



Hydrologic Monitoring in Walnut Canyon National Monument

Water Years 2012 through 2014

Natural Resource Data Series NPS/SCPN/NRDS—2015/965



ON THE COVER
Walnut Canyon National Monument, Arizona. NPS photo.

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1 Introduction

Walnut Canyon National Monument (WACA) protects ancient ruins nestled in the sandstone cliffs above a sinuous stretch of Walnut Creek in northern Arizona. The monument is located downstream of two dams constructed in 1904 and 1941. These dams divert much of the flow that historically occurred in the canyon (Rowlands et al. 1995). Repeat photography of the area shows an increase in canyon bottom vegetation since construction of the dams (Brian 1992). A recent study of Arizona walnut (*Juglans major*) in WACA found the population was healthy and stable (Schelz et al. 2013).

The Southern Colorado Plateau Network (SCPN) Inventory & Monitoring Program began monitoring hydrologic conditions at sites in WACA in 2010 with the goal of documenting the timing, duration, and magnitude of streamflow (Soles and Monroe 2012). Both streams are ephemeral, flowing only in response to infrequent large storm events. SCPN's specific objective for this project is to determine status and trends of the streamflow in Walnut Creek and one of its major tributaries in Cherry Canyon. This information will improve understanding of the hydrologic relations between streamflow, vegetation, and precipitation.

2 Methods

SCPN has been monitoring hydrologic conditions at WACA since 2010. Following methods described in the network's integrated riparian monitoring protocol (Monroe et al. in review), this project documents the timing, duration, and magnitude of surface water flow events, as well as changes in shallow ground water at three sites in the Walnut Canyon drainage (Table 1,

Figure 1). The two sites on Walnut Creek are LLM01, just below Lower Lake Mary, and NUB01, near the old upstream boundary of the park. CHC01 is on Cherry Creek about 0.4 km upstream of its junction with Walnut Creek. These sites were originally part of a network of crest-stage gages installed to monitor flood flows through WACA, and were maintained by the U.S. Geological Survey during the period 1995–2002 (McCormack et al. 2003).

At all three sites, 2-inch galvanized pipes (either single or in pairs) were anchored securely to bedrock or a large boulder and are designed to function as crest-stage gages. The pipes are capped on the top and bottom, and are drilled with holes near the bottom to allow water to enter during flow events and to drain back out. SCPN staff converted the crest-stage gages to recording stage gages (RSG) by installing pressure transducers (Levellogger; Solinst Corp.) in the lower of two gage riser pipes at LLM01 and CHC01, and in the single, 3 m pipe comprising the gage at NUB01. The three pressure transducers record air temperature and absolute pressure during periods of no flow, and water temperature and water levels when flow is present. A fourth transducer, known as a Barologger (Solinst Corp.), is a barometric pressure sensor suspended from a tree across the channel from the gage at NUB01 and records air temperature and absolute pressure. These data are used to compensate raw transducer data for fluctuations due to atmospheric pressure.

Instruments at the monitoring sites were set to record data at 15-minute or hourly intervals. During initial site visits, the locations of all equipment, control points, and important channel features were surveyed using a total station survey instrument. Accuracy for SCPN's

Table 1. Hydrologic and climate monitoring sites used by SCPN in and near Walnut Canyon NM, Arizona.

Location	Elevation (m) ^a	Coordinates ^a	Data type
Walnut Creek below Lower Lake Mary (LLM01) ^b	2067.08	446054.11 E, 3886190.07 N	water level recorded by pressure transducer
Walnut Creek near upstream boundary (NUB01) ^c	1945	452264 E, 3891534 N	water level recorded by pressure transducer
Cherry Creek near downstream boundary (CHC01) ^c	1920	456125 E, 3890463 N	water level recorded by pressure transducer
WACA climate station GHCND:USC00029156 ^d	2040.6	453586.4 E, 3892247.5 N	precipitation
Flagstaff Pulliam Airport climate station GHCND:USW00003103 ^d	2134.5	439305.3 E, 3889226.5 N	precipitation

^a Horizontal coordinates are reported in Universal Transverse Mercator (UTM) Projection, Zone 12, North American Datum of 1983 (NAD 83). Vertical heights are referenced to the North American Vertical Datum of 1988 (NAVD 88).

^b Surveyed with Total Station and GPS.

