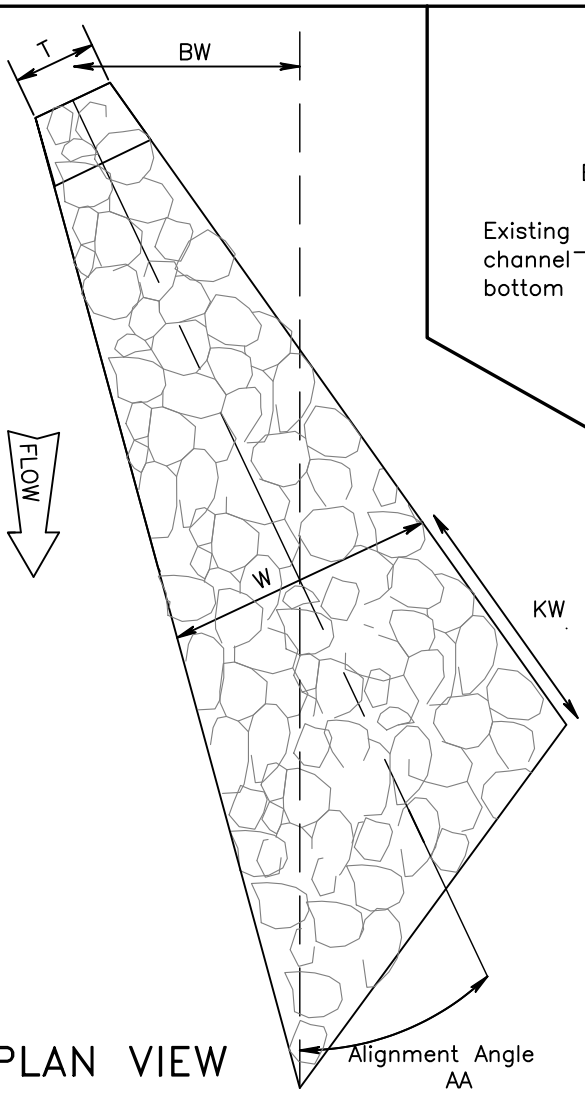
- Slope bank to angle between 2:1 and 10:1 to optimize vegetative growth.
- Do not disturb any intact vegetation at toe of bank.
- Install plantings.
- Install erosion control fabric, opening holes for plantings where neccessary.
- Secure edges and ends with stakes.

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Bank Sloping - Seeding - Fabric/Mulch		DATE April 2011
			REVISION DATE
			BMP NO. 15

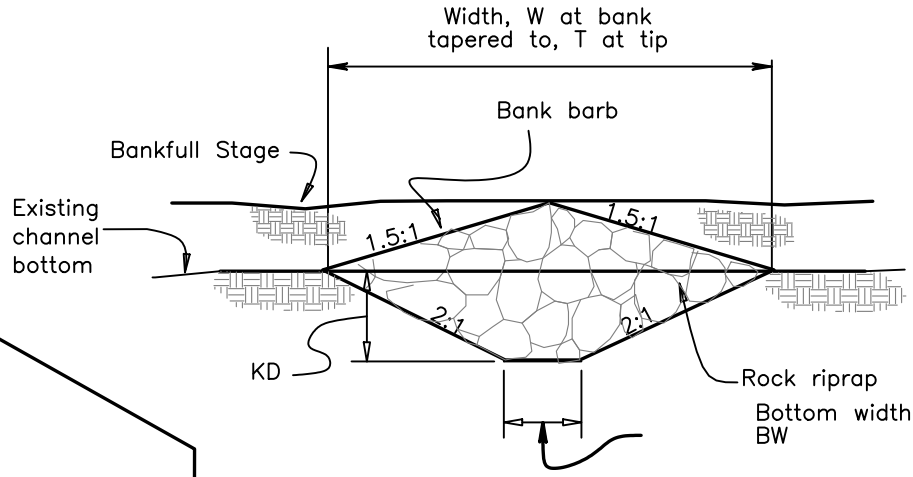
ROCK STREAMBARB

TYPICAL SECTION





PLAN VIEW



CROSS–SECTION
AT BANK
(Not to Scale)

NOTES

1. Use well–graded, angular rock with bulk specific gravity greater than 1.7
2. Rock riprap shall conform to the following gradation:

% Passing Dry Wt. Basis	Size Opening (inches)
100	
50	
min	

DIMENSIONS

KW ____ ft
BL ____ ft
BH ____ ft
KD ____ ft
BL ____ ft
W ____ ft
T ____ ft
AA ____ ft

(Not to Scale)

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

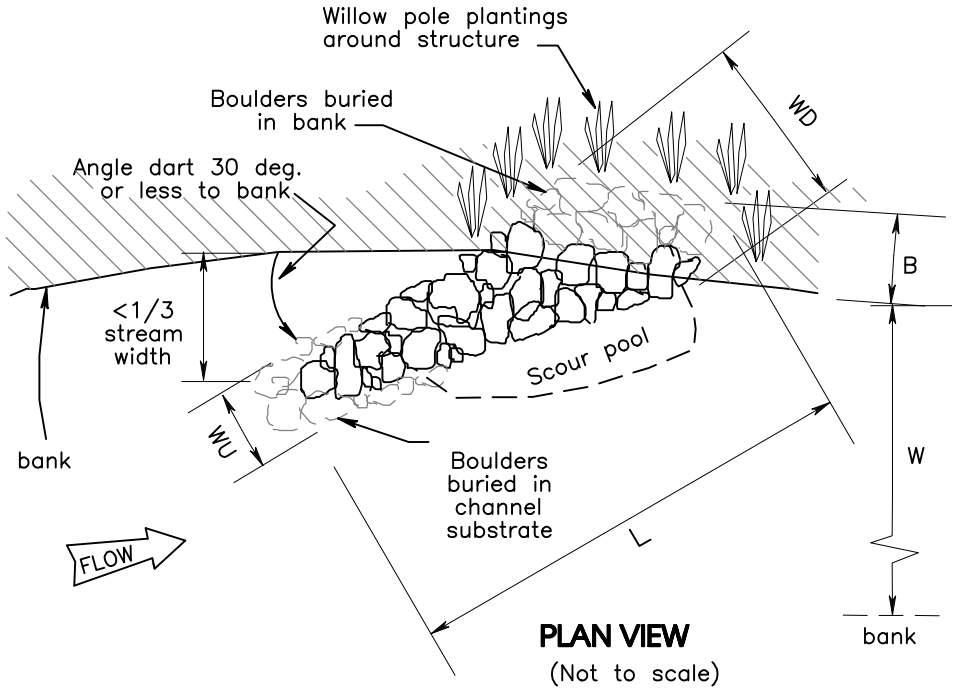
DETAIL:
Rock Streambarb

Preliminary
Not For
Construction

DESIGN BY: S.Yard
DATE April 2011
REVISION DATE
BMP NO. 16

BOULDER DART

Provides habitat and bank protection, breaks up high velocities along outside of meander and creates small scour holes with verticle cover



PLAN VIEW
(Not to scale)

DIMENSIONS

D = _____ (ft)

L = _____ (ft)

B = _____ (ft)

W = _____ (ft)

WU = _____ (ft)

WD = _____ (ft)

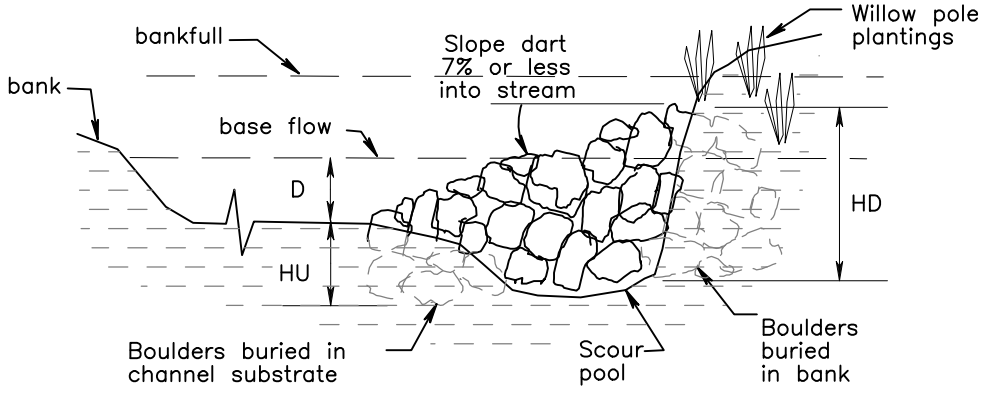
HU = _____ (ft)

HD = _____ (ft)

BOULDERS

Dia = _____min(in) _____max(in)

# of rocks per structure _____



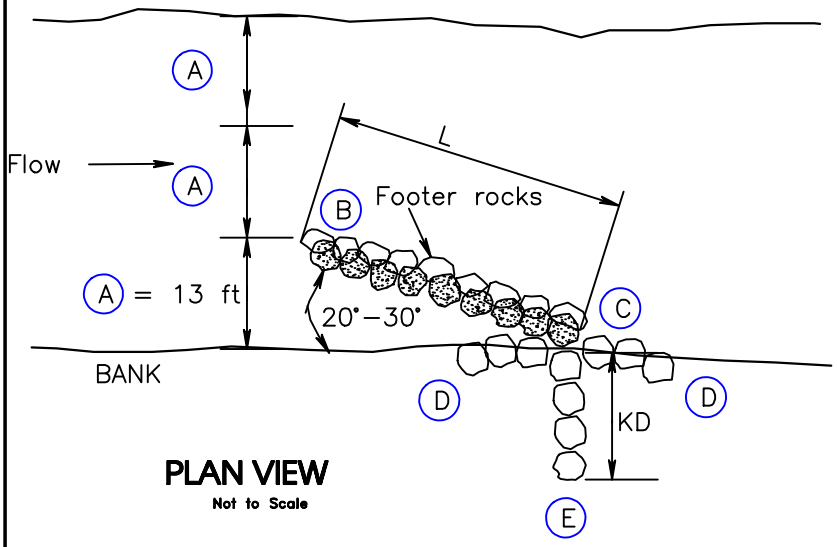
SIDE VIEW
(Not to scale)

GENERAL NOTES

1. Bury boulders at ends in substrate and in bank for tie–in.
2. Angle structure upstream at 30 deg. or less sloping from bankfull height or less at 7 deg.
3. Plant willow pole clusters in bank around structure.
4. Dig out downstream side to initiate scour pool developement.
5. This standard drawing requires supporting technical documentation prior to use and must be adapted to the specific site.

