

Oak Creek Watershed  
Water Quality Monitoring Report  
Recreation Education and Awareness Project  
(REAP)

August 2015—May 2016

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Prepared for  
Oak Creek Watershed Council

In partial fulfillment of Clean Water Act Section 319 Nonpoint Source Pollution  
Reduction Grant, Recreation Education and Awareness Project (REAP)

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## PROJECT SUMMARY:

Between August 2015 and May 2016, the Oak Creek Watershed Council's Recreation Education and Awareness Project (REAP), funded by ADEQ, reduced *E. coli* bacteria in the Oak Creek Watershed through several boots-on-the-ground projects identified and outlined in the Oak Creek Watershed Improvement Plan, including the Oak Creek Cleanup project, the Oak Creek Ambassadors project, and the Pet Waste Station & Education project. Water quality assessment was achieved by monitoring *E. coli* and turbidity over the study timeline to investigate if during the summer or peak season there are more recreationalists tied to spikes in *E. coli* concentrations.

The study led to the conclusion that humans have an impact on the water quality of Oak Creek but overall the impact has been reduced. This reduction indicates the work of the Ambassadors has an overall positive effect on reducing the instances of *E. coli* exceedances along Oak Creek. The percent exceedance within watershed for the *E. coli* standard was 8% indicating that a majority of the time during the study the sites met water quality standards of < 235 MPN/100mL. A strong campaign of litter and fecal waste pick-up, tabling and outreach, as well as water sampling and an engaging water quality education program with local area schools, has made a lasting positive impact toward the ongoing health of this Outstanding Arizona Water.

The Oak Creek Watershed is a tributary of the Verde River, a part of the Lower Colorado River Basin. Previous research and monitoring in Oak Creek have found *Escherichia coli* (*E. coli*) bacteria concentrations exceeding the maximum of 235 colony forming units (cfu) per 100 ml water per single sample, or a monthly mean of 126 cfu, the Arizona Water Quality Standard for full body contact.

Efforts have been made to try to reduce human-caused sources of *E. coli*, yet *E. coli* exceedances remain a problem especially where there is concentrated recreation in the creek, such as at Slide Rock State Park, and during storm events that deliver additional *E. coli* through sediment transport to the creek.

Crucial components of these projects came from elements of EPA's Adopt-A-Watershed program, including ongoing involvement of watershed residents and businesses throughout the Oak Creek corridor, by providing pet waste amenities at popular trailheads, and by having a branded presence in heavy recreation areas focused on educating recreation area users about human impacts on the creek. The goal has been a continued elevation of awareness of *E. coli* as an indicator of fecal coliform pollution in order to change attitudes and behavior of residents and promote a sense of personal responsibility for keeping private and public property clean and free of trash & feces, thereby reducing/eliminating *E. coli* contamination in Oak Creek.

In 2015, Oak Creek water quality monitoring was intended to evaluate the

effectiveness of 2013 and 2014 BMPs that were focused within Oak Creek Canyon. Sampling sites in Oak Creek Canyon and Middle Oak Creek were chosen for this analysis during 2015-16. Due to the Slide Fire, the Oak Creek Watershed Council was unable to sample water quality within the Canyon in 2014.

The project in 2015-16 was focused to include sites that were unavailable for testing due to Canyon closures in 2014 as well as selected sites located in the Middle Oak Creek area. The focus of this project was to monitor water quality at high recreational sites and time periods and evaluate *E.coli* bacteria loading and turbidity above and below popular recreational sites along Oak Creek. Water Samples were collected from Oak Creek starting within the Canyon down through Middle Oak Creek.

