As Lake Berryessa Flows:
A Combination of Science, Engineering, and Natural Beauty

By Peter Kilkus (7/14/17)


Lake Berryessa is almost a living creature. It breathes in and out, grows and shrinks. But it breathes water not air. Actually it is always breathing out a bit through evaporation and outflows through Monticello Dam all year. All of these processes define its hydrological cycle.

Hydrology is the scientific study of the waters of the earth, especially with relation to the effects of precipitation and evaporation upon the occurrence and character of water in streams, lakes, and on or below the land surface - the cycle from precipitation to re-evaporation or return to the water of the seas. But Lake Berryessa's hydrology is heavily modified by man from the time the water drops from the sky until its return to the ocean.

California Droughts are Common

Long-term weather patterns are cyclic in nature but unpredictable in practice. The master chart below shows the history of Lake Berryessa since Monticello Dam was built in 1957. The lake has had previous droughts, one in the late 1970's, a ten-year drought from 1986 to 1996, and the latest from 2006 to 2017.

California endured severe droughts in 1976 and 1977, which ended in 1978. The master chart below shows that Lake Berryessa levels did not even show the usual winter uptick during those years and had dropped to less than 50% of capacity by 1978.

The 1987-92 statewide drought was notable for its six-year duration and the statewide nature of its impacts. Statewide reservoir storage was about 40 percent of average by the third year of the drought, and did not return to average conditions until 1994. But Lake Berryessa had dramatically dropped to only 30% of capacity by then and did not fill up again until 1996. 1991 was the single driest year of the drought.

A 1994 study of relict tree stumps rooted in present day lakes, rivers, and marshes suggested that California sustained two epic drought periods, extending over more than three centuries. The first epic drought lasted more than two centuries before the year 1112; the second drought lasted more than 140 years before 1350. In this study,

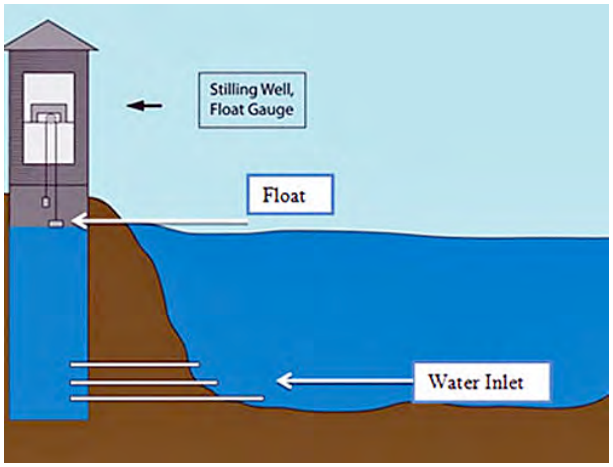
the researcher used drowned tree stumps rooted in Mono Lake, Tenaya Lake, West Walker River, and Osgood Swamp in the central Sierra. A conclusion that can be drawn from these investigations is that California is subject to droughts more severe and more prolonged than anything witnessed in the historical record.

Lake Berryessa, or Solano Water Project, is the main drinking water source for more than 400,000 people so a drought can have a serious impact. SCWA member agencies and their annual Lake Berryessa allocations in are-feet are: Solano Irigation District (SID) - 141,000 AF, Fairfield – 9,200 AF, Vacaville – 5,600 AF, Suisun City – 1,600 AF, Maine Prairie – 15,000 AF, and Vallejo – 14,750 AF for a total allocation of 187,150 acre-feet.

The Solano County Water Agency (SCWA) uses a wide variety of water management tools and options to maximize resource and minimize the need to import water. The SCWA and its member agencies have comprehensive urban and agricultural water conservation programs. They also have a Drought Contingency Plan which specifies that when storage in Lake Berryessa falls below 800,000 acre-feet as measured on December 1, they will implement reasonable water conservation measures, investigate potential emergency supplies and other reasonable measures which could reduce the depletion of storage in Lake Berryessa.

Measuring Levels and Rainfall

The Lake Berryessa water level is actually measured on the Monticello Dam in a "stilling well". The simplest method of measuring lake water levels is a stilling well equipped with a float tape attached to a digital rotary encoder that measures accurately to 0.01 ft.




Rainfall is measured using a tipping bucket rain gauge. However, the rain gauge on the top of Monticello Dam has never been very representative of precipitation in the overall Lake Berryessa area. The gauge is working well but the location, surrounded by mountains on two sides with a strong up-draft coming up the canyon and over the dam, prevents getting reliable data. SCWA is considering changing this gauge location.

Rainfall measurements at the dam may not be representative of the area, but they are also not the best indicator of how fast the lake may rise. The Lake Berryessa watershed encompasses the 576–square mile area primarily fed by Putah Creek which originates from springs on the eastside of Cobb Mountain in Lake County. Putah Creek enters Napa County about 11 miles east of Middletown. It merges with Butts Creek just before it empties into Lake Berryessa.

Therefore, rainfall over the Cobb Mountain and Middletown areas provides the bulk of water entering Lake Berryessa. One reason that Lake Berryessa rose so quickly in 2017 was the very heavy rainfall that occurred on Cobb Mountain and the Middletown area.

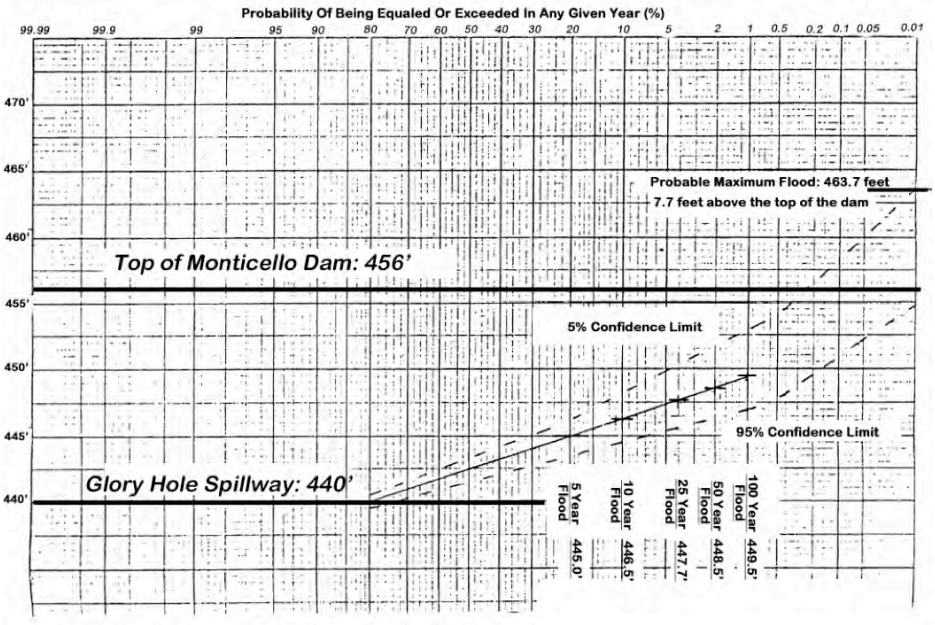
But Can Lake Berryessa Flood (Over the Dam)?

Not very likely. The lake level has never been higher than 446.7 feet (1983) since the dam was constructed. Since 1985 it has only reached 444 feet once in 1998. It is typically at or below 440 feet (Glory Hole). The master chart below shows that the lake has reached 440 feet twenty-five times in its 60-year existence. According to the Bureau of Reclamation, droughts are a significantly higher risk than floods since this is a reservoir which has some control over outflow rates but must provide water by law even if there is low rainfall.

