Paired Watershed Study to Track Soil Moisture and Alluvial Water Response Before and After Brush Treatments in the Gila Watershed Region, New Mexico

FINAL REPORT, 2013

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This project encompasses two study areas, in the Burro Mountains and at Stiver Canyon in the Gila River headwaters. This report is accompanied with a CD containing all data collected June 2012-June 2013. Data from the start of the project were included with the annual reports for project years 2008 through 2011. Report contents are organized as shown below.

BURRO MOUNTAINS SITE

- Map
- Table of data collection sites
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  - Climate
  - Vegetation data

STIVER CANYON SITE

- Map
- Table of data collection sites
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DATA ANALYSIS

BURRO MOUNTAINS STUDY AREA

All soil moisture instrumentation in the study area in the Burros Mountains was replaced in late August, 2010, just prior to thinning treatments at the site. They are slated for replacement in the fall of 2013. Vegetation transect re-measurements will be completed at the same time. Sensors and other instruments were generally downloaded bi-monthly . Table 1 summarizes the data collection sites and data collection periods since study inception in November 2007. Soil moisture data collection sites, identified by letters, are shown on the map below. The map also shows thinning treatment zones established in conjunction with Gila National Forest staff. Treatments were completed between September and December 2010.

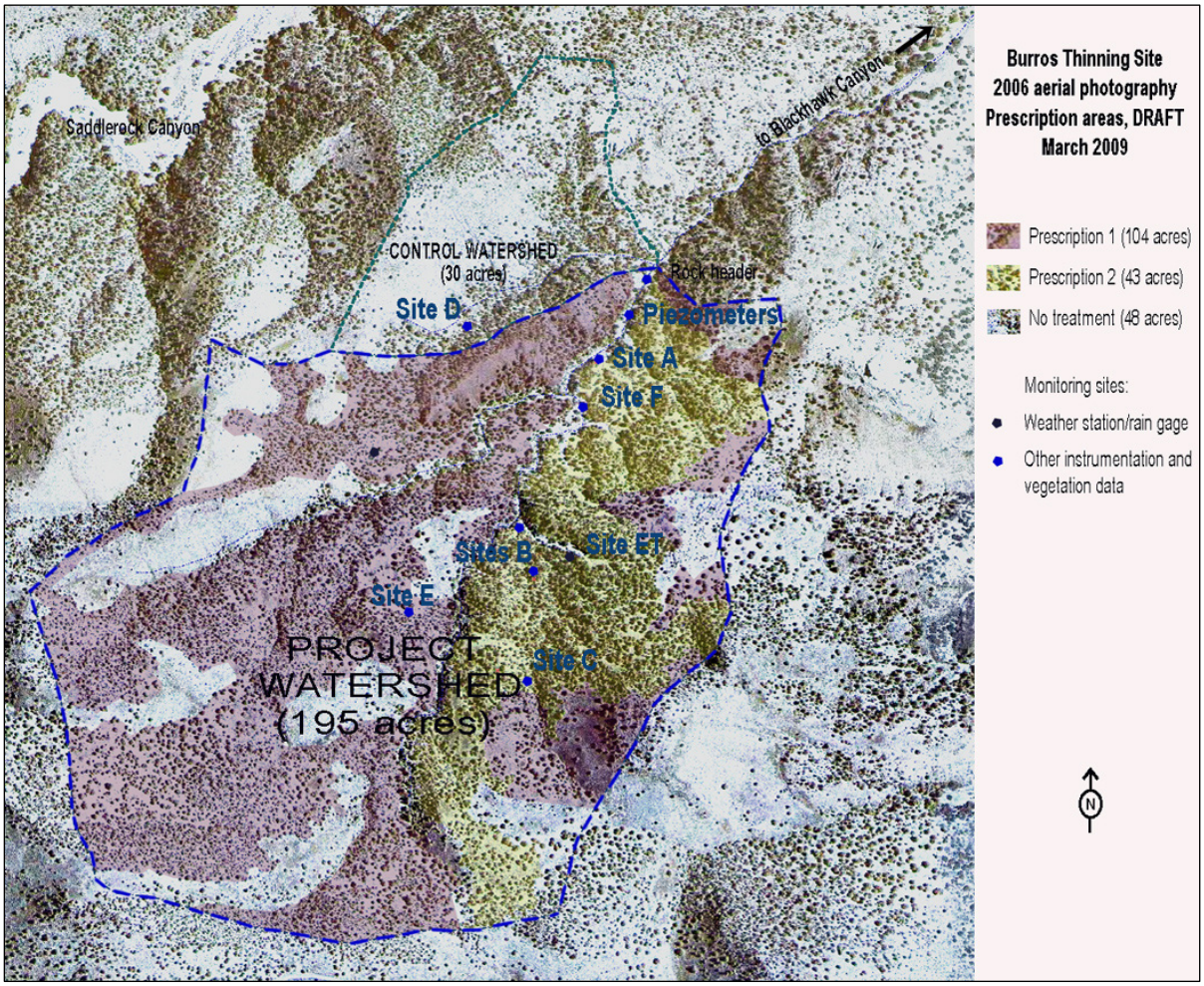

Table 1. Data collected at Burro Mountains project area since project start, November 2007.

	Archived data			
Site	**Alluvial and soil moisture**	**Vegetation**	**Climate**	**Other**
Site A				
Deep	11/2007-6/2013			