^c Location digitized from 1 m resolution aerial imagery; elevation calculated from 2013 USGS 10 m Digital Elevation Model

^d NOAA climate station data (ncdc.noaa.gov)

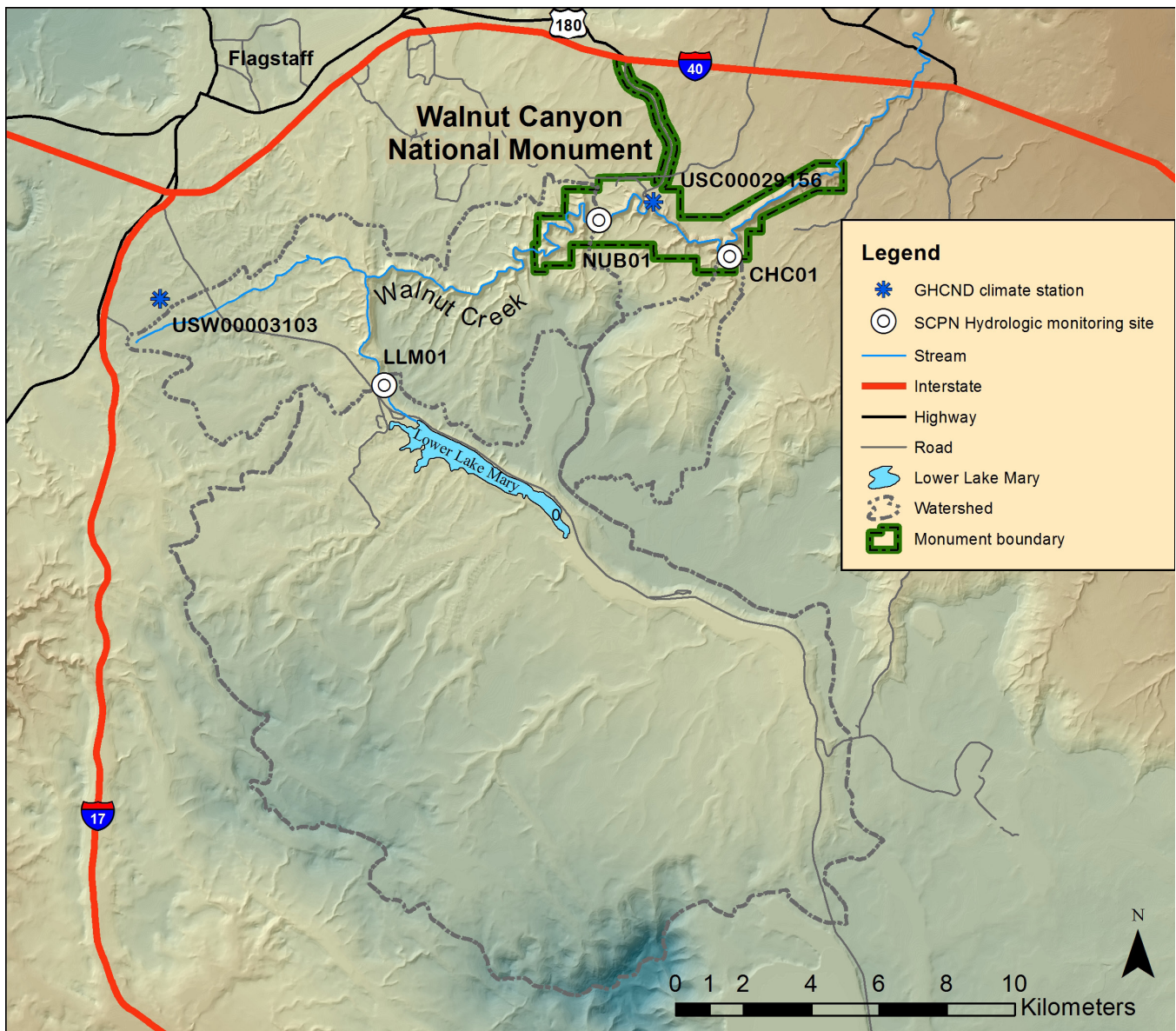


Figure 1. Sites associated with hydrologic monitoring in Walnut Canyon NM.

total station surveys is ± 0.02 meters over a 500 m distance for vertical and horizontal. An additional survey was completed at LLM01 using high accuracy GPS equipment. Accuracies for this survey are ± 0.045 meters horizontal and ± 0.022 meters vertical.

SCPN staff visited sites at WACA two to four times per year during 2012, 2013, and 2014 to download instrument data. Data in this report are presented for time periods known as Water Years (WY), which begin October 1 (of the previous year) and end September 30. This is the time period commonly used in hydrologic studies because it best delineates seasonal precipitation patterns. Local precipitation data are avail-

able from the Flagstaff Pulliam Airport climate station GHCND:USW00003103, corresponding to the LLM01 and NUB01 watersheds, and the WACA GHCND climate station GHCND:USC00029156 southeast of the monument Visitor Center, corresponding to CHC01's watershed. These stations are operated by the National Climatic Data Center (NCDC) (National Climatic Data Center, Climate Data Online n.d.).