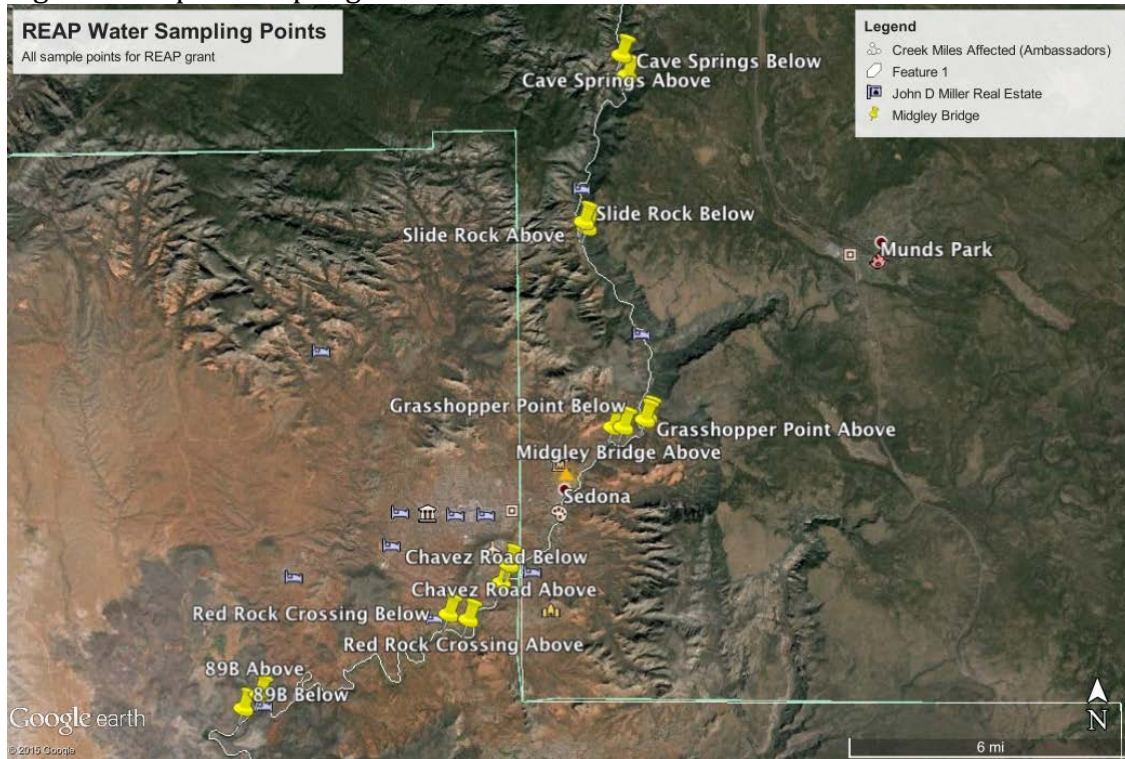
There were two phases to the project where samples were collected every Thursday and Sunday during August and September 2015 and then once a month from October to May. There were 14 sites evaluated. Water samples were collected at each site in 100mL IDEXX sterile bottles and evaluated for *E.coli* bacteria. A 100mL sample was also collected for turbidity analysis. Oak Creek Ambassadors that were trained in water quality sample collection and analysis collected these samples.

Samples were analyzed for *E.coli* and turbidity at the Sedona Wastewater Treatment Plant Laboratory using equipment maintained by Oak Creek Watershed Council and it's employees. The 14 sample sites were above and below Cave Springs, above and below Slide Rock State Park, above and below Grasshopper Point, above and below Midgley Bridge, above and below Chavez Road, above and below Red Rock Crossing, and above and below 89b. Samples were transported to the Sedona Wastewater Treatment Plant Laboratory where they were analyzed for *E. coli* bacteria concentrations using the IDEXX QuantiTray method.

Turbidity was also tested in the laboratory using a HACH nephelometric turbidimeter. Results were recorded in a lab book then transferred to an Excel spreadsheet database. For quality assurance purposes, a duplicate sample was collected and analyzed for about one out of ten samples.

Sampling locations are shown in Figure 1. Map of Sampling Locations

Figure 1. Map of Sampling Locations:



Sampling was conducted within Oak Creek Canyon (Cave Springs, Slide Rock, Grasshopper Point), at Midgley Bridge and within Middle Oak Creek (Chavez Road, Red Rock Crossing, 89B) throughout the study. Sampling occurred Thursday and Sunday at all sites but Midgley Bridge during August and September 2015. August and September are considered busy times (peak) for recreation in along Oak Creek. All sites were then sampled once a month from October 2015 through May 2016. These sampling sites and sampling points have been selected due to past investigation of locations that have shown increased *E. coli* and turbidity loading following high recreation as well as storm flow.

The sites within Oak Creek Canyon are high recreation locations. The sites selected within Middle Oak Creek are also locations that see high use during weekends. The Oak Creek Canyon Sites and the Middle Oak Creek Sites see heavy day use and camping throughout the summer as well as other times throughout the year. There are limited toilet facilities and trash collection in some areas, which leads to litter and feces left behind by patrons.

During the first phase of sampling when samples were collected from 14 sites twice a week (above and below a highly recreated location) between August 2015 and September 2015 a total of 144 samples were collected. During phase two of the project between October 2015 and May 2016 a total of 104 samples were collected from the same 14 sites once a month. Sites were given codes as seen in Table 1 below.

Table 1.