Canopy	11/2007-10/2008			
Veg. transects		4/2008		
Veg. biomass		3/2009		
Soil samples (sensor calibration)				11/2007
Site B1 (upper)				
Canopy	11/2007-6/2013			
Open	11/2007-6/2013 (gap 8/2008)			
Veg. transects		4/2008		
Veg. biomass		3/2009		
Site B2 (lower)				
Deep	11/2007-6/2013			
Open	11/2007-6/2013			
Soil samples (sensor calibration)				11/2007
Site ET				
Veg. transects		4/2008		
Veg. biomass		3/2009		
Temperature/RH/ wind speed/soil temperature/solar radiation/ precipitation			12/2008-6/2013 (gap 7/2009-11/2009)	

Table 1 continued.

Site C				
Deep	11/2007-10/2012; 4/2013-6/2013			
Canopy	11/2007-10/2012 4/2013-6/2013			
Dripline	11/2007-7/2008; 9/2008-5/2011 10/2011-6/2012			
Open	11/2007-5/2011 10/2011-6/2013			
Veg. transects		4/2008		
Veg. biomass		3/2009		
Veg. richness		11/2008		
Temperature			11/2007-8/2010	
Soil temperature			11/2007-6/2012	
RH			11/2008-8/2010	
Soil samples (sensor calibration)				11/2007
Site D1 (initial control)				
Deep	1/2008-4/2013			
Open	1/2008-4/2013			
Canopy	1/2008-4/2013			
Site D2 (supp. control)				
All sensors (4)	10/2011-6/2013			
Site E				
Deep	5/2008-6/2008;			
Canopy	9/2008-3/2011			
Dripline	10/2011-6/2013			
Open	(all sensors)			
Veg. transects		4/2008		
Veg. biomass		3/2009		
Soil samples (sensor calibration)				8/2008

Table 1 continued.				
Site F				
Deep				
Canopy	5/2008-6/2013			
Dripline	(3 of 4 sensors)			
Open	5/2008-8/2010			
Veg. richness		11/2008		
Soil samples (sensor calibration)				8/2008
Site UV				
Veg. transects		4/2008		
Piezometers				
01 (below spring)	12/2007-6/2013			
02 (above spring)	12/2007-6/2013			
Barologger (ambient temp.)	12/2007-6/2013			
Precipitation				
Recording rain gage			11/2007-6/2013	
Snow gage			12/2009-2/2010; 11/2010-4/2011 11/2011-4/2012	
Bird count (Audubon)				4/2009
Bird survey (Hawks Aloft)				1/2009; 5/2009

