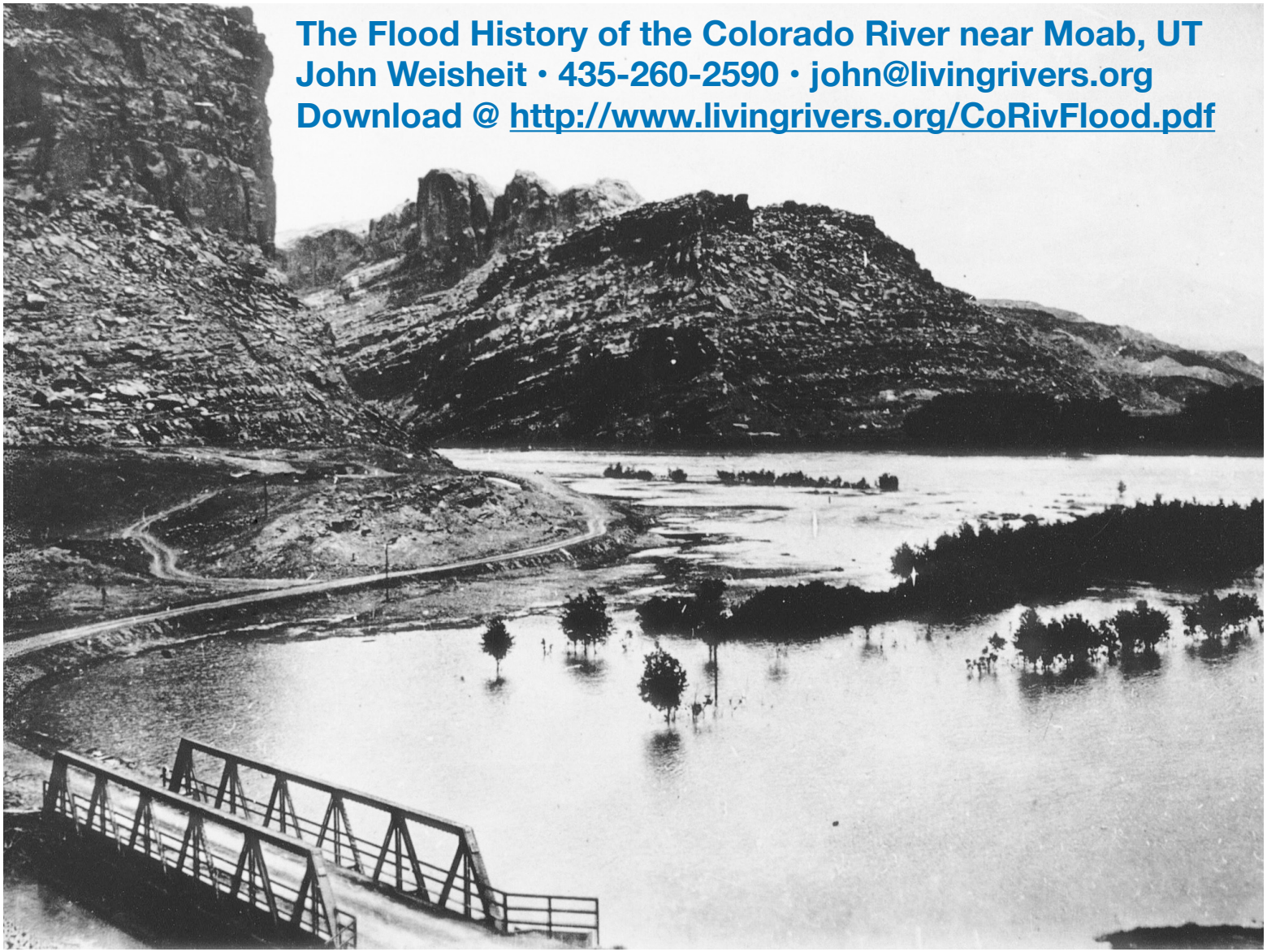


Colorado River Flood in 1921 near confluence of Courthouse Wash, Moab, Utah. The Cisco gage on the Colorado River below the mouth of the Dolores River was not operational in 1921. The gage at Fruita, Colorado reported 81,000 cfs. We can safely assume that the flow of the Dolores River increased the total volume to 90,000 cfs. The photographer for this image is unknown and the photo was provided by Utah State Archives. It is important to understand that upstream reservoirs do not have the capacity to store snow melts of this magnitude, which forces dam managers to bypass the surplus water through outlet works and spillways. **NOTE: All references are listed on last page.**