There is only a 1 in 100 chance that there will be a flood level up to 450 feet. The top of the dam is at 455 feet. Highway 128 was designed to be the emergency spillway before the lake overtops the dam. Economic impacts due to potential floods are a very low probability and thus a low planning priority. The following table, based on an analysis completed in 1986, depicts the water elevation that, on the average, may be reached or exceeded for various time periods.

| Frequency (Years) | Probability (%) | Elevation (Feet) |
|---|---|---|
| 1.25 | 80 | 440 |
| 5 | 20 | 445 |
| 10 | 10 | 446.5 |
| 25 | 4 | 448 |
| 50 | 2 | 449 |
| 100 | 1 | 450 |

The Bureau of Reclamation did a Flood Elevation Probability Study in 1986. Although this is a bit of statistical game-playing, it is interesting to see the worst-case scenarios and the probability of their occurrence. Flood flows in this study were assumed to start at the initial elevation of 440 feet. All the frequency floods used in this study had a duration of 7 days. In other words, if the lake were already at 440 feet and then the various rainfall levels and flood flows (5-yr, 10-yr, 25-yr, 50-yr, 100-yr) began and lasted for 7 days, how bad could it get?




The impact of the 1984 Probable Maximum Flood flow produced a water surface elevation of 463.7 feet, or 7.7 feet ABOVE the dam for several days. This level was assumed to be the maximum reservoir elevation that could ever be reached during a flood. A related note in the study said, "Monticello Dam was assumed not to fail."

Not to worry too much since this worst case scenario had a VERY low probability – somewhere between 10,000 and 1,000,000 years. Even the probability of the lake reaching the top of the dam at 456 feet was very low with a

5% confidence limit of 417 years recurrence and 95% confidence limit of 16,667 years recurrence. As stated in the study, "computed probabilities beyond a 100-year recurrence are not considered to be reliable; therefore, only confidence limits are provided. There is a 90% probability of a specific event occurring somewhere in the interval between confidence limits."

A 90% probability sounds high, but would you place a "sure bet" that the lake would hit 463.7 feet, 7.7 feet above the dam, if you had to wait somewhere between 400 and 16,000 years to collect?

Can Monticello Dam Break?

This is also highly unlikely. The Solano County Water Agency is under contract with the U.S. Bureau of Reclamation to operate, maintain, and administer all of the programs of the dam. Subsequently, it is SID who sub-contracts with the Solano County Water Agency to perform the day-to-day operations.

With the 2017 scare in Oroville, in which its dam's primary and emergency spillways were substantially damaged, prompting nearly 200,000 evacuations of nearby residents, organizations like SID were put on alert with making sure the Monticello Dam doesn't endure a similar scenario.

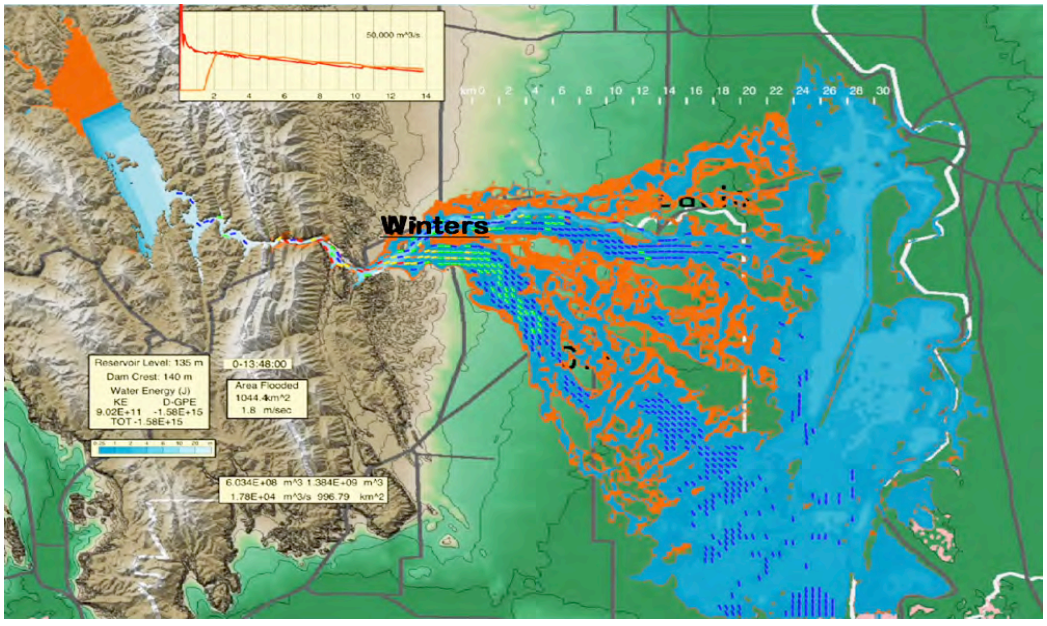
Reclamation has protocol and inspections, and with every inspection, everything has checked out so far, according to SID. The construction and structure of Monticello Dam are much different from Oroville. Monticello Dam is in very narrow canyon embedded in bedrock.

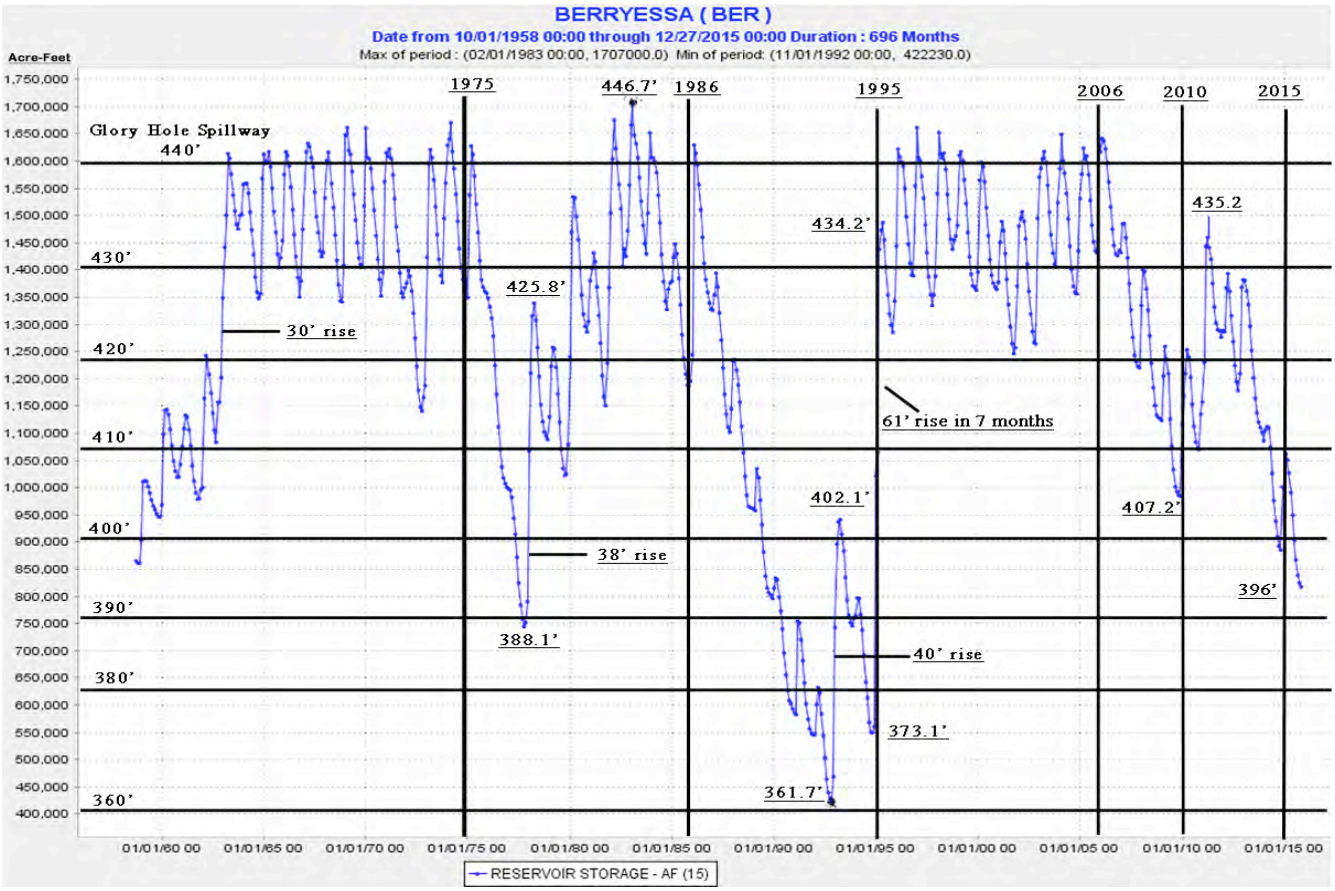
The traditional spillway construction wouldn't have fit here. It would have been very costly to drill into the side of the mountains here. It's very far-fetched and unlikely that something like that would happen at Lake Berryessa. The recent peak of 8,500 cubic feet per second the dam experienced was just a fifth of what the dam is able to handle. A SID spokesman boasted, "We're not concerned. I can't emphasize that enough."

