Restore the Delta Webinar Notes Tim Stroshane, Policy Analyst
Delta Water Quality Plans and Voluntary Agreements
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Contents

Introduction to Central Valley and Delta Hydrology[1]

Hydrology is the study of the ***hydrologic cycle***—the activity of water that is subject to natural fluctuations and is susceptible to human modification. The cycle describes the motions of water from its evaporation by the sun to the atmosphere, the formation of clouds, the transport of clouds to land where precipitation occurs, and the distribution of water from precipitation throughout the landscape as rain or snow, into soils and rivers, or by percolating into deeper pores in the earth where it collects as groundwater. Eventually, the cycle renews when rivers reach the sea, or groundwater flows to the ocean from geologic strata below sea level. ***Delta hydrology*** is the study of how the Delta gets its portion of water from the hydrologic cycle playing out over and in California.

The ***Central Valley*** is the area bounded by huge mountain ranges—the Cascades in the north, the Sierra Nevada along the eastern edge, the Coast Ranges along the western edge, and the Transverse and Tehachapi ranges forming the southern edges of this great bowl in the center of California. The Delta is the low place of the Central Valley. A big bathtub from Redding to Bakersfield, with the Delta's channels and estuary at the "drain" to San Francisco Bay via Carquinez Strait.

[1] This introduction is provided as training for new advocates. Some webinar participants with more experience may skip this section.

Central Valley rivers from Fresno to Redding flow directly to the Delta. The Delta's flows drain by gravity to San Francisco Bay and the Pacific Ocean.

Tulare Lake Basin (also known as the southern San Joaquin Valley) extends from Mendota, west of Fresno, to Arvin. Waters generally stay in this basin, no typical flow to the Pacific Ocean—EXCEPT in flood years where high flows fill Buena Vista Lake and old Tulare Lake before draining out Fresno Slough to the San Joaquin River. Last time that happened was 1983, an El Niño year.

Most CV rivers flow from east to west to mainstem Sacramento and San Joaquin Rivers. Sacramento drains north to south; San Joaquin drains south to north from Mendota (after flowing west out of Sierra).

Major northern tributaries to the Sacramento: Feather, Yuba, Bear, American.

Major southern tributaries to the San Joaquin: Stanislaus, Tuolumne, Merced, Upper San Joaquin (above Fresno).

Major Tulare Lake Basin tributaries: Kings, Kaweah, Tule, Kern.

There are many other much smaller creeks. These larger tributaries are generally the ones that carry snowmelt from the Sierra in spring months.

Before colonization there were extensive wetland basins in the Sacramento, San Joaquin, and Tulare Basin floors. They acted as broad reservoirs that helped maintain flow in the rivers all year round and hosted large flora and fauna populations.

This means that the large valley-floor basins acted like giant flood control basins in wet years and as sources of baseline river flows in drought years. They are also often areas of extensive groundwater recharge.

Major Delta tributaries, after the Sacramento and San Joaquin: Mokelumne, Calaveras, and Cosumnes rivers. These all flow into the San Joaquin within the Delta Estuary. Only the Mokelumne has headwaters in higher elevations touching snowpack.

Key hydrology concept: ***Unimpaired flow*** (UF) idea—the approximate "natural flow" estimated by adding into observed flow all diversion flows and evaporative losses from reservoirs along a river. UF also known in data circles as "Full Natural Flow."

This enables us to talk about flow levels to and through rivers, and to and through the Delta.

Natural flows to the Delta breakdown as follows: Sacramento River basin accounts for about 80 percent of natural flow to the Delta; San Joaquin about 15 percent; other

smaller creeks (like Mokelumne, Calaveras, Cosumnes, Marsh and others) about 5 percent in any given year.

Some other terms you may hear:

Storms: There are typically two types of storms that reach California from the Pacific Ocean during the wet season—1) ***colder, drier, and often weaker storms*** that come from the Gulf of Alaska or otherwise northwest of California called "***midlatitude cyclones***"; and 2) warmer, wetter "***atmospheric rivers***" that stream to California from the tropics often around Hawai'i. Hydrologists believe that atmospheric rivers are typically the cause of California's largest floods in history.

Snowpack—the quantity of water stored as snow at any given time at elevations where it can remain frozen. Snowpack is especially important the closer spring comes because it signals how much water reservoirs will see entering—and consequently whether there is concern for controlling floods and storing water for later use in irrigation or urban and ecological beneficial users. Snowpack can also be measured as "snow water equivalent"—attained by weighing a quantity of snow of a certain volume and then figuring out how much of the snow was air and how much is water.

Snowmelt—the quantity of flow that is generated when snowpack melts in the spring.

Hydrograph—a chart or graph of how a river's flow changes over time, such as during a storm, or throughout a "water year."

Water Year—a twelve-month period during which river flow (often called "runoff") or precipitation is measured. In California, the water year starts October 1 and runs through September 30.

The worst floods occur when the Sierra Nevada gets a lot of snow early in the winter, and then the atmospheric circulation changes to let an atmospheric river reach California. Warm atmospheric rivers often have very high snow elevations (e.g., 7,000 feet or higher), which can melt all or nearly all the accumulated ***snowpack*** very quickly. This happened in the southern Sierra Nevada and nearly caused overtopping of Friant Dam from Millerton Lake in January 1997. Lots of flood damage downstream in the San Joaquin Valley. It also happened in February 2017 in the Feather River basin, which feeds water to Lake Oroville, and resulted in extensive damage to its main and emergency spillways at Oroville Dam. It is believed that a 45-day atmospheric river caused the great flood of December 1861-January 1862 that flooded Sacramento badly and much of the valley and Delta for a couple of months afterward.

Acre-foot is a unit of measure of water volume. Envision a football field (about an acre) with water one-foot deep—this is about 325,828 gallons, or about 43,560 cubic feet.

Sometimes water is quantified in thousands of acre-feet (TAF) or millions of acre-feet (MAF). Conversions to metric volumes are available.

Central Valley Water Quality Background

Water quality is an object of study and concern because ***water almost always contains impurities***, which are described generally as "***constituents***."[2] Potentially toxic constituents are often referred to as "***contaminants***."

Water quality of rivers coming off the Sierra Nevada is some of the best in the world due to its underlying granite geology of most canyons through which they flow.

(Coincidentally, most of the best dam sites are located, and already developed, at the mouths of these same canyons at the western edge of the Sierra Nevada.)

Intense diversions of these rivers for irrigation, especially for San Joaquin River tributaries below the rim dams.

Irrigation diversions pass through orchards and fields, generating what is called "***return flow.***" Return flow is drainage back to rivers (either at the ground surface or below) that has typically picked up salts, sediment, pesticides, other types of contaminants, and "nutrients" from use of fertilizers that contain large amounts of nitrogen and phosphorus (as nitrates and phosphates).

Pesticides can cause nerve problems and cancer in humans, depending on the compound. And they can be harmful to wildlife when pesticides are transferred through different levels of food webs. Some pesticides, however, do break down and cause less problems in ecosystems and food webs.

Nutrients are important in at least a few ways. Nitrates (NO_X) can be carcinogenic (can cause cancer) if found in drinking water, as well as cause other health problems. This has been a problem in both the San Joaquin Valley and the Salinas Valley to the west.

Both nitrogen and phosphorus are factors in the life cycle of ***cyanobacteria*****, a kind of alga (plural "algae")**. Cyanobacteria occur naturally in fresh and brackish water environments that generally have slow moving water—places like sloughs in the Delta estuary, reservoirs, natural lakes, and wetlands (even if the tides influence them).