SITE CODES	
CS-1	Cave Springs Above
CS-2	Cave Springs Below
SR-1	Slide Rock State Park Above
SR-2	Slide Rock State Park Below
GP-1	Grasshopper Point Above
GP-2	Grasshopper Point Below
MB-1	Midgley Bridge Above
MB-2	Midgley Bridge Below
CR-1	Chavez Road Above
CR-2	Chavez Road Below
CM-1	Red Rock Crossing Above
CM-2	Red Rock Crossing Below
89B-1	89b Above
89B-2	89b Below

Differences in above and below *E.coli* concentrations and turbidity were compared within sites as well as throughout the canyons. Analysis between seasonal differences was also reviewed and it was shown that *E.coli* numbers at all sites tend to be lower during off peak recreational time periods. During the entire study the percent of exceedances of *E.coli* bacteria found across all sites was only 8%. That indicates that 92% of the data points analyzed from this study show water quality below and within the 235 MPN/100mL recreational water quality standard for *E.coli* in surface waters. This represents that the watershed, although highly utilized by human and wildlife traffic, measured *E.coli* bacteria exceedances less than 10% of the time between August 2015 and May 2016.

The geometric mean analysis of all sample sites shows that *E.coli* numbers stayed well below the 235 MPN/100mL standard during this study. The CR-1 (Chavez Road Above) site had the highest geometric mean value for *E.coli* at 87.62 MPN/100mL. Turbidity measure in rivers in Arizona tends to be less than 20 NTU normally. Exceedances above normal, < 20 NTU, were seen during this study but rarely.

The turbidity data below shows how turbidity increases as you move southward in the watershed. Max turbidities were seen well above the 20 NTU but the geometric mean shows turbidity overall is in a normal range for Oak Creek at < 20 NTU. High turbidity does not always correlate directly with high *E.coli* or vice versa but sometimes after a storm event or heavy recreation a peak can be seen in turbidity and *E.coli*. It has also been seen in research and in this data set peaks in *E.coli* without a peak in turbidity.

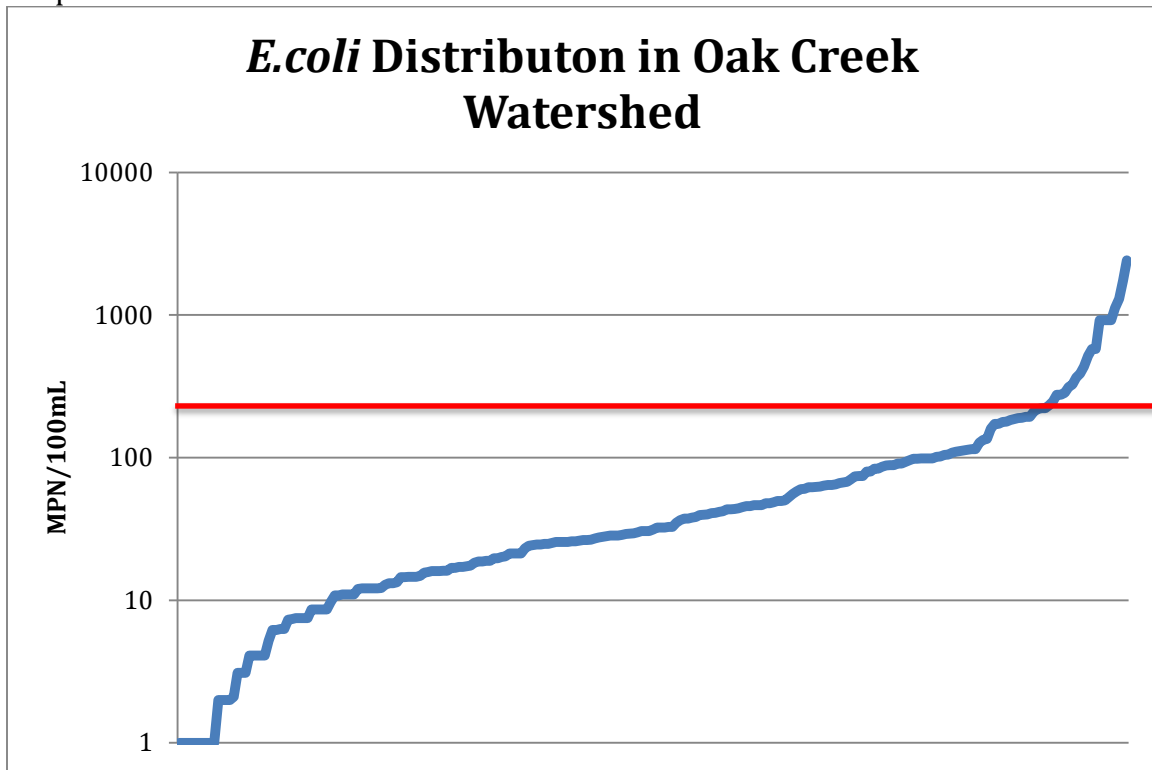
There were 248 data points collected which is sufficient to conduct statistical analysis as well as other interpretive inferences. Below is a table of all sites during the study stating the min, max and geometric mean found for *E.coli* and turbidity.