Sensor regression analysis

The data analysis will seek to combine data from as many sensors of each type as possible, in order to increase the robustness of the data set's applicability across the project area. Previous years' data sets were evaluated by regression analysis; the analysis has not yet been performed again for more recent sets. A simple regression curve compares the data collected by individual sensors of each type and the mean for all sensors of that type. In the data sets collected through May 2010, r^2 values ranged from 0.683–0.972. Variations in the intercept values were generally small, except for the "open" sensor at Site D, where the intercept for the

2009–2010 data set was –0.11. This suggested 1) sensor calibration, and 2) installation of an additional control site at a location more similar to the treatment sites. A 4-sensor installation was placed within the control watershed in October 2011 (Site D2), and data were collected at both control sites through April 2013. Site D1 was then discontinued. Regression analysis will also examine correspondence between data collected by the similar sensor types at each control to determine 1) the intercept value for sensor data from Site D2, and 2) whether a uniform adjustment applied to the data from Site D1 will fit its data to those collected at Site D2.

Data sets: *Recording soil moisture sensors*

All soil moisture sensors in the Burro Mountains project area, except those at the control site, were replaced in August, 2010. Most sensors were nearing the end of their 3-year reliable calibration period (sensors at the control site were originally placed a few months after those at the treatment sites). Replacing the sensors immediately prior to the thinning treatments also provided a brief period during which data continuity could be checked. In fact, soil moisture levels recorded by the sensors dropped after replacement; most recovered to earlier levels after rainfall in early September, 2010. The drop in recorded levels is likely because the soil contact with each sensor is lessened during replacement; although the soil around each new sensor was tamped down as well as possible, we did not "water" the sensors as during initial placement. However, data recorded by the sensors at the lower B site suggest that soil contact with those sensors remains inconsistent.

The final data download for the current project period was on June 30. Soil moisture data were collected at 15-min time steps. The resulting data sets were evaluated for sensor errors (i.e., during frozen soil conditions) and damage. Invalid data were removed. (The data will be re-evaluated prior to identifying any periods for which data from all sensors at any site will be excluded.) The graphs that accompany this report CD show the resulting data sets since thinning treatments in 2010. Previous reports show data graphed for all project years. Site locations are shown on the map.

The data gaps that have developed at some sites over time suggested that site visits should be scheduled more frequently than quarterly, and site visit frequency was increased in late 2011-2012 to bi-monthly; we returned to this schedule for the spring of 2013.

Alluvial groundwater

The most recent data downloaded from the two site piezometers were collected in June 2013. All piezometer data were checked against manual water level measurements made during site visits. Variance between manual measurements and levels recorded by transducer were < 0.1 ft. Graphs of all piezometer data collected since 2010 are included on the CD containing this report; previous data collected since the project began in November 2007 are plotted in previous reports.

Soil temperature and climate data

Hourly soil and ambient temperatures, and relative humidity data are collected by the weather station. All weather station data are included on the report CD. The Barologger at the piezometer installation site also collects ambient temperature data.

Vegetation transects and biomass plots

Detailed ground and canopy cover data were collected throughout the project area (Table 1) by the end of 2009. All vegetation data, graphs, and photos from each data collection site were included with the final report for 2009.

These sites will be re-measured periodically in order to 1) document vegetation response to treatment and 2) provide representative vegetation data against which estimates of evapotranspiration can be calibrated. The next measurements will occur in the fall of 2013.

STIVER CANYON STUDY AREA

Soil moisture instrumentation at the Stiver Canyon site was replaced during site visits in late 2011 and early 2012.

The frequency of site visits for downloading and/or replacing instrumentation increased again in 2011-2012; monthly visits occurred through June of 2012 but were discontinued due to time constraints. Only two site visits were made between January and June of 2013. The final data collection run for this project year was on June 8.