Monticello Dam Failure Simulation

Steven Ward, a research geophysicist at the Institute of Geophysics and Planetary Physics at UC Santa Cruz has created a computer simulation of the first 16 hours of flooding that might be expected from the failure of Monticello Dam from a possible earthquake. This worst-case scenario envisions a nearly instantaneous breakdown of the structure and a reservoir filled to capacity. This is unlikely but informative.

The simulation can be downloaded at: http://es.ucsc.edu/~ward/berryessa-dam.mov or on YouTube at: www.youtube.com/watch?v=HEJEHnKrueo




BERRYESSA ( BER )
Date from 10/01/1958 00:00 through 12/27/2015 00:00 Duration : 696 Months
Max of period : (02/01/1983 00:00, 1707000.0) Min of period: (11/01/1992 00:00, 422230.0)
Acre-Feet
Glory Hole Spillway
440'
430'
420'
410'
400'
390'
380'
360'
1975
446.7'
1986
1995
2006
2010
2015
425.8'
434.2'
435.2
30' rise
38' rise
61' rise in 7 months
402.1'
407.2'
396'
388.1'
40' rise
373.1'
361.7'
01/01/60 00
01/01/65 00
01/01/70 00
01/01/75 00
01/01/80 00
01/01/85 00
01/01/90 00
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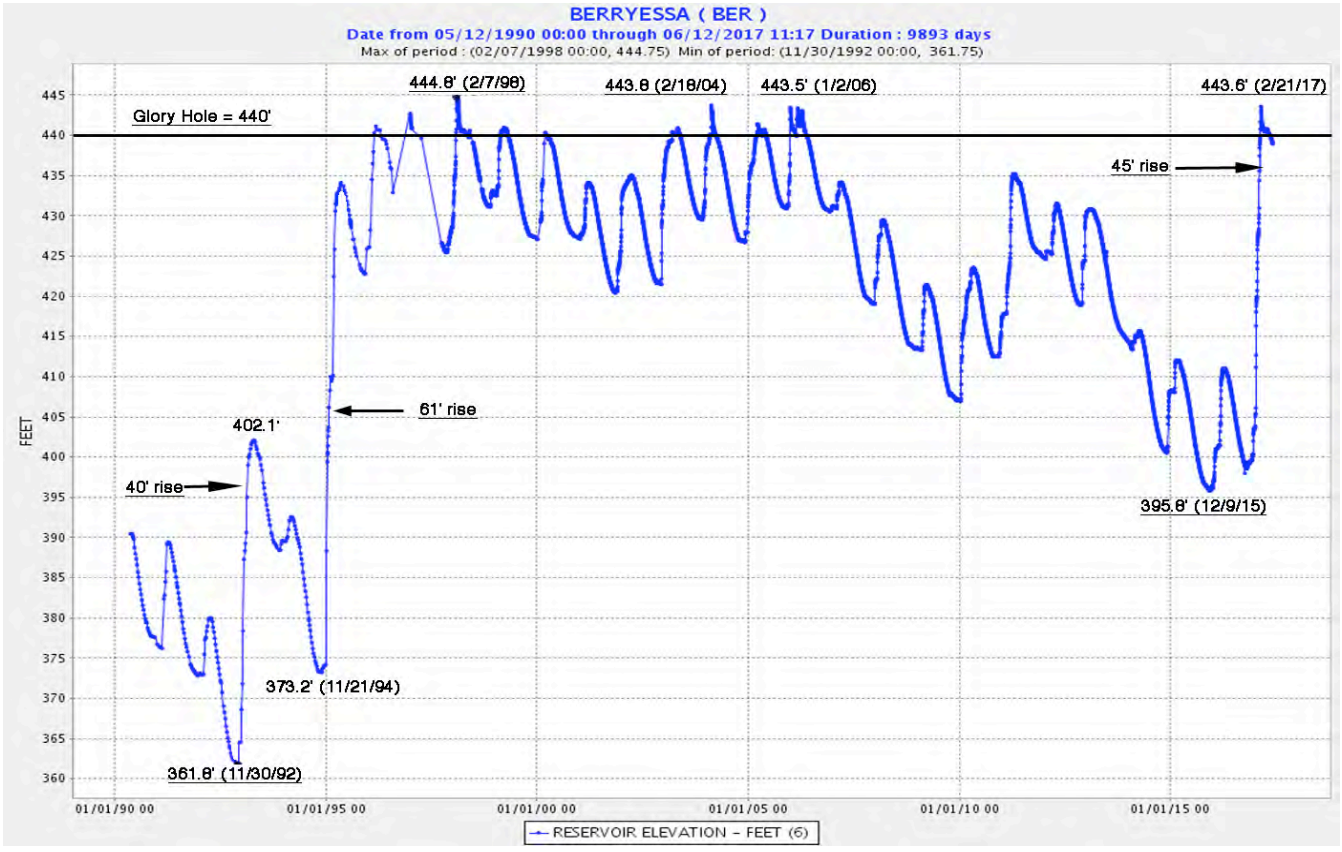
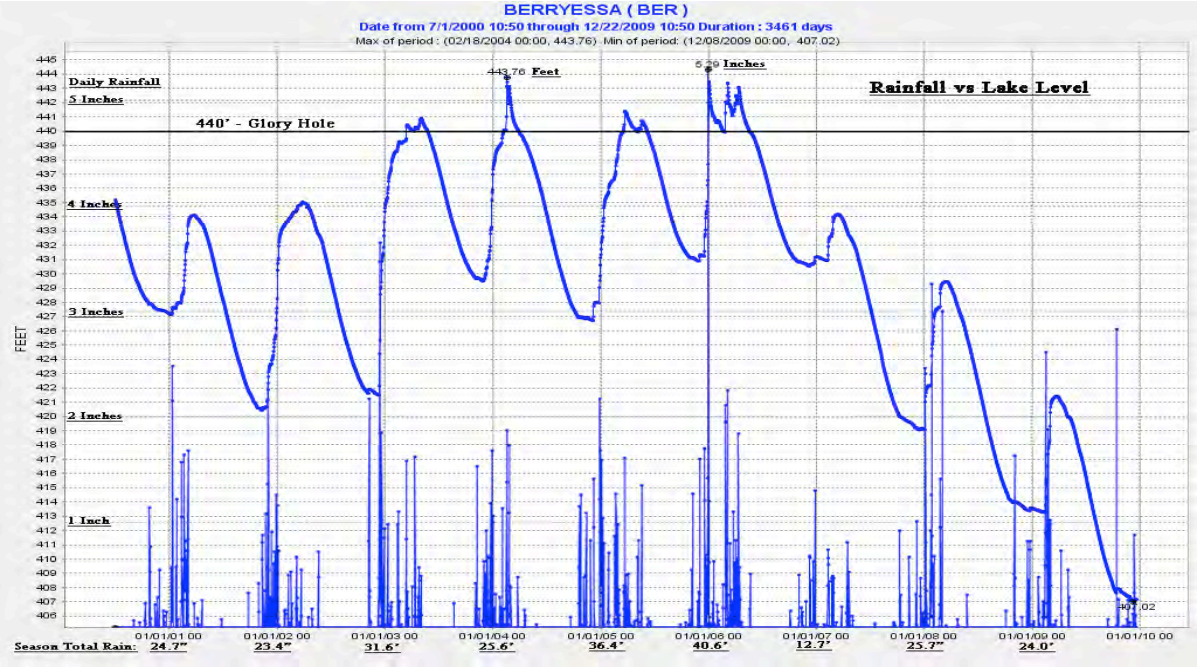
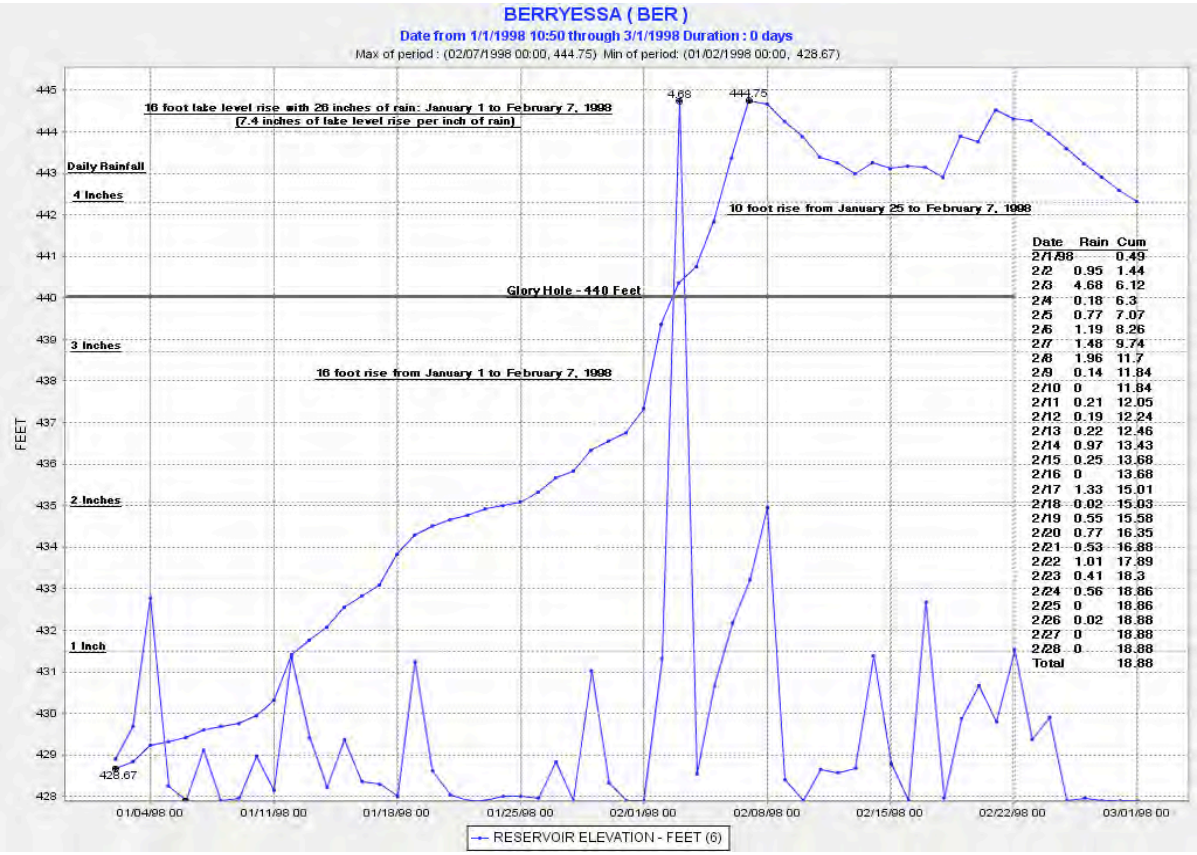
01/01/15 00
RESERVOIR STORAGE - AF (15)