(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Boulder Dart		DATE April 2011
			REVISION DATE
			BMP NO. 17

ROCK VANE

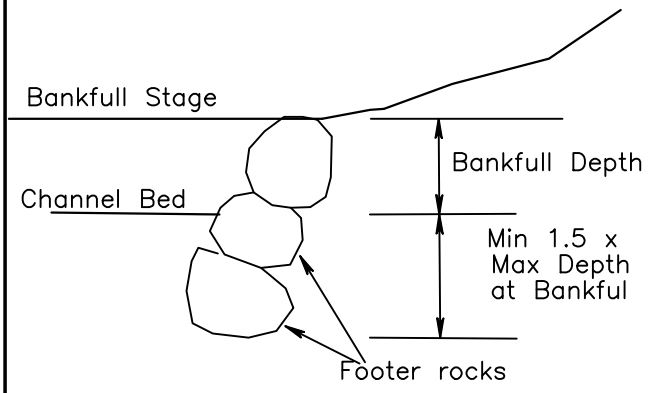


PLAN VIEW
Not to Scale

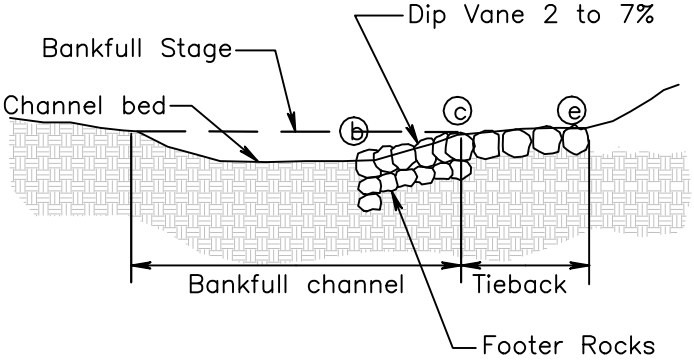
(A) 1/3 Bankfull Channel Width (max)
(B) Top Rock at Bed Elev
(C) Top Rock at Bankfull Elev
(D) Optional Toe Rock – Length Varies
(E) Tieback at Floodplain Elev

VANE DIMENSIONS
Bankfull Channel Width = _____ ft
Bankfull Depth = _____ ft
Floodplain Elevation = _____ ft
A _____ ft
B _____ ft
C _____ ft
D _____ ft
E _____ ft
L _____ft
KD _____ft

TOE ROCK
at Rock Vane or Cross-Vane Weir



CROSS-SECTION
Not to Scale



CROSS-SECTION
Not to Scale

SPECIFICATIONS FOR ROCK VANE & TOE ROCK

Rock Vane: min. dia. _____ ft
Footer Rocks: min. dia. _____ ft

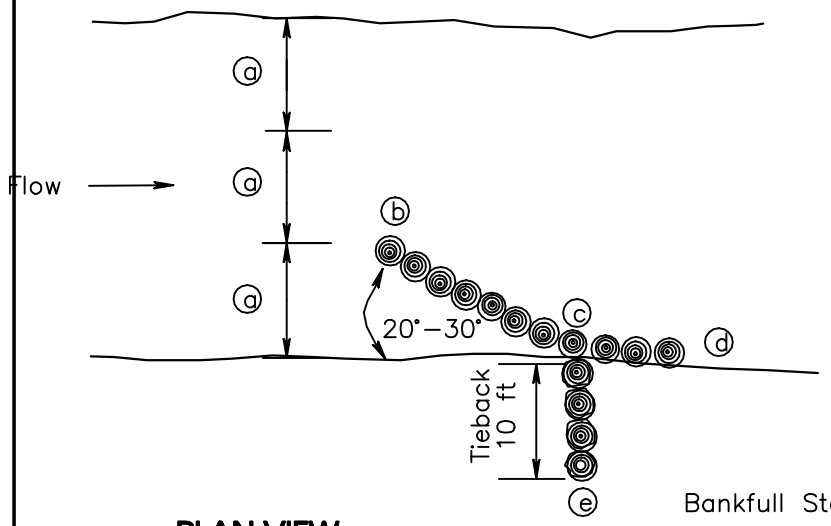
Angular rock with specific gravity > 1.7

NOTE: Toe rock shall be tied a minimum of one rock diameter into bank at upstream and downstream ends.

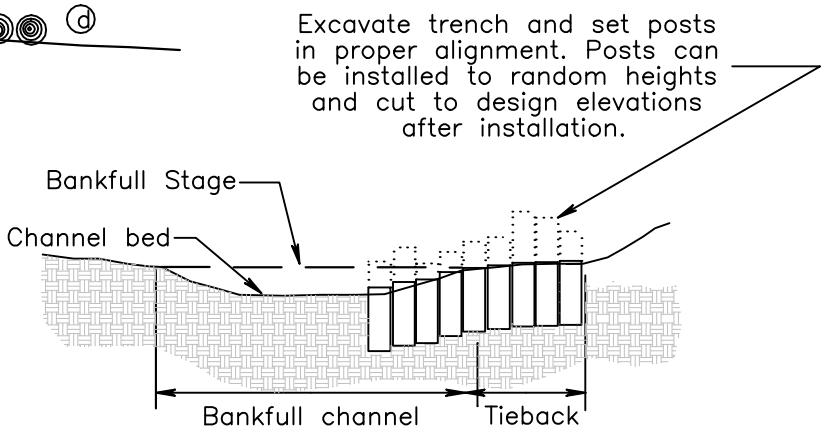
(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Rock Vane		DATE April 2011
			REVISION DATE
			BMP NO. 18

POST VANE

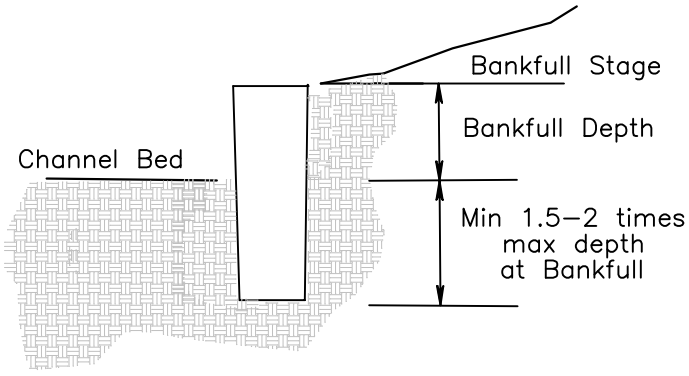
ⓐ 1/3 Bankfull Channel Width (max)
ⓑ Top Post at Channel Bed Elev
ⓒ Top Post at Bankfull Elev
ⓓ Optional Toe Posts or Toe Rock
ⓔ Tieback at Floodplain Elev



PLAN VIEW
Not to Scale



CROSS-SECTION
Not to Scale



TOE POST CROSS-SECTION
Not to Scale

SPECIFICATIONS FOR POST VANE

Minimum diameter 6–inch post set in trench

Post Material is Locally Available Tree Species Prefereably a Decay Resistant Species

Minimum Diameter 6 inches (Depending on Size of Stream)
Posts extend below Stream Bed 2X Max Depth at bankfull

Posts installed upside down to prevent resprouting if using invasive, non–native species

(Not to Scale)
Adapted From Zeedyk

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

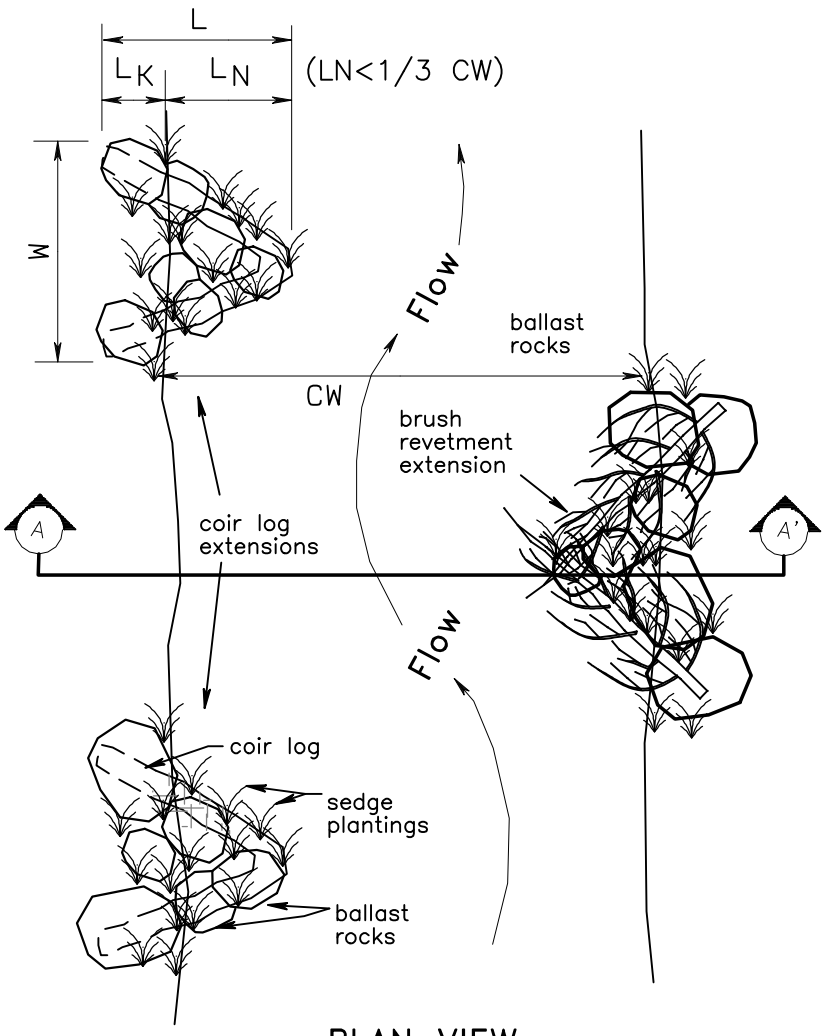
DETAIL: Post Vane

Preliminary Not For Construction

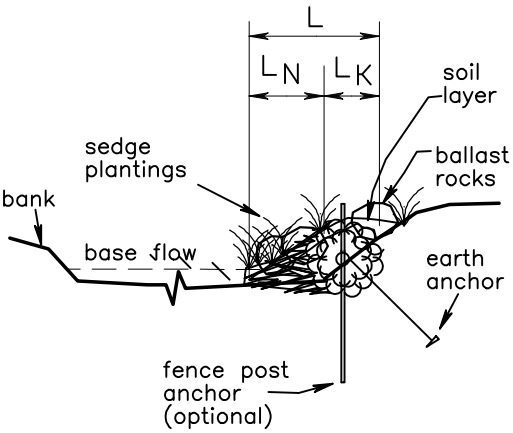
DESIGN BY: S.Yard
DATE April 2011
REVISION DATE
BMP NO. 19