Sensor and microstation depradation by wildlife lessened between June 2012 and early 2013 (despite numerous visits by coyotes, bears, cattle, and elk documented by the wildlife camera at the site). However, all sensors at the Schneberger treatment site were destroyed sometime during the early winter of 2013, and the microstation itself was missing in February 2013. After consideration, we decided against replacing the instrumentation until a definitive date for treatments at the site is determined. The Black Range District of Gila National Forest had originally planned a prescribed burn for 2012, but it was delayed by funding constraints to 2013, and then delayed again due to the extremely dry conditions. With more than 100,000 acres to the south burned and burning in the ongoing Silver fire, it is unlikely that staffing to conduct the planning or implementation for a prescribed burn will be available next year, either—assuming that climatic conditions cooperate. More than 4 years of baseline data have now been collected at the site, and while data collection will continue for the life of the existing sensors, none will be replaced until all of the variables affecting treatment implementation enable the Black Range to set a firm date for the treatments. Table 2 summarizes the data collection sites and valid data periods since study inception in November 2008. Soil moisture and climate data collection sites are shown on the map below. Vegetation transects are located at the soil moisture sites.

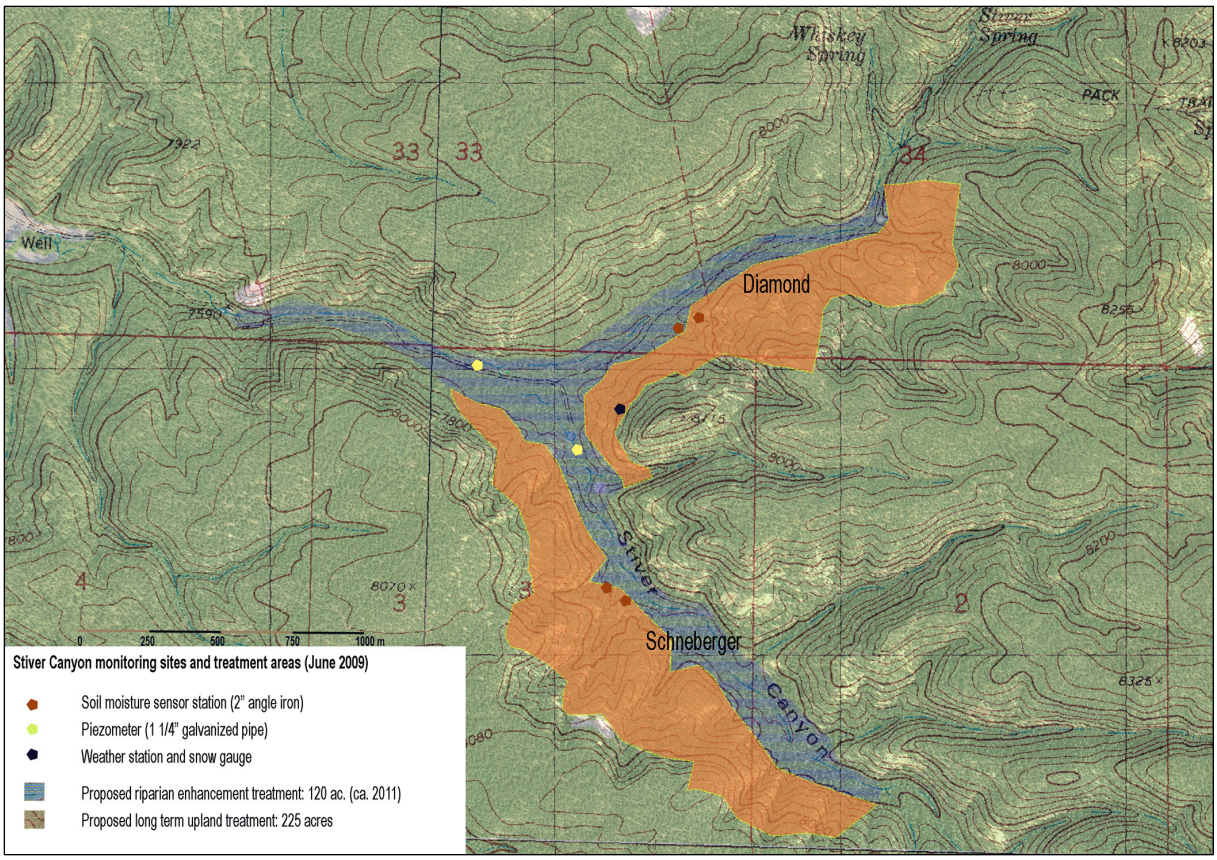

Table 2. Data collected at Stiver Canyon project area since project start, November 2008.

