

**To:** National Park Services  
Montezuma Castle National Monument  
Richard Goepfrich, Facility Manager

**From:** Multicultural Technical Engineers

**Date:** Tuesday - February 13, 2018

**Subject:** 30% Hydrology and Hydraulics Report

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## Background Summary

The National Park Services (NPS) is looking to add a large single unit parking lot to the Montezuma Castle National Monument (MCNM). MCNM is in Central Arizona 5 miles north from the City of Camp Verde and is located along a river called Beaver Creek. Figure 1 below displays the location within the state of Arizona.

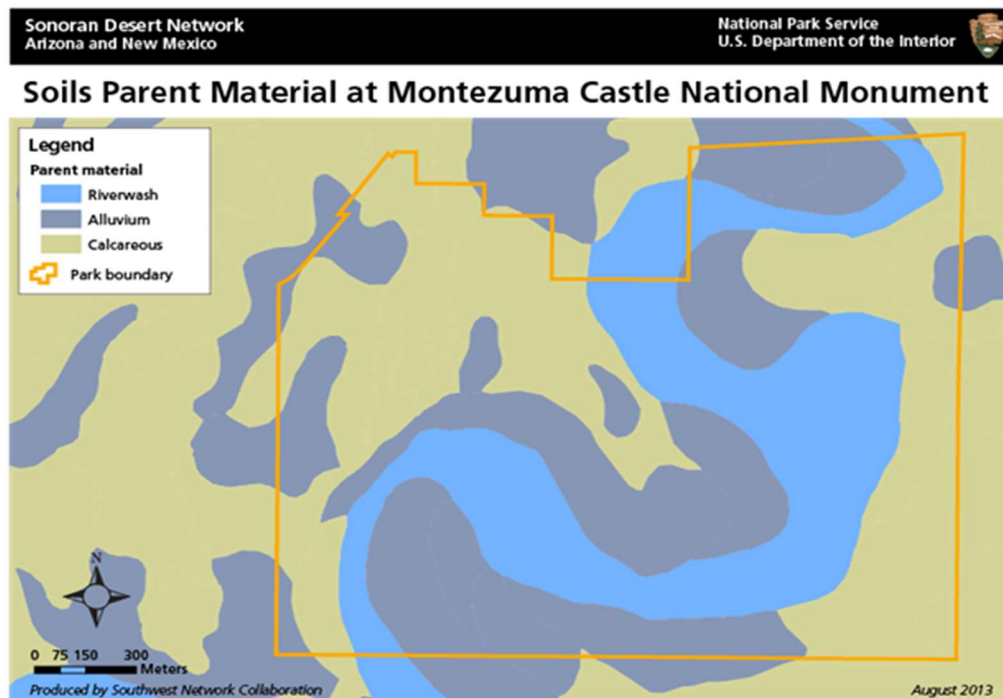


*Figure 1: Statewide view of Montezuma Castle National Monument in Arizona*

MCNM supports a variety of streams, vegetation, land birds, plants, climates and seeps and Tinajas. Montezuma Castle National Monument climate is similar to what is found across the southern part of the state. The spring and fall are warm and dry with little to no precipitation. The summer seasons are filled with extreme heat with a monsoon season that can bring destructive weather and precipitation. The rainy season brings the largest amount of precipitation for the year. The winter season brings winds and some precipitation. The precipitation during the winter can fluctuate between snow and rain but mainly rain. With large precipitation events Federal Emergency Management Agency (FEMA) determined that the proposed parking lot area is not in a hazardous or chance of a flood hazard.

### INSERT FEMA MAP

The geology of the site ranges between two types of soil: riverine bottomland alluvium and rocky upland soil. These soils are typically found along river systems and seasonal flows in natural channels [1]. The soil was soft to step on and very airy but once compacted it was tough and hard. Our team believes the soil is easy to transport by a rainfall or by wind if uncovered and open to the surface (no vegetation to restrain the soil). **Geotech?**



*Figure 2: Soil Map of Montezuma Castle National Monument*

Information including the precipitation frequency was determined using National Oceanic and Atmospheric Administration (NOAA). This information was used with accordance to the Federal Highway Administration Urban Drainage Design Manual. The amount of precipitation aides in analyzing the drainage for the proposed parking lot. The Rational Method is used to determine the peak flow. The use of the rational method is because the drainage basin of interest is less than 200 acres. The

stormwater conveyance is analyzed with CulvertMaster and FlowMaster. Both systems are supported by Bentley.

The proposed parking lot will cause change in the impervious area which will affect the existing drainage system. The team will discuss the existing drainage basin and storm water system and the proposed plans due to adding the new unit.

## **1.0 Existing Conditions:**

The existing site is approximately 843 acres that includes pavement, buildings, water and wastewater detention ponds, and natural landscapes. The net existing areas are shown in Table 1.

*Table 1: Existing Areas Onsite*

Area Type	Existing Area	General Location/ Notes
Natural Landscapes	836.88 Acres	All areas that do not have an impervious system.
Pavement	4.49 Acres	Located throughout the site, does not include proposed area.
Water/ Wastewater Ponds	1.3 Acres	Located to the south of the Existing Roads and southern tip of the site.
Buildings	0.33 Acres	Includes Guest Services and Management Buildings.
Total Areas	843 Acres	

Within the Montezuma Castle National Monument there are many hydrologic basins. The largest one deposits water into a natural channel in the center and is conveyed to a 42 inch Corrugated Steel Pipe (CSP) that runs under Montezuma Castle Road with a north/south orientation. Once on the other side of the road the water is then conveyed to Beaver Creek where it is finally deposited. The smaller basin of interest is located on the west side of Montezuma Castle Road and the water is collected into a roadside ‘V’ channel and conveyed to a 15 inch CSP that runs north/south under the road and is deposited into a natural area where a channel has formed. Once the energy is insufficient to keep the water moving the channel is flattened out and leeches into the existing soil. An easy to read site plan of the basin boundaries and flow of water with respect to the park and proposed lot is attached in the appendix.

## **1.1 Existing Water Entering Proposed Site**

Our team used the Rational Method provided from the FHA to calculate total runoff in the area. This is due to the small size of the drainage basins (<200 Acres) see in Figure 2. The drainage basin is north of



the road and is 5.5 acres. With the design storm of 100 year and 12 hours at an intensity of 1.52 in/ hr, a time of concentration of approximately 18.3 minutes, the expected flow rate through the 15 inch CSP is 3.14 CFS at a rate of 10.4 ft/s. The amount of water entering the proposed site through this culvert is significant and needs to be mitigated appropriately.

<https://msc.fema.gov/portal/search?AddressQuery=montezuma%20castle%20national%20monument#searchresultsanchor>

Soil Map:

[https://www.nps.gov/im/sodn/images/soilmapMOCA\\_1.png?maxwidth=650&autorotate=false](https://www.nps.gov/im/sodn/images/soilmapMOCA_1.png?maxwidth=650&autorotate=false)

Geology info:

<https://www.nps.gov/im/sodn/moca.htm>