VEGETATED TOE EXTENSION

Provides low water depth and cover



PLAN VIEW
(Not to scale)



SECTION A–A' VIEW
Brush Revetment Extension
(Not to scale)

NOTE: Same layering applys for coir log extension: Anchored coir log, ballast rock, soil, sedge plantings

DIMENSIONS

CW _____ (ft) L _____ (ft)

W _____ (ft) L_N _____ (ft)
(<1/3 CW)

L_K _____ (ft)

BOULDERS

Dia = _____min(in) _____max(in)

# of rocks per structure _____

COIR LOGS

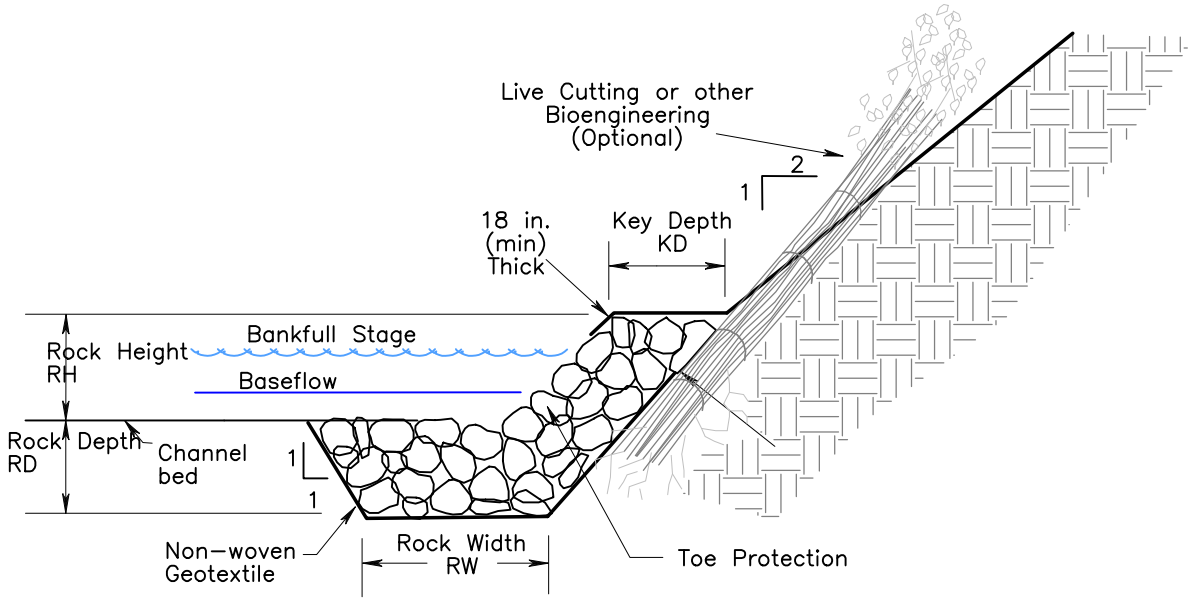
Diameter _____(in) Length _____ (ft)

GENERAL NOTES

- Used to constrict low water flow which would ordinarily spread over bar in a thinner sheet, unusable by adult fish.
- Captures fine sediments and builds out toe of bank.
- Install in alternating pattern in low slope riffles or runs which are wide and shallow.
- Install brush revetment or coir log, anchored with buried boulders.
- May require additonal earth anchor or fence posts to secure brush or coir log.
- Plant with sedges and/or deer grass.
- May need to add some starter material to plant in, or let revetment catch sediment, then plant during next season.
- This standard drawing requires supporting technical documentation prior to use and must be adapted to the specific site.

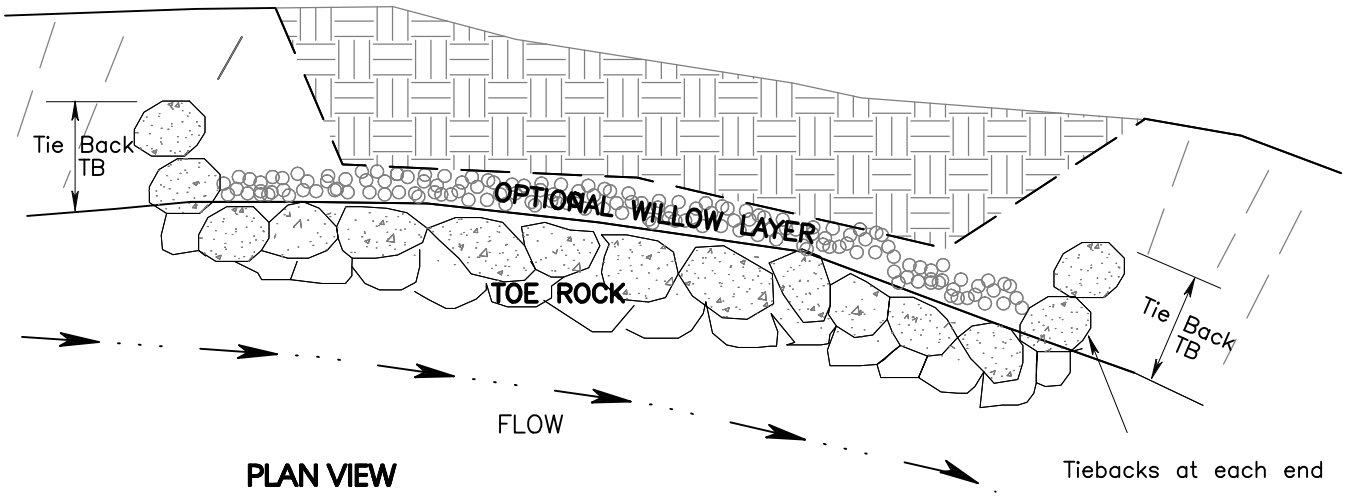
(Not to Scale)	**Coyote Creek Best Management Practices**	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	**DETAIL: Vegetated Toe Extension**		DATE April 2011 REVISION DATE BMP NO. 20

TOE ROCK WITH OPTIONAL BRUSH TRENCH



TYPICAL TOE ROCK SECTION

(Not to Scale)



PLAN VIEW

(Not to Scale)

Tiebacks at each end

Note:
Rooted/leafed condition of the living plant material is not representative of the time of installation. See SHEET 8 for willow bundle installation detail.

DIMENSIONS

RH _____ ft

RD ___ ft

RW _____ ft

KD _____ ft

TB _____ ft

ROCK SPECIFICATIONS

Use well–graded, angular rock with bulk specific gravity greater than 2.5

Rock Riprap Rocks: Dmin = 3 in.
D50 = 9 in.
Dmax =15 in.

(Not to Scale)

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL: Toe Rock with Willow Trench (optional)

Preliminary Not For Construction

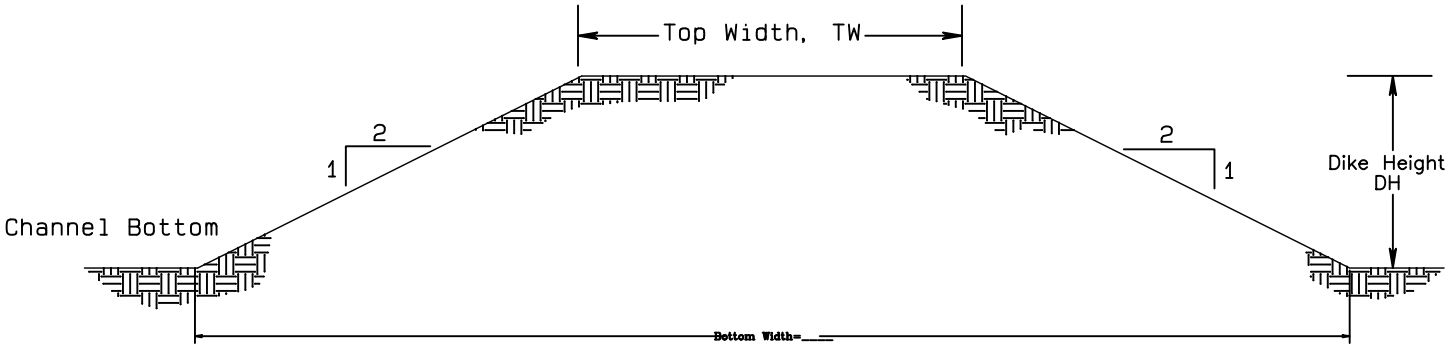
DESIGN BY: S.Yard

DATE April 2011

REVISION DATE

BMP NO. 21

DIKE

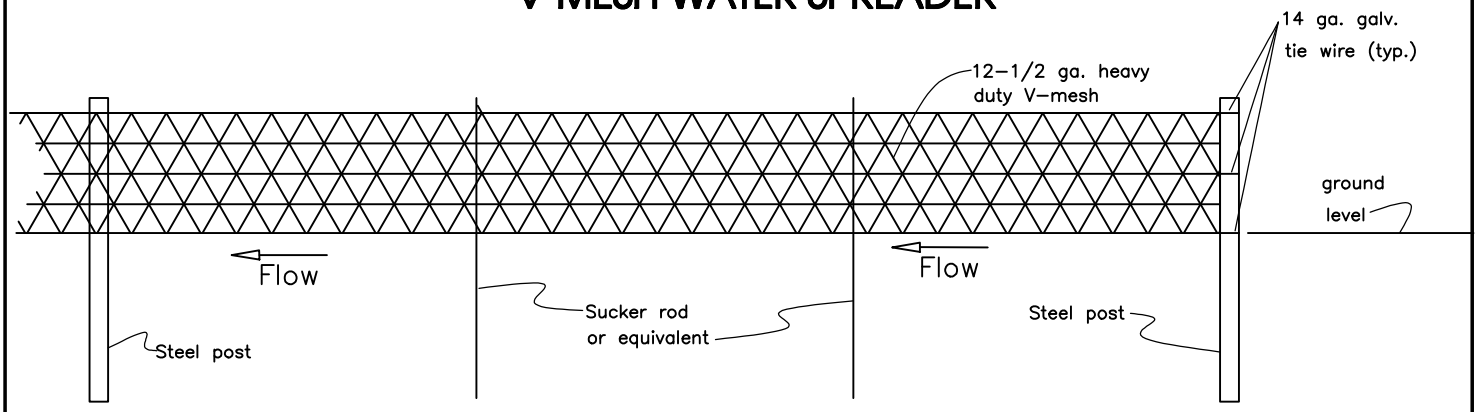


DIKE CROSS–SECTION

NOTES:
1. Embankment material shall be placed in lifts no greater than 4 in. thickness before compaction if a tracked vehicle is used for compaction.
2. Maximum layer thickness shall be 6" prior to compaction if a rubber–tired vehicle is used for compaction.
3. Equipment shall pass over entire surface of lift before next lift is placed.
4. The stream side of dike shall be protected with rock barbs and vegetation
5. If necessary top soil shall be spread over dike in order to establish the required vegetation.