	Archived data			
Site	**Alluvial and soil moisture**	**Vegetation**	**Climate**	**Other**
Diamond control				
Canopy	12/2008-10/2010; 12/2010-6/2012			
Open Dripline	12/2008-10/2010; 12/2010-6/2013 (both sensors)			
Veg. transects		11/2008		
Veg. biomass		4/2009		
Soil samples (sensor calibration)				11/2008

Table 2 continued.

Diamond treatment				
Canopy Dripline	12/2008-4/2009; 6/2012-6/2013			
Open	12/2008-4/2009			
Veg. transects		11/2008		
Veg. biomass		4/2009		
Soil samples (sensor calibration)				11/2008
Schneberger control				
Canopy Deep Dripline	12/2008 – 9/2010; 12/2010-6/2013 (3 sensors)			
Open	12/2008-6/2010; 12/2010-6/2013			
Veg. transects		11/2008		
Veg. biomass		4/2009		
Soil samples (sensor calibration)				11/2008
Schneberger treatment				
Canopy	12/2008-5/2012			
Open	4/2009-5/2012			
Dripline	12/2008-5/2012			
Deep	4/2009-5/2012			
Veg. transects		11/2008		
Veg. biomass		4/2009		
Temperature			2/2009-6/2010	
Soil temperature			11/2008- 6/2012	
RH				
Soil samples (sensor calibration)			2/2009-4/2009	11/2008
Site ET (weather station)				
Temperature/soil temperature/RH/wind speed/solar radiation/ precipitation			4/2009 – 6/2013	

Table 2 continued.			
Piezometers			
DS (below confluence)	11/2008-6/2013		
US (Schneberger)	11/2008-6/2013		
Barologger (ambient temp.)	11/2008-6/2013		
Precipitation			
Recording rain gage		11/2008-6/2013	
Snow gage		11/2008-6/2013	
Riparian vegetation mapping (*populus/salix*)			4/2009

Data sets: *Recording soil moisture sensors*

Soil moisture sensor site locations are shown on the map above.

Soil moisture data were collected at 15-min time steps. The resulting data sets were evaluated for sensor errors (i.e., during frozen soil conditions) and damage. Graphs of the valid data collected between November 2008 and June 2013 by the soil moisture sensors are included on the report CD.

Alluvial groundwater and climate

Data from transducers in the two site piezometers were last collected in June 2013. All piezometer data were checked against manual water level measurements made during site visits. Variances between manual recorded levels were < 0.1 ft. All piezometer data collected since November 2008 are plotted with cumulative precipitation in the graphs included with the report CD. Extreme drought continues at the project area. The graph clearly shows the drought's effects on alluvial groundwater levels at the site, although levels in the Schneberger drainage upstream of its confluence with the drier Diamond drainage feature remain relatively elevated. Daily cumulative precipitation recorded by the rain gauge at the site is plotted on the soil moisture and piezometer graphs.

Data from the weather station are included on the report CD but are not graphically represented.

Vegetation transects and biomass plots

Detailed ground and canopy cover data have been collected at each of the soil moisture data sites (Table 2). All existing riparian vegetation (e.g., *salix, populus tremuloides*) were also mapped by high-accuracy GPS. All baseline vegetation data and data collection site photos were reported with the 2009 annual report.

These sites will be re-measured following treatment and periodically thereafter in order to 1) document vegetation response to treatment and 2) provide representative vegetation data against which estimates of evapotranspiration can be calibrated.

DATA ANALYSIS

The ongoing regional drought began in September 2010. Precipitation at both study areas has been extremely limited, with virtually no snowfall received at the Stiver site this winter. The lack of rainfall at the Burro Mountains site continues to limit pre- and post-thinning comparisons of soil moisture and alluvial groundwater response under similar rainfall conditions; i.e., conditions prevailing prior to the thinning treatment were substantially wetter than post-thinning conditions. Data evaluation and analysis therefore continue to be postponed awaiting the return of moisture.

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