Table 2. Oak Creek Canyon and Middle Oak Creek Results

Site	Turbidity (NTU)			<i>E.coli</i> (MPN/100mL)		
	MAX	MIN	GEOMEAN	MAX	MIN	GEOMEAN
CS-1	32.1	0.34	1.18	275.5	1	13.49
CS-2	31.4	0.69	1.83	190.4	1	12.82
SR-1	85.8	0.93	3.49	920.8	1	24.95
SR-2	83.2	0.98	3.72	1299.7	1	36.43
GP-1	30.5	1.07	3.11	209.8	3.1	34.03
GP-2	31.1	0.92	3.45	313	7.5	43.25
MB1	30.8	1.03	3.62	95.9	2	18.51
MB2	30.7	0.91	3.32	98.8	8.6	25.30
CR-1	46.8	1.14	4.56	1119.9	19.7	87.62
CR-2	45.1	1.26	4.95	920.8	14.5	72.00
CM-1	140	1.03	5.58	325.5	8.6	53.92
CM-2	115	1.63	7.86	579.4	6.3	49.57
89B-1	580	1.37	11.13	1732.9	3.1	32.70
89B-2	666	2.08	11.63	2419.6	2.1	32.42

Below is a graph showing distribution of *E.coli* throughout the study sites with the red line representing the 235 MPN/100mL standard. In this graph you can see that a majority of samples collected were below the standard.

Graph 1.



The project was very successful in conducting continuous water quality monitoring during peak and off peak recreational time periods. Impacts of visitor and resident patrons were measured through *E.coli* and turbidity analysis but also by litter and fecal matter collection. During August and September 2015, 478 lbs of feces, 268 diapers and 2368 lbs of trash were collected and removed from the entire study region. Between October 2015 and May 2016, 167.2 lbs of feces, 77 diapers and 934.6 lbs of trash were removed from the entire study area. In total the Oak Creek Ambassadors collected 4212.1 lbs of trash between August 2015 and May 2016. Of that, 944.9 lbs was recyclable material that they took to the Sedona Recycling Center. The Ambassadors also collected 385.2 lbs of feces and 124 diapers. Their outreach efforts educated 7543 people for a total of 1544.26 hours about leaving no trace while recreating within the Oak Creek watershed.

Results show that in the peak recreational time period of August and September 2015 *E.coli* numbers stayed below the recreational water quality guideline of < 235 MPN/100mL 92% of the time. Exceedances were seen in August and September at Cave Springs Above, Slide Rock above and below, Grasshopper point below, Chavez Road above and below and 89B above and below. These exceedances were on 8/9/15, 8/13/15, 8/27/15 & 9/6/15. These are all weekends of heavy use and human impact through feces and litter left behind shows exceedances in the *E.coli* counts in Oak Creek.

Some sites showed increase in *E.coli* loads from above to below the site as well. Notably, when recreation increases in Oak Creek *E.coli* bacteria loads increase however; *E.coli* bacteria can also come into Oak Creek through storm water runoff and erosion. Percent exceedances for the entire study area showed no more than 8% at some sites. Table 3 below shows the percent exceedances at each site within the study. Sites in both the Oak Creek Canyon and Middle Oak Creek showed exceedances.

Table 3.

SITE	PERCENT EXCEEDNACE <i>E.coli</i> BACTERIA
CS-1	5%
CS-2	0%
SR-1	5%
SR-2	8%
GP-1	0%
GP-2	5%
MD-1	0%
MD-2	0%
CR-1	8%
CR-2	5%
CM-1	0%
CM-2	3%
89B-1	5%
89B-2	8%

Due to the increase in temperature in the city of Phoenix in May many people come to Oak Creek to recreate and leave behind their impact. Water quality was assessed and documented during this study and a baseline of information was established to determine human impact over time at these high use sites. When trash picked up and also encouraged to be picked up, people become more educated about how to reduce their impact and behavior change is made.

Findings of the 2015-16 water quality monitoring efforts include the following:

- Samples collected during the study only showed 8% exceedance of the 235 MPN/100mL throughout the peak and off peak season between August 2015 and May 2016.
- Distribution of *E.coli* throughout the study shows that a majority of samples fall below the standard for safe recreation in surface waters.
- *E.coli* geometric means were highest at Chavez Road above and below. Slide Rock, Grasshopper Point and Red Rock Crossing also showed heightened geometric mean results for *E.coli* as well because these were the sites to show the greatest number of exceedances throughout the study.