When conditions are right, cyanobacteria undergo population explosions. The needed conditions include heat, slow and clear water flow, lots of sunlight (from which they

[2] "Distilled water" is an exception, having been artificially purified to remove nearly all chemical and biological constituents of water. Also, whether water is considered basic or acidic (corrosive) is not addressed in these notes.

photosynthesize energy they need to reproduce), and a supply of nutrients they can consume in the course of reproducing—such as nitrogen and phosphorus. When the conditions are right, their populations explode as algal blooms.

Some cyanobacteria generate toxic chemicals in their microscopic bodies—these are called ***cyanotoxins***. When algal blooms form among cyanobacteria that produce these toxins, they are referred to as "harmful algal blooms." If ingested, dogs can sicken and die very quickly. Humans can get very sick. One species of cyanobacteria, ***Microcystis***, produces a toxin called Microcystin that produces these effects when ingested.

(Another cyanotoxin is ***domoic acid.*** A few years ago domoic acid was deemed responsible for killing a sea otter in San Francisco Bay, and its presence in Bay waters can delay start of the Dungeness crab harvest season until domoic acid is no longer found through testing and monitoring.)

Other water quality contaminants can include naturally occurring ions of elements like boron, selenium, arsenic, molybdenum, and others. Soils and rocks of the western San Joaquin Valley (west of places like Gustine, Firebaugh, and Mendota; and further south around Kettleman City and Buttonwillow) naturally have high concentrations of some or all of these contaminants. They can be released into rivers and wetlands when fields are irrigated and drained.

Salts are another important water quality constituent. They can affect the metabolism of plants and animals, which are differently adapted as to whether and how they process salts and keep them out of their bodies. Some are more tolerant than others of salts. Salts can include chlorides and bromides and iodides of sodium, calcium, and magnesium.

Salts come from the ocean, but they also come from San Joaquin Valley soils and rocks. The salt concentration of the San Joaquin River increases dramatically between its arrival at Millerton Lake near Fresno and its eventual arrival in the Delta, and which is true also for the major tributaries.

Salts of course come from the tidal flows of San Francisco Bay to the Delta. This is an issue for the state and federal export pumps. Tidal flows containing salts are denser than fresher water flowing to the Delta from the rivers of the Central Valley. Consequently, shallower water in the Delta tends to be fresher than water measured at greater depth in Delta channels. The pumps cannot distinguish these flow characteristics of different densities of water—they just pull it all in and lift to the aqueducts uphill.

Interaction of Flow Hydrology and Water Quality

Because flows in rivers and estuaries change with the seasons so does water quality. Flows and water quality also change over the course of years depending on what weather and climate occurs during that period.

During **wetter years**, generally Delta water quality varies seasonally, with higher flows from spring snowmelt (often in the San Joaquin basin from April through June) and less concentrations of water quality constituents (salts, pesticides, contaminants, nutrients, etc.), to times in the late summer and fall (September through November) with lower flows and higher concentrations of water quality constituents.

During **drier or drought years**, Delta water quality continues to vary seasonally, but with much higher concentrations of each water quality constituent year-round. Farmers actually irrigate as much or more than they do in wet years (when rainfall may reduce their irrigation water demands) but they often get a larger share of their irrigation water supply from pumped groundwater rather than imported or diverted water supplies.

A Little History—State and Federal Water Projects

While White Americans and later public and private corporations came to control nearly all water resources in California, they found the state's rivers unreliable and unstable for consistent farm irrigation and urban water supplies.

Nineteenth century irrigation expanded in the Central Valley, earlier in the San Joaquin Valley, later in the Sacramento Valley (early twentieth century, especially with advent of rice culture).

Only by the 1890s did any effort to collect flow and water data begin as a state-organized activity, and then only by 1920s was it begun statewide.

At that time, the State of California realized most of the flow and runoff is north of Sacramento and the Delta; most of the agricultural production was south of the Delta.

Central Valley Project (CVP) planning began in the 1920s. It received narrow voter approval in December 1933 (margin of 33,600 votes out of 885,000 votes cast) and construction began in the late 1930s. California couldn't sell bonds for it, but was desperate enough for its construction to have the federal Bureau of Reclamation take it over. Initial phases included a canal to Contra Costa County, the Delta Mendota Canal, a Tracy pumping plant in the south Delta, Shasta Dam (near Redding) and Friant Dam (near Fresno). While the CVP was an important Depression-era employment generator, it was beset by wartime shortages and was not completed until 1951. It is US-taxpayer subsidized, so its water is sold cheaply to farmers.

Subsequently, three other large reservoirs were developed later by the Bureau at Trinity Lake (Trinity River), Folsom Lake (American River), and San Luis Reservoir near Gustine and Santa Nella along Interstate 5. In all, the CVP has a capacity to deliver about 7 to 8 million acre-feet of water, north and south of the Delta.

The CVP is considered to be "storage rich" because of its several large reservoirs and "conveyance poor" because its canals (Delta-Mendota and Friant-Kern) and Jones pumping plant near Tracy are generally of smaller capacity relative to the SWP.

Most CVP customers are agricultural water districts with some small towns. It also supplies electricity to some cities elsewhere in California (e.g., Redding, Santa Clara).

State Water Project (SWP) planning began in 1951 as "Feather River Project." Project bonds were narrowly approved by California voters in November 1960 (receiving a 165,000 vote margin out of 5.8 million votes cast). Initial phases included Oroville Dam, small dams in the upper Feather River region, a large pumping plant near Byron in the south Delta, and two other pumping plants in the San Joaquin Valley to move water up the valley and lift it over the Tehachapi Range into Los Angeles County, to three terminal reservoirs (Castaic, Perris, Pyramid) that would supply water to Metropolitan Water District of Southern California's service area. It also began delivering water to Santa Clara County in this phase.

The SWP is considered to be "conveyance rich" because of its larger Banks pumping plant and larger capacity California Aqueduct compared with CVP facilities.

Most SWP customers are urban—principally, Silicon Valley, San Luis Obispo, Santa Barbara, and urban southern California, though there are key agricultural water contractors like Kern County Water Agency and several smaller ones in the San Joaquin Valley. A major state water contractor is the Metropolitan Water District of Southern California, whose service area extends from Ventura County to the Mexican border and inland to San Bernardino and Riverside counties.

Once two large projects were both pumping water out of the south Delta, problems emerged quickly: the pumps created ***reverse flows*** in which both Old and Middle rivers in the Delta flow uphill, backwards to the pumps at Byron and Tracy. This has at least three major impacts: 1) the export pumps take in ***much more salt than they would like*** to; and 2) the pumps have historically drawn in migratory and young larval fish from which the fish cannot escape. The fish are either eaten by predators or destroyed and killed at the pumps themselves; and 3) farmers in the south Delta have frequently seen water levels fall below the levels at which their siphons or pump diversions can draw water from channels into their island fields. The south Delta farmers are also harmed by salty water from the reverse flows.

Water quality laws and regulations began just after World War II (as far as I know right now). They came about due to rapid post-war growth that caused sudden and serious sewage spills and pollution in water ways all over the state, including the Delta.

Water Quality Control Planning

History

State integrates water rights and water quality regulation under the authority of the ***State Water Resources Control Board*** **(SWRCB)** in 1967.

California passes its most comprehensive water quality control law in 1969, the Porter-Cologne Water Quality Control Act—still in effect today.

U.S. Congress passed and President Richard Nixon signed the 1972 federal Clean Water Act, which lays out the basic structure of water quality control planning.

Structure of a Plan

A water quality control plan (WQCP) is supposed to be a recurring three-year event, but in the Delta's case its cycle has been much much longer, largely because of both complexity of Delta issues and state water politics.