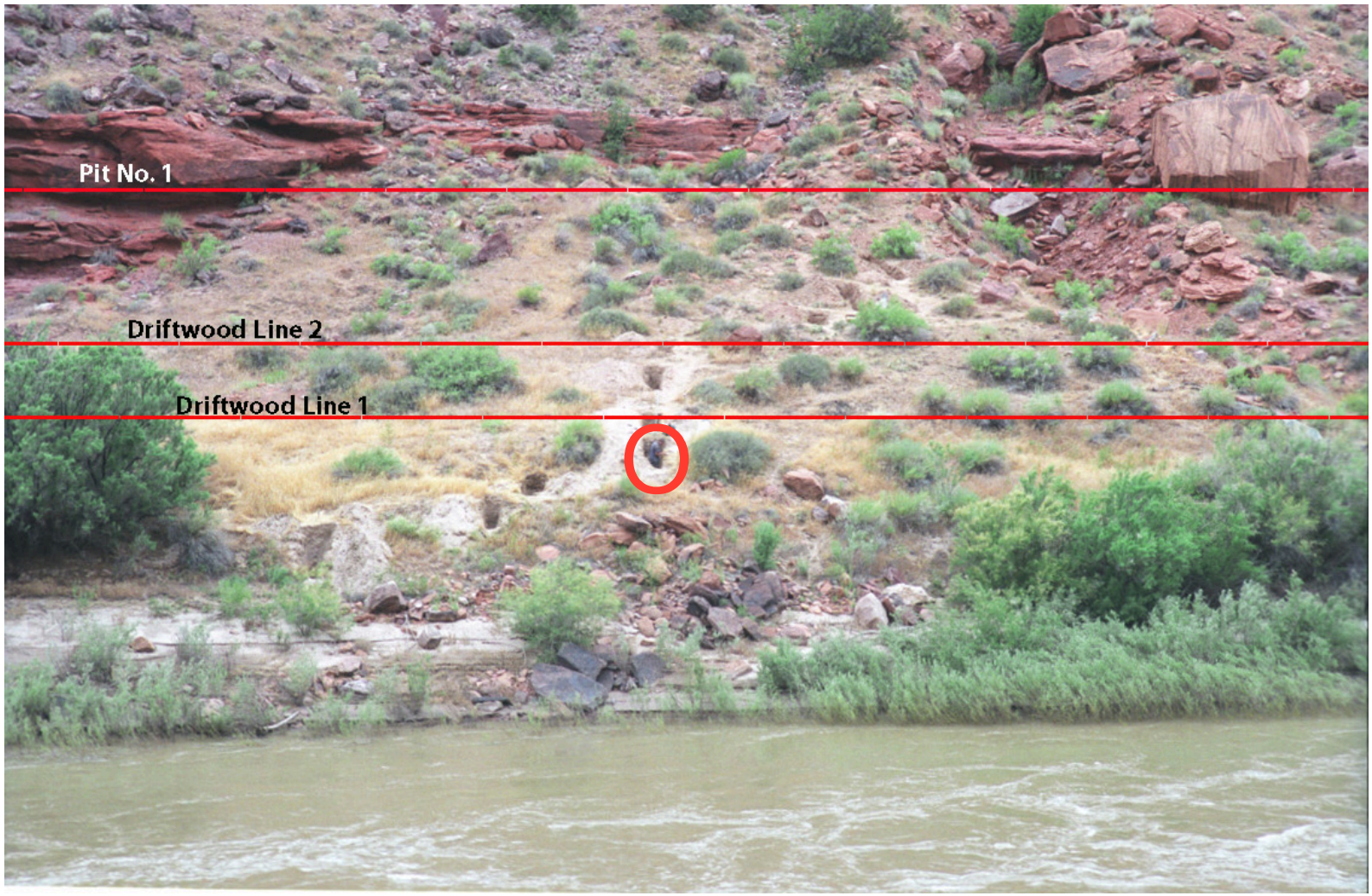
Paleoflood Hydrology and the Colorado River near Moab, Utah

