

# Pre-proposal

## Oak Creek Watershed Improvement Plan

### Project Summary

In spite of multiple efforts and funding to educate people about eliminating sources of fecal contamination to Oak Creek, impairment by the fecal coliform *Escherichia coli* (*E. coli*) continues to be a persistent problem, resulting in seasonal closures of recreational areas of the stream as well as an “Impaired” classification by the ADEQ. Most recently, an approximately 4-mile long reach of an Oak Creek tributary, Spring Creek, was listed as impaired. The Oak Creek watershed contains approximately 300,000 acres, and includes five (5) tributaries (Pumphouse Wash, West Fork Oak Creek, Munds Creek, Dry Creek and Spring Creek) between the headwaters in Fry Canyon to the confluence with the Verde River south of Cornville.

Annual seasonal bacteriological exceedances of water quality were first identified in Oak Creek in 1973 (Obr *et al.*, 1978) and confirmed by Jackson (1981), Rose *et al* (1987), and Hansen and White (1992); these later studies also correlated water quality impairment with peaks in recreational use. Consequently, the waters of Oak Creek, especially in the vicinity of Slide Rock State Park, have been monitored and studied extensively by several management agencies, including the United States Forest Service (USFS) - Coconino National Forest, the Sedona Ranger District, the Arizona State Parks Service, the Arizona Department of Health Services, Coconino County Environmental Health Service, the Arizona Department of Environmental Quality (ADEQ) and the Arizona Non-point Education for Municipal Officials (NEMO), to determine the causes of and solutions to this problem.

A monitoring study of Oak Creek waters and sediment by Donald *et al* (1998) and genotyping studies by Southam *et al* (2000) identified recreational use and wildlife as co-contributors to increased *E. coli* levels; e.g., they found that 1) Fecal coliforms, including *E. coli*, are sequestered in sediments in yet-to-be-identified pools, with disturbance to these pools during seasonal stormwater events results in exceedances; and 2) the primary source of fecal coliforms within the stream were from wildlife sources.

In 2002, the ADEQ 305(b) Assessment of Oak Creek identified turbidity and *E. coli* as the pollutants of concern in Oak Creek and classified the region between West Fork and Dry Creek (excluding Slide Rock State Park) as “Impaired” and Slide Rock itself as “Not Attaining”. The plan states that Oak Creek has been designated by statute as a “Unique Waters”, which carries an anti-degradation clause to prevent increased pollution. Aside from public swimming and recreation areas, aging septic systems are identified as the probable sources of *E. coli* and/or fecal coliform pollutants.

Recent (February, March and September 2008) informal pedestrian surveys by Oak Creek Canyon Task Force (OCCTF) Directors Morgan Stine of Canyon Services, Rex Bergamini of EcoRx, and Lee Luedeker of Arizona Game and Fish Department (AGFD) of recreational use areas confirm that anthropogenic sources of contamination – improper disposal of human feces, trash and diapers, dog feces, aged and/or primitive and/or impaired septic systems, septic systems in close proximity to the stream channel and septic systems within alluvial fill situated on top of bedrock - continue to persist as potential significant sources of impairment.

The persistence of *E. coli* concentrations suggests confounding effects and/or multiple, unidentified sources of coliforms within the Oak Creek watershed. In addition, this persistence suggests that there may be different sources of variability or some degree of complexity that may include multiple variables, inter- and intra-variable interactions, high variability, threshold effects and/or asymptotes.

Our Watershed Improvement Council (WIQ) will tackle the TMDL *E.coli* exceedence within the entirety of the 300,000 Oak Creek watershed (see topographic map in Figure 1) using model-based inference, an information-theoretic approach that is both iterative and holistic. This approach should allow us to develop several working hypotheses and models for developing Best Management Practices to mitigate for both wildlife and anthropogenic *E. coli* sources and source-sink populations. In conjunction with public involvement, education, and monitoring programs, our goal is to delist portions of Oak Creek from its impaired designation, and eventually the entirety of the watershed.