A WQCP addresses these questions:

- What are the ***beneficial uses of water*** in the area subject to the plan?
- What ***water quality standards or objectives*** should be applied to ensure continuation of those beneficial uses now and for the long term?
- How will protection of the beneficial uses by the water quality standards/objectives be achieved? This is the question answered by the ***program of implementation*** for the WQCP.

Beneficial uses, water quality standards/objectives and implementation are the building blocks and language of a WQCP. These terms help create emotional distance about from what they actually described, but they also establish a framework within which WQCPs are created.

A ***beneficial use*** can be just about anything that the state recognizes to be a beneficial use of water—industrial cooling and processing, agricultural diversion for irrigation, fish and wildlife, municipal and domestic urban uses by residents, businesses, community faicilities, as well as groundwater recharge, rare and endangered species, recreational (contact and non-contact with water), estuarine (such as nesting and rearing habitats of species that reside in or transit through a water body like the Delta). ***Never has the SWRCB recognized export water use as a beneficial use of water in the Delta.*** I

still ponder what that means but I have argued that they need to take a hard line on protecting the Delta for precisely this reason. It's not something you otherwise hear about. SWRCB political gives more credence to exporters' Delta claims than they legally need to.

The water quality standards or objectives are derived from scientific research, monitoring, and regular surveillance of flow and water quality in all state rivers, streams, and water bodies. "***Standards***" are the federal Clean Water Act term; "***objectives***" are the state Porter-Cologne Act terms for the same thing—usually a ***numerical threshold*** below which a beneficial use is considered to be protected from "***degradation***"—that is, if the water has a constituent that exceeds a certain threshold, such as for drinking water, then that water may not taste good, or worse, it might be unhealthy to drink.

Because water quality changes seasonally and across different water years (think wet, dry, drought), water quality standards may also include a calendar of thresholds during which a particular threshold may apply, or a particular level of flow below which more is needed to protect a beneficial use.

Another component not within the WQCP that the SWRCB uses to try to stay on top of emerging and ongoing water pollution problems is the "303d list." This inventory of water quality surveillance is very technical and chemistry/biology science heavy. The 303d list catalogs which water bodies have impaired beneficial uses and from what contaminant or constituent the impairment stems. It is less relevant to Delta WQCP stuff, but I want you to be aware of it.

Water quality criteria can be controversial because the levels at which they are set dictate how much fresh river inflow and Delta outflow are put toward protecting in-Delta beneficial uses as compared with how much of those flows can be exported to CVP and SWP customers beyond the Delta.

Quantity of Flow Issues

Understanding Delta WQCP politics and content requires we understand significant flow and legal issues involved.

Over-appropriation is a little recognized legal and psychological issue with Central Valley water rights. The quantified "face value" of junior water rights leads to inflated expectations held by junior water right holders. The largest junior water right holders in the Central Valley watershed are the USBR (for the CVP) and DWR (for the SWP). Over-appropriation is simply the idea that the claims to appropriate water from a stream exceed the flows available to supply them from the stream. The excess of claims over actual water available is also referred to as "***paper water***"—that is, over-appropriation identifies water that exists primarily on paper. In research I did for the California Water Impact Network between 2010 and 2012, I found that consumptive water rights claims

in the Sacramento and San Joaquin River basins exceeded average annual flows in the rivers by a factor of five (5). In a year when flows are just half the average, that paper water ratio goes up to ten (10). That is, in a drought, there might be twice as much paper water held by water claimants as there is in an average year; another way to think of it is that there will be twice the competition for scarce water supplies. These property holders nonetheless want their water. Other studies have found similar ratios of paper water.

CVP and SWP water rights aim to divert and store any surplus water (not already legally claimed by others) for use by their contractors/customers. They had to arrive at contractual settlements with all senior water right holders to make sure they didn't accidentally or purposely steal someone else's water. This was done to avoid litigation later.

There are groups of settlement contractors on three major rivers in the Central Valley:

Sacramento (nearly 150)—settled with USBR
Feather (about five or six)—settled with DWR
San Joaquin River (four)—settled with USBR

The basic agreement with these contractors is that their senior water rights will be served *first* from state or federal reservoirs, before later (or "junior") CVP or SWP water contractors are supplied with water. This is especially pertinent when supplies are short.

To meet the terms of these agreements requires intense coordination of operations between the federal CVP and the SWP so they negotiated Coordinated Operating Agreements (COAs) in 1960, 1971, 1986, and most recently in 2018, when the 1986 COA was amended to give more water to the CVP and less to the SWP. The Trump Administration took advantage of the fact that the CVP has senior water rights to divert from the Delta and the Sacramento River. State water officials relented, allowing the CVP more exports for its irrigators or face potential water rights litigation from the federal government.

Water Quality Issues for Delta Beneficial Users

As I mentioned before, rapid industrial and urban growth in California prompted water quality regulation to deal with serious emerging pollution problems. The Delta by the 1930s was ringed with industries drawing water from the Delta for cooling and processing—and by the 1960s the Carquinez Strait was lined with petroleum refineries in Martinez, Vallejo, Benicia, and power plants in Pittsburg and Antioch. More and more commercial shipping traffic passed through this corridor as well as the Port of Stockton grew and became and inland entrepôt for goods into the Central Valley and beyond (bypassing Oakland and San Francisco). And the cities all along this corridor were growing in Solano (Fairfield-Suisun City, Rio Vista), Yolo (West Sacramento),

Sacramento (Elk Grove, Galt), and San Joaquin County (Stockton, Lodi, Tracy, Manteca, Lathrop).

As I also mentioned, ecological issues were emerging from the pollution problems, though the state was slow to conduct basic ecological studies of the Delta estuary until the middle 1960s. Prior to that time the major ecological issue from the 1930s and 1940s was recognition that migratory Chinook salmon and steelhead (rainbow) trout could be harmed by upstream dams and intense irrigation diversions. Not much thought was given to their needs as well as the needs of the food webs through which they passed, which included other migratory species but also species that resided in the sediments and open waters of the Delta and the rivers feeding it.

Old and Middle rivers are directly affected by ***reverse flows*** caused by Jones (CVP, 4,600 cubic feet per second [cfs] capacity) and Banks (SWP, 11,600 cfs capacity) Pumping Plants. Export pumping, river inflows, and Delta outflows (heading to San Francisco Bay) correlate with each other: when exports are high, Delta outflow tends to go down, and vice versa. The beneficial uses involved are multiple—export water salinity, agricultural irrigation, drinking water quality for Stockton and Contra Costa Water District, and Delta estuarine ecological health, including various food webs and rare and endangered species.

Key water quality issues include:

- What are the appropriate ***salinity objectives*** for South Delta agriculture? This area—from about State Route 4 to Vernalis south of Manteca—receives both tidal flows and salty San Joaquin River flows. The same pumping that reverses flows on Old and Middle rivers also draw down water levels in South Delta channels, limiting farmers' diversion amounts and impairing their water quality with tidal salts.

- ***Massive fish kills*** (called "fish salvage" although there is nothing salvageable about fish carcasses) at especially the Banks pumping plant and Clifton Court Forebay. Pumping at both Jones and Banks has to be reduced when migrating and larval fish are present in south Delta stream channels to reduce fish kills. These kills have happened during heavy winter-time pumping to fill reservoirs south of the Delta. Though Endangered Species Act biological opinions ("BOs") have functioned to reduce the incidence and scale of earlier fish skills since 2009, these BOs are the object of constant rhetorical and legal assault by water contractors and the SWP and CVP operators.

