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The Colorado and Virgin Rivers before Lake Mead

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ABSTRACT

In 1936, the completion of Hoover Dam on the Colorado River in Nevada and Arizona created Lake Mead, the largest reservoir in the United States. When the lake reached capacity in 1941 several canyons and valleys were flooded, along with two towns, several mines, farm fields, and roads. The area had not been surveyed archaeologically and little detailed information exists about the vegetation and geology of this region. The map reconstructs the geography of the area in 1930 before Lake Mead was constructed, showing roads, towns, mines, physical features, and private property, and was created using a range of historical United States Geological Survey (USGS) maps, a digital elevation model (DEM) providing underwater elevations, and other historical sources. The map includes portions of southern Nevada and northwest Arizona, United States, and is at a scale of 1:210,000. It is hoped that the map may draw attention to the lost geographies of other localities across the United States due to the more than 84,000 dams and reservoirs in the country.

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1. Introduction

In 1936, the completion of Hoover Dam on the Colorado River in Nevada and Arizona created Lake Mead, the largest reservoir in the United States. This deep blue lake just outside Las Vegas is now the centerpiece of Lake Mead National Recreation Area, the seventh most visited unit of the national park system.

The Lake Mead area has a long history. The Colorado and Virgin Rivers had been home to Native Americans for over a thousand years; evidence of their presence had been seen in several village ruins. Euro-American farmers settled the area in 1869 and scattered mining took place in the late 19th and early 20th centuries. The construction of Hoover Dam and the filling of Lake Mead erased much of that history. This erasure is even more complete than might be expected because at the time Lake Mead was constructed there were no requirements for archaeological salvage surveys, and none were carried out except for investigations around one prehistoric ruin (McClellan, Phillips, & Belshaw, 1980). The vegetation of the area was never surveyed (Webb, Leake, & Turner, 2007), and even the geology of the region was not fully investigated before the lake filled (Longwell, 1936). The canyons of the Colorado and Virgin Rivers had received little attention by scientists other than several early surveying parties that passed quickly through the region; the area appeared to have few resources to attract their interest.

An important moment in the history of the U.S. environmental movement took place with the

construction of Glen Canyon Dam and the Lake Powell reservoir in the 1950s and 1960s further upstream on the Colorado River. The Sierra Club popularized the Glen Canyon region as ‘the place no one knew’, one which would be lost forever when the canyons filled with water. The idea of Glen Canyon as a lost world remains a strong sentiment today with the public and the environmental community (Crampton, 2009; Fowler, 2011). Yet archaeologists and other scientists scoured the canyons before they flooded; those filled by Lake Mead in the late 1930s remain much less known and better fit the title of ‘the place no one knew.’

The purpose of this project is to bring attention back to the Lake Mead area by creating a map of the canyons and valleys of the Colorado and Virgin Rivers as they were in the years before Lake Mead was constructed. The map uses a range of cartographic and textual sources to reconstruct the human and physical geography of the area as it was around 1930. The map is intended for general audiences, as well as historians, historical geographers, and others interested in the changing geography of the American West.

The map includes the town of St. Thomas, which was flooded by Lake Mead but has reemerged in recent years due to a prolonged drought. The National Park Service recently created a brochure and map to allow visitors to the town to understand what they are seeing (National Park Service, 2016). This map is a simple black and white street map of the town with remaining concrete foundations labeled and covers only a very

small area that was inundated by the lake. The map created here ([Main Map](#)) shows the entire region as well as roads, mines, and landmarks that disappeared under the lake and provides more information about the area before Lake Mead was created.

2. Data

The primary source of data was an elevation surface for the canyons and valleys filled by Lake Mead. Digital Elevation Models (DEMs) produced by the United States Geological Survey (USGS) provide this data for most of the U.S. However, these DEMs have been produced only in recent decades and therefore represent only current terrain and water surfaces; DEMs are inappropriate any place where terrain has changed significantly over time, as with strip mines, landslides, volcanoes, or reservoirs ([United States Geological Survey, 2015](#)). In such data the Lake Mead area is depicted at its maximum water level of 1229 feet, although this level was last reached in 1983 due to a prolonged drought.