### Citizen Participation

Our preferred method of encouraging active and broad citizen participation in the Watershed Improvement Council is to identify a landowner and/or business point-of-contact and to contact them

directly. Once stakeholder groups, such as homeowner associations and agricultural consortiums, are committed, we anticipate points-of-contact to reach out to their constituents for participation, and that the type and degree of effort that organizations and individuals are willing to commit to in the planning process will become apparent. To facilitate this early in the planning process, interested parties will become involved in technical advisory workgroups; at this point, we propose the following as potential candidates for workgroups:

- Education/Outreach Workgroup
- Watershed Survey Workgroup
- BMP Implementation/Monitoring Workgroup
- Fund-raising Workgroup
- Public Relations Workgroup

Ensuring long-term participation and support by stakeholders requires early involvement in the watershed planning process in the formulation of goals, problem identification, and development of management strategies, as well as organizing the level of effort to help stakeholders contribute their expertise at a level of effort they are comfortable. In addition, we will schedule working group meetings and general meetings to meet the level of commitment available from stakeholders; e.g., we anticipate that technical advisory workgroups meet once per month, with general meetings held quarterly.

The most efficient, cost-effective and universally accessible method of making information and progress of workgroups transparent and available to the public is the internet. To that end, we will establish a website that is updated monthly with links to local environmental and conservation groups, select businesses, and municipal, county, state and federal agency websites. Documents used and generated by the Oak Creek WIC will be available digitally on websites as portable document format (PDF) with paper copies held in the Sedona and Cottonwood Public Libraries.

Local media will be invited to attend quarterly meetings; press releases will be issued to local media not in attendance, including newspapers, radio and local cable companies. Media with the greatest coverage in the Verde Valley are four (4) radio stations (KAZM 780 News Talk Radio in Sedona, KNAU FM 88.7 in Flagstaff, KVRD Country 105.7 FM and KYBC America's Best Music AM in Cottonwood); three (3) newspapers (Camp Verde Bugle in Camp Verde, Red Rock News in Sedona and Verde Independent in Cottonwood); and one Cable Broadcast (Sedona Cable One).

## Watershed Improvement Council

As our initial step in including broad citizen participation in the watershed planning effort, we identified and obtained commitments from the following entities representative of stakeholders in Oak Creek: **State & Federal Agencies** [Arizona State Parks (ASP), Arizona Game & Fish Department (AGFD) and United States Forest Service (USFS)], **Local Municipalities** (City of Sedona), **County Agencies** (Coconino County Environmental Services, Yavapai County Environmental Services), **Universities, Colleges & Schools** (Northern Arizona University, Sedona Oak-Creek Unified School District, Mingus Union School District), **Business & Industry** (Sedona Chamber of Commerce), **Technical Consultants** [Arizona NEMO, Canyon Waste Services, EcoRx, Master Watershed Stewards (NWS), Pender Engineering and Salt River Project (SRP)] and **Environmental & Conservation Groups** (Oak Creek Canyon Task Force (OCCTF), Nature Conservancy and Verde Valley Land Preserve Institute (VVLPI))

Having the backbone of technical expertise defined, the next step is identification and inclusion of broad community representation with all groups likely to be affected by implementation in the Watershed Improvement Plan. Our focus is on including: **Homeowners Associations** (Junipine, Pine Flats, Shangri-La, Back-o-Beyond, Rio Bonito Ranch, Snake Trail Ranch, Cross Creek Ranch, and McCain Harper Properties), **Agricultural Businesses/Landowners** [Arizona Cattlemen's Association, Arizona Wine Growers Association, and Verde Valley Community Supported Agriculture (CSA)]. We anticipate needing technical support from Arizona Department of Transportation (ADOT), Arizona Department of Water Resources (ADWR), United States Army Corps of Engineers (USACE) and United States Fish & Wildlife Service (USFWS) and matching funding from Yavapai County and Coconino County Juvenile & Adult Probation. Being that this is an iterative process, our initial meeting of stakeholders will be polled to identify gaps in representation.