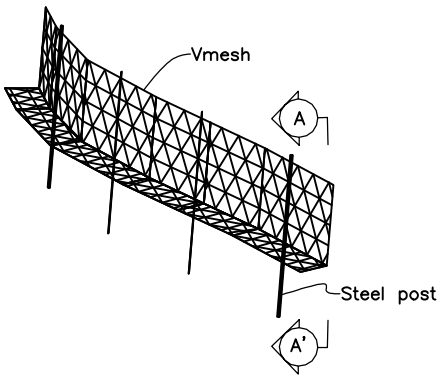
(Not to Scale)	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Dike		DATE April 2011 REVISION DATE BMP NO. 22

V-MESH WATER SPREADER

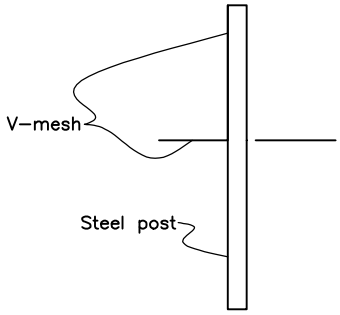


TYPICAL V–MESH SPREADER

Not to Scale



ISOMETRIC VIEW



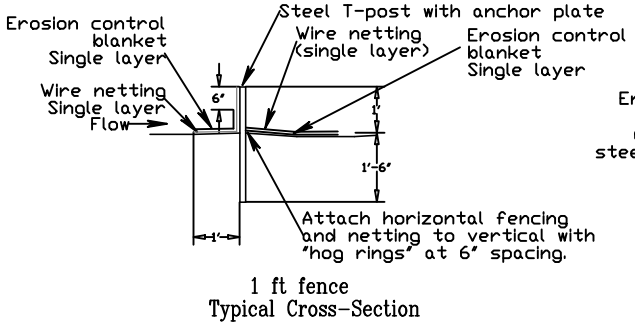
SECTION A–A'

DESIGN AND INSTALLATION GUIDELINES

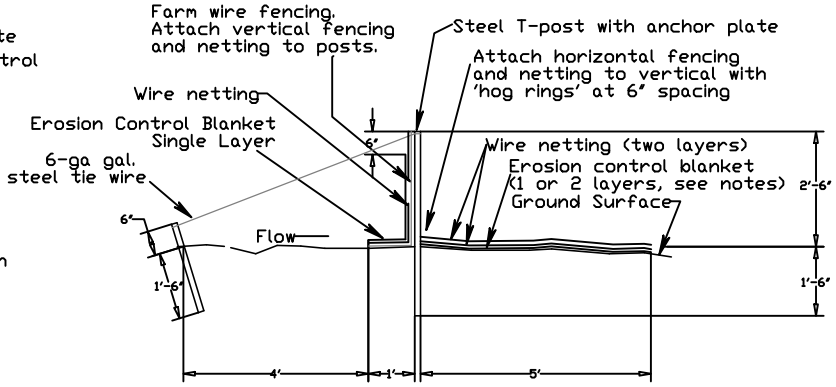
1. The purpose of V Mesh Spreaders is to prevent concentration of runoff from causing rills, gullies, and headcuts. The spreader acts to slow the runoff, at a slower, non–erosive rate. Spreaders can be used to:
   ––Stabilize the flow from emergency spillways
   ––Stabilize headcuts by rerouting flow
   ––Prevent concentration and channeling of runoff from roads, kickouts, etc.
   ––Prevent concentration of flow on rangelands and forestlands
2. Spreaders induce vegetative growth by increasing the infiltration of runoff into the ground.
3. Height of wire can vary from 1–2 ft.
4. Selection of the proper grade is the critical design parameter. The grade along the alignment can vary from 0–4% (0–4 ft per 100 ft)
   A. When crossing the draw, the alignment grade is at least 1/2 of draw slope.
   B. When the cross slope is 2% or greater, the grade shall not exceed 1/2 of the cross slope, once the alignment is out of the draw.
   C. When picking up water from emergency spillways, diversions, grassy draws, or swales, the grade must be sufficient to prevent silt buildup but catches trash. It is critical to have an accurate staked alignment.
   D. For the first 50 to 100 ft of spreader, it is common in the mountain areas to begin with a grade of 2–3 ft. per 100 ft, then 0.5 ft per 100 ft, then end with 0 ft per 100 ft.
5. When used for emergency spillways, the top of the spreader shall be 0.5 ft lower than the crest of the spillway.
6. Spreaders shall not be installed on sandy soils which produce a lot of sediment or are subject to wind erosion.
7. Errors in staking and/or construction can usually be corrected by pulling up the spreader intact and changing the grade.
8. When crossing a dip, rill, or concentrated flow area, the spreader needs to the "away" grade, and/or increase the height of spreader wire and posts through the low area in order to keep the top of the spreader level.

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: V-Mesh Water Spreader		DATE April 2011 REVISION DATE BMP NO. 23

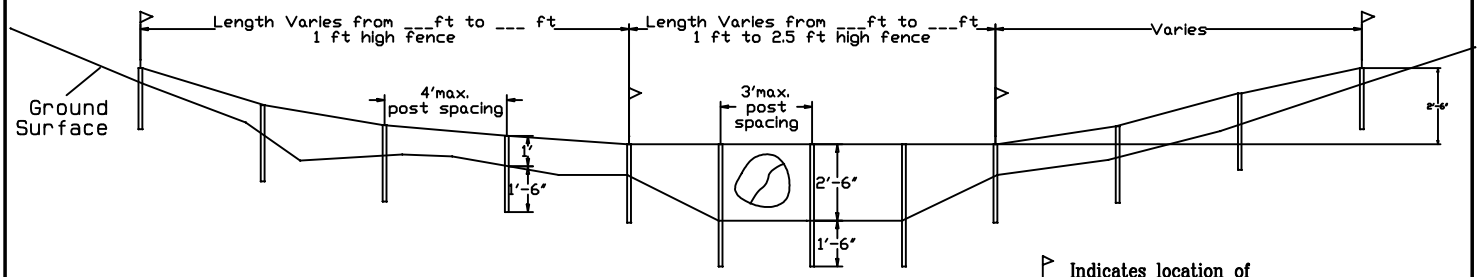
SEDIMENT FENCE



1 ft fence
Typical Cross-Section

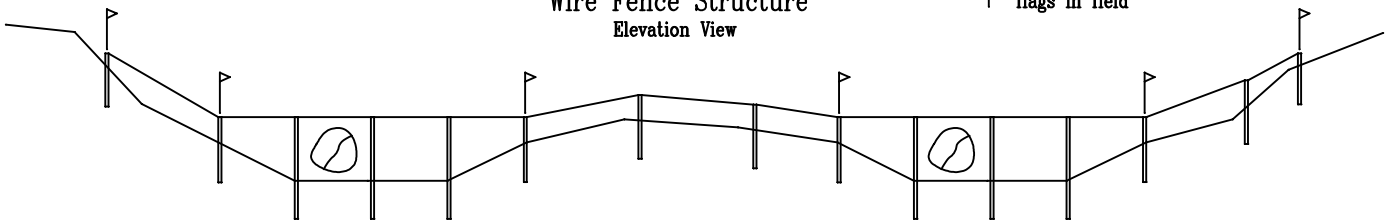


1 ft to 2.5 ft fence
Typical Cross-Section



Wire Fence Structure
Elevation View

Indicates location of flags in field



Wire Fence Structure Multiple Gully
Elevation View

Materials Used

1. Erosion Control Blanket
   North American Green Product
   C-125 Coconut fiber blanket or
   P-300 Nylon Blanket
2. Type 1, T-section steel posts, 5 feet long shall be used.
3. Fencing shall be galvanized steel, meeting requirements of ASTM Standard A-116. Vertical fencing shall be woven Wire, design No. 939-6-12.5 (Farm Fence) with a minimum of 9 line wires and is 39" in height. Maximum spacing of stay wires is 6". Intermediate line wires and stay wires shall be 12.5 gage or heavier.
4. Wire netting shall be galvanized steel mesh. The wire shall be 0.0475 inch diameter or larger. The maximum opening shall be 1.5 inches.

Construction Notes

1. Steel posts shall be driven so anchor plates are below ground and to the depth specified. Posts shall be trimmed to the height shown on drawings.
2. Wire fencing shall be tied together with wire ties at 2 foot intervals.
3. Erosion control blanket shall be tied to fencing at 2 foot spacing along the edges.
4. Erosion control blanket shall be a double layer of C-125 or a single layer of P-300.
5. Anchor fencing and netting to ground using 1/8" dia, 9" long staples at 4' maximum spacing. Use #3 rebar bent into a hook at corners and overlaps.
6. Splices in the erosion control blanket shall have a minimum overlap of 6".