- A **paleoflood** is a large flood event that occurred before stream gages were installed, or before written reports and graphics were published or archived. For the Colorado River Basin these are the floods that occurred before 1862.

- A scientist called a paleoflood hydrologist (Noam Greenbaum, in this photo) will look for **flood indicators** along the floodplains of rivers or dry stream beds.

- A few examples of flood indicators include perched driftwood and sediment deposits at slackwater sites. Sediment deposits can be dated using a process called **optically stimulated luminescence** (OSL).

- This photo by John Weisheit was captured upstream of Moab near the BLM boat ramp at Mile Marker 10.3 along Hwy 128.



Pit 9

Pit 10

After permits are acquired, and with on site inspections by a certified archeologist, pits are dug by hand at selected sites of slackwater deposits.

A paleoflood hydrologist will describe the characteristics of the slackwater deposits in great detail to determine the frequency of flood events, and then take samples of wood (carbon) and sediment (quartz) to acquire an approximate date of the flood event. This is accomplished in a certified laboratory.

Technicians will survey a 3 mile section of the river corridor to determine the volume (magnitude) of the flood. This includes measuring the depth and width of the river bed (bathymetry). Photos by John Weisheit.

RESULTS: Colorado River Floods 10 Miles above Moab Bridge

Slackwater Deposits 14 total sites	Maximum elevation in feet	Maximum discharge in cfs	Historic or approx. paleo time stamp	Estimated total volume of snowmelt
Pits 12-14 12 floods	21 feet	60,500 69,500	1983 AD 1984 AD	15 million acre-feet
Pits 10-11 8 floods	28 feet	124,000	1884 AD	30 million acre feet
Pit 9 5 floods	32 feet	152,000	Unit 5 1615 AD	
Pits 3-8 9 floods	40 feet	212,000	1862 AD	45 million acre-feet
Pit 2 4 floods	44 feet	247,000	Unit 5 595 AD	
Pit 1 2 floods	50 feet	293,000	No materials for dating	
Flood indicators above Pit 1	60 feet	349,616		

- The Colorado River provides 42% of total system water to Lee's Ferry (LF), Arizona
- The Green River provides 33% of total system water to LF
- The San Juan River provides 13% of total system water to LF
- All the other tributaries provide 4% of total system water to LF