BERRYESSA ( BER )
Date from 05/12/1990 00:00 through 06/12/2017 11:17 Duration : 9893 days
Max of period : (02/07/1998 00:00, 444.75) Min of period: (11/30/1992 00:00, 361.75)
FEET
Glory Hole = 440'
444.8' (2/7/98)
443.8 (2/18/04)
443.5' (1/2/06)
443.6' (2/21/17)
45' rise
61' rise
402.1'
40' rise
373.2' (11/21/94)
361.8' (11/30/92)
395.8' (12/9/15)
01/01/90 00
01/01/95 00
01/01/00 00
01/01/05 00
01/01/10 00
01/01/15 00
RESERVOIR ELEVATION - FEET (6)

The early 1980s were mostly above average in precipitation in northern California and throughout the West, with the wettest year of the decade occurring in 1983 – also the highest level the lake ever reached, 446.7 feet, almost 7 feet above Glory Hole! The rainfall versus lake level chart below gives daily and annual rainfall totals versus lake levels for the 2000 to 2008 seasons.



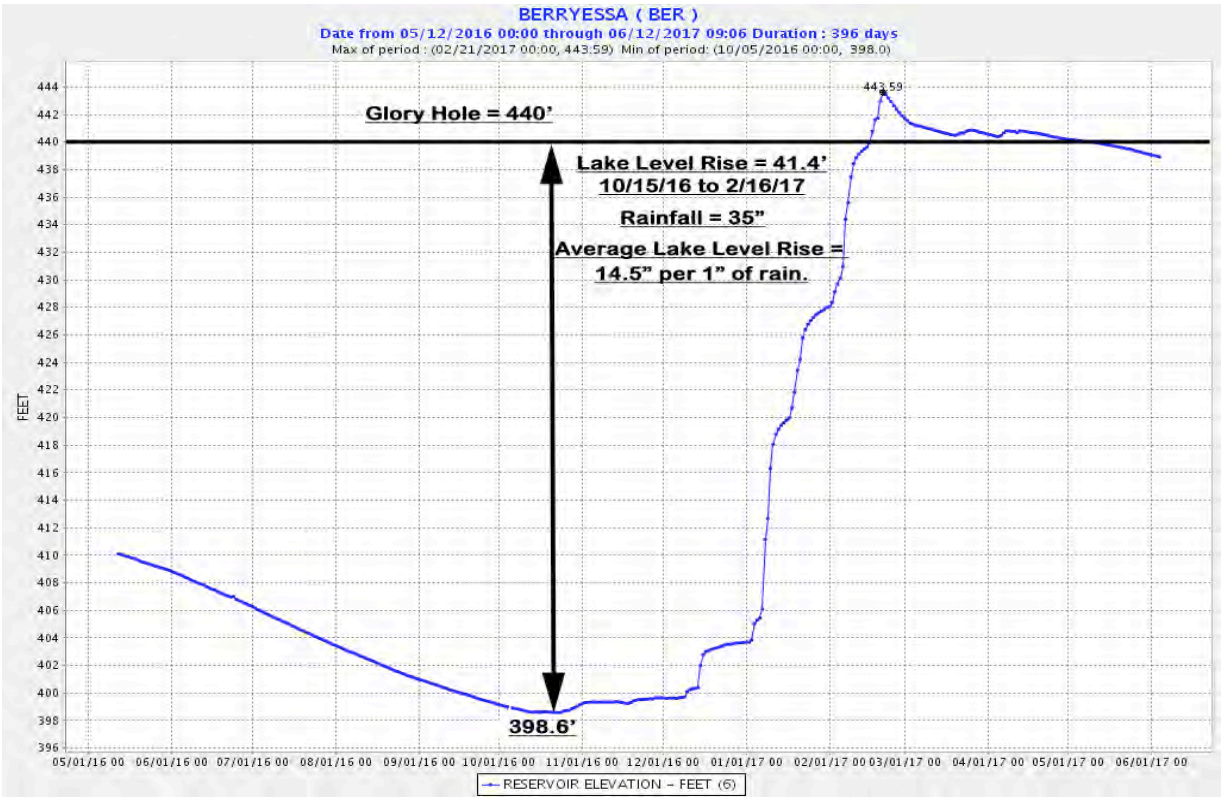



Lake Level vs Acre-Feet of Storage

Local residents use a rule of thumb that the lake increases a foot in level for every inch of rainfall after the ground has been saturated by several initial inches of rain. This is not completely accurate since the relationship between the lake level and its storage capacity is not linear. The lake is shaped roughly like a bowl (with peaks and valleys and inlets and large flat areas), which means that the higher the water level gets the more rain is needed to raise it further. From the data below we can see that it takes about 25% more rain to go from 430' to 440' than it does to go from 390' to 400'. The chart below showing rainfall versus level for the first three months of 1998 shows that the lake rose 16 feet with 26 inches of rain – or 7.4 inches of level per inch of rain.

| Lake Level | Acre-Feet of Storage per Foot of Level Increase |
|---|---|
| 350' – 380' | 11,500 |
| 380' – 390' | 13,270 |
| 390' – 400' | 14,820 |
| 400' – 430' | 17,050 |
| 430' – 440' | 18,500 |
| 440' – 445' | 19,500 |

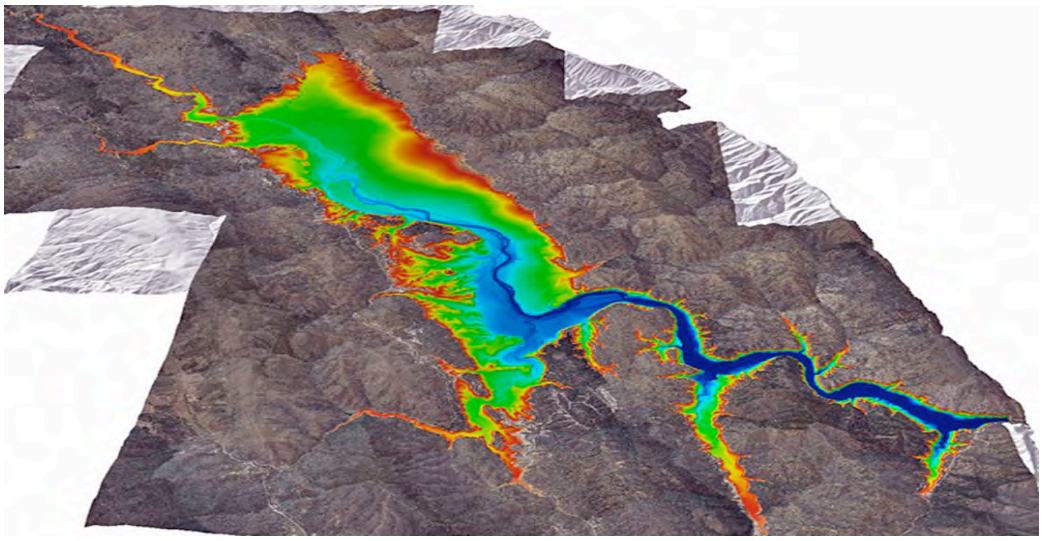
However, the unexpectedly rapid rise of the lake in 2017 provided data that showed the rise was twice as great as the normal average.




The number of acre-feet rise with a 1-foot level rise implies the lake surface area is approximately 18,500 acres when full. The surface area when full at 440' is 25% greater than the surface area at 400' and 60% greater than at its low water mark of 362' during the drought of 1986 to 1996.

The water at the dam is 275' deep. The lowest level during the drought of 86-96 of 362' (78 feet down) meant that the lake had dropped in level by 30%. But the capacity had dropped from 1,600,000 acre-feet to 400,000 acre-feet – a decrease of 75%.

A few years ago, SCWA hired a consultant to survey the bathymetry (bottom surface) of Lake Berryessa and determine if the lake had experienced significant sedimentation as well as create new capacity curves based upon the new survey data. In general, the sedimentation was found to be fairly minimal, but the new capacity curves did show a reduction in Lake Berryessa capacity due to more precise measurements.



Lake Berryessa Hits Full Capacity, But 51,708 Acre-Feet Are Missing!

The world-wide attention focused on Lake Berryessa"s Glory Hole Spillway overflowing for the first time in a decade raised some questions from some sharp-eyed observers. Using the published standard capacity of 1,602,000 acre-feet (AF), they noticed that as the level approached the 440 foot mark (100%), the capacity was less than that figure. In fact, at 440 feet (100%) the official storage value was only 96.2% of capacity - a 3.7% discrepancy.

The 1,602,000 AF is a number that was derived from the original Area-Capacity curve developed from surveys of the empty lake bed when the project was being built. In 2007 the Solano County Water Agency (SCWA) performed a comprehensive bathymetric survey of Lake Berryessa to look at sediment accumulation over the last 50 years of the project. Another goal was to verify the accuracy of the Area-Capacity curve. The sedimentation in the lake was determined to be less than expected - minimal considering the 50 year life of the project. A new dataset was developed that can be compared to any future bathymetric study to accurately determine the actual sedimentation rate. The scuba divers who went down to the old Putah Creek Stone Bridge found only a few inches of fine silt on the bridge surface.

During this study a new Area-Capacity curve was developed that was slightly lower than the previous curve. This new lake level versus capacity was officially adopted by the Reclamation and SCWA in 2009. The new curve has a lake capacity of 1,551,292 AF at a level of 440 feet - 50,708 AF less than previously calculated. The difference between the present and former AC curves is a combination of some sedimentation and the difference in technology used to derive the new curve. Obviously another traditional survey of the dry lake bed will not be possible. The bathymetric survey was the only option that could be used to provide a dataset that could be compared in future studies.

The new AC curve has been officially accepted by Reclamation, but the old 1,602,000 AF is still used by most agencies. That figure remains in public descriptions of lake capacity and is proving to be very hard to change since it's been used for so long.

Monticello Dam: Tear it down and build it bigger?

The rumor of raising Monticello Dam has been around for decades. Where did this rumor start and why does it pop up every now and again? According to David Okita, general manager of the Solano County Water Agency, CalFed, a collaboration among 25 state and federal agencies, did a “brainstorming” survey many years go of every potential future water project in northern California.

Although raising Monticello Dam made the original list of possible projects, after practical criteria such as cost, safety, flooding adjacent property, were applied to screen the list down to real opportunities, raising the dam was dropped from the list. It has never been discussed seriously since then. It is NOT in any plan and never will be.

But there is another potential source to this rumor, and it was a much more ambitious project than just raising the dam.

According to “The Solano Water Story” published by the Solano Irrigation District, banner headlines in California's newspapers in September, 1963 announced Governor Edmund G. Brown's startling new state water plan in which Berryessa would have a major role.

The $3.7 billion plan included 35 dams, 70 miles of tunnels, 10 pumping plants, and 15 powerplants. The time-table called for start-up in 1976 and completion about 2020.