(Not to Scale)
Adapted From NRCS Drawings

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL: Sediment Fence

Preliminary Not For Construction

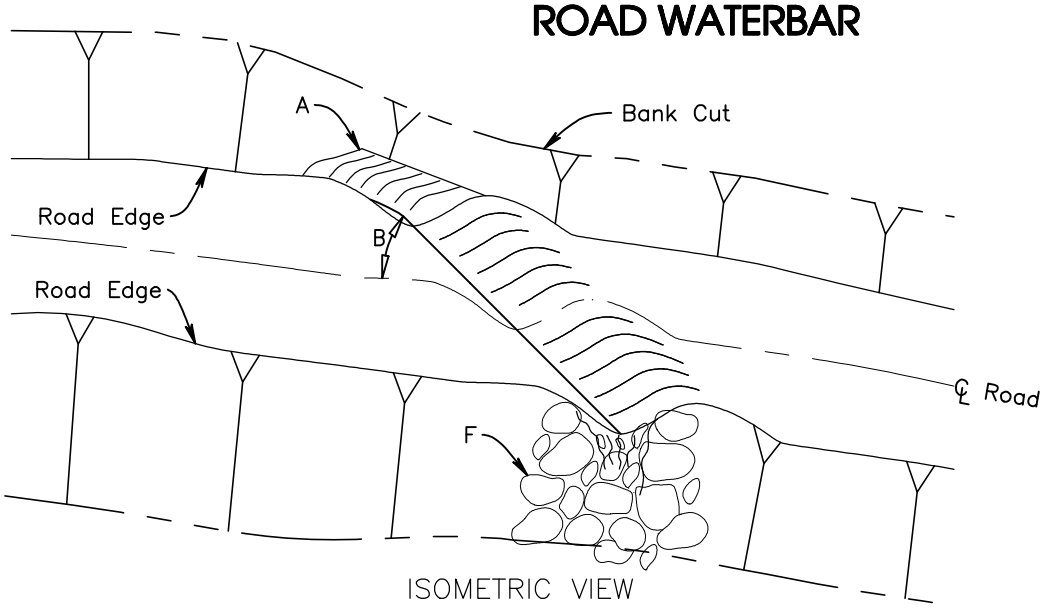
DESIGN BY: S.Yard

DATE April 2011

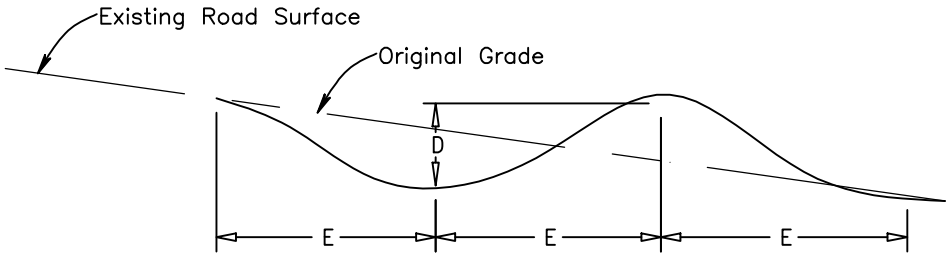
REVISION DATE

BMP NO. 24

ROAD WATERBAR



ISOMETRIC VIEW



WATER SECTION VIEW

Road Slope (%)	D–(ft)	F–(ft)
2–3	1.3	1.0
4	2.0	1.4
5	2.3	1.8
6	2.7	2.0
7	3.0	2.3
8	3.5	2.8

Water bar construction for forest or ranch roads, firebreaks, stocktrail and walkways. Specifications are typical, adjust to site conditions.

A: Bar fill extends to Bank Cut slope

B: Angle drain 30° degrees from U+2104 of road

D: Depth 1 ft maximum

E: 3 ft to 4 ft minimum

F: Erosion protected constructed outlet.

_____ Yes _____ No

Outlet Material

Materials _____

Thickness _____

Design length _____

Constructed angle _____

Constructed depth _____

1. Water Bars to be spaced at maximum of 10 ft of elevation change between each one.
2. Specifications are typical, adjust to site conditions.

NOTES:

. This standard drawing requires supporting technical documentation prior to use and must be adapted to the specific site.

. Outlets will be free of woody debris, dams, or any obstructions that prohibit drainage from the lower end of the waterbar.

. Use 3" angular rock riprap where necessary for outlet.

. Disturbed areas and slopes shall be seeded and mulched to grass upon completion.

Seeding Species _____

Seeding Rate_____Lbs. PLS/AC

(Not to Scale)
Adapted From NRCS Drawings

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL: Road Waterbar

Preliminary Not For Construction

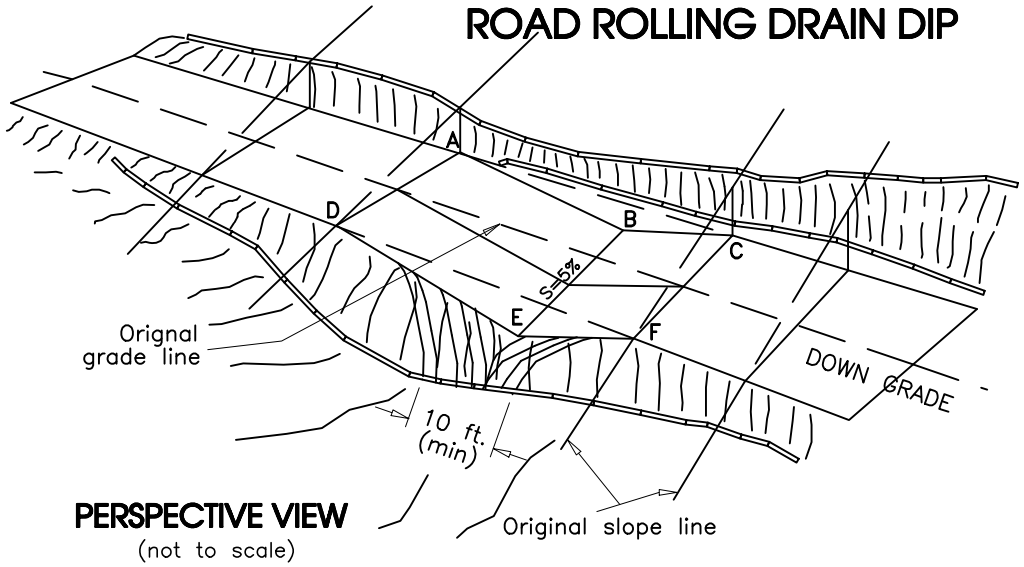
DESIGN BY:

DATE

REVISION DATE

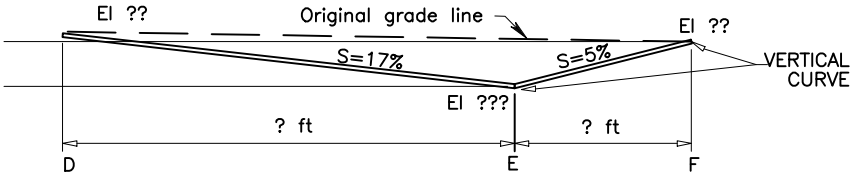
BMP NO. 25

ROAD ROLLING DRAIN DIP

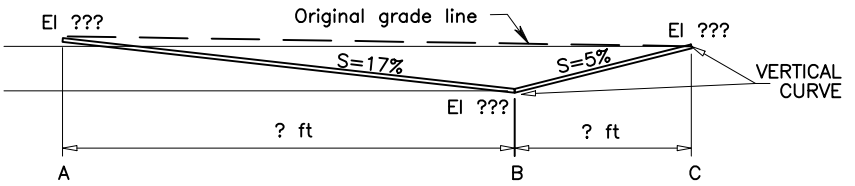


PERSPECTIVE VIEW
(not to scale)

Road Slope (%)	D–(ft)	F–(ft)
2–3	1.3	1.0
4	2.0	1.4
5	2.3	1.8
6	2.7	2.0
7	3.0	2.3
8	3.5	2.8

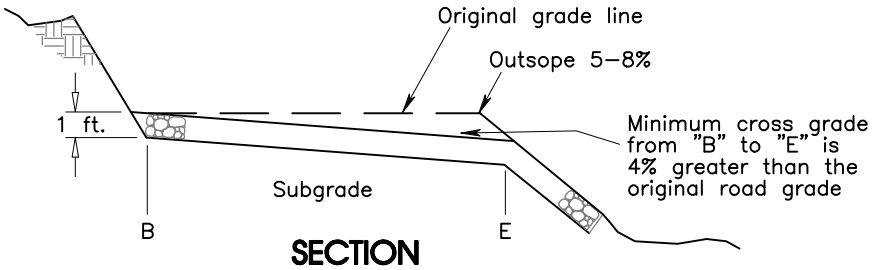


Road Profile Along D–E–F of Draing Dip



Road Profile Along A–B–C of Drain Dip

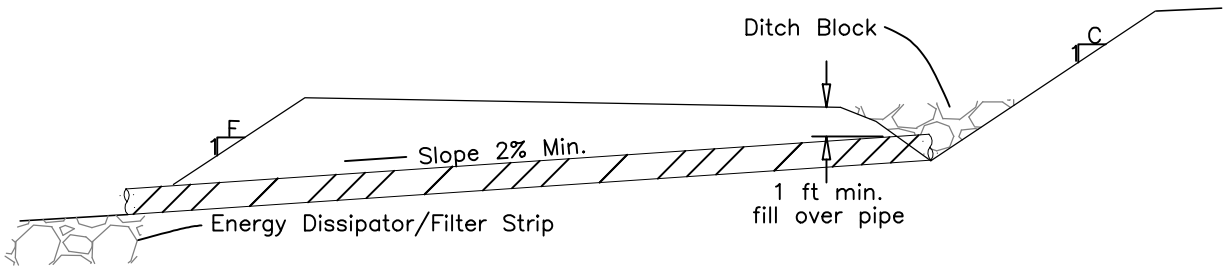
PROFILES
(not to scale)



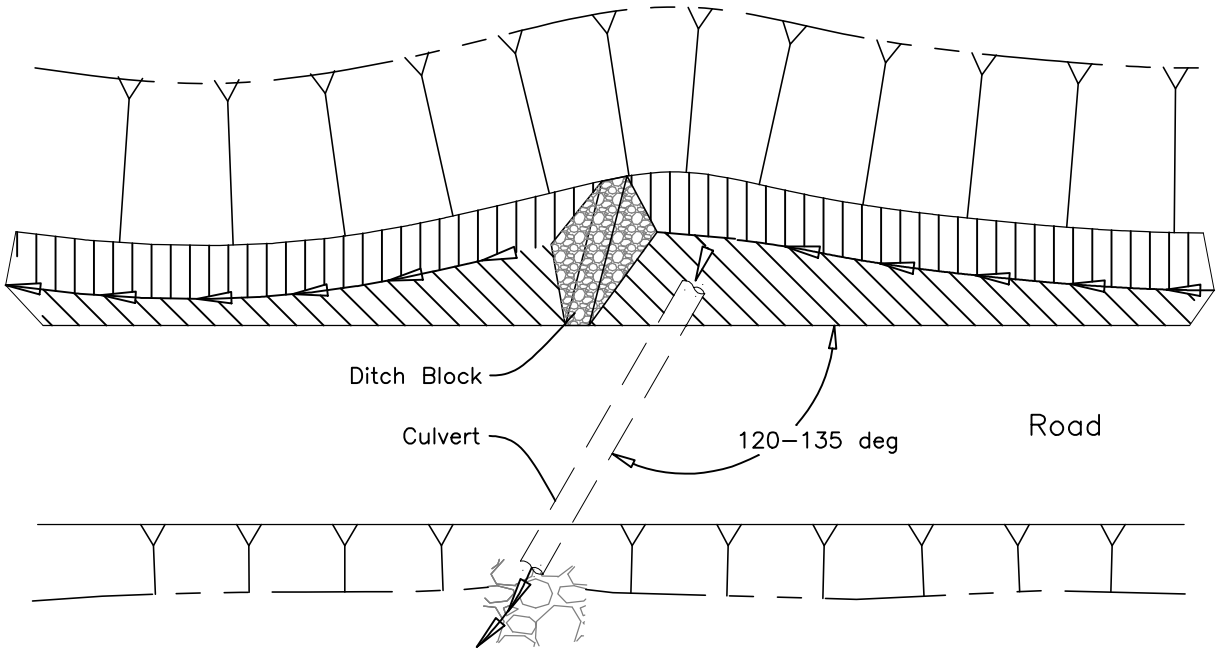
SECTION
(not to scale)