2000 years of flood history: Upper Colorado River floods near Moab, Utah

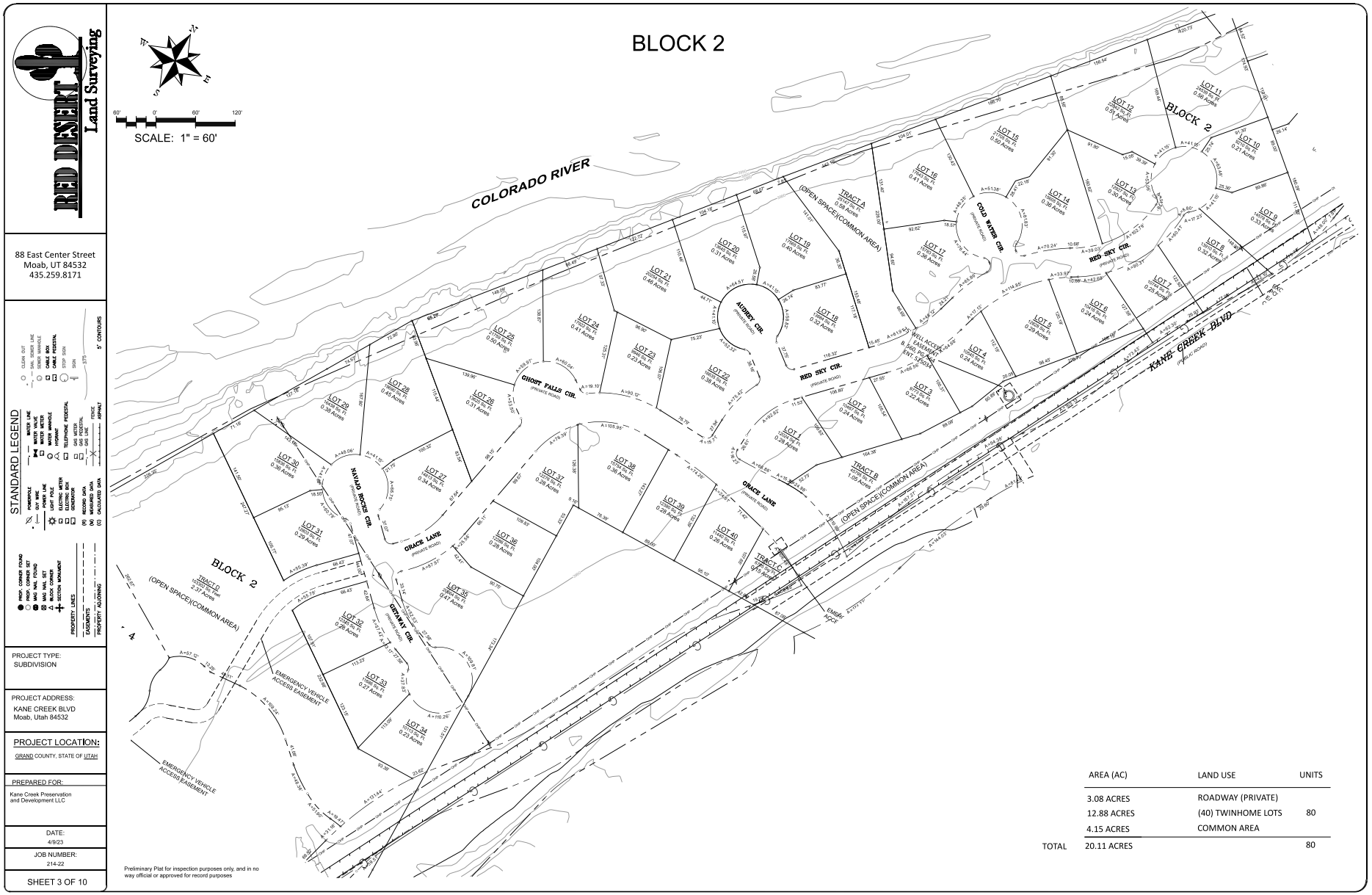
DATA Statistical Vs Empirical	100 year	Number of Floods	500 year	Number of Floods	1,000 year	Number of Floods	Probable Maximum Flood
Statistical Data Kenney (2004, USGS)							
In cubic meters per second	2,765	?	3,400	?	?	?	8,500
In cubic feet per second	97,645	?	120,070	?	?	?	300,175
Empirical Data Greenbaum, et al. (2014, Univ. of Arizona)							
Cubic meters per second (at average ranges)	4,670	34	6,675	20	7,680	5	9,200
Cubic feet per second (at average ranges)	164,920	34	235,725	20	271,217	5	324,895
Volume in 24 hours	327,112 acre-feet		467,554 acre-feet		537,950 acre-feet		644,419 acre-feet

References:

- 2004 - Initial-Phase Investigation of Multi-Dimensional Streamflow Simulations in the Colorado River, Moab Valley, Grand County, Utah. Terry A. Kenney. US Geological Survey.
- 2014 - A 2000 Year Record of Magnitude and Frequencies of Largest Upper Colorado River Floods near Moab, Utah. Greenbaum et al.