A unique resource for this project is a dataset showing lake bottom depths, originally created for a USGS sedimentation study of Lake Mead ([Twichell, Cross, & Belew, 2003](#)). This provided a composite DEM that combined above water elevations from existing DEMs with underwater elevations based on sonar data. The lake surface is not shown in this data, allowing this composite DEM to be used here to represent the terrain surface before the lake was filled. This is not strictly accurate as sedimentation has occurred in the old river channel, landslides have occurred above water along with slumping below the water level, and wave-cut terraces have developed at the shoreline ([Gould, 1960](#)). However, it provides a close approximation to the pre-lake land surface, especially at the scale of this map.

Other data was needed to map out roads, towns, mines, and other features of the study area. The region inundated by Lake Mead was mapped beginning in 1884, when the United States Geological Survey (USGS) produced several topographic maps covering the area at 1:250,000 scale ([Moffat, 1985](#)). A 1923 USGS expedition descended the Colorado River and created a series of 14 maps at a scale of 1:31,680 showing the area along the Colorado and Virgin Rivers in detail, though features away from the river were not mapped. These maps cover the river between Lees Ferry, Arizona (hundreds of miles upriver from the study area) and the site of Hoover Dam ([United States Geological Survey, 1924](#)). Six of these maps (sheets I, J, K, L, M, and N) depict the study area; a portion of Sheet M showing the Virgin River is shown in [Figure 1](#).

These maps were the most detailed representation of the river made before Hoover Dam was built, and remained the basis for river mapping through the Grand Canyon until recently ([Boyer & Webb, 2007](#)). They show the location of the Colorado and Virgin

Rivers, roads, settlements, mines, springs, and the few place names that existed in the region. The 1924 maps were obtained from the University of Nevada Las Vegas (UNLV) library digital collections website ([UNLV, 2017](#)). The USGS also released several standard topographic quadrangles of this area at a scale of 1:96,000 in 1926, but these show considerably less detail than the 1924 maps. They do however map features farther from the river and were necessary supplements to the 1924 maps. These were obtained from the USGS website ([www.usgs.gov](#)).

A variety of historical sources on the Lake Mead area were used to identify and locate important cultural features for mapping ([Belshaw & Peplow, 1980](#); [Lingenfelter, 1978](#); [Longwell, 1928, 1936](#); [McArthur, 2012](#); [McClellan et al., 1980](#); [Smith, 1972](#); [WESTEC Services, Inc., 1980](#)). Eight mines were identified from these historical sources, all of which were located within areas of patented mining claims; many other mining claims existed that were not associated with mines shown on the USGS topographic maps.

General Land Office (GLO) records contain allow the identification of land ownership in the area. All private land along the Colorado or Virgin Rivers was either farmed, used as grazing land or represented patented mining claims. Although Euro-American settlers arrived in 1869 the majority of lands they claimed were only purchased from the government in the 1930s, when government appraisers began to compensate owners for the loss of their land due to the reservoir. This was due to the area having been settled largely by Mormons, for which land allocation was handled communally by the Mormon Church ([McArthur, 2012](#)). Under this system members of the community had no need to formally homestead or purchase land.

Reconstructing historic vegetation is an important topic in many fields in order to understand environmental changes due to Euro-American settlement, the effect of introduced species, and the potential effects of climate change. Unfortunately, the USGS maps do not depict vegetation and no such data is available for the pre-lake period other than a few general observations from early surveyors and explorers.

3. Methods

The lake bottom DEM was obtained from the USGS project website, along with a separate data set from the same source contained a hillshaded raster depicting terrain. Both were raster GIS datasets and required no editing. Vector GIS data for national park unit boundaries and hydrologic data (water features depicted with lines) were obtained from the Census Bureau ([Census Bureau, 2017](#)).