- Operations of the ***Delta Cross Channel (DCC)*** near Walnut Grove affect survival of fish migrating out of the Delta. The DCC connects north Delta channels like the Sacramento River with flows in the central Delta from Snodgrass Slough and Georgiana Sloughs. Young salmon can get off course if they enter the DCC or Georgiana Slough during their outmigration to the Pacific Ocean. The trip becomes

longer for them, they may tire or get disoriented by changes in salinity, and are more vulnerable in central Delta channels to predation from several introduced predatory fish species. This has resulted in a WQCP operational objective that controls DCC operations so that its gates close in the spring, and at other times of year when migratory salmon are present.

- During droughts, Delta river inflows are low (that is, from upstream), greater tidal salinity invades the Delta (called "***salinity intrusion***"), encroaching upstream since lower fresh inflows cannot resist as much of the landward tidal flows from San Francisco Bay. This of course affects South Delta agricultural and Contra Costa urban and industrial beneficial uses, including drinking water quality.

- Because so much of the San Joaquin River is diverted (including at Friant Dam near Fresno to Kern County), its lower flows reaching the Delta used to receive so much nutrient volume along the way and from the Stockton Wastewater Treatment Plant that ***dissolved oxygen would nearly disappear***, totally consumed by chemical reactions from algae growth in the Stockton Deep Water Ship Channel that would suffocate fish migrating in the San Joaquin to sea past the Port of Stockton. For this reason, there is a dissolved oxygen standard to protect fish and wildlife beneficial uses in the Bay Delta WQCP. To reduce the incidence of these fish kills from "anoxic" (without oxygen) conditions (as well as to eliminate nutrients) from the San Joaquin River, Stockton's Wastewater Treatment Plant moved to tertiary treatment and installed an aerator for this reach of the San Joaquin (not unlike an aerator bubbling in an aquarium).

- What should be the ***contribution of the major tributaries of the Sacramento and San Joaquin Rivers*** to improving water quality and flow conditions in the Delta?

- Contra Costa Water District (CCWD) and the City of Stockton rely on direct diversions from Delta channels to ***drinking water treatment facilities***. While there are salinity objectives for CCWD's diversion points (such as Rock Slough and Victoria Island), both water suppliers are concerned that any increases in salinity will raise costs of treatment to maintain drinking water quality for their customers.

During prolonged droughts, DWR has sometimes resorted to placing massive rock barriers to block tidal salt water in the Delta on a temporary basis. While porous, the barriers serve to reduce the rate and volume of salt moving into the Delta from Carquinez Strait at the same time that low fresh flows are still coming downstream. Such structures are desperate measures for desperate times—such as summer 1977 and summer 2015.

San Joaquin River Flow and South Delta Salinity Objectives WQCP

SWRCB in 1995 adopted a Bay-Delta Plan that said one thing about how to attain Vernalis flows, and D-1641 was supposed to implement that plan. Instead, SWRCB allowed something else for Vernalis flow compliance—specifically, the Board allowed ***a voluntary "San Joaquin River Agreement" and its Vernalis Adaptive Management Plan (VAMP)*** both of which could be implemented in lieu of the Vernalis flow standard adopted in 1995.

In 2006, Appellate Justice Ronald Robie (himself a former SWRCB member and later a director of DWR before becoming a state appellate justice) determined that the SJRA and VAMP were inconsistent with the 1995 WQCP, and therefore illegal. Justice Robie's determination contributed in early 2009 to the SWRCB bifurcating its once-unified Bay-Delta WQCP into two phases or parts (San Joaquin side separate from Sacramento side).

Also different now is that SWRCB incorporates the "voluntary settlement agreement (VSA)" concepts into the plan (in the ***program of implementation***), to comply with Robie's decision (that provisions of the WQCP and implementing water rights decision are consistent and parallel with each other). Holding the negotiators of VSAs to the new Bay-Delta plan's unimpaired flow objectives had advantages for placing constraints on what VSAs could do to reduce flows to meet their negotiators' preferences for higher exports and diversions on tributaries. Negotiating parties openly resisted the Board in 2018, but the Water Board's Bay Delta WQCP San Joaquin flow amendments were approved in December 2018, and are summarized here:

San Joaquin River Flow Objectives

- ***Increased flow on the San Joaquin River and its tributaries to a range of 30 to 50 percent, with a starting point of 40 percent of unimpaired flow from February through June.*** According to SWRCB, historical median February through June flows from 1984–2009 in the Merced, Tuolumne, and Stanislaus Rivers were, respectively, 26, 21, and 40 percent of unimpaired flow. In other words, half of the time more than 60 or 70 percent of each river's flow is diverted out of the river during these months, periods when young salmon and steelhead attempt to grow and migrate to the ocean.

- ***The unimpaired flow requirement is designed to mimic the cues of nature that species have evolved to respond to, but is not intended to be rigid*** and fixed percent of unimpaired flow. That type of targeted effort can provide more timely and efficient use of flows, in combination with habitat restoration or in light of observation, as compared with a set regime of calendared flows thresholds.

- ***SWRCB recognizes financial and operational challenges to local economies of reduced diversions.*** The proposed increased flow requirement

range is a compromise between optimal flows for fish and wildlife, and the needs of agriculture and local economies.

- ***Stakeholders are encouraged to work together to reach voluntary agreements*** that could implement Bay-Delta Plan objectives for fish and wildlife beneficial uses. ***Voluntary actions to implement non-flow measures to improve conditions for fish and wildlife may support a change in the flows within the 30 to 50 percent range.***[3]

- The proposal contemplates that ***biological goals will be among the tools*** that inform future State Water Board decisions on whether ***to adjust the unimpaired flow percentage within the 30 to 50 percent range***. Put another way, ***adaptive management will optimize the balance between fishery and human uses***, while rewarding actual improvements in biological conditions that support native fish. SWRCB believes that adaptive implementation of flows will also allow a nimble response to changing information and changing conditions while minimizing unintended impacts.

Southern Delta Salinity Objectives

- The amendment to the southern Delta salinity objective (southern Delta salinity proposal) ***eliminated the seasonal element of the previous objective by changing the objective to a higher salinity level (1.0 deciSiemens per meter (dS/m) year-round***, from the previous 0.7 dS/m April through August and 1.0 dS/m September through March).

- SWRCB maintains, despite evidence to the contrary, that existing salinity conditions in the southern Delta are suitable for all crops and that ***the existing April through August salinity objective is actually lower than what is needed to reasonably protect agriculture.***[4]

- ***USBR will be required to continue to comply with the 0.7 dS/m salinity level for the SJR at Vernalis as a condition of its water rights.***[5]

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[3] Had SWRCB not adopted these water quality objectives but allowed Voluntary Agreements to go forward on the San Joaquin, such VAs would not have had to comply within the 30 to 50 percent of UFs range.

[4] South Delta farmers and growers and some environmental water groups disputed this claim throughout the nine years of this process.

[5] Only the Bureau is made responsible because DWR has no operational control over San Joaquin inflows to and through the south Delta channels of Old, Middle, and the mainstem San Joaquin rivers.

- ***The amendment required that the SWP and CVP address export operation impacts on water levels and flow affecting South Delta salinity conditions.***[6]

- The southern Delta salinity amendment would also replace the three current fixed points for monitoring southern Delta salinity compliance, and instead identifies three extended channel segments for monitoring conditions and measuring compliance.[7]

- SWRCB also contends that its San Joaquin River flow amendments for increased February through June flows would improve salinity conditions in the southern Delta early in the irrigation season [that is, through the end of June, but not after].