Coordinates for Moab, UT: 38.5733, -109.5498. Moab-Spanish Valley is a collapsed salt anticline. Direction of Colorado River flow is from right to left. The river is entrenched in the Jurassic Glen Canyon Group. The slopes in the valley are Triassic shales. Three perennial streams: Courthouse Wash (top center); Granstaff Creek (top right); Mill/Pack Creek (bottom right). One ephemeral stream with gravity flow through the bed gravels: Kane (Cane) Creek (lower center).

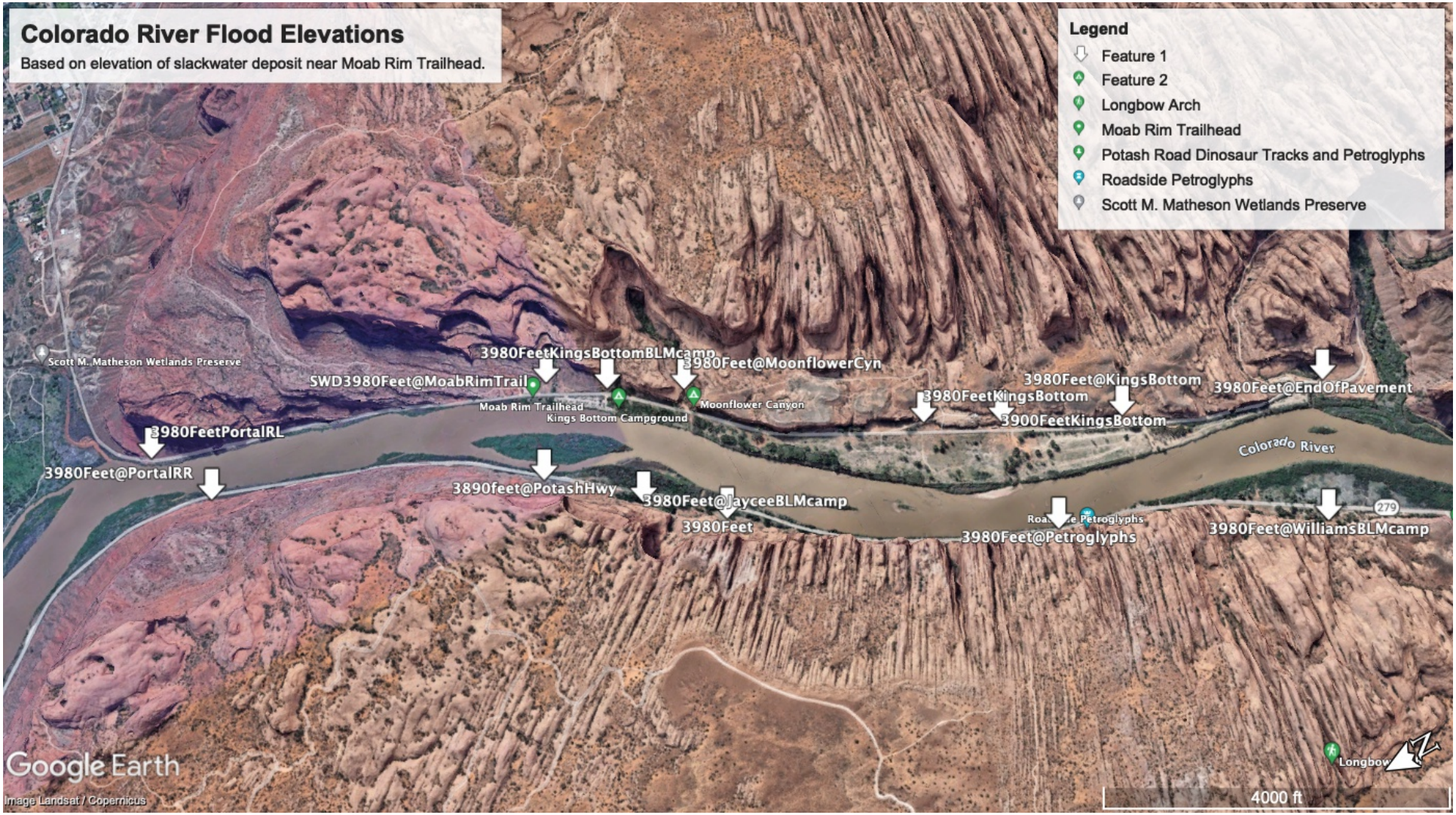
Coordinates for Kings Bottom downstream of Moab: 38.549288, -109.595565. A sizable expansion bar of mobilized river alluvium shaped by the magnitude and frequency of past flood events. This river bottom will be developed for private homes and commercial amenities.