The remainder of the features depicted on the map had to be created. The first step was to map the

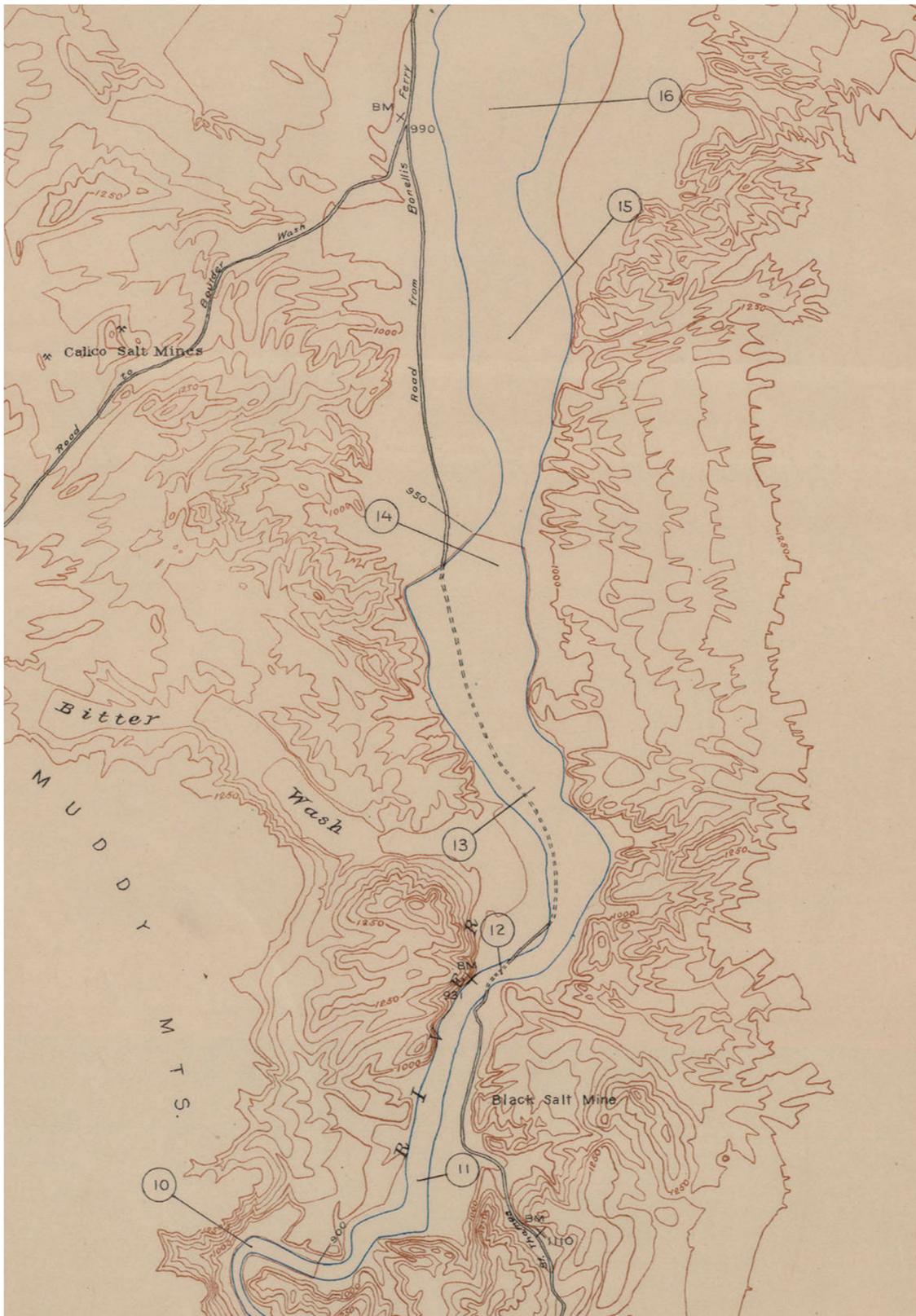


Figure 1. The Virgin River as mapped by the USGS in 1924. Source: Detail of plan and profile of Colorado River from Lees Ferry, Ariz. to Black Canyon, Ariz.-Nev., and Virgin River, Nev. USGS, 1924.

