

Glory Hole Watch 2024: By the Numbers

by Peter Kilkus (4/8/24)

But what are the numbers?

Lake area in acres (to 1 acre); lake level in inches (to 0.01 inch); lake depth in feet (to an average of 1 foot); lake volume in acre-feet (to 1 acre-foot average, varying by depth), lake input in cubic feet per second or acre-feet; lake output in cubic feet per second (to 5%) or acre-feet (to 1 acre-foot); lake evaporation in inches (to 0.01 inch); rainfall in inches (to 0.01 inch). Some are big numbers, some are small numbers, some are tiny numbers, and some are really just estimates (aka guesses). These numbers all interact to produce a final result.

Precision and accuracy are often used interchangeably, but in science they have very different meanings. Measurements that are close to the known value are said to be accurate, whereas measurements that are close to each other are said to be precise. So, a good machine may measure precisely to a half inch every time it takes a lake level reading, but if the calibration point is off in accuracy by one foot, what does it matter? The ideal situation is when the measurement is both accurate and precise.

But the accuracy of any measurement relies on how the measurement is made - and all measurements have some level of variability. Variability is the tendency of the measurement process to produce slightly different measurements on the same test item, where conditions of measurement are either stable or vary over time, temperature, operators, etc. Short-term variability is ascribed to the precision of the instrument. Since most of the survey measurements on which Lake Berryessa data depends were performed in the 1950s with good optical equipment but in rough, irregular terrain, how variable in accuracy was the final data set - what was the level of the statistical standard deviations of the fundamental measurement results?

The following report is meant to explain some of the issues regarding the quickly changing status of the Glory Hole Watch 2024. Is it spilling, flowing or, as some folks have proposed, just drooling over the lip. As of 4/8/24 it seems the lake is full but not yet spilling, and may not officially spill this year. That would be a new historical record - the highest the lake level has ever reached without actually "flowing" over Glory Hole. Our Lake Berryessa News introduction photo shows the results of all the elements of the Glory Hole actually flowing.