According to the plan, the still-young, 304-foot high Monticello Dam would he removed, rather than letting it remain as an underwater barrier. It would he replaced with a 650-foot high earth and rockfill dam a mile downstream from the concrete arch dam. The new reservoir would be three times larger than Lake Berryessa, with 10 times its capacity or 16 million acre-feet (compared with Shasta's 4.5 million acre-feet).

The enlarged lake would extend into Pope Valley almost as far as Aetna Springs in Napa County and into Capell Valley, taking nearly 18,000 acres of agricultural and grazing land out of production.

Estimated cost of the Greater Berryessa Project, as it was called, was put at $360 million by the State Department of Water Resources (DWR). The timetable for this part of the project indicated a start-up in about 1990.

In essence, the idea was to integrate the Greater Berryessa Project with the $280 million Clear Lake Diversion Project. The latter included three dams on the Middle Fork of the Eel River, with tunnels to the Main Eel River, Russian River, and Clear Lake to Putah Creek, then through two more dams and Lake Berryessa to the Sacramento River.

From Clear Lake, the water would be diverted by a two-mile tunnel to Soda Creek in the Upper Putah Creek basin, developing 400 feet of powerhead that would he harnessed with the construction of two dams on Soda Creek.

According to the DWR, discharges from the power facilities would be released into an enlarged Lake Berryessa capable of meeting the export demands of the Sacramento-San Joaquin Delta and those of the Solano Project.

Even the Bureau of Reclamation, which had never been accused of thinking small, was impressed by the scope of Governor Brown's plan, describing the overall project as "staggering but physically possible and since the Greater Berryessa Project would not be built for at least another 30 years, the present Monticello Dam by that time will have served its useful life."

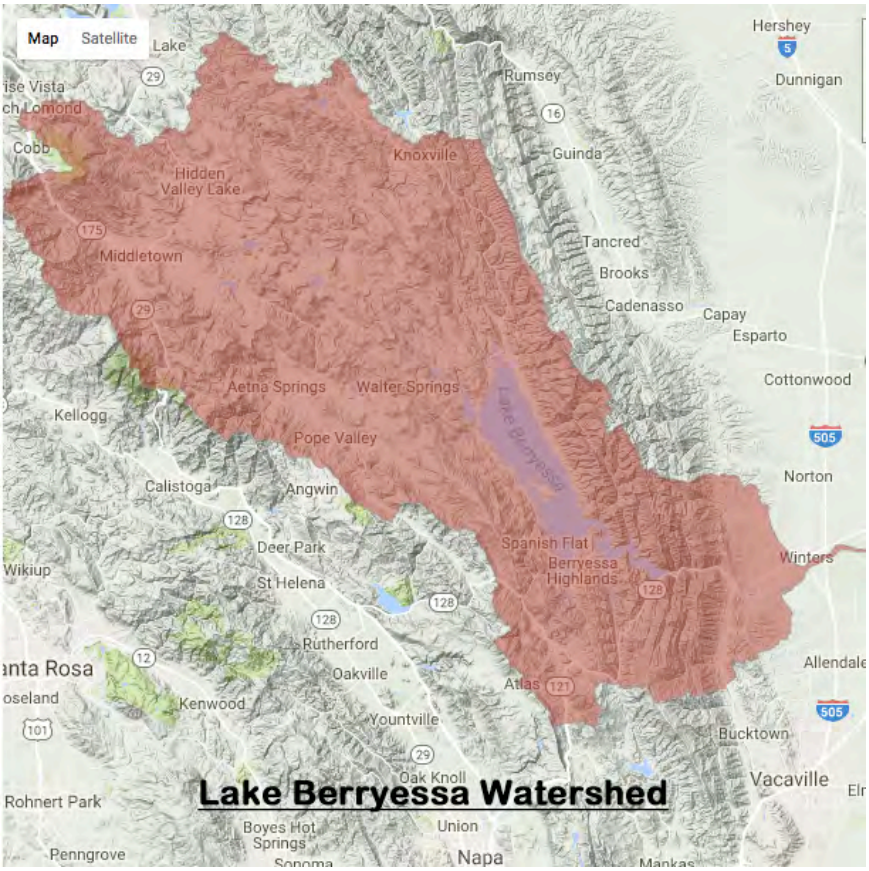
Brown's master plan for the state's water problems never caught on with the public or the legislature. His grand plans are collecting dust at the DWR.

The number one project on the list continues to be Sites, east of Maxwell. Those of you who are ATV/dirt bike/jet ski enthusiasts have probably gone to Stonyford or East Park Reservoir to ride. You've driven through Sites and seen the narrow canyon at the brown rock quarry where a dam similar to Monticello Dam could be built.

A simpler approach to storing more water in Lake Berryessa would be to raise Glory Hole itself by installing movable gates that could be raised and lowered as necessary to impound more water during the rainy season. Raising Glory Hole by 5 feet to 445' would increase Lake Berryesssa storage by approximately 100,000 acre-feet without significantly affecting facilities along the shoreline. Although the highest the lake level has ever reached was 446.7 feet in 1983, and it has often exceeded 440 feet, according to David Okita of SCWA, a review of the historical data shows that the level does not exceed 440 feet often enough to justify the expense of installing this type of control device on Glory Hole, much less justifying raising the dam itself. The lake level has reached or exceeded Glory Hole only 25 times in 60 years.

Rainfall Impacts

The water supply for Lake Berryessa is derived from the 568 square mile drainage basin above the dam. The elevation of the basin ranges from 182 feet at the dam to 4,722 feet at the upper end of Putah Creek with most of the basin lying below 1,500 feet. There are four principal creeks that flow into Lake Berryessa: Capell Creek, Pope Creek, Eticuera Creek, and Putah Creek, the main drainage of the basin.




How fast the lake rises is dependent on rainfall over the whole watershed. The lake is 23 miles long, 3 miles wide, with 165 miles of shoreline and is fed by the headwaters to the 576 square mile Putah Creek watershed. Rainfall levels vary significantly by location. Moskowite Corners is usually about 10% - 20% higher in rain totals than the nearby (7 miles) Berryessa Highlands. Below are some average rainfall totals for the region.

Calistoga, Angwin, and Napa provide an interesting precipitation comparison, but they are not within the Putah Creek Watershed. Middletown rainfall is a better comparison since it is really the headwaters to Putah Creek and flows directly into the lake.

Average annual rainfalls:

Monticello Dam (97-08): 28”
Markley Cove: 25.7”
Middletown (1938-1995): 48.6”
Angwin (1939-1995): 41”
Napa: 24”
St. Helena: 34.4”
Calistoga: 37.4”
Winters: 22.8”

Putah Creek Flows: Water In, Water Out, But From Where?

The rain causing the rapid increase in 2017 lake levels raised questions for some about where all the water comes from and where it goes. The lake was rising and lower Putah Creek was flowing fast, but not much water was being released from the dam. And some people questioned why any water was being released from Lake Berryessa when it was not yet full.

Many people don’t understand that Lake Berryessa was created for: 1. Irrigation in Solano County, 2. Drinking water (now for 500,000 people). Recreational use was not considered a priority because of the large swings in water level expected. Many also don’t realize that Napa County gets little of Lake Berryessa water except for the small villages scattered around the lake like the Berryessa Highlands, Spanish Flat, Berryessa Pines, and Berryessa Estates. But that’s a political history story for another day.

The watershed for Lake Berryessa is derived from the 568 square mile drainage basin above the dam. There are four principal creeks that flow into Lake Berryessa: Capell Creek, Pope Creek, Eticuera Creek, and Putah Creek - the main drainage of the basin.