- Turbidity increases as data points move through the watershed from north to south.
- Turbidity numbers reflected normal river turbidity rates as seen in Oak Creek historically. However, on the days of higher use (8/9/15, 8/27/15 & 9/6/15) at Slide Rock and 89B, very popular camping and swimming sites, the measure of turbidity was higher and the *E.coli* readings were above standard (235 MPN/100mL).
- Removing dog feces and litter from high recreation sites helps to reduce *E.coli* concentrations by reducing the number of wildlife attracted to the site by litter and the amount of fecal matter on the land that can contribute to *E.coli* loading in the river after storms.
- This study provides a baseline of knowledge to understand the impact of recreation at a site by analyzing the above and below site loading of *E.coli*. Further studies should reproduce these methods and begin sampling in June when recreation is high as well. Sampling from June-September will better capture peak season impacts.
- This study helped to identify high use recreation locations that should be a focus for clean up efforts along Oak Creek. By measuring *E.coli*, turbidity, feces and litter collection sites can be identified as an area of increased loading and more effort can be made to educate the patrons of where garbage cans are located and how they can help to reduce fecal pollution in Oak Creek.

Recommendations are to continue and expand the litter clean up program coupled with education about leave no trace practices. Working with Arizona Game Fish as well as the US Forrest Service will help to expand the Oak Creek Ambassadors monitoring and clean up capabilities. To reduce recreation impacts to water quality, property owners (both public and private) in Oak Creek Canyon should consider expanding efforts to limit the number of people recreating in the creek at any one time. Slide Rock State Park (SRSP) has a policy regarding this, but the Forest Service and some of the larger commercial enterprises and residential communities in the canyon should consider adopting similar and supportive policies. Also, there could be more vigilant efforts to reduce littering, especially of diapers and food waste, through targeted outreach activities in the canyon and through public service announcements.

Perhaps most importantly, more public restroom facilities must be made available in Oak Creek Canyon. The recent addition of a restroom at Midgley Bridge is a great improvement. The Forest Service, with the assistance of collaborators, should continue to add toilets, update the forest map to show their locations, and provide signage and adequate parking so visitors make optimal use of available facilities. Information kiosks at public restrooms can provide education opportunities to raise visitors' awareness of what they can do to project water quality and human health.

Oak Creek Watershed Council's year 2015-16 water sampling efforts resulted in 132 samples that were collected from Oak Creek in Oak Creek Canyon, 116 samples collected in Middle Oak Creek. During the peak season monitoring (August &

September) 144 samples were collected and during off peak season 104 samples were collected from all sites in the study. Resulting *E.coli* bacteria concentrations and turbidity measurements were consistent with past monitoring at sites that had been assessed previously but will serve as a baseline for new sites included.

On weekends of heavy recreation during peak season spikes in *E.coli* were seen at some of the more popular recreational sites such as Slide Rock and 89B. Water quality assessment was achieved by monitoring *E.coli* and turbidity over the study to investigate if during the summer or peak season there are more recreators and spikes in *E.coli* concentrations, which leads to the conclusion that humans have an impact on the water quality of Oak Creek but overall the impact is not as great as perceived. On the other hand, this could be an indication the work of the Ambassadors has an overall positive effect on reducing the instances of *E.coli* exceedances along Oak Creek. The percent exceedance within watershed for the *E.coli* standard was 8% indicating that a majority of the time during the study the sites met water quality standards of < 235 MPN/100mL.

The level of education that the Ambassadors passed onto the public was extraordinary. They covered everything from how the creek was formed, to how people's trash is affecting the concentration of *E. coli* bacteria in the creek. These individuals were highly informed about the issues revolving around Oak Creek, thanks to Amina Sena, Hydrologist for the Red Rock Ranger District, Candice Mark, Visitor Information specialist, and the Oak Creek Watershed Council staff and volunteers. The Oak Creek Ambassador Project assisted in successfully reducing the total number of allowed camping days at 89B from 14 days to 5 days due to the trash and water sampling data collected.

The Project also informed the newly approved Watershed Restoration Action Plan (WRAP) in Lower and Middle Oak Creek, along with the stem of Oak Creek in Upper Oak Creek for the United States Forest Service, Red Rock Ranger District. The Ambassadors were instrumental in data collection that informed top priority projects. These projects will be funded to complete the NEPA requirements to make shovel ready projects which assist in continual watershed improvement.