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard DATE April 2011 REVISION DATE
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Road Rolling Drain Dip		BMP NO. 26

ROAD CROSS DRAIN/CULVERT



CROSS SECTION



PLAN VIEW

NOTES:

1) Minimum cover over culvert is 1 ft.
2) Spacing and size of relief culverts to be based on local conditions
3) Disturbed areas and slopes shall be seeded and mulched to grass upon completion.
4) Culvert outlet to be directed across a vegetated area for filtering out sediment and away from wetlands and streams.
5) Use rock riprap where necessary for erosion protection at outlet.
6) Minimum culvert diameter 18" in Western WA 15" in Eastern WA.

Culvert Diameter _____ (in.)
Culvert Length _____ (ft)
Culvert Material _____

Cut Side Slope(C) ___ :1
Fill Side Slope (F) ___ :1

Seeding Species _____

Seeding Rate _____ Lbs. PLS/AC

Outlet Rip Rap
Rip Rap Diameter _____
Depth _____

(Not to Scale)
Adapted From NRCS Drawings

Coyote Creek Best Management Practices

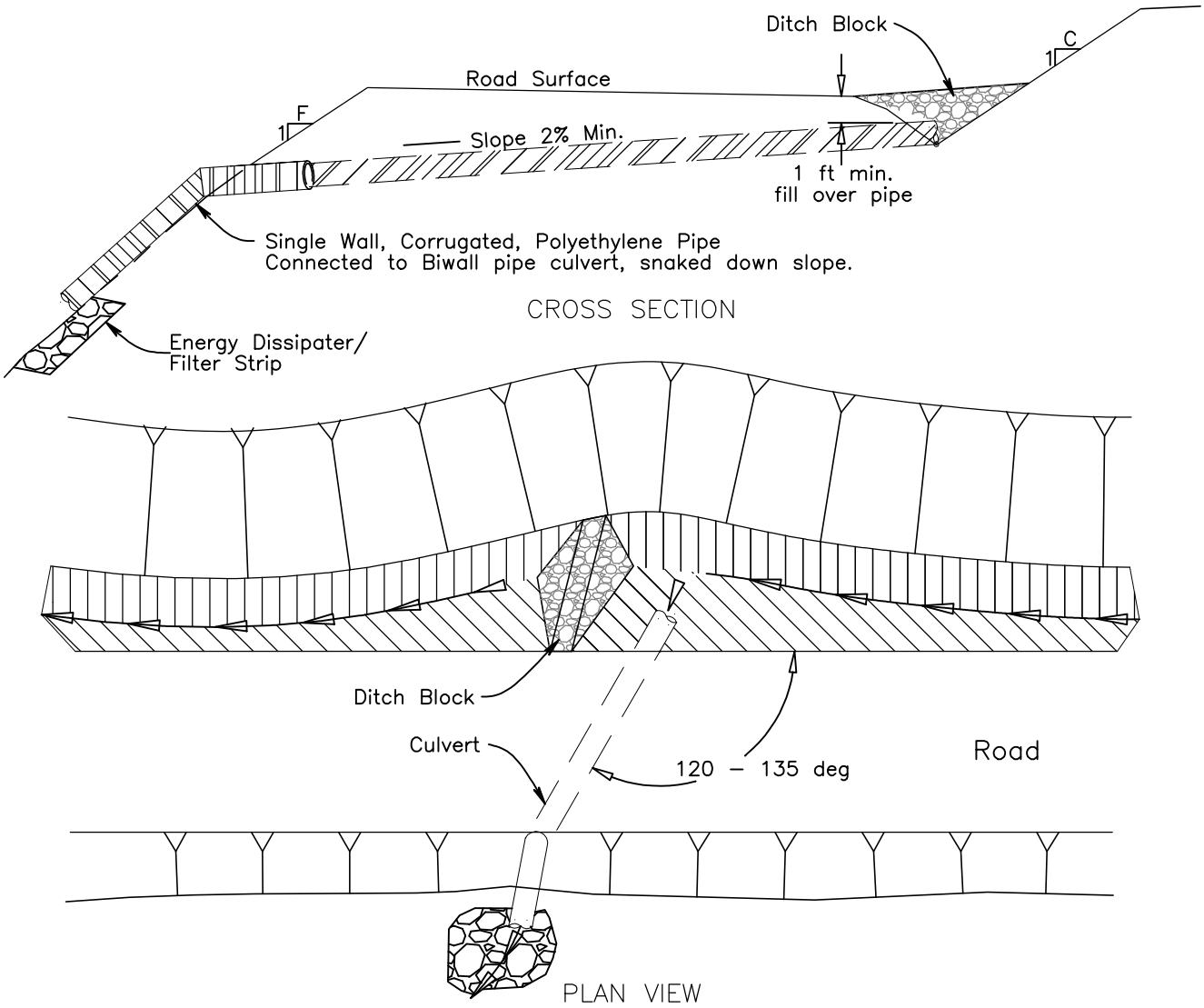
Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL: Road Cross Drain Culvert

Preliminary Not For Construction

DESIGN BY: S.Yard
DATE April 2011
REVISION DATE
BMP NO. 27

ROAD CROSS DRAIN WITH DOWNSPOUT



NOTES:

1) Minimum cover over culvert is 1 ft.
2) Spacing and size of relief culverts to be based on local conditions
3) Disturbed areas and slopes shall be seeded and mulched to grass upon completion.
4) Culvert outlet to be directed away from direct discharge into wetlands and streams.
5) Use rock riprap where necessary for energy dissipater at outlet
6) Anchor downspout where stability is necessary using rock or treated posts.

Culvert Diameter _____ (in)
Culvert Length _____ (ft)
Culvert Material _____

Downspout Length _____ (ft)
Downspout Material _____

Cut Side Slope(C) ___ :1
Fill Side Slope (F) ___ :1

Seeding Species _____
Seeding Rate _____ Lbs. PLS/AC

Energy Dissipater Rip Rap
Rip Rap Diameter _____ (ft)
Depth _____ (ft)

(Not to Scale)
Adapted From NRCS Drawings

Coyote Creek Best Management Practices

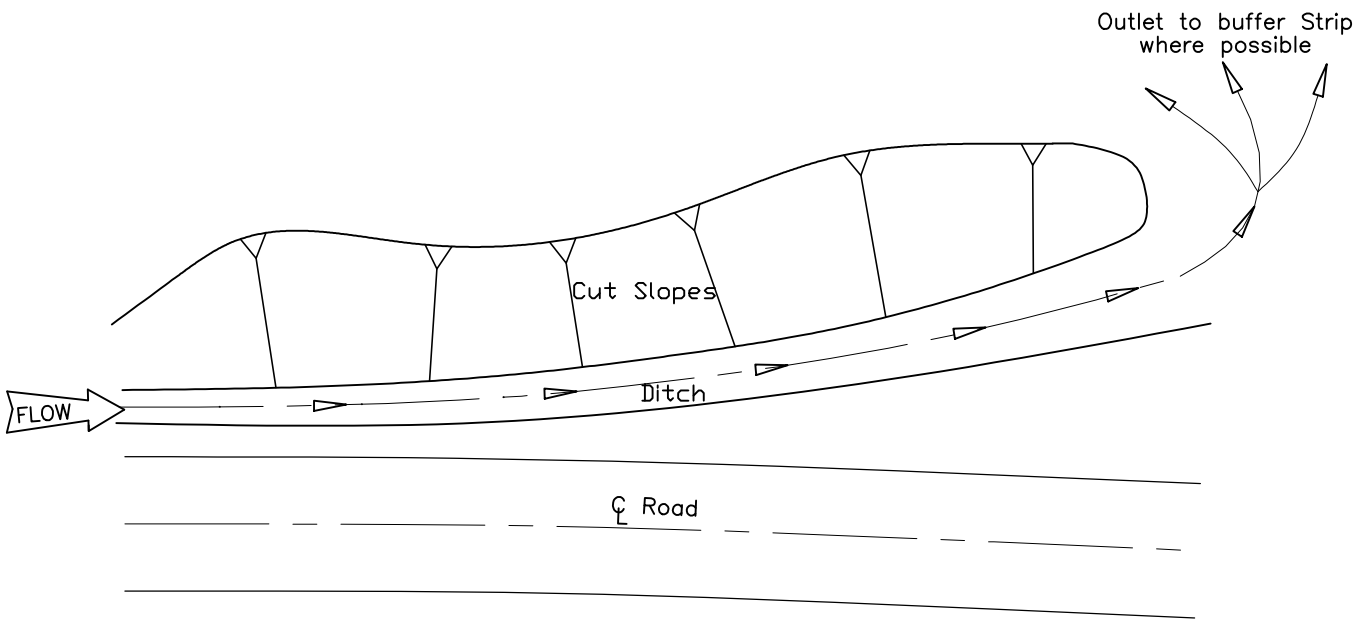
Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL: Road Cross Drain with Downspout

Preliminary Not For Construction

DESIGN BY: S.Yard
DATE April 2011
REVISION DATE
BMP NO. 28

ROAD DITCH OUTLET



PLAN VIEW

Length _____ (ft) Spacing (maximum) _____ (ft) Slope (maximum) _____ (%)

NOTES:

. This standard drawing requires supporting technical documentation prior to use and must be adapted to the specific site.

. Locate Ditch Out off of road prism where terrain allows ditch water to be drained away from road on same side the ditch is on.

. Ditch Outs should not be used where water will drain toward fill or sidecast material, unstable slopes or directly into a stream or wetland.

. Slope and length of Ditch Out to be based on local conditions and site. Energy dissipater may be necessary if a stable outlet is not available.