The "Sacramento Side" of the Bay-Delta WQCP (Phase 2)

SWRCB work through July 2018 on the "Sacramento Side" (also called "Phase 2") of the Bay-Delta WQCP made a similar effort to analyze and draw conclusions from the best available science at the time on the Delta's ecological crisis as well as to put forward "trial balloons" about the objectives it anticipated proposing. Beyond what has been put out about VAs since December 2018 and this or that rumor, not much else is known about Board thinking about what its Sacramento River Bay-Delta WQCP will look like. We do know from both a "Scientific Basis Report" (SBR) issued in October 2016 and a "Framework" for the updated plan issued in July 2018 what SWRCB was thinking until the end of 2018.

The 2016 SBR first and foremost acknowledged and documented the Delta's ecological crisis, including a prolonged and precipitous decline in numerous native species, including spring-run and winter-run Chinook salmon, longfin smelt, Delta smelt, and Sacramento splittail. The species declines are attributable to numerous stressors in the ecosystem, including reduced and modified flows, loss of habitat, invasive species, and water pollution. A fact sheet issued by SWRCB stated at the time: "Although the Report acknowledges the importance of addressing non-flow stressors to protect the ecosystem, it focuses on flows, because flows are the direct responsibility of the State Water Board, and because flows are an essential part of restoring healthy ecosystem functions."

The SBR also considered the ecosystem as a whole as SWRCB strived to develop Sacramento River basin "instream flows" (essentially, flow thresholds to serve

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[6] Export operations at Banks Pumping Plant in Byron is the only DWR facility. It primarily affects water levels in river channels of the south Delta (lowering levels below which farmers could divert or pump).

[7] There were methodological problems with the old way of assessing and measuring salinity at points in the three south Delta locations. This provision was not without contention either, however. The concern generally is that by using average conditions, measurement will fail to identify spikes in salinity, giving DWR and USBR an easier time of complying.

potentially as formal flow objectives) that generally resemble or mimic natural flow to which native species adapted in the basin. These would apply to the Sacramento and its major east side tributaries: Feather, Yuba, Bear, and American rivers. It also addressed the need for cold water habitat for spawning adult salmon, as well as hatching and rearing of young wild salmon.

The 2018 Framework floated two new proposed objectives on the Sacramento River system for inflows to the Sacramento and to the Delta as well as "related cold water habitat measures." SWRCB anticipated in 2018 that it would propose unimpaired inflow ranges between 45 to 65 percent of unimpaired flow, with a starting point of 55 percent of unimpaired flow from November through June. This approach is analogous to what SWRCB did on the San Joaquin River flows (range of 30 to 50 percent of UF, with 40 percent the starting target). Like the San Joaquin WQCP, the Sacramento proposal would use adaptive management strategies to determine whether and where the flow sweet spot occurs for ecologically beneficial flows to and through the estuary.

And, like the San Joaquin WQCP (Phase 1), the 2018 Framework "proposed implementation provisions to encourage voluntary agreements to implement the Plan amendments. The difference this time, is that it is only a "Framework" suggesting voluntary agreements, not an adopted plan. This means that the VAs that get negotiated could result in forcing the Sacramento Phase 2 plan to conform to the VAs, rather than the other way around. All involved may see it as more subtle than that, but that would be overall effect. By choosing delay, an opportunity was lost for SWRCB to shape the VAs for the Sacramento River Basin; now, the VAs are much more likely to shape the Sacramento Phase 2 WQCP—as well as opening up the Phase 1 flow objectives to potentially weakened revision.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
1920-1934	Intensely dry period, including worst single dry year in state history to date (1924) and longest dry period to date (1928-1934). The 1928-1934 drought results in runoff from all rivers and streams tributary to the Delta that was less than 60 percent of average flow.
1922-1931	Period of intense state-wide water resource development planning, with submission of the first California state water plan to the Legislature in 1931.
1928	**November:** California voters pass Proposition 7, a constitutional amendment banning waste and unreasonable use, methods of use, and methods of diversion of water statewide by a nearly 4-to-1 margin. The constitutional amendment requires that all uses and diversions must be reasonable, including riparian rights, thereby addressing the issues raised by *Herminghaus.*
1933	**December:** California voters narrowly pass the Central Valley Project Act by a muring of 33,603 votes statewide, authorizing the state to build its first coordinated water system. Because of the Great Depression, however, the state could not finance the project.
1937	The US Bureau of Reclamation (USBR) takes over ownership, design, construction, and operation of the Central Valley Project from the state of California.
1939	US Bureau of Reclamation executes “exchange contracts” with water districts that descend from land monopolist cattle corporation Miller & Lux, settling water rights along San Joaquin River from Friant to Mendota.
1940s	Rapid growth of California wartime industries leads to post-war urban development and population bloom—an already diverse state becomes moreso. USBR completes Shasta Dam on the upper Sacramento River near Redding in 1944. Friant Dam completed on upper San Joaquin River in 1949. **August 1945**—Japan’s surrender to the United States ends World War II. First federal Water Pollution Control Act enacted in the late 1940s in response to rapid growth of many US cities after World War II and growing water pollution problems that resulted.
1951	Central Valley Project initial facilities completed with operation of Tracy Pumping Plant and the Delta-Mendota Canal between Tracy area and Mendota along the San Joaquin River. State Legislature authorizes planning and design of the Feather River Project. **September:** Hundreds of Sacramento Valley water rights holders file protests of a petition by USBR for permits from the state to begin operating the Central Valley Project. This triggers a long period of intense study of the river and its water rights.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
1955	**December:** Intense storms trigger flooding throughout northern and central California, leading to calls for damming of the Feather River.
1951-1959	Congress authorizes and presidents Truman and Eisenhower signed separate bills authorizing additional storage dams on the American River (completed 1956) and Trinity River (completed 1966).
1956	State Legislature creates the modern-day Department of Water Resources (DWR) to centralize coordination of water resource development planning statewide.
1957	Release of Bulletin 3, the California Water Plan.
1959	**May:** Governor Pat Brown signs the Burns-Porter Act, which authorizes design and construction of the State Water Resources Development System, to become known as the State Water Project, and to have bond financing subject to voter approval in November 1960. Governor Brown also signs the 1959 Delta Protection Act, enacting an "area of origins" policy for the Delta that the Delta's water needs shall be met prior to export of any surplus from the Delta elsewhere.
1960	**May:** First Coordinated Operating Agreement executed by USBR and DWR for coordinating operations of the CVP and SWP. **Summer:** State Water Rights Board issues a decision authorizing coordinated operation of the CVP and formally legalizing the dewatering of San Joaquin River between Mendota Pool and the river's confluence with the Merced River, some 40 miles north. **November:** California voters narrowly approve Proposition 1 by 174,000 votes (out of several million cast), containing provisions for bond financing of the State Water Project. **December:** DWR releases a preliminary draft "Bulletin 76" plan presenting alternatives for "Delta Facilities" called for in Proposition 1. It contains neither canals nor tunnels, but offers different configurations of control structures and levees to move surface water through existing Delta channels.
1962	State Water Project begins deliveries to water districts in Santa Clara and Alameda counties via the South Bay Aqueduct.
1963	**June:** Congress passes, and President John F. Kennedy signs, the San Luis Act, authorizing addition of San Luis Dam to the CVP and shared financing of both San Luis Reservoir and the California Aqueduct (a portion of which would be called the San Luis Canal). San Luis Reservoir would be jointly operated by California, but claims to its storage space would be divided between CVP (about 55%) and SWP water contractors (about 45%).