3 Results and Summary

This report summarizes data from WYs 2012 through 2014. Data from WY 2011, available in *Hydrologic monitoring in Walnut Canyon National Monument: 2010–2011 summary report* (Soles and Monroe 2012) are also included here to provide a longer term view of hydrologic patterns at Walnut Canyon NM.

Approximate height of floods and number of days in which flow was documented are shown in Table 2. There were no floods at any of the sites during WY 2012. In WY 2013 one flow event was recorded at each of the LLM01 and NUB01 gages (Figures 2 and 3, respectively), and seven flow events were registered at CHC01 (Figure 4). During WY 2014, two floods occurred at CHC01, and none at LLM01 or NUB01.

Flow events were recorded at LLM01 and CHC01 on 27 January 2013. These floods were the result of a wet winter storm that produced greater than 50 mm of precipitation over a period of three days. The flow event on 27 January 2013 documented at LLM01 was relatively small and did not reach NUB01, 15.82 kilometers downstream.

Floods occurred at NUB01 and CHC01 on 9 September 2013. At NUB01 the flood began in the afternoon of the 9th, peaked that evening, and flow continued until 15 September 2013. This storm was an extended regional late-monsoon storm system that deposited more than 50 mm of rain over a period of four days at

Table 2. Floods recorded at hydrologic monitoring sites in and near Walnut Canyon NM, Arizona.

Location	Flood date	Height of flood peak above thalweg (m)	Number of days
Walnut Creek below Lower Lake Mary (LLM01)	2/21/2011	0.7	4
	1/27/2013	0.2	2
Walnut Creek near upstream boundary (NUB01)	9/9/2013	1.2	6
	3/5/2011	0.4	5
	1/27/2013	0.4	2
	3/12/2013	0.3	2
	8/26/2013	0.7	1
Cherry Creek near downstream boundary (CHC01)	8/30/2013	0.7	2
	8/31/2013	0.9	2
	9/9/2013	0.9	2
	9/10/2013	0.4	2
	3/1/2014	0.4	3
	8/15/2014	1.1	2

both the WACA and Flagstaff Pulliam Airport GHCND climate stations. The flow event at NUB01 on 9 September 2013 was not recorded upstream at LLM01. This is probably because any runoff from this storm in the upper parts of the watershed was retained by Upper or Lower Lake Mary dams.

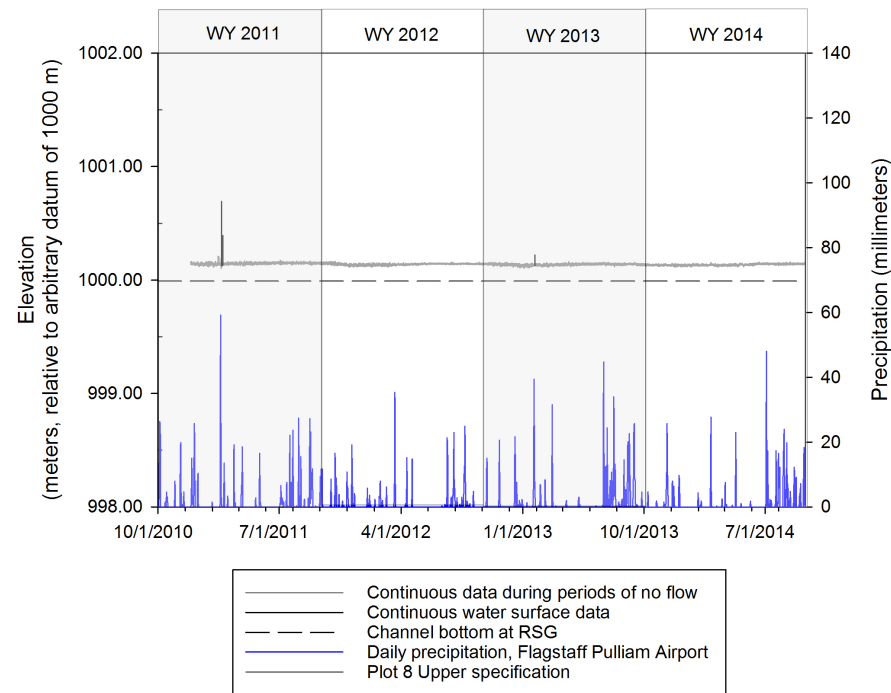


Figure 2. Recorded water levels at LLM01 from 14 October 2010 through 30 September 2014 in Walnut Canyon NM. Daily precipitation recorded at the Flagstaff Pulliam Airport climate station (GHCND:USW00003103) from 1 October 2010 through 30 September 2014 is plotted relative to the right axis.