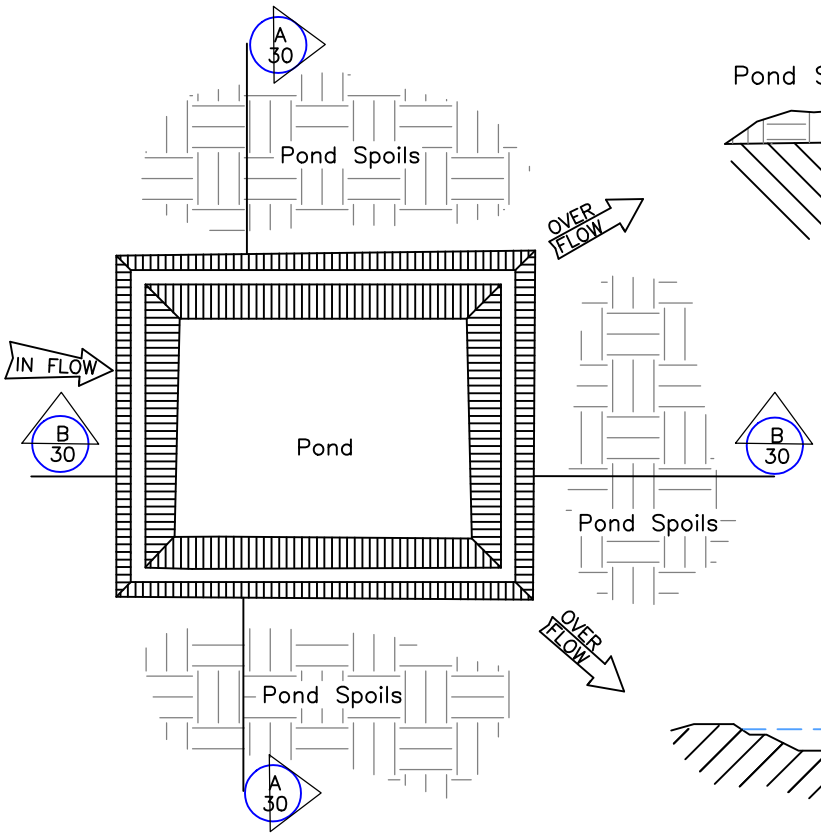
. Disturbed areas and slopes shall be seeded and mulched to grass upon completion.

Seeding Species _____

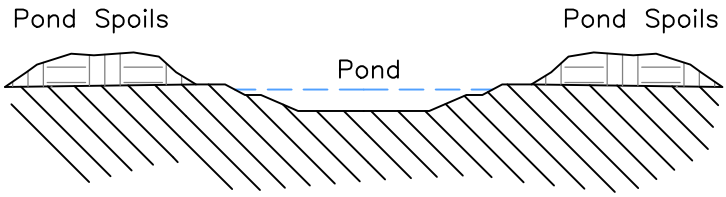
Seeding Rate _____ Lbs. PLS/AC

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Road Ditch Outlet		DATE April 2011
			REVISION DATE
			BMP NO. 29

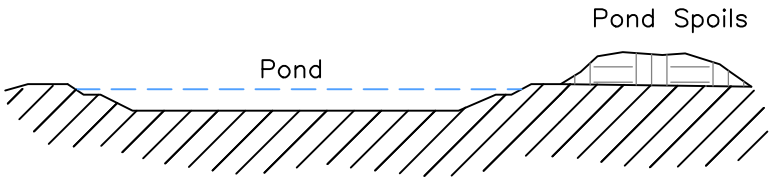
POND



POND PLAN VIEW



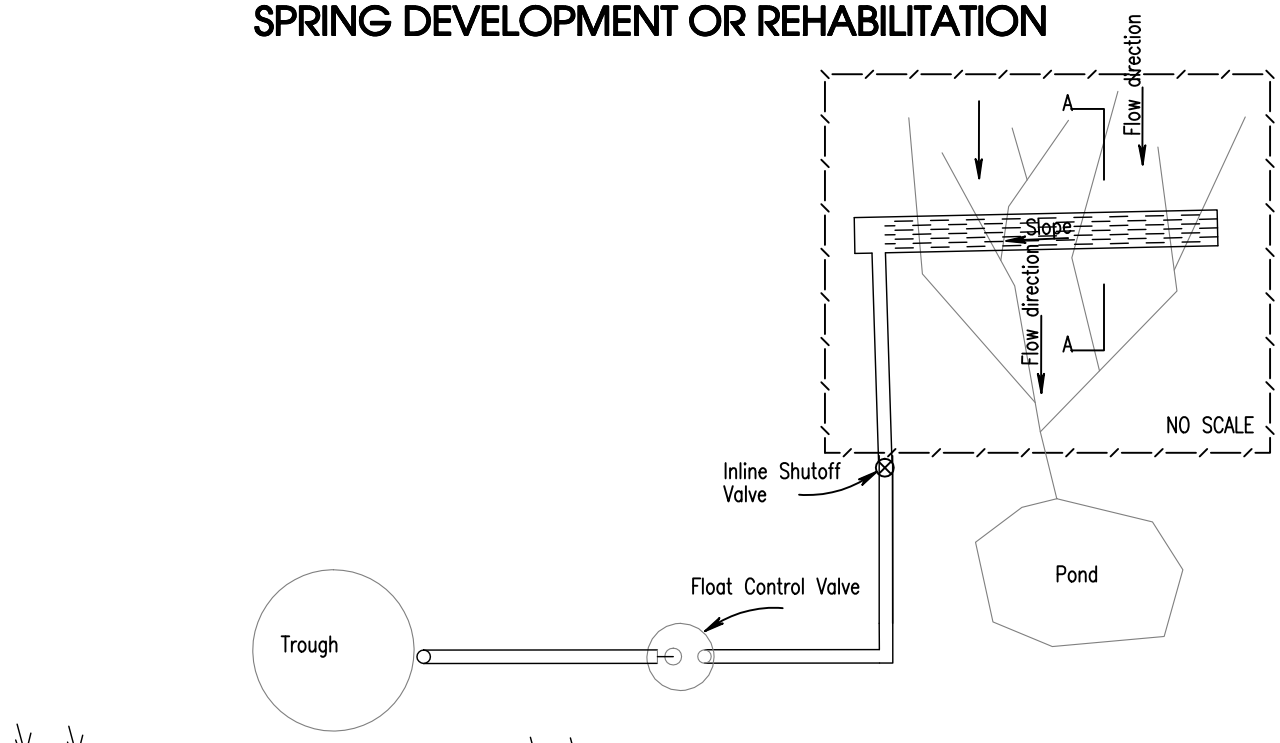
SECTION A 30

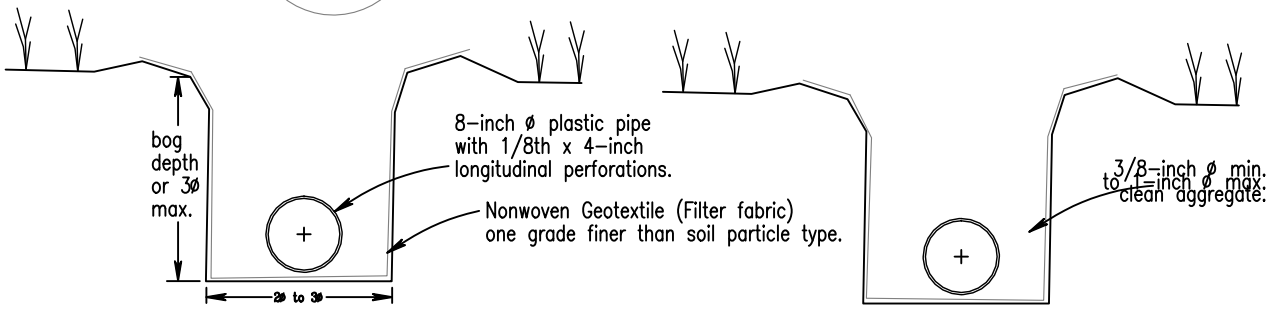


SECTION B 30

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Pond		DATE April 2011
			REVISION DATE
			BMP NO. 30

SPRING DEVELOPMENT OR REHABILITATION

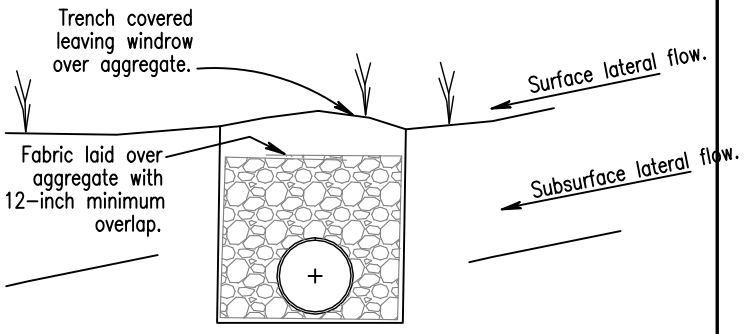




Step 1 Step 2

DESIGN NOTES:

1. Oversized perforated inlet pipe increases the area in contact with the subsurface lateral flow of water.
2. Coarse aggregate and oversized pipe provide the least resistant course for subsurface water flow through the trench.
3. Filter fabric is required to eliminate the migration of soil particles into the aggregate while allowing water to pass to the pipe.
4. The aggregate filled trench and oversized pipe act as a temporary storage reservoir.
5. The porous trench and perforated pipe allow non-intercepted water to continue through the wet soil profile in the wetland.
6. The only water removed from the wetland is the quantity needed to sustain a full watering facility.
7. Because there is no impervious cutoff wall in the wet spring area the damage to the integrity of the wetland is minimized.
8. Replace components as necessary for rehabilitation.