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
1964	USBR releases a proposed design for a Peripheral Canal that would divert water from a point near the Delta town of Hood, southeastward around the Delta to the new SWP pumping plant at Byron and the CVP's Tracy pumping plant.
1964, cont.	USBR also completes settlement contracts with Sacramento Valley water rights holders, paving the way for stable CVP operations along Sacramento River. Congress passes and President Lyndon B. Johnson signs into law the first Wild and Scenic Rivers Act, which places sections of un-dammed and scenic rivers off limits to water resource development (damming or diversion).
1965	Second federal Water Pollution Control Act passed and signed into law by President Johnson. **November 19:** USBR, DWR, and other major water interests, including Delta officials, complete negotiations to establish the first formal water quality criteria (standards) for the Delta.
1967	State water regulation of water rights and water quality control are formally merged into State Water Resources Control Board (SWRCB) in an effort to coordinate water quality protection by controlling water rights usage for that purpose.
1969	National Environmental Policy Act (NEPA) passed by Congress and signed into law by President Nixon.
1970	California Environmental Quality Act (CEQA) passed by State Legislature and signed into law by Governor Reagan. President Nixon establishes the United States Environmental Protection Agency (US EPA) with broad authority to regulate pollutants and contaminants in the environment.
1971	First CEQA case involving water project—a second Los Angeles Aqueduct to divert Owens River water to Los Angeles, in which the city is required to write a credible and authoritative environmental evaluation of the project.
1972	A comprehensive federal Clean Water Act (formerly the Water Pollution Control Act) of 1972 passed by Congress and signed by President Nixon. It is to be administered by the US EPA.
1973	Federal Endangered Species Act passes Congress and signed by President Nixon. Its provisions are administered by the US Fish and Wildlife Service (in the US Department of the Interior) for terrestrial and some aquatic resident species; but migratory species that enter the ocean are protected and ESA programs for them are administered by the National Marine Fisheries Service, part of the US Department of Commerce.
1974	Draft environmental impact report released to the public about the proposed Peripheral Canal project.
1975	CVP and SWP reservoirs both fill from a wet winter.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
1976-1977	Worst two-year drought in recorded state history leaves California with less than 40 percent of average historical runoff to the Delta from Central Valley watershed rivers and streams.
1978	SWRCB adopts the first Water Quality Control Plan (WQCP) for the Delta, and Water Rights Decision 1485 (D-1485), establishing salinity objectives that are largely still in effect today. The SWRCB declined to assign responsibility to any water agencies for meeting the salinity objectives, however. Eight different lawsuits are filed against D-145 and the WQCP, and are soon consolidated into one court case.
1970s	Despite the deep two-year drought, average annual Delta exports of the SWP and CVP came to 3.66 million acre-feet.
1980	SB 200 passed by state Legislature and signed by Governor Jerry Brown, putting a referendum on the proposed Peripheral Canal, two proposed new north state reservoirs (one similar to the proposed Sites project now), and other proposed Delta environmental protections, to be placed on the June 1982 ballot.
1982	**June:** California voters reject Proposition 9 (SB 200 facilities) by a nearly 2 to 1 margin.
1983	An "El Nino" winter generates the wettest water year (1982-1983) in recorded state history. California Supreme Court issues the Mono Lake Decision (*National Audubon Society v. Superior Court*) declaring that the state of California may regulate water right entitlements (including licenses and permits) and use that authority to protect public trust ecological resources of Mono Lake, and that the state, through its regulatory boards like SWRCB, had continuing jurisdiction over water rights permits and licenses to ensure continual protection. The Court cited the Public Trust Doctrine, which has a long history in California and the United States, but also originates in Roman jurisprudence.
1984	SWRCB issues Water Rights Decision 1594 that approves a broad formula for determining river basin flow production for Delta exports, which became the basis for the 1986 Coordinated Operating Agreement between USBR and DWR. Two key formulae, proposed by USBR and DWR and agreed to by SWRCB, address whether unimpaired flows and storage are equal to or greater than Sacramento Valley in-basin uses plus Delta exports. If unimpaired flows are high, SWRCB allows that CVP and SWP may divert, store, and convey flows that may be delivered to south-of-Delta customers.
1986	**February:** After about seven consecutive days of rain, major floods in the Feather River and Yuba River Basins overtop levees in the Yuba City and Marysville region, causing property damage and loss of life.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
1986, cont.	**May:** The D-1485 and 1978 WQCP litigation concludes with 3rd Appellate Court issuing a decision that upholds both the Public Trust Doctrine and the federal Clean Water Act's water quality control planning provisions, and instructs the SWRCB to redo the WQCP to follow federal rules. The California Supreme Court declined to hear appeals of the decision, and it became known as the "Racanelli Decision." Congress authorizes USBR to engage in negotiations with the state of California to determine coordinated operations of the CVP with the SWP, signed by President Reagan. **November:** USBR and DWR complete negotiations on a new Coordinated Operating Agreement for the CVP and SWP relying on defined formulae agreed to in D-1594.
1987-1994	Lengthy water rights hearings held, three different draft WQCPs issued (1988, 1991, 1992) by SWRCB to implement the Racanelli Decision. Longest drought in modern California leaves state with just 56 percent of average Sacramento Valley runoff and 47 percent of average San Joaquin Valley runoff to the Delta from Central Valley watershed rivers and streams. One wet year in 1993 followed by a critically dry year in 1994.
1988	State Legislature adopts the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act, setting as state policy a goal to double production of salmon and steelhead fish in California. **October:** After more than a year of evidentiary hearings into public trust resource and water supply issues, SWRCB issues Draft Bay-Delta WQCP calling for a new "water ethic," new flow objectives for Delta channels, and pre-SWP export rates (but split between CVP and SWP pumps) as a "reasonable interim goal until a safe level of exports is found." After water contractors strenuously object to the draft plan, it is withdrawn.
1987-1989	Despite three consecutive dry water years (1987 through 1989), average annual Delta exports increased to 5.06 million acre-feet.
1991	US EPA, through its federal Clean Water Act (CWA) authority, threatened to reject California's 1991 Bay-Delta WQCP and assume responsibility for regulating Delta water quality to comply with the CWA. Most SWP contractors see zero or near-zero contractual water deliveries due to continuing drought conditions. DWR creates a "Drought Water Bank" and buys water from Yuba County Water Agency's Yuba River sources to sell to south-of-Delta water agencies to somewhat offset their water needs. Metropolitan Water District of Southern California receives just 45,000 acre-feet when its contractual amount exceeds 2 MAF per year.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
1992	**Summer:** With continuing dry conditions in the Central Valley watershed, DWR uses the Drought Water Bank again. **December:** Draft Decision 1630 released by SWRCB to implement 1991 WQCP, and would have included spring and fall pulse flows to benefit salmon in the San Joaquin River, together with spring-time export limits for the CVP and SWP pumps.
1993	**March:** US Fish & Wildlife Service lists the Delta smelt as threatened with extinction under the federal Endangered Species Act (ESA). Delta smelt once numbered several hundred thousand individuals—a schooling fish—as recently as the mid-1980s, but declined dramatically in recent years with advent of coordinated operations since 1973. **April 1:** After the US EPA again threatens to reject Draft D-1630 and take control of regulating Central Valley and Delta waterways itself, then-Governor Pete Wilson orders SWRCB to withdraw the draft decision and start over.
