National Park Service
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Natural Resource Stewardship and Science

Hydrologic Monitoring in El Morro National Monument

Water Years 2012 through 2014

Natural Resource Data Series NPS/SCPN/NRDS—2015/805

ON THE COVER
Monitoring activities at the Historic Pool in El Morro NM, New Mexico.

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June 2015

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Funding for the SCPN water resources field crew was provided to Northern Arizona University by the National Park Service through Colorado Plateau CESU Agreement H1200090005 (Tasks 11AC90785 and 12AC10394) and Agreement H2370094001 (Task P13AC01043).

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This report is available from the Southern Colorado Plateau Network website (http://science.nature.nps.gov/im/units/scpn/), and the Natural Resource Publications Management Web site (http://www.nature.nps.gov/publications/nrpm/) on the Internet. To receive this report in a format optimized for screen readers, please email irma@nps.gov.

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Please cite this publication as:

Monroe, S. A., and E. S. Soles. 2015. Hydrologic monitoring in El Morro National Monument: Water years 2012 through 2014. Natural Resource Data Series NPS/SCPN/NRDS—2015/805. National Park Service, Fort Collins, Colorado.

NPS 308/128779, June 2015

Introduction

Naturally occurring pools in the arid southwestern United States sustain a rich diversity of plant and animal life. In western New Mexico, the Historic Pool in El Morro NM lies at the base of a sandstone bluff known as Inscription Rock, where humans, drawn to the pool, have left evidence of their presence for centuries in the form of petroglyphs and inscriptions. In recent years the inscriptions have gradually eroded, possibly due to water flowing on and over the rock or to capillary action (Pranger 2001). The source of water in the pool is uncertain, with some maintaining the pool is fed by only surface runoff and others suggesting a groundwater source also exists (van Dam and Hendrickx 2007).

The Southern Colorado Plateau Network (SCPN) Inventory and Monitoring Program of the National Park Service began monitoring hydrologic conditions at this site in 2010 with the goal of documenting water level fluctuations in the pool and in nearby observation wells (Soles and Monroe 2012). SCPN's specific objective for this project is to determine status and trends of the water level in the Historic Pool. This information will improve understanding of the hydrologic relations between water in the pool, local groundwater, and precipitation.

Methods

SCPN has been monitoring hydrologic conditions at the Historic Pool in El Morro NM since September 2010. Following methods in the network's Integrated Riparian Monitoring Protocol (Monroe et al. in review), this project includes collection of data documenting changes in the pool's water level and in three nearby shallow observation wells (Table 1).

In October 2010 SCPN used a total station survey instrument to survey Historic Pool bathymetry, SCPN instrumentation, and related features in the area. Figure 1 is an updated version of the site map based on coordinate and elevation transformation from a high accuracy GPS survey of control points in May 2012.

At the pool, a pressure transducer (Levelogger; Solinst Corp.) suspended inside a 2-inch diameter PVC pipe measures and records water level and water temperature hourly (HPL01RSG). A 1-inch diameter steel pipe near the water's edge enables manual measurement to the water's surface as a check against the transducer (HPL01a). A second transducer, known as a Barologger (Solinst Corp.), is installed 40 m away and records air temperature and absolute pressure. These data are used to compensate raw pool transducer data for fluctuations due to atmospheric pressure.

Three observation wells were installed near the Historic Pool at El Morro NM by a previous researcher (van Dam and Hendrickx 2007) for the purpose of defining the extent of hydrologic connectivity between water in the pool and local subsurface water. The wells are 2-inch PVC pipe 1.05, 3.29, and 3.35 meters deep, and are located 10 to 20 meters downgradient from the pool. SCPN staff measure depth to water at each well during site visits.

Local daily precipitation data are available from the ELMO climate station (GHCND:USC00292785) and provide information about the contribution of surface water input to the pool. SCPN instruments also collect air and water temperature data to monitor additional climate conditions at the site.

SCPN staff visited El Morro NM four times during each Water Year (WY), 2012 and 2013, and twice during WY 2014 to download instrument data and to manually measure water levels at the pool and observation wells. A Water Year is the period beginning October 1 (of the previous year) and ending September 30. It is the time period commonly used in hydrologic studies because it best delineates seasonal precipitation patterns.

Table 1. Hydrologic and climate monitoring sites used by SCPN at El Morro NM, New Mexico.