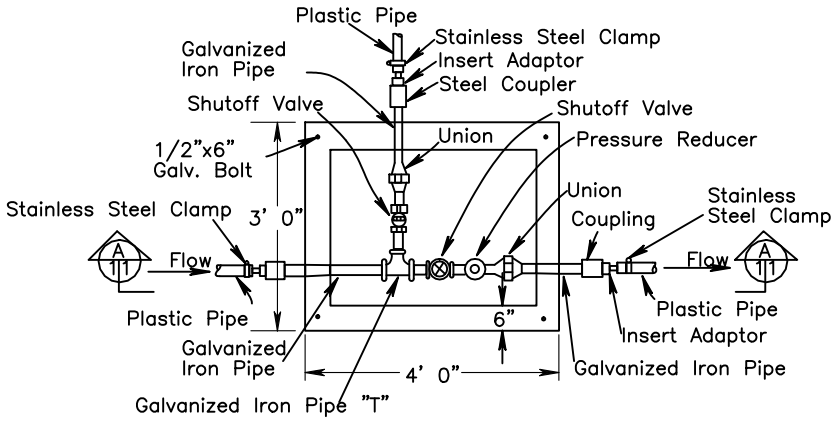


Step 3

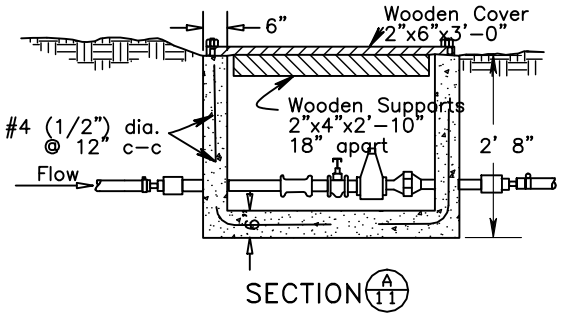
SECTION A-A

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Spring Development or Rehabilitation		DATE April 2011
			REVISION DATE
			BMP NO. 31

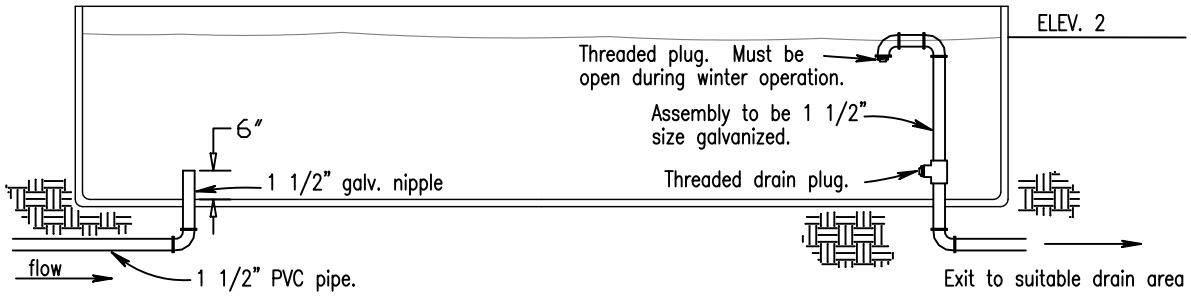
PIPELINE AND TROUGH



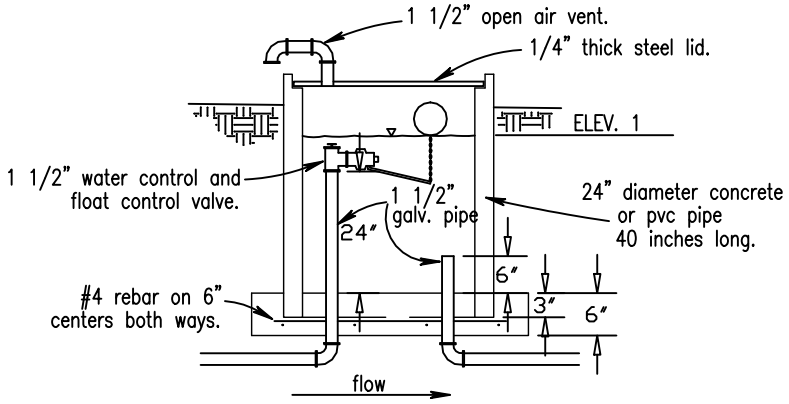
PRESSURE REDUCING STATION
WITH LATERAL LINE



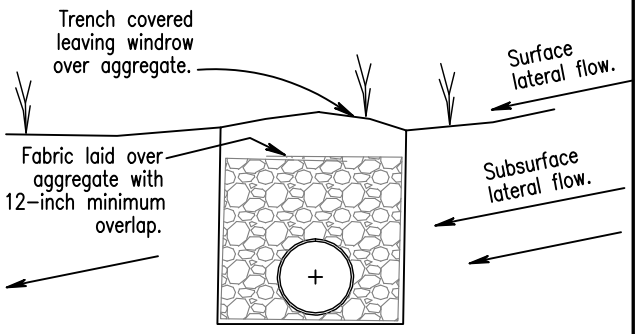
SECTION A/T1



TROUGH



WATER LEVEL CONTROL BOX

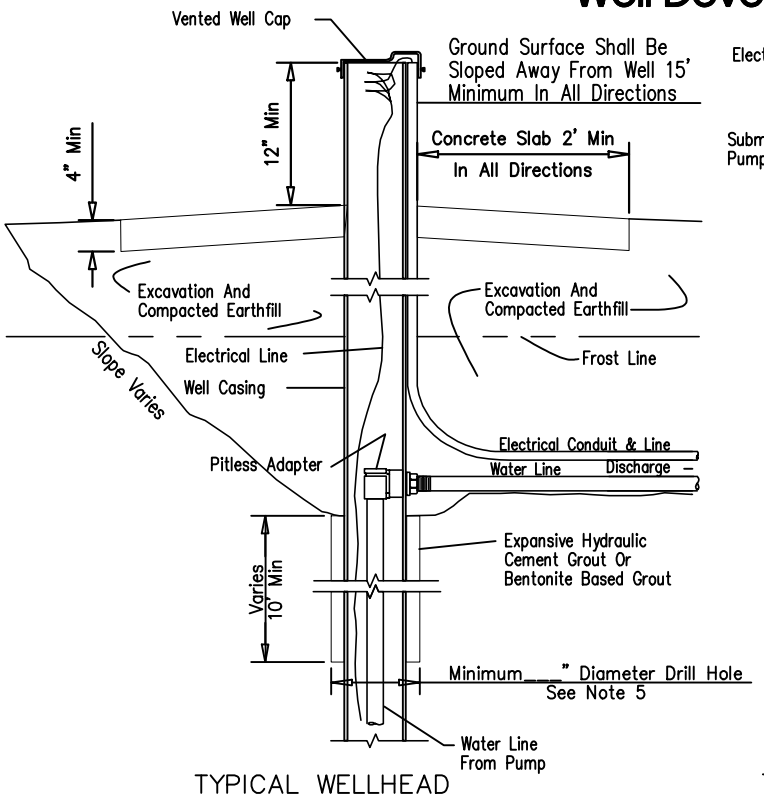


TRENCH DETAIL

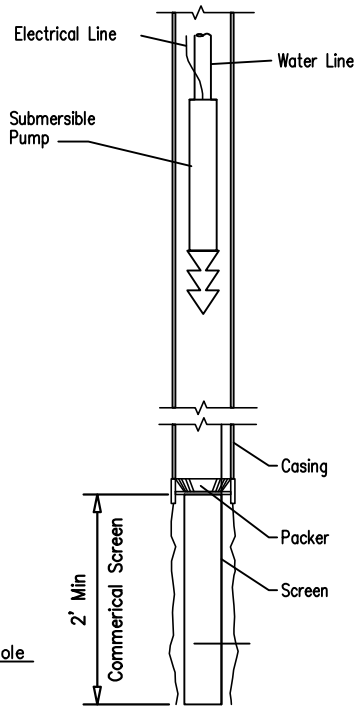
NOTE:
Elevation 1 in the Water Level Control Box and Elevation 2 in the Trough must be the same.

(Not to Scale) Adapted From NRCS Drawings	Coyote Creek Best Management Practices	Preliminary Not For Construction	DESIGN BY: S.Yard
Natural Channel Design, Inc 206 S. Elden St. Flagstaff, AZ 86001 928-774-2336	DETAIL: Pipeline and Trough		DATE April 2011
			REVISION DATE
			BMP NO. 32

Well Development



TYPICAL WELLHEAD
Not To Scale



TYPICAL WATER WELL
Not To Scale

NOTES:

1. Water well and pump installation shall comply with all applicable local and state regulations.
2. Excavations and all other work shall conform to OSHA regulations.
3. Electrical wiring must comply with local codes and manufacturers requirements.
4. Pitless Adapter and waterline may be installed above the frost line only when the well is used seasonally.
5. When an oversized drill hole is constructed for the installation of the casing, the diameter of the drill hole shall be a minimum of 3 inches greater than the outer diameter of the casing or coupling, whichever is greater.
6. Casing diameter shall be sized so that the uphole velocity is less than 5 ft/sec.
7. Only steel casing shall be used for driven wells.
8. Minimum casing strength shall be determined as described in IL Practice Standard 642, Water Well.
9. The screen shall be sized to permit water entrance at no greater than 0.7 ft/sec.
10. Pump intake shall not be placed inside a well screen.
11. An airline shall be installed where water level lies more than 250 feet below the ground surface. This airline can be copper, polyethylene, or galvanized tubing and shall have Presta valve installed to allow the connection of an air compressor. Airline must be airtight and its exact length must be documented.
12. The well capo shall be removable to allow for measurement of depth to water surface or pressure.
13. After construction is complete, the well shall be disinfected pre local or state requirements.

DESIGN DIMENSIONS

Estimated Well Depth = _____(ft)

Required Production = _____(gpm) min

Casing Materials: ☐ Plastic ☐ Steel

Casing Diameter =_____(in)

Wall Thickness = _____(in)

SDR = _____

Pitless Adapter = ☐ Yes ☐ No

RECORD OF WELL INSTALLATION (As Built)

Name Of Landowner _____
Date Of Completion _____

Name Of Person Performing Well Construction _____

Company _____

Address _____

_____

Was a Water Well Construction Permit Obtained From The IL Dept Of Health or Approved Local Health Department Prior to Construction? (Attach A Copy Of The Permit.) ☐ Yes ☐ No

Were the Water Well Construction and Pump Installation Reports Submitted to the appropriate Health Department? ☐ Yes ☐ No (Attach A Copy Each Report)

Was An Airline Installed? ☐ Yes____Ft. Length ☐ No

Actual Well Depth_____ft
Depth Pump Set_____ft
Pumping Capacity_____gpm

I certify that this practice has been completed In accordance with this plan and specifications and the above record of well installation.

Well Driller _____ _____
Sign Here Date

As Built Practice Meets the ENGINEER'S Specifications

_____ _____
ENGINEER'S Certification Date

(Not to Scale)
Adapted From NRCS Drawings

Coyote Creek Best Management Practices

Natural Channel Design, Inc
206 S. Elden St.
Flagstaff, AZ 86001
928-774-2336

DETAIL: Well Development or Rehabilitation

Preliminary Not For Construction

DESIGN BY: S.Yard
DATE April 2011
REVISION DATE
BMP NO. 33