## Management Practices and Criteria for Application (Phase II)

We've identified five (5) potential nonpoint contamination sources of *E. coli* pathogens to Oak Creek that collectively may result in TMDL exceedance. The potential sources are recreational users, wildlife, livestock, agricultural practices, faulty or poorly functioning septic systems and municipal stormwater. Potential Best Management Practices (BMPs) to be implemented in Phase II for each source are:

### Municipal Stormwater

- **Bioretention Systems.** Bioretention is an increasingly popular stormwater treatment practice used in urban settings by municipalities to significantly reduce peak runoff from small to midsize storm events, turbidity and concentrations of target pollutants (Hunt *et al*, 2008), including nutrients (TN, TKN, NH<sub>4</sub>-N and TP), fecal coliforms (*E. coli*) and selected metals (Cu, Pb and Zn). Although we have not investigated the cost or efficacy of installing bioretention systems, it is a BMP that warrants further investigation for the mitigation of stormwater contamination from the City of Sedona.

### Faulty Septic Systems

- **Septic System Upgrade Incentives.** Reviewing the septic system risk assessment conducted by Morgan Stine would enable prioritizing septic systems for upgrades, targeting three (3) residential and three (3) commercial septic systems. One possible BMP discussed with Coconino County Environmental Services is offering incentives to property owners. An incentive may be waiver of County permit, design and observation hole fees, which would effectively save the property owner up to 25% of the cost of septic system replacement.
- **Slide Rock Flush Toilette.** We have approached the Fire Department about providing funding for a flush toilette to replace the vault toilette adjacent to Oak Creek at Slide Rock State Park. The Fire Department has expressed interest; however, with cost and technical difficulty currently unknown, this BMP may wait for a later phases.

### Wildlife

- **Wildlife Enclosure Installation & Maintenance.** Chain-link fence wildlife enclosures can be effective in reducing wildlife degradation in riparian areas. Enclosures for livestock and elk are a BMP implemented at Fox Ranch near the headwaters of Munds Creek; however, there is concern that the enclosure is in need of repair, and additional subwatersheds of Oak Creek may warrant enclosures as well.
- **Reduction of Wildlife Attractants.** Streamside garbage may attract wildlife; specifically, skunk, raccoon and ring-tail cat, thereby increasing deposition of wildlife feces streamside. DNA source mapping studies by Southam *et al* (2000) indicate that 30% and 11% of *E.coli* contributors to Oak Creek waters within Oak Creek Canyon were raccoon and skunk, respectively (genotyping was not addressed for ring-tail cat).
- **Tributary Sediment Traps.** Sediment traps situated in drainage channels may be an effective way to capture microbes prior to into Oak Creek.

### Recreational Users

- **Limiting Streamside Access.** The Forest Service is currently considering limiting streamside access to Oak Creek by limiting roadside parking.
- **Reducing Streamside Litter and Contamination.** Providing streamside users with trash bags, dog waste bags, WagBags and/or swim diapers, along with installation of additional recreational use area and/or wildlife-proof streamside trash receptacles are suggested BMPs warranting further exploration.
- **Renovating Existing / Installing Additional Bathroom Facilities.** Recreational users may choose to defecate outdoors because of absent or inadequate bathroom facilities.

### Agriculture

Livestock use proximal or within riparian areas, including herd crossings of streams, is a recognized key fecal microbe transmission route (Davies-Colley *et al* 2004). In addition to the obvious source of fecal coliforms in fecal deposition adjacent to or within streams, livestock damage vegetation and

compact soils, thereby reducing vegetative entrapment and soil infiltration of surface water-borne fecal microbes. Best management practices for livestock mitigation may include the following measures:

- **Bridges or Culverts.** Livestock crossings through stream channels should be avoided by use of bridges or culverts.
- **Exclusion Fencing.** Permanent exclusion fencing is the most stringent and absolute measure with which to prevent sporadic incursions by livestock into waterways.
- **Riparian Buffers.** Riparian buffers of native plant species created between the stream channel and exclusion fencing prevent stormwater overland transport to the stream by entrapping microbes washed in from upland and upslope areas.
- **Embankment Soil Restoration.** Restoration of soil infiltration capacity by targeting areas of soil and vegetation damage (devegetation, soil compaction, removal of cattle 'ramps') restores riparian functioning by recreating high soil infiltration capacity and microbial attenuation that reduces transmission of fecal microbes by surface runoff.
- **Alternative Resources.** Providing alternative resources (water, shade and shelter) encourages livestock away from waterways (Miner *et al* 1992; Sheffield *et al* 1997).
- **Irrigation Management.** Current practices in irrigation management should be identified and investigated as a potential source of *E. coli* contamination to Oak Creek. For example, irrigation water is returned to Oak Creek in Scheurmann Ditch, and additional drainages may return water from border-strip irrigation practices, which involve flooding of soil surfaces and hence has the potential for bypass flow to collect microbes. Close *et al* (2005) identify the need to avoid border strip irrigation of pasture immediately following the grazing of livestock, as studies indicate an order of magnitude declines in microbes if the interval between grazing and irrigation increases from 1 to 7-10 days (Hedley *et al* 2005; Connolly *et al* 2004). An effective BMP mitigation measure may be converting from border strip irrigation to spray irrigation.

## Key Personnel and Support

**Relevant Organization/Personnel Experience.** Pender Engineering will act as the prime and Authorized Agent and Rex Bergamini will act as the Project Manager. Mr Bergamini has 18 years experience as an ecologist, environmental scientist and project manager on numerous projects in Arizona, the Southeast and Northeast United States, including bacteriological enumeration and assessments of the Cutler River watershed in New Hampshire and water quality monitoring programs in Oak Creek, Beaver Creek and the Verde River.

Pender Engineering (Pender) specializes in civil and environmental engineering, project management, and contract management-at-risk (CM@R). Pender has for the last 11 years offered clients a variety of services, including hydrology, hydraulic and floodplain analyses; drainage, domestic water and wastewater system design; land planning; construction management; land and construction survey; site civil and highway engineering; and National Environmental Policy Act (NEPA) environmental planning, documentation and compliance services for environmental clearances. Pender has established and continues to promulgate excellent working relationships with project stakeholders, whether they are local governments, political entities, federal agencies or private parties, and has a proven track record of managing project completion on-time and within budget. Pender is currently implementing an ADEQ-funded 319(h) educational grant in Oak Creek Canyon.