Location	Elevation (m)	Coordinates	Data type
RSG in Historic Pool (HPL01RSG)	2209.25	741593.3 E, 3880746.7 N	pool water level, recorded by pressure transducer
Measuring point in Historic Pool (HPL01a)	2210.24	741594.9 E, 3880740.3 N	pool water level, measured manually
North Well near Historic Pool (HPL01b)	2208.62	741608.8 E, 3880744.2 N	well water level, measured manually
Center Well near Historic Pool (HPL01c)	2209.52	741603.3 E, 3880737.0 N	well water level, measured manually
South Well near Historic Pool (HPL01d)	2211.29	741604.1 E, 3880715.3 N	well water level, measured manually
ELMO climate station (GHCND:USC00292785)	2201.6	741825.9 E, 3880470.4 N	precipitation

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

Results and Summary

This monitoring brief reports data from Water Years 2012–2014 (Figure 2). Data from WY 2011, available in the full report by Soles and Monroe (2012), are also included here for a longer term view of hydrologic patterns at El Morro NM.

In recent years the southwestern United States has experienced extreme drought, and amounts of precipitation recorded at El Morro NM have been very low (Figure 2). During October 2010–September 2014, water levels in the Historic Pool varied by approximately 0.7 m, ranging from 0.65 m below the spillway crest to 0.07 m above (Figure 2). Water reached the level

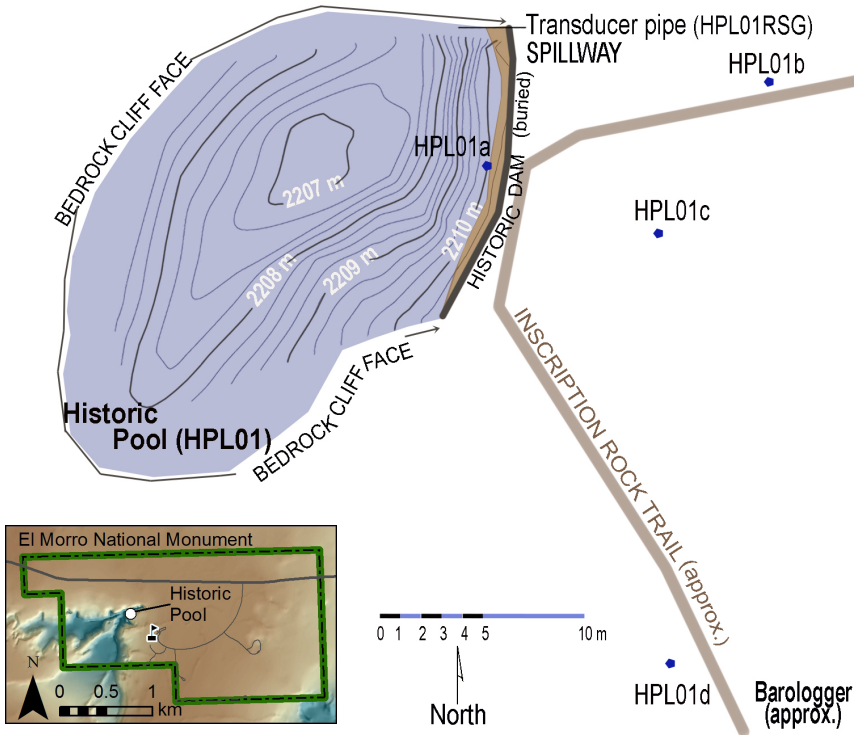

Figure 1. Contour diagram of the Historic Pool and location of measurement instruments (see also Table 1) generated from the total station survey data collected 27 October 2010 in El Morro NM. Contour intervals shown in the pool are at 0.25 m intervals; 1 m contours are labeled in white. The historic concrete dam (now buried beneath soil) is a bold black line. Blue shading shows the extent of the pool water surface on the survey date, and brown shading is soil exposed upstream of the historic dam at this water level.