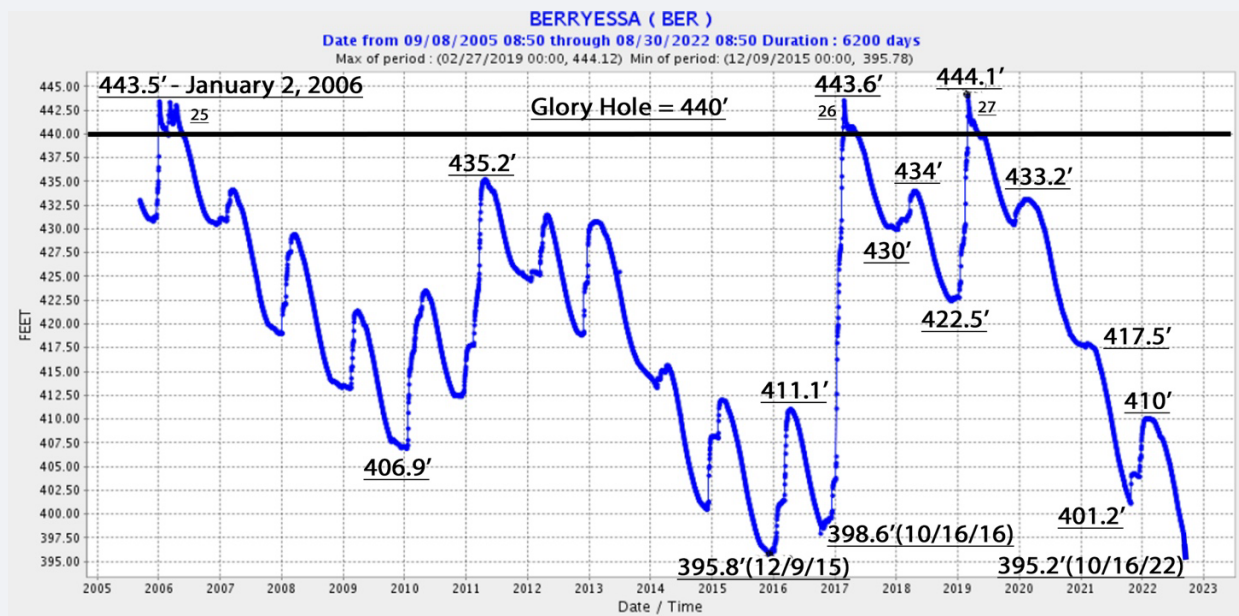
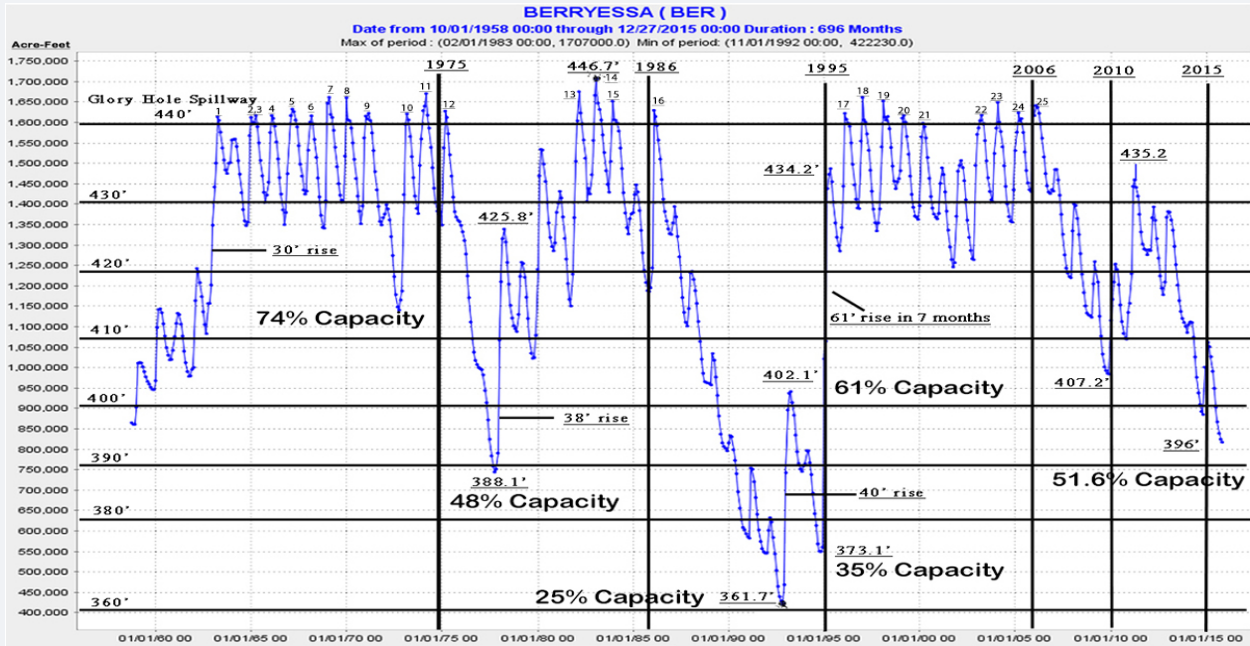


Lake Berryessa Glory Hole Watch 2024

Is it spilling or not?

by Jay Cuetera

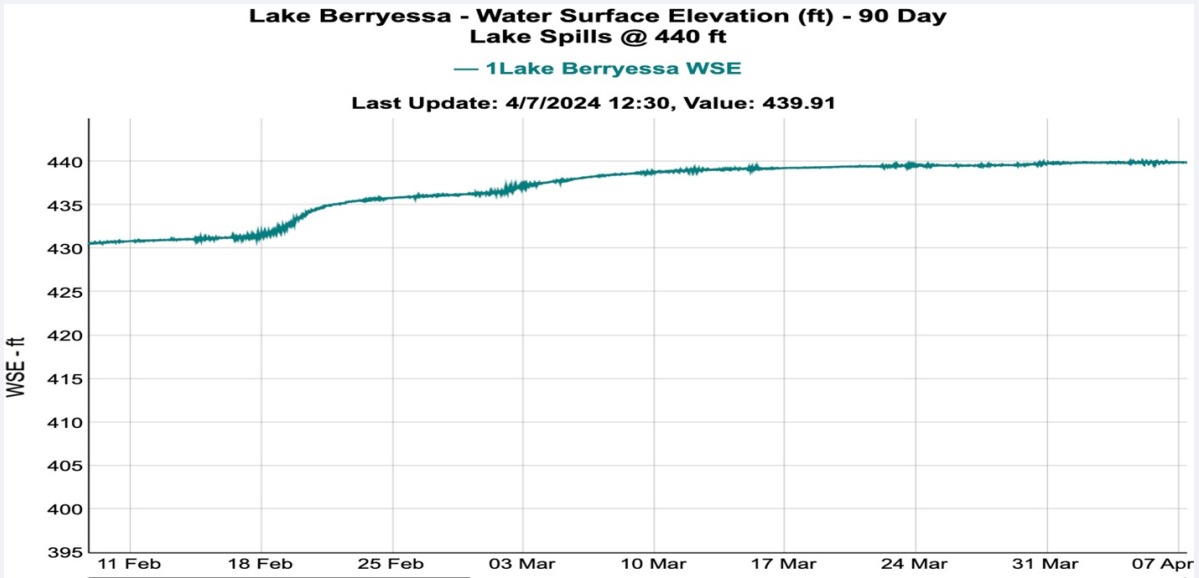
This has truly been a year for the record books at Lake Berryessa. This discussion of "spilling or not" has never happened before. In years past when the lake spilled it would quickly rise above the spill level and stay there for weeks if not months. Once the lake is "officially" spilling we start calculating how many acre feet per day have spilled for our monthly reports to the Bureau of Reclamation.