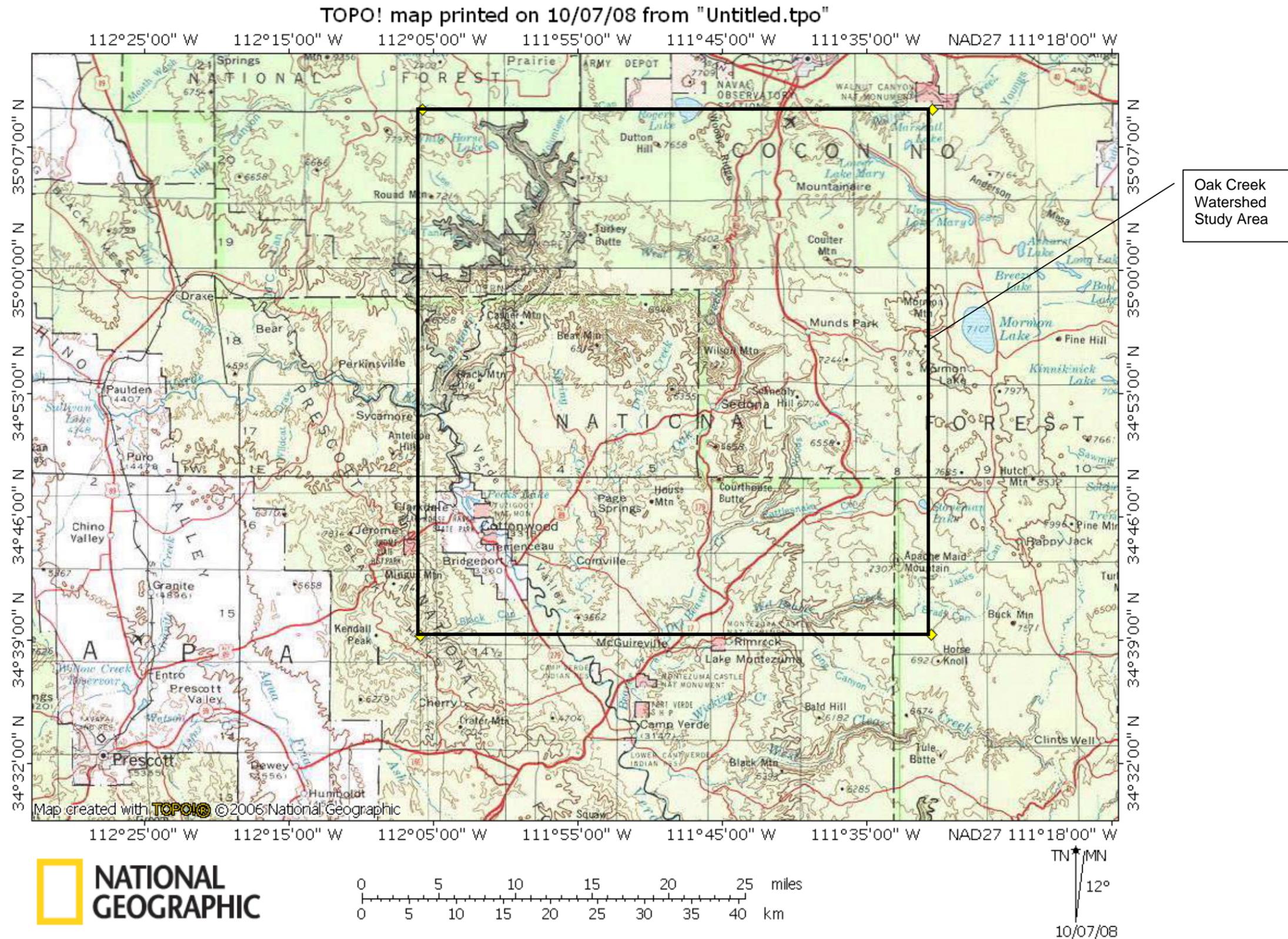
**Existing Community Support.** Existing community support for completing and implementing a targeted plan is difficult to quantify; however, discussions with Gary Arbeiter, Park Manager of Red Rock State Park, indicate that groups like park's benefactors are eager to fund water quality education and monitoring initiatives, particularly at the primary and secondary school levels. Homeowner associations in Oak Creek Canyon and surrounding Red Rock State Park typically allow and encourage stream access from their properties, which we take as a measure of support.

**Partners.** Our current partners include a wide array of public agencies, business interests, educational institutions and environmental groups, and at a minimum include the partners listed in Table 1.

**Table 1.** Oak Creek Watershed Improvement Coalition stakeholders. Confirmed partners and points-of contact are in bold black, pending in bold red, contacted but unconfirmed in red, and targeted in blue.