Although there’s a lot of water flowing in Lower Putah Creek, people need to remember that nearly 90% of the Putah Creek watershed is above Lake Berryessa. Nearly all of the rain that we have received is flowing into Lake Berryessa NOT OUT OF IT. Nearly all of the flow in Putah Creek near Winters today is from the main creeks below Lake Berryessa.

For example, the total flow out of Lake Berryessa was 1,625 acre-feet (AF) for January, 2017. During that same period, the lake’s capacity rose by 399,970 AF. The output was only 0.4% of the input. (1 CFS = 1.98 acre-feet per day; 1 AF = 325,851 US gallons per day)

The Solano Irrigation District monitors this and actually reduces flows from the bottom of Lake Berryessa during rain events to conserve as much water as possible in the lake. But the flow needs to be at least 45 CFS in order to properly operate the power house - this has been the average outflow every day for the full month of January, 2017.

There are four main creeks below Berryessa. They are Wildhorse Creek (Cold Creek) right next to the Monticello Dam, Pleasant's Creek which empties into Lake Solano, and McCune Creek and Dry Creek below the Diversion Dam just upstream of the railroad bridge at Winters.

These creeks can contribute significant inflow to the system before entering Winters. It is estimated that during the 1/8/2017 storm the flow through Winters was between 2,500 and 3,000 CFS.

Combined, there is normally 2100 CFS of water flowing underneath the bridge at Winters during the winter rains, which is much higher than the normal flow 25 CFS in the same spot seen during summer. All of this water entered the system from tributaries below the Monticello Dam, not from Lake Berryessa.

Since there is no need for irrigation flows during rain events, and to keep the diversion canal free of silt and mud, nearly all the water from Pleasants Creek and Wildhorse Creek flows over the Diversion Dam at Lake Solano and continues downstream towards Winters.

Power Generation at Monticello Dam

The Power House at the base of Monticello Dam is owned and operated by the Solano Irrigation District. The only water released from the dam or through the power house is being used for agriculture and maintaining minimum flows in Putah Creek. The only other time water is released is when the lake is above 438 feet to generate power instead of letting it flow through the Glory Hole.

When the power house is operating all of 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. Normally the only time the bypass valves are operating is when they are doing maintenance on the power house and need it shut down but still need to deliver the water required for the Putah South Canal and Putah Creek downstream of the Diversion Dam. The smaller of the two visible jet valves is used when the required flow is at the lower levels which is between 45-90 cubic feet peer second (cfs). When the required flow is above this they will switch to the big jet valve. When the powerhouse is running at full capacity it is only using around 900 cfs. The reason for this is that the maximum summer flows required by the PSC and Putah Creek is around 900 cfs.


Water is never released above what is being used downstream so there is no reason to have the ability to go above this value. During heavy rain conditions like 2017 they run everything wide open to assist the Glory Hole in controlling the lake level. If the Glory Hole releases so much water that the jet valves become submerged they need to be shut down, and at those flows they aren't really doing much compared to the Glory Hole anyway.

The Monticello Dam, which began construction in 1953 and commenced operations in 1957, also is a backbone for local energy. Due to a 50-year contract that started in the 1980s, SID sells wholesale power to Pacific Gas and Electric, which they then place into their grid. Primarily, the power is transferred to PG&E's Santa Rosa substation, but the power is capable of being sent elsewhere. During the recent heavy rain conditions and rapid lake level rise, SID was producing 11.5 megawatts, which is peak production. Along with its contract with PG&E, SID also works with several other organizations on the dam, one of which is the Bureau of Reclamation.

Predicting the Future

Several climate prediction centers are forecasting El Niño conditions for the later part of 2009 and the early part of 2010. California does not always see an increase in precipitation during El Niño years. With the majority of the last ten years showing below normal precipitation in much of the state, researchers are hoping for a potential abundance of rainfall without flooding or coast-damaging storms.

The National Weather Service issues 30 and 90-day forecasts. Academic institutions, such as the Scripps Institution of Oceanography in San Diego, have attempted experimental seasonal forecasts. The accuracy and level of detail of these efforts remains insufficient for water project operations. It is only recently, for example, that researchers have had sufficient understanding of global weather patterns and atmospheric/oceanic interactions to be able to identify conditions associated with the El Niño Southern Oscillation (ENSO) in the Pacific Ocean. That understanding has yet to be translated to forecasts of runoff, partly because ENSO events affect different parts of California differently.

Lake Berryessa had normal fluctuations in water levels from 1995 to 2006. A middling El Niño brought steady rains that filled Lake Berryessa to the brim in January, 2006 – the last year the lake spilled over Glory Hole. A previous El Niño brought seemingly nonstop rains in the winter of 1997-1998. See February, 1998 chart above – 18.9 inches in that one month – more than the total of 12.7 inches of rainfall in 2006-2007! I witnessed Lake Berryessa go up 9 feet in 12 days in 1998 from my deck at Steele Park Resort.

Glory Hole did spill in January, 2006; however, the lake did not exceed 440 feet again until February, 2017 - the first time in 11 years.

**2017 Breaks An 11-Year Drought: Lake Berryessa Fills, Glory Hole Spills (Drone Videos)**

This amazing series of Lake Berryessa News Drone videos by Evan Kilkus documents the 45 foot rise of Lake Berryessa in 2017. It was the second largest annual increase in the history of the lake. It was also the second highest level the lake has reached in its 58 year history. The lake has only spilled into Glory Hole 26 times in those 58 years. Also the rainfall total (46.4 inches as of 4/12/17) is the highest in 20 years.

The first video shows how low the lake was 2 years ago. You should watch it before the others to get some perspective on the amazing rise of the lake in 2017.

December 2014: The lake is LOW: https://youtu.be/5d-WIJcmu60

January 10, 2017: The Action Begins: https://youtu.be/bGJvofIyTwQ

February 10, 2017: Only 2 Feet To Go!: https://youtu.be/PRWAfVw9DBU

February 12, 2017 - First Time Lake Berryessa Water Splashes Into Glory Hole!: https://youtu.be/8pIPsgLFggk