These calculations are made with daily averaged lake levels. This 2024 season, even dropping down to hourly averaged lake levels, they have so far been below spill level, even though there have been many instantaneous values that are over the "spill" criterion. SCWA web pages show instantaneous values not averaged. A good example is comparing the hourly instantaneous values below to the hourly averaged values for the same time frames. Even the hourly average has been no higher than 439.94. The daily average is used for calculating the spilled volume. The measurements will be changed to one hour averages for the 24-25 rain season.

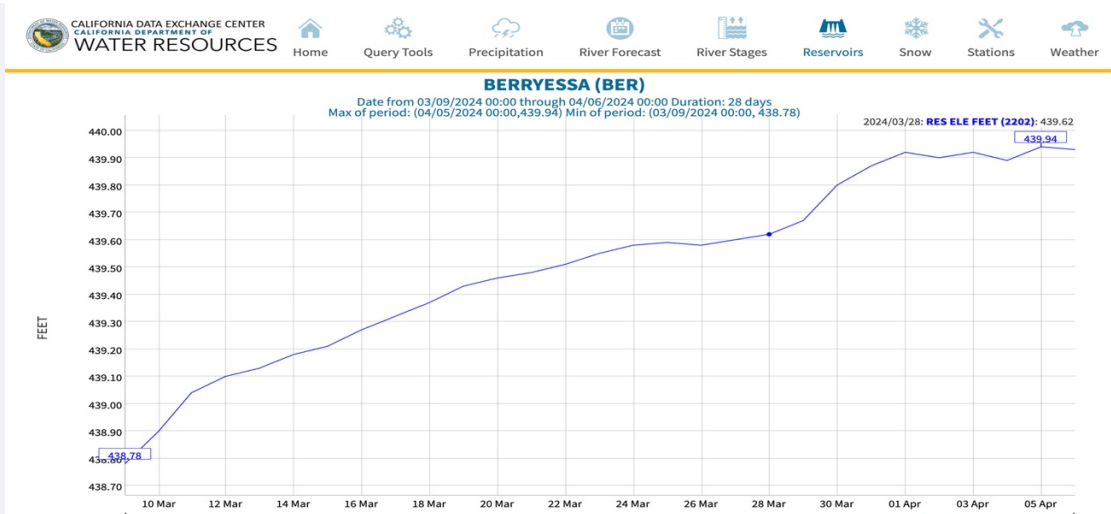
Hourly averaged data (SCWA)

4/6/24 6:00am 439.94
4/6/24 7:00am 439.94
4/6/24 8:00am 439.94
4/6/24 9:00am 439.94