Watershed Partners	Points-of-Contact	Responsibility
<b>ADEQ</b>	<b>TMDL Unit</b>	Technical Assistance
<b>AGFD</b>	<b>Lee Luedeker, Wildlife Enf Ofc</b>	Technical Assistance; Fieldwork
<b>Arizona NEMO</b>	<b>Channah Rock, PhD, Wtr Qual SP</b>	Technical Assistance
	<b>Kristine Uhlman, PM</b>	Technical Assistance
<b>ASP - Red Rock State Park</b>	<b>Gary Arbeiter, Park Mgr</b>	Education
	<b>Patricia Denison, Asst Park Mgr</b>	Education
<b>ASP- Slide Rock State Park</b>	<b>Steve Pace, Park Manager</b>	Education
	<b>Frank van Devender, Asst Park Mgr</b>	Education
<b>AZ Wine Growers Assoc (AWGA)</b>	<b>Eric Glomski, AWGA VP</b>	Business Representation
<b>Canyon Waste Services</b>	<b>Morgan Stine, Pres</b>	Doc Prep
<b>City of Sedona (MS4)</b>	<b>Charles Mosley, Public Works Dtr</b>	Technical Assistance
<b>Coconino County Env Services</b>	<b>Randy Phillips, Senior Mgr</b>	Technical Assistance
	<b>Marlene Gaither, Env Health SP</b>	Technical Assistance
<b>EcoRx LLC</b>	<b>Rex Bergamini, Senior Ecologist</b>	Doc Prep
<b>Master Watershed Stewards</b>	<b>Candice Rupprecht, Prog Coord</b>	Technical Assistance
	<b>Howie Usher, Biology</b>	Education; Fieldwork
<b>Mingus Union School District</b>	<b>Rob Szmanda, Earth Science</b>	Education; Fieldwork
	<b>Mike Westcott, Chemistry</b>	Education; Fieldwork
	<b>Justin Brereton, Agriscience</b>	Education; Fieldwork
<b>Nature Conservancy</b>	<b>Brenda Bermann, NAZ Prog Dir</b>	Technical Assistance
	<b>Wilbert Odem, PhD, Chair, Env Eng</b>	Technical Assistance
	<b>Abe Springer, PhD, Hydrogeology</b>	Technical Assistance
	<b>Paul Trotta, PhD, Dir Wastewater Proj</b>	Technical Assistance
<b>Northern Arizona University</b>	<b>Paul Keim, PhD, Genomic Analysis</b>	Technical Assistance
	<b>Egbert Schwartz, PhD, Microbial Ecol</b>	Technical Assistance
	<b>Thomas Sisk, PhD, Con Bio</b>	Technical Assistance
	<b>Brett Dickson, PhD, Con Bio</b>	Technical Assistance
<b>Oak Creek Canyon Task Force</b>	<b>Barry Allan, Co-Chair</b>	Meeting Facilitation
<b>Oak Creek Ranch School</b>	<b>David Wick, Jr, Headmaster</b>	Education
<b>Page Springs Hatchery</b>	<b>Cindy Dunn, Asst Mgr</b>	Tech Assist
<b>Pender Engineering</b>	<b>Rex Bergamini, Senior Env SP</b>	Meeting Facilitation; Fieldwork
<b>Salt River Project</b>	<b>Charles Ester, Manager</b>	Technical Assistance
<b>Sedona Chamber of Commerce</b>	<b>Jennifer Wesselhoff, CEO</b>	Business Representation
	<b>Bob Murphy, Science Chair</b>	Education
	<b>Jason Baldwin, Earth Science</b>	Education
<b>Sedona-Oak Creek School District</b>	<b>Chris Leverington, Earth Science</b>	Education
	<b>Scott Fray, WSS Science</b>	Education
	<b>Karla Heckrodt, WSS Science</b>	Education
	<b>Rod Baumbach, BPS Science</b>	Education
<b>Sterling Springs Hatchery</b>		Education, Technical Assistance
<b>US Forest Service</b>	<b>Amina Sena, Hydrologist</b>	Meeting Facilitation; Doc Prep
<b>Verde Valley CSA</b>	<b>Sandra Boyce</b>	Business Representation
<b>Verde Valley Land Preserve Inst</b>	<b>Bob Rothrock, President</b>	Education
<b>Verde Valley School (VVS)</b>	<b>Andrew Gill, Science Dept Chair</b>	Education; Fieldwork
<b>Verde Watershed Association</b>	<b>Dan Campbell, Director</b>	Education
<b>Yavapai County Env Services</b>	<b>Suzanne Ehrlich, Senior Env SP</b>	Technical Assistance
	<b>Geoff Meek, Env Unit Mgr</b>	Technical Assistance

Figure 1. Topographic map of the Oak Creek watershed.



Oak Creek Watershed Study Area