1994	**Summer:** State operates its third Drought Water Bank in four years, allowing Sacramento Valley senior water rights holders to sell surface water to pump large amounts of groundwater to substitute for their surface water supplies. In and around the town of Durham (Butte County), deep agricultural wells went dry, one of three municipal wells was shut down due to contamination, and many residents taps were empty that summer, and well levels fell throughout the northern and central parts of the Valley. **December 1:** DWR and State Water Contractors execute an agreement at Monterey, California, to restructure allocation water within SWP operations. **December 15:** DWR, USBR, state and federal water contractors (urban and agricultural), and some environmental water groups sign the Bay-Delta Accord, an agreement committing stakeholders to ecosystem restoration in the Delta watershed while protecting contractors' Delta export rates. It is to be incorporated into the Bay-Delta WQCP. **December 19:** US Fish and Wildlife Service designates the entire Delta as "critical habitat" for threatened Delta smelt under the ESA.
1995	**May:** SWRCB adopts a revised Bay-Delta WQCP that incorporates the changes called for in the Bay-Delta Accord. The essence of this 1995 WQCP still governs the Delta today. Extensive SWRCB hearings begin to create Water Rights Decision 1641 (D-1641) to implement the 1995 WQCP and the Bay-Delta Accord.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
1995, cont.	Bay Delta Accord also becomes starting point for CalFED Bay-Delta Program (CalFED). CalFED quickly became the most ambitious stakeholder-involved comprehensive planning process for improving Delta conditions in state history, while also attempting to maintain "no net loss to exports." Its scope included scientific research into estuary ecological conditions, Delta levee seismic and flooding evaluations, upstream storage expansion projects, an experimental program to compensate water right holders for providing water for fish ("Environmental Water Account"), increased Delta export pumping, water market transfers, habitat and ecosystem restoration efforts, and identification of Delta "stressors" in water quality and endangered species protection. At its core, Bay-Delta Accord inaugurated a Delta industrial complex largely peopled by stakeholders (including mainstream environmental groups NRDC, EDF, and The Bay Institute), state and federal water and fisheries agencies, academic scientists, and state and federal water contractors (both urban and agricultural). Process continues for five years.
1996	Provisions of the Monterey Agreement are executed into SWP contract amendments by project water contractors with DWR.
1990s	After three years of drought early in this decade, average annual Delta exports still reach 4.68 million acre-feet (MAF), helped by an El Niño wet year in 1998.
2000	**March:** SWRCB adopts D-1641, assigning DWR and USBR responsibility, starting in April 2005 for complying with south Delta salinity standards. **June:** CalFED announces its "Framework for Action" that outlines what actions the state will take from the previous five years of planning effort. **August:** USBR releases the CalFED Record of Decision that outlines actions the federal government intends to take from the CalFED planning process.
2000-2006	Delta exports increase 53 percent in this period over the SWP average of 2.1 MAF in the 1990s. Meanwhile, Delta fish populations, of salmon, striped bass, Delta smelt, and other species collapse, despite runoff in 2006 reaching 173 percent of normal for the Central Valley watershed of the Delta.
2004-2006	**March 2004:** US Fish and Wildlife Service reaffirms need to retain Delta smelt as a threatened species, and considers whether to change its status from threatened to endangered. **2005:** USBR and DWR inform SWRCB that it had to violate D-1641 salinity standards in the south Delta. **2005 and 2006:** National Marine Fisheries Service lists winter-run Chinook salmon and killer whales as endangered, and spring-run Chinook salmon, Central Valley steelhead, green sturgeon and Central Coast steelhead as threatened (along with their critical habitats in the Central Valley watershed) under the federal ESA.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
2004-2006, cont.	**February 2006:** SWRCB adopts Water Rights Order 2006-0006 demanding that USBR and DWR cease and desist from further violations of south Delta salinity standards. SWRCB gives the agencies until July 1, 2009 to demonstrate permanent compliance with the standards, stating that they wound not extend the deadline. SWRCB offers DWR and USBR many options for complying, yet the agencies ignore them in favor of planning permanent operable tidal barriers through the "South Delta Improvement Program."
2006	A very wet year for California from the winter of 2005-2006. **Spring:** California's Third District Appellate Court issues a long and complicated decision by Appellate Justice Ronald Robie addressing issues raised by D-1641, including water quality plan amendment process, appropriateness and application of water quality objectives, and public trust issues. **Summer:** SWRCB does quick update to the 1995 WQCP and D-1641 with no significant changes to the policies and water quality objectives of either. **November:** DWR, USBR, water contractors of CVP and SWP, and mainstream environmental groups enter into a "planning agreement" to write and implement a Bay Delta Conservation Plan (BDCP). The public is not allowed to access their meetings for several years.
2007	Drought conditions return to California for first time since 1994. Runoff falls to 53 percent of normal in 2007. Fisheries scientists publicize a "pelagic organism decline" in the Delta (involving open water species) to a concerned public. SWRCB holds information hearings: Delta fish and other species populations at all levels of the food web plunged dramatically as SWP and CVP Delta water export pumping reached historic record levels. Average Delta exports combined for SWP and CVP from 2000 through 2007 = 6.01 million acre-feet. The collapse is blamed on multiple factors, but including exports, contaminants, and nonnative invasive species. Geologists discover that land subsidence in parts of the San Joaquin Valley has resumed with onset of more intense groundwater pumping during the drought.
2008	Drought conditions continued, though runoff improves to 63 percent of normal. **May:** Pacific Fisheries Management Council closes commercial salmon fishing season for all of 2008 due to poor spawning salmon returns and fear that any fishing might drive the fish to extinction. **September:** DWR establishes and prepares to operate a 2009 Drought Water Bank, including identification of potential water sellers and buyers using the Environmental Water Account impact statement/report to justify it. A coalition of local, statewide, and national environmental groups mount strenuous opposition to the 2009 Drought Water Bank.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
2008, cont.	**December:** US Fish and Wildlife Service releases new Delta smelt biological opinion concerning operations of the SWP and CVP. It recommends seasonal flow and export changes intended to help Delta smelt avoid "jeopardy"—that is, survive, if not recover.
2009	**February:** SWRCB announces it will split the historically holistic Bay-Delta WQCP into two parts—the first addressing San Joaquin River flow and south Delta salinity objectives revision, and the second addressing Sacramento River flow/ water quality objectives and water project operational objectives (such as export/ inflow ratio, Delta Cross Channel closures). **September:** Amid continuing drought fears for 2010, Governor Schwarzenegger calls extraordinary session of the Legislature in September to seek passage of a package of bills intended to "fix the Delta." This effort fails. **November:** After Schwarzenegger calls a second extra session, the Legislature finally passes three new laws which the governor signs: The Delta Reform Act of 2009, another addressing urban and agricultural water conservation, and a third creating a groundwater monitoring system.
2010	**January through March:** Delta Reform Act required SWRCB to convene a Delta flow criteria hearing to determine Delta inflows and outflows needed to recover endangered and threatened fish species. The criteria are intended only for informational use. **July to August:** SWRCB releases and approves its Delta Flow Criteria Report acknowledging that its for informational and not regulatory purposes. Nonetheless, it states that restorative flows benefiting fish for the Sacramento River would be at least 75 percent of unimpaired flows from November through June; on the San Joaquin at least 60 percent of unimpaired flows from February through June, and for Delta outflow at least 75 percent of unimpaired flow from January through June. **October:** SWRCB releases its first scientific basis report for San Joaquin River flow and South Delta salinity objectives WQCP process.
2011	A REALLY WET YEAR FOR CALIFORNIA. Combined Delta exports for the CVP and SWP exceed 6.6 million acre-feet, a new record. North state reservoirs fill.
2012	Governor Jerry Brown announces that long-awaited BDCP conveyance infrastructure should be two tunnel bores under the Delta from near Courtland to Clifton Court Forebay, saying he wants to "get shit done." Dry conditions set in throughout California. They will last five years. Growers increasingly plant almond orchards to capitalize on a booming export market to Asia, made possible by economic sanctions imposed by the western world on Iran, once a major producer of almonds, for Iran's efforts to develop nuclear weapons and nuclear energy.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