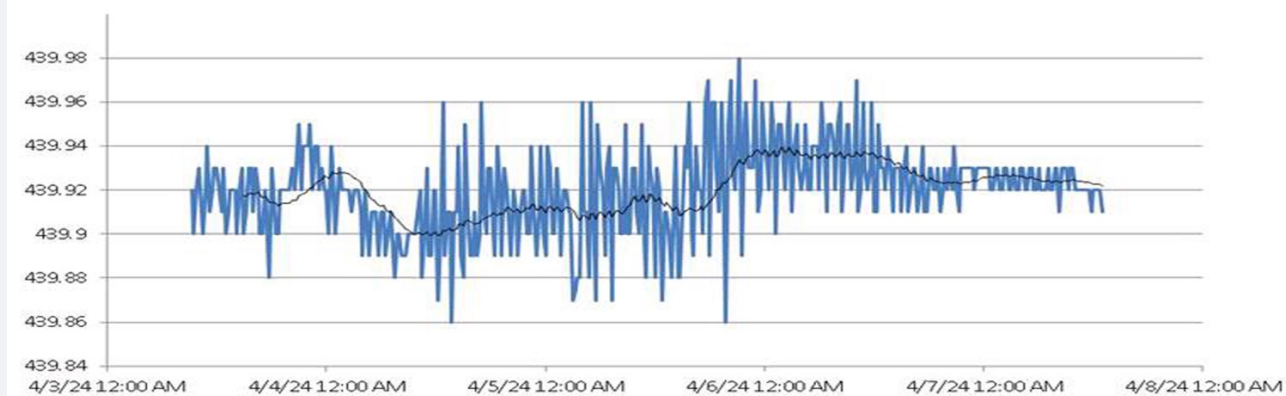


Instantaneous 15 minute data (CDEC)

4/6/24 6:00 am 439.95
4/6/24 7:00 am 439.95
4/6/24 8:00 am 439.95
4/6/24 9:00 am 439.97



Average Level April 3-7 2024

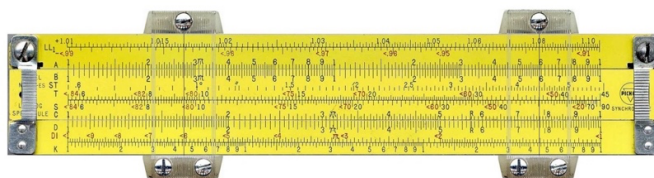


There is also instrument error, so even trying to get down to hundredths of a foot accuracy is difficult if not impossible. This has been the challenge and is why there has not, and most likely won't, be an official statement that the lake is spilling.

It is very likely this will be the closest the lake has ever been to spilling without going over the edge, at least officially. The highest hourly averaged level the lake has previously reached this year was 439.94 ft and occurred on 4/3/2024 at 9:00 PM. The lake's water surface elevation is measured using an hourly average to avoid fluctuations caused by such things as wind and boat wakes. The elevation has hit 439.94 feet, but needs to be at 439.95 feet for an official spill.

Most people are used to hearing that the lake spills at 440 feet, but it actually starts to spill 1 cubic foot per second (CFS) at a level of 439.95; 2 CFS at a level of 439.96, and 10 CFS at a level of 440 feet. These values are listed in a Spillway Discharge Table for Monticello Dam computed in 1963.

Editor's Note: There was no AI nor many computers in the 1960s. I remember it well, just equations and slide rules. This was my high school graduation present from my father. We also had the very big book of CRC Standard Mathematical Tables.



Engineers needed to solve simple equations like this one to calculate the Spillway Discharge Table. The water flow over a spillway when neglecting viscosity is given by the equation:

$$Q = \frac{2}{3} w \sqrt{2gy^3}$$

where w is the width of the spillway, g is the acceleration due to gravity, and y is the height of the water above the spillway. This is derived by using Bernoulli's equation and Torricelli's equation, and taking into account the flow over an area rather than just a point.

Below is a scan of the first page of the Spillway Discharge Table still in use. It calculates the flow through Glory Hole at 1 cubic foot per second after the lake level reaches 439.95 feet.

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 2
CENTRAL VALLEY OPERATIONS OFFICE
SPILLWAY DISCHARGE TABLE
MONTICELLO DAM