Kings Bottom preliminary plat by Kane Creek Preservation and Development, LLC. This is Block 2. The project has a total of 6 blocks.

Paleoflood indicators just upriver from Kings Bottom. The building (upper left) is an outhouse on a BLM parking lot for Moab Rim Trail. The camp trailers (lower right) are parked in a BLM campground. To the right of the outhouse are perched river gravels. The slackwater deposit at Site #1, near an orange sandstone boulder, is of good quality, but the deposits on the slopes are scant and quite weathered; the elevation is 3980 feet.

Slackwater deposit (SWD) at Site #1 near the “orange sandstone boulder” (previous page). Notice the SWD on the slope behind the boulder.



Flood elevation markers based at the elevation of the slackwater deposit located near BLM parking lot for Moab Rim Trailhead, which is 3980 feet. The river gradient here is about one foot per mile. In general, the paved roads on both sides of the river are completely inundated by the Colorado River.

Lower Kings Bottom. Between the yellow bars, 10 photos were captured of slackwater deposits.

Lower Kings Bottom, Site A (downstream of BLM campground facilities). The height of the vehicle is 6 feet. All the SWDs along the road were altered by road construction.

SWD Site B; the sequence of photos is going downstream from pullout at Site A.

SWD Site C. The digging holes are human caused, and not from animals, nor scientists.

SWD Site D.

SWD Site E.

SWD Site F. Note the embedded river cobbles at the base of this flood deposit.

SWD Site G.

SWD Site H.

SWD Site i.

Roadside
Petroglyphs

Kane Creek Road looking upstream. SWDs are along the bedrock cliff & ledges. There is a buried gas pipeline in this easement corridor. The destination of this fuel is the downstream solution mining facility operated by Intrepid Potash. The Colorado River reached these bedrock cliffs during the 20th century pluvial, in 1884 and in 1862.

Consult with a paleoflood hydrologist to prepare a professional report that will interpret the flood hazards of the proposed development at Kings Bottom. I recommend Dr. Victor R. Baker, Regents Professor at University of Arizona, Tucson.

BIBLIOGRAPHY

Note: A comprehensive resource page for Colorado River floods can be found at this website called On The Colorado:
http://www.onthecolorado.com/resources.cfm?mode=section&id=Floods

Slide 1: Projecting the Colorado River flood volume of 1921: See Table 1.2; page 10. Colorado River Basin Probable Maximum Floods Hoover and Glen Canyon Dams; 1990, US Bureau of Reclamation.
http://www.riversimulator.org/Resources/USBR/MaxProbableFloods.pdf

Slides 2 & 3: The Moab Mill Project: A technical report towards reclaiming uranium mill tailings along the Colorado River in Grand County, Utah. John S. Weisheit and Sarah Fields, 2006.
http://www.riversimulator.org/Resources/Hydrology/MoabMillProject.pdf

Slides 4: Greenbaum, et al. (2014). A 2000 year natural record of magnitudes and frequencies for the largest Upper Colorado River floods near Moab, Utah, Water Resource Research. doi:10.1002/2013WR014835. http://www.riversimulator.org/Resources/Hydrology/2000YearRecordMagnitudeFrequenciesLargestUpperColoradoRiverFloodsMoabUtahGreenbaum2014.pdf

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