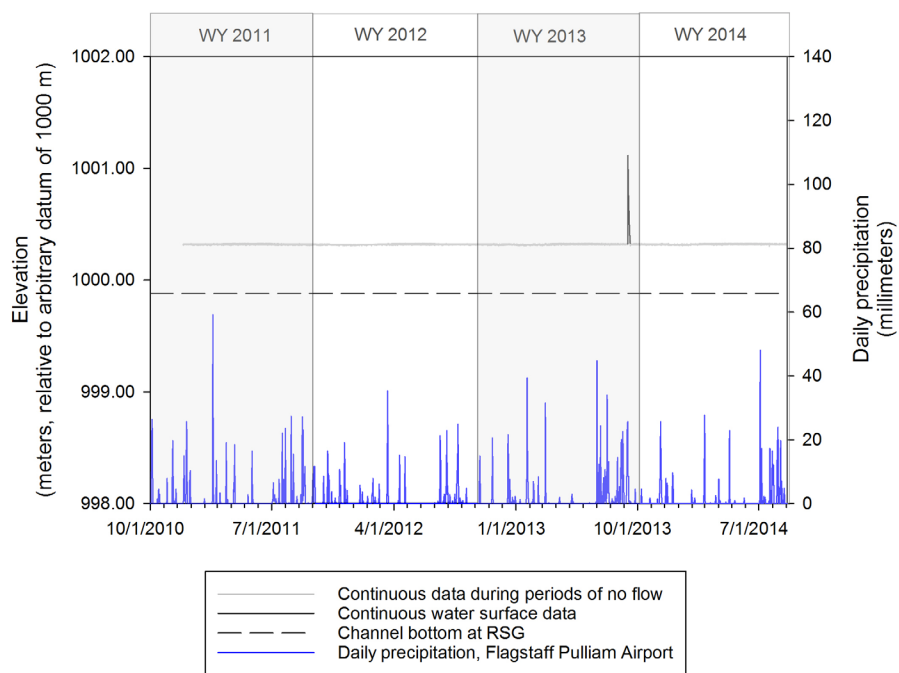


Figure 3. Recorded water levels at NUB01 from 13 October 2010 through 30 September 2014, in Walnut Canyon NM. Daily precipitation recorded at the Flagstaff Pulliam Airport climate station (GHCND:USW00003103) from 1 October 2010 through 30 September 2014 is plotted relative to the right axis.

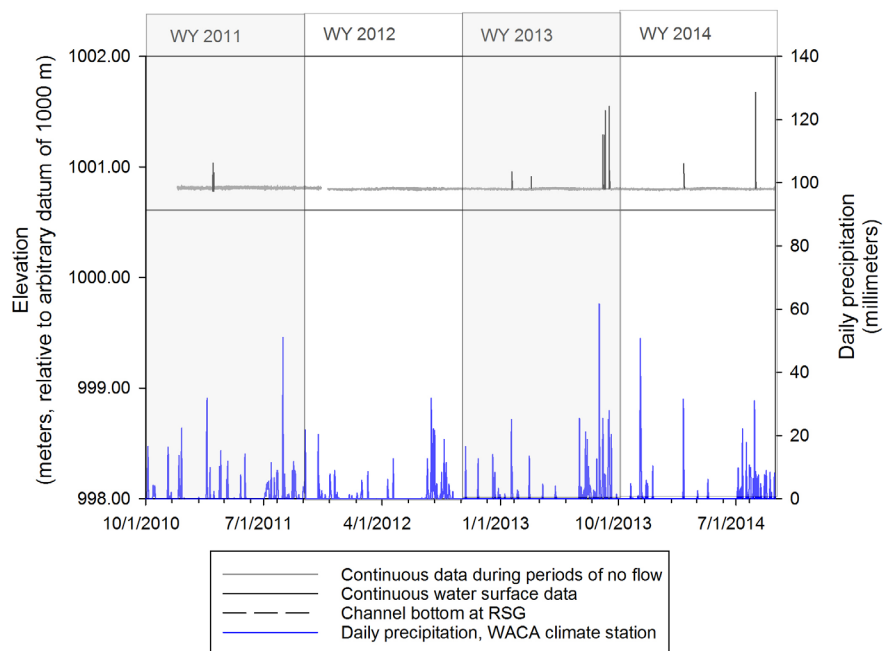


Figure 4. Recorded water levels at CHC01 from 13 October 2010 through 30 September 2014 in Walnut Canyon NM. Daily precipitation recorded at the WACA GHCND climate station (USC00029156) from 1 October 2010 through 30 September 2014 is plotted relative to the right axis.

4 More Information

More detailed information about hydrologic monitoring at Walnut Canyon NM is available in the report for the first year of monitoring at the site, (Soles and Monroe 2012), available from SCPN (<http://science.nature.nps.gov/im/units/scpn/>) or from the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>).

Contact Stephen Monroe for more information about water resources monitoring in SCPN parks, stephen_monroe@nps.gov.

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