Colorado and Virgin Rivers as they appeared in the 1920s. To do this a pre-dam river polygon was created from the detailed 1924 Colorado and Virgin River survey maps (United States Geological Survey, 1924). The course of the Colorado River has changed substantially

over time, with several islands mapped in 1875 (Bergland, 1876) having disappeared by 1924, but this map provides the river's locations near the end of the pre-dam period. Due to falling lake levels portions of the Colorado and Virgin Rivers are once again flowing

streams, but in different locations than they were before the reservoir was completed. Upriver of Iceberg Canyon it proved difficult to match the 1924 map with current topography due to sedimentation that has occurred in the old river channel while it was underwater during high lake levels. However, the lake bottom DEM did not cover this area and it was not included in the final map.

Property records were downloaded from the Bureau of Land Management (BLM) website ([Bureau of Land Management, 2017](#)), along with BLM public land survey system shapefiles for Nevada and Arizona. Public land survey subdivisions in private ownership were selected out in GIS and exported to a new dataset. The property records included some parcels with overlapping claims by multiple owners, but this was not a problem as there was no need to map out lands belonging to specific owners.

All other data, including roads, springs, mines, school districts, and rock formations, were created by digitizing maps in GoogleEarth. The GIMP graphic editor software was used to convert PDF files to Jpeg images when needed. Roads, springs, mines, and place names were identified and mapped using the 1924 USGS river maps as well as 1926 topographic maps for areas farther from the rivers. Nevada Highway Department road maps were used to identify the state highway that passed through St. Thomas ([Nevada Department of Transportation, 2017](#)). School districts were digitized from a 1927 Clark County map ([McWilliams, 1927](#)) obtained from the (UNLV) library digital collections website ([UNLV, 2017](#)). The boundaries of Valley of Fire State Park were also digitized in GoogleEarth, using a USGS topographic map overlay with the Valley of Fire West, Valley of Fire East, Weiser Ridge, and Overton 7.5 minute quadrangles. These were produced in 1983 and 1984 and are the most recent topographic maps showing the park's boundaries.

All federal (USGS, Census Bureau) data met National Map Accuracy Standards of locational accuracy within 166 feet (51 meters). Data that was digitized in GoogleEarth is accurate to within about 250 feet (76 meters), with the exception of the Mormon Temple rock formation. This feature is shown on a 1907 photograph in the UNLV library digital collection and its location given only as Las Vegas Wash. The author is confident it is depicted within 1000 feet (305 meters) of its location.

4. Cartographic design

The Colorado River in the vicinity of Lake Mead was actually the very first place in the U.S. to be mapped using shaded relief to depict terrain, as part of Frederick von Egloffstein's 1861 map of the Colorado River ([Krygier, 1997](#)). A shaded relief or hillshaded map was also used as the base for the map created here.

This combined a custom color scheme for elevation and a hillshading theme to depict terrain using false shadows. Eight elevation categories represent elevations below 800 feet, between 800 and 1080 feet (the elevation of Lake Mead in August 2017 when the map was made), between 1080 and 1229 feet (the full lake elevation), between 1229 and 1500 feet, 1500–2000 feet, 2000–2500 feet, 2500–3500 feet, and above 3500 feet. Colors range from olive at the lowest elevations to light yellow at the highest. The DEM was displayed with 40% transparency to allow the hillshading to be visible; the hillshading in turn was lightened by 40% to lighten the colors on the map.

Early accounts consistently state that the Virgin River was a much smaller stream than the Colorado and often dry within a broad sandy bed, but it was represented on the 1924 topographic maps as being as wide as the Colorado ([Smith, 1972](#)). To be consistent with these data sources the 1924 width of the river was used to generate a stippled polygon representing the sandy bed of the river, and a line was drawn within it to represent the stream itself.