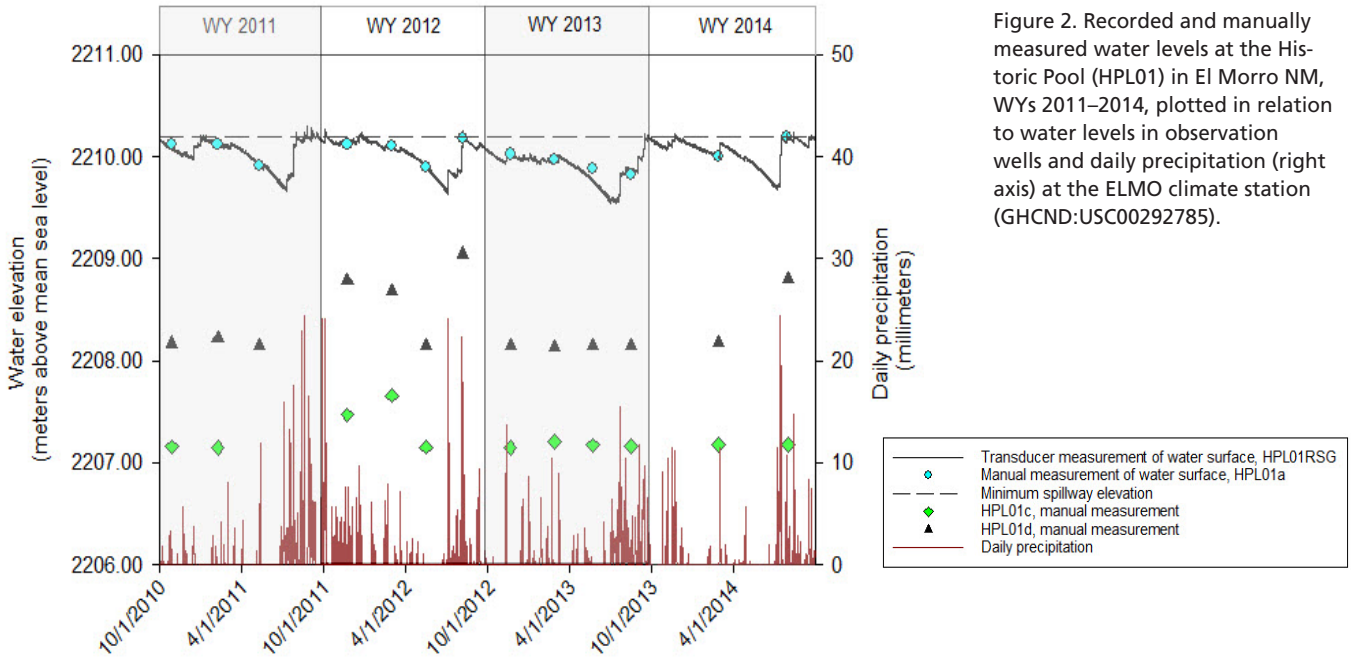

Figure 2. Recorded and manually measured water levels at the Historic Pool (HPL01) in El Morro NM, WYs 2011–2014, plotted in relation to water levels in observation wells and daily precipitation (right axis) at the ELMO climate station (GHCND:USC00292785).

of the spillway three times during WY 2012, just once in WY 2013, and three times during WY 2014 (Table 2). The highest recorded pool water levels occurred from late July to early October, and aligned with periods of substantial rainfall during the summer monsoon. High water levels also corresponded to late fall and early winter storms in 2011 and 2013. Each year water levels in the pool declined during the late spring and early summer months when there was little or no precipitation, and the lowest water levels were recorded in early July (Table 3). The lowest average pool water levels during any WY, 2012–2014, occurred in 2012–2013, corresponding with extremely limited precipitation that year (Figure 2).

During WY 2012 through WY 2014, measured water levels in the Center observation well (HPL01c) ranged from 2.4 m to about 3.0 m below the pool water level, and water levels in the South observation well (HPL01d) ranged from 1.3 m to 1.9 m below the water level in the pool on the same date. The North observation well (HPL01b) was dry throughout the entire period. Most water level increases in HPL01c and HPL01d corresponded to increases in pool water level following precipitation events. Water levels in HPL01c and HPL01d generally, but not always, fluctuated synchronously. The relationship between these water levels could reflect groundwater recharge directly from the pool, infiltration resulting from surface water runoff over a larger area, or some combination of these.

Table 2. Number of consecutive days height of water in pool at El Morro NM exceeded spillway crest (2210.20 meters) and maximum heights of water above crest, Water Years 2011–2014.

December 2011	7	2210.24	0.04
September 2013	1	2210.22	0.02
July 2014	2	2210.23	0.03

Table 3. Minimum annual height of water in pool at El Morro NM, Water Years 2011–2014.

Date	Minimum water level in pool during year (m)	Difference between spillway elevation and level of water in pool (m)
July 9, 2011	2209.66	-0.54
July 3, 2012	2209.64	-0.56
July 2, 2013	2209.55	-0.65
July 7, 2014	2209.68	-0.52

More Information

More detailed information about hydrologic monitoring at El Morro NM is presented in the report for the first year of monitoring at the site (Soles and Monroe 2012), available from the SCPN website (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 on water resources monitoring in SCPN parks, stephen_monroe@nps.gov.

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NPS 308/128779, June 2015

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