February 13, 2017: Lake Berryessa Is Full!: https://youtu.be/EH0LQW7iduY

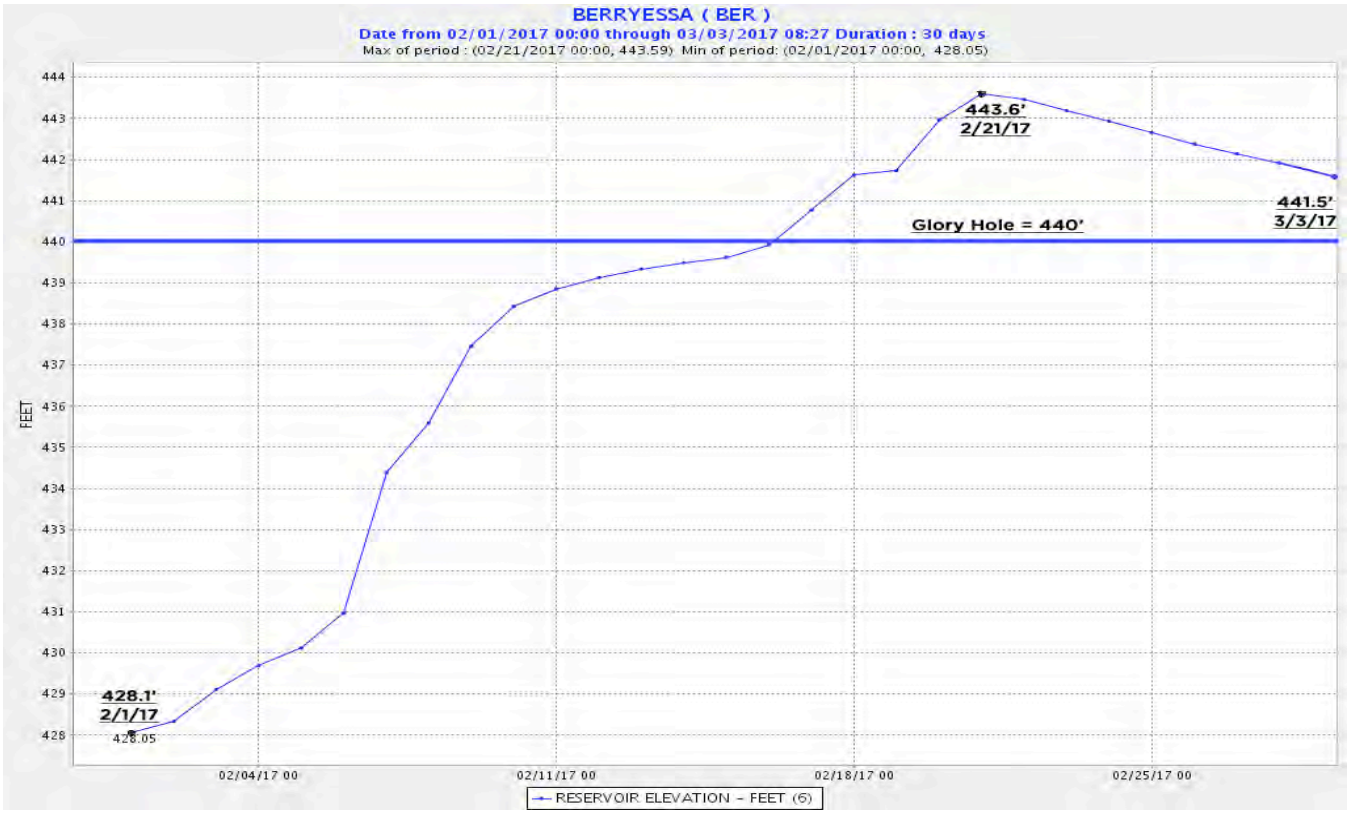
February 16, 2017: Lake Berryessa Officially Spills Into Glory Hole: https://youtu.be/cB0BKIm1EzM

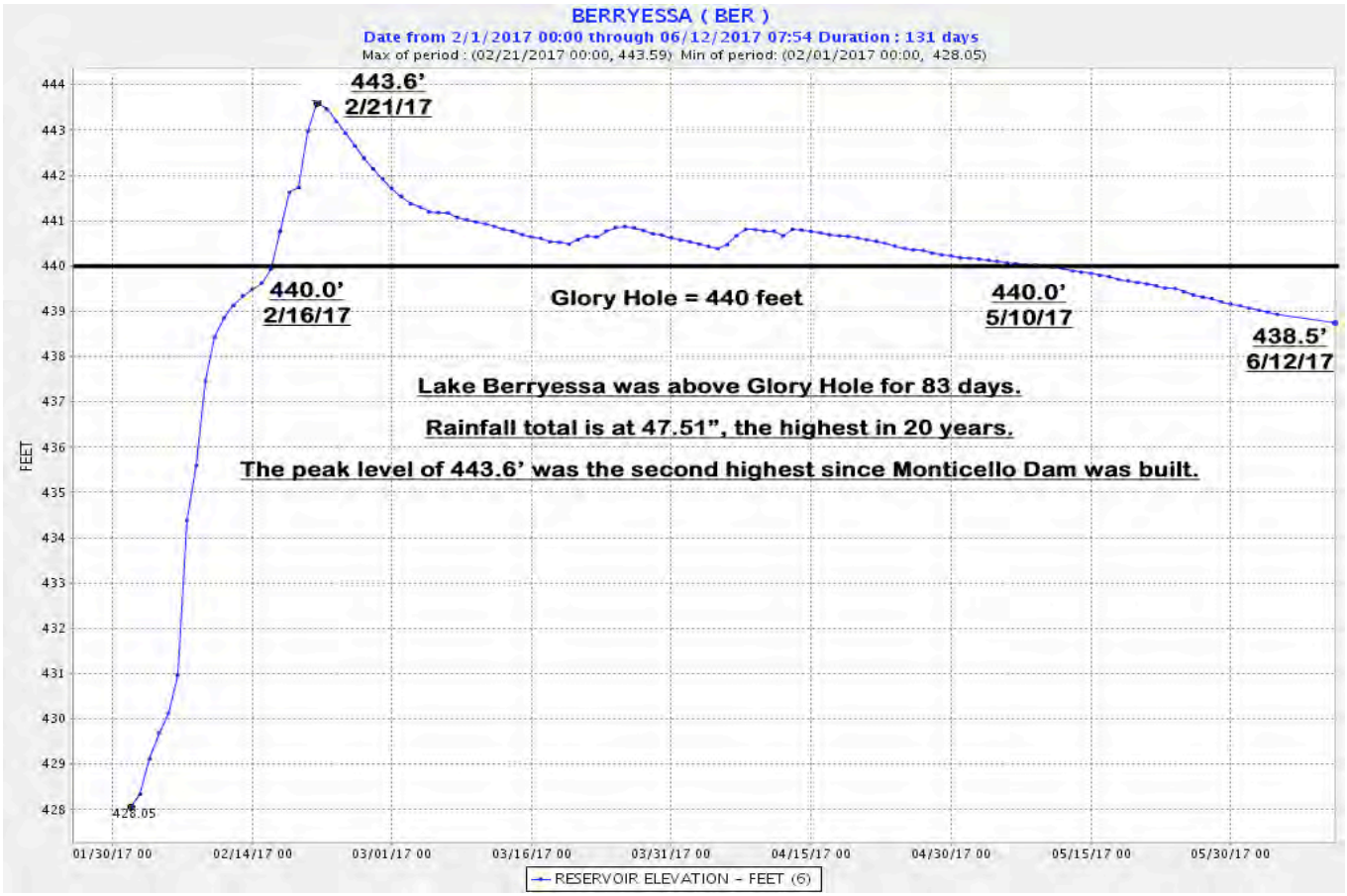
February 18, 2017: Overflowing Glory Hole: https://youtu.be/NxOOnKL265I

February 21, 2017: Lake Berryessa Hits Second Highest Water Level In History!: https://youtu.be/-iHAjOrrU4k

February 21, 2017: A Full Lake Just Feels Good: https://youtu.be/qhPzR2Gqzs0

April 14, 2017: Spring Comes to a Full Lake Berryessa: https://youtu.be/1TVX9Euix3E


BERRYESSA ( BER )
Date from 02/01/2017 00:00 through 03/03/2017 08:27 Duration : 30 days
Max of period : (02/21/2017 00:00, 443.59) Min of period: (02/01/2017 00:00, 428.05)
443.6'
2/21/17
441.5'
3/3/17
Glory Hole = 440'
428.1'
2/1/17
428.05
FEET
02/04/17 00
02/11/17 00
02/18/17 00
02/25/17 00
RESERVOIR ELEVATION - FEET (6)


BERRYESSA ( BER )
Date from 2/1/2017 00:00 through 06/12/2017 07:54 Duration : 131 days
Max of period : (02/21/2017 00:00, 443.59) Min of period: (02/01/2017 00:00, 428.05)
443.6'
2/21/17
440.0'
2/16/17
Glory Hole = 440 feet
440.0'
5/10/17
438.5'
6/12/17
Lake Berryessa was above Glory Hole for 83 days.
Rainfall total is at 47.51", the highest in 20 years.
The peak level of 443.6' was the second highest since Monticello Dam was built.
428.05
FEET
01/30/17 00
02/14/17 00
03/01/17 00
03/16/17 00
03/31/17 00
04/15/17 00
04/30/17 00
05/15/17 00
05/30/17 00
RESERVOIR ELEVATION - FEET (6)