Roads, mines, major washes and springs were depicted using appropriate symbolization: roads as gray lines, mines with a pick and shovel symbol, washes with a blue dashed line, and springs with a blue spring symbol. All roads are shown with the same symbol as all of these were unimproved dirt roads, but a website was used to create Nevada route markers for state highway 12 ([Kendrick, 2017](#)). Parcels are shown using a pink tint with 20% transparency for contrast with the elevation color ramp. A number of landmarks in the form of unusual rock formations existed in the area; these are shown as circles while the two peaks named on the USGS maps are depicted as brown triangles. The map shows the area as it appeared in the 1930s; several mining operations and ferry crossings had been long abandoned by that time and are noted accordingly. Labels for landmarks, mines, school districts, and St. Thomas were displayed using variable depth masking with a two point convex hull mask. To avoid conflicts landmark labels were positioned to the upper left of the feature while mine labels are to the upper right. Landmark labels are in italics to distinguish them from mines.

Aside from elevations the only contemporary features shown on the map are the Arizona-Nevada state line and boundaries of Lake Mead National Recreation Area, Valley of Fire State Park, and Gold Butte National Monument, each of which was created after construction started on Hoover Dam. They are provided for reference as most of the region depicted on the map is within one of these areas. Showing them will allow visitors to better locate places depicted on the map.

Although the Virgin River is a minor tributary of the Colorado River, it contains considerable history so the

map extent was centered on the Virgin River. The map center is also placed around the confluence of the Virgin and Colorado Rivers where the Old Bonelli Ferry, once the crossroads of the region and the head of navigation on the Colorado River, was located.

The final map has a scale of 1:210,000 and uses the Universal Transverse Mercator grid coordinate system, centered on zone 11, based on the North American Datum of 1983.

5. Conclusions

This is the first map made in over 90 years of the canyons and valleys of the Colorado and Virgin Rivers before Lake Mead, made possible by the fortuitous existence of the DEM showing underwater elevations. It is hoped that the map may draw attention to the lost geographies of other localities across the United States due to the more than 84,000 dams and reservoirs in the country. Preserving the history of many flooded valleys and towns is a growing topic among historians, and reservoirs can serve as time capsules preserving artifacts and structures underneath their surface. Archaeologists and other researchers are paying increasing attention to shrinking reservoirs for what clues they may offer about past environments, what will happen in other areas when reservoirs are constructed, or even the long term effects of sea level rise and coastal flooding (Lenihan et al., 1981; Li et al., 2009; Sohn, 2006). The DEM showing lake bottom elevations was a tremendous resource for this project; this is only available for a few other reservoirs whose importance has warranted expensive and lengthy sonar-based sedimentation surveys. If the original terrain of other inundated areas is to be mapped a different approach will be necessary to obtain lake bottom elevations. Digitizing contour lines from topographic maps and then using these to construct a DEM might offer the best approach.

The most important lesson learned during this project was of the difficulty of compiling a diverse range of historical sources that were not always consistent. For example, the 1924 topographic maps depict the Virgin River as being as wide as the Colorado River, though explorer's account describe it as a much smaller river occupying a wide, sandy bed. These two sources are clearly in conflict, and the solution used here was to show the broad sandy bed with a stippled polygon and the river as a narrow line. An early lesson was the need to limit the time period depicted on the map; the original goal was to include Native American archaeological sites, early farm towns dating back to 1869, and the routes of nineteenth century explorers, but this quickly overwhelmed the map. Restricting it to a single point in time, immediately before Lake Mead came into existence, was necessary to make the map readable.

Software

GoogleEarth was used to display current and historic USGS topographic maps and create KML data. GIMP 2 was used to process topographic maps in PDF for display in GoogleEarth. ESRI ArcGIS 10.3 was used to convert the KML files to shapefiles, compile GIS datasets, edit data and create the final map.

Disclosure statement

No potential conflict of interest was reported by the author.

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