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
439.90					0	1	2	3	5	7
440.00	10	12	15	18	21	24	27	31	34	38
440.10	42	46	50	55	59	64	68	73	78	83
440.20	88	93	98	104	109	115	120	126	132	138
440.30	144	150	156	162	169	175	182	188	195	202
440.40	209	215	223	230	237	244	251	259	266	274
440.50	281	289	297	305	313	321	329	337	345	353
440.60	362	370	379	387	396	405	413	422	431	440
440.70	449	458	467	477	486	495	505	514	524	534
440.80	543	553	563	573	583	593	603	613	623	633
440.90	644	654	665	675	686	696	707	718	728	739
441.00	750	761	772	783	795	806	817	828	840	851
441.10	863	874	886	898	910	921	933	945	957	969
441.20	981	993	1006	1018	1030	1043	1055	1068	1080	1093
441.30	1105	1118	1131	1144	1157	1170	1183	1196	1209	1222
441.40	1235	1248	1262	1275	1289	1302	1316	1329	1343	1357
441.50	1370	1384	1398	1412	1426	1440	1454	1468	1483	1497
441.60	1511	1525	1540	1554	1569	1583	1598	1613	1627	1642
441.70	1657	1672	1687	1702	1717	1732	1747	1762	1778	1793
441.80	1808	1824	1839	1855	1870	1886	1902	1917	1933	1949
441.90	1965	1981	1997	2013	2029	2045	2061	2077	2094	2110
442-00	2127									

SOURCE DATA IS LETTER DATED AUGUST 6, 1963 TO ASSISTANT REGIONAL DIRECTOR AND CHIEF OF OPERATIONS FROM CHIEF, IRRIGATION DAM BRANCH OF IRRIGATION DIVISION. TABLE COMPUTED AUGUST 1963.

Source data is letter dated August 6, 1963 to Assistant Regional Director and Chief of Operations from Chief, Irrigation Dam Branch of Irrigation Division. Table computed August 1963.

The discharge table has a zero value at a level of 439.94 and is considered the 100% lake full level. The lake has been hovering around 439.9 ft since 4/1 which is just over 1 inch from spilling. When the lake is this close to spilling, any surface fluctuations from wind or boating activities will splash some water over the edge. Even though this is water "spilling" into the spillway, the volume of water going over the lip is so small that it is unmeasurable. Since it is not at a level that can be calculated it is therefore not considered officially spilling.



See the recent video of the Glory Hole from inside at the bottom of concrete tunnel. The amount of water coming down is so small that it cannot be measured.

[See water spilling into Glory Hole from inside at the bottom.](#)



<https://www.lakeberrypressnews.com/resources/Inside-GH-flows.mp4>

There have also been questions about the water being released from the Monticello Dam. During most of the year the only water released from the dam is what is ordered by the cities and farmers of Solano County, as well as providing required environmental flows to Putah Creek. The only exception to this is when the lake level is above 438 ft and has a likely chance of spilling.

At these higher levels the operators are given some flexibility with releases to help maximize the beneficial use of every drop of water that enters the lake as long as these additional releases never go above the inflow to the lake. It is also much better to maintain controlled releases through a dam rather than allow uncontrolled spilling and losing some of the additional benefits that could be utilized from this water.

DATE	WATER ELEVATION	STORAGE A.F.	SPILL CFS	RELEASE CFS	RELEASE A-F
Official	440.00	1,551,292	10	NA	NA
	440.01	1,551,481	12	NA	NA
	440.02	1,551,670	15	NA	NA
	440.03	1,551,858	18	NA	NA
	440.06	1,552,425	27	NA	NA
	440.10	1,553,180	42	NA	NA
	440.50	1,560,743	281	NA	NA
	441.00	1,570,400	750	NA	NA
Actual					
4/1/24	439.92	1,549,782	0	650	1,280
4/2/24	439.92	1,549,782	0	650	1,280
4/3/24	439.93	1,549,971	0	650	1,280
4/4/24	439.92	1,549,782	0	650	1,280
4/5/24	439.94	1,550,160	0	650	1,280
4/6/24	439.93	1,549,971	0	650	1,280

This season is a perfect example of how this flexibility is meant to be used. When it was determined a spill was likely, some additional releases were made to comply with the mandated spring pulse flow for Putah Creek which is designed to help flush the salmon fry from this seasons spawn out to the ocean. These pulse flows also provide flushing benefits to other native species in the creek.

After the pulse flow requirements were met the operators then diverted water through the powerhouse at levels below the inflow to the lake so that power could be generated with the “extra” water rather than letting it run through the spillway which bypasses this opportunity for clean power. When the powerhouse is operating all the flow is diverted through the turbines and is output below the concrete pad which is below the water surface. There is no indication it is running unless you look very closely and notice the turbulence from under the pad. This season has been a perfect example of how a dam should be operated.



No matter how you look at it, we officially have a full lake which is still not "officially" spilling. In my biased opinion it is one of the most beautiful lakes in California - see you all on the water!!

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