2012-2015	Worst drought cumulatively in California modern history. SWP & CVP nearly drain north state reservoirs (Shasta, Oroville, Folsom, New Melones) over first three years (2012-2014) for delivery to southern California reservoirs and San Luis Reservoir in San Joaquin Valley.
2013	BDCP Draft EIR/EIS released by DWR with 7.5 month review period because the report (plus appendices) is 40,000 pages long. SWRCB releases an environmental impact document on the San Joaquin River/ South Delta WQCP before focusing on increasing drought emergency responses. It is nearly universally panned. USEPA Region IX in San Francisco comments that "proposed [San Joaquin River] flows do not appear to be substantially different from existing flows," and that they may be "too low to provide essential ecological functions." The agency also commented that SWRCB proposed flows are significantly lower that such flows adopted elsewhere in the United States and internationally, and that its analysis of South Delta salinity impacts was inadequate.
2014	**January:** This January goes down as driest January on record, ending a rainless period of 14 months from December 2012 through January 2014.USBR and DWR file petitions for "temporary urgency changes" to their water rights' conditions (based in D-1641) concerning Delta export levels and salinity objectives. Over the next few months, SWRCB grants several of their waiver requests, allowing tidal flows to encroach further into the Delta for the sake of protecting cold water remaining upstream in reservoirs needed for later in the year for returning salmon using river gravels to spawn. (Cold water essential to preserving and protecting eggs and young salmon alevins.) **May:** Restore the Delta, Environmental Justice Coalition for Water, and several other Stockton-based communities of color send letter to DWR criticizing DWR's handling of environmental justice issues in its BDCP Draft EIR/EIS. **July:** Comments on the BDCP Draft EIR/EIS overwhelm DWR and force the department to modify the project over the coming winter.
2015	**January:** USBR and DWR again file petitions for "temporary urgency changes" in anticipation of conditions continuing dry in 2015. SWRCB again grants them, overlooking the rapid drawdown of north state reservoirs for pumping today **April:** DWR announces it is splitting the tunnels project away from habitat restoration, renaming it "California WaterFix," while renaming the habitat portion of BDCP "EcoRestore." **June:** DWR releases a supplemental Draft EIR/EIS for California WaterFix. Another review period of four months is triggered.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
2015, cont.	**October:** DWR and USBR submit petitions to make changes to their existing Delta points of diversion for the SWP and CVP to incorporate north Delta diversions between Courtland and Walnut Grove along the Sacramento River. Public comments on the supplemental Draft EIR/EIS due. Combined Delta exports by SWP and CVP through the first three years come to just an average of 2.276 MAF. Average deliveries during the drought were 1.257 MAF for the SWP and 1.02 MAF for the CVP.
2015-2018	CWF Change Petition Hearing proceedings last 24 months, from October 2015 through September 2018.
2016	Winter rains return to California. Hopes are to refill seriously depleted reservoirs after four consecutive critically dry years. **January:** Evidentiary hearings before the SWRCB open on the California WaterFix change petitions from DWR and CVP. Restore the Delta and Environmental Justice Coalition for Water submit prehearing conference letters insisting that environmental justice issues be part of the scope of the hearings. SWRCB accepts this request. It is the first time a water right change petition proceeding has allowed environmental justice issues as part of the scope. **September 19:** Governor Jerry Brown initiates voluntary agreements to address Delta flows by sending a letter to SWRCB Chair Felicia Marcus urging the Board to "move quickly to complete the remainder of the analysis on the Sacramento River basin." He added that he directed the state Natural Resources Agency to "explore the potential for a comprehensive agreement on environmental flows in both the San Joaquin and Sacramento River basins." **December 8:** RTD presents its groundbreaking environmental justice case against the California WaterFix Change Petition to the SWRCB. **December 16:** RTD and dozens of other members of the public presented their views at an SWRCB hearing on the San Joaquin River/South Delta WQCP in Stockton Civic Auditorium. **December 22:** SWRCB Chair Marcus responds to Governor Brown, stating that Board efforts in the two river basins "are designed to carry out the board's statutory mandate, but also to accommodate voluntary agreements that reasonably protect beneficial uses, improve flows, and restore habitat….Board Members and staff recognize that sufficiently protective voluntary agreements can reduce uncertainty, be more durable, and be implemented more quickly than traditional regulatory processes." But she informed the governor that there was a definite need to extend the comment period, because it may "create positive opportunities for engagement and negotiation. In the end, though," she wrote, "the State Water Board will use its authorities in 2017 to accelerate improvements in the Delta ecosystem and its tributaries.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
2017	**February:** Adding to an already wet winter in 2016-2017, a warm atmospheric river strikes northern California, melting snowpack and generating high flows throughout Central Valley watershed. High runoff on the Feather River causes DWR to open Oroville Dam spillway. On February 7, parts of the aging spillway crater and are eroded, destroying the spillway and cutting down into bedroom of the hillside supporting it, adjacent to Oroville Dam. An attempt to use the "emergency spillway"—a brush-covered hillside—results in still more erosion. By afternoon of Sunday, February 13, emergency officials in Butte County declare an emergency evacuation from the city of Oroville and surrounding Sacramento Valley communities. California WaterFix proceedings are delayed while DWR responds and regroups. **Summer:** SWRCB releases a revised environmental report on the San Joaquin River/South Delta objectives of the Bay-Delta WQCP. **October:** SWRCB releases a "scientific basis report" for new and modified Sacramento River inflows and its eastside tributaries to the Delta. **December:** Trump Administration's Department of the Interior announces its intent to maximize Delta exports for benefit of CVP contractors south of the Delta.
2018	**July:** SWRCB releases final Bay-Delta WQCP and a Sacramento River scientific basis report for public review and comment, coinciding with last few months of WaterFix Petition hearing. **August:** Remembering how, during the 2013-2015 years of drought, SWP received greater water supplies south of the Delta than did CVP, Trump Administration threatens changes to legal and administrative rules to increase Delta exports to south-of Delta CVP contractors. **November:** California voters elect former lieutenant governor and San Francisco mayor Gavin Newsom governor of the state. During his campaign he indicated support for a single tunnel option and did not like the cost of California WaterFix. **December 12:** SWRCB, after several long public hearings and delays since August, adopts its San Joaquin River flow/South Delta salinity WQCP. Board members agreed to encourage negotiation of voluntary settlement agreements and to delay release of the draft environmental report on its Sacramento River flow objectives in the meantime. Also on December 12, DWR and USBR announce an "addendum" to the 1986 Coordinated Operating Agreement that increases the CVP's share of Delta water exports at the expense of DWR's during times "excess conditions" (that is, sources of water greater than expected uses) as well as during droughts. While publicly unacknowledged by state and federal water officials, it represents a defeat for SWP customers. This, and the onset of voluntary agreement negotiations is the context for how the future of Delta flows and water quality will be decided.

Year	A Century of Events in California Hydrology, Water Projects, and Water Quality Planning
2019	**May:** Governor Newsom orders his Department of Water Resources to withdraw all California WaterFix litigation and change petitions, essentially pronouncing it dead. Newsom also announced that his Natural Resources Agency would assemble a "water resilience portfolio." The portfolio would support continuing negotiations toward voluntary agreements among water right holders on the San Joaquin and Sacramento rivers in lieu of having the SWRCB consider and adopt new Sacramento River flow objectives. In sum, Newsom has continued the tacit suspension of state and federal water quality control planning processes established in law.
2020	February: State officials announce a "framework" for Voluntary Agreements that appears to raise more questions than answers as to how Sacramento River-related WQCP amendments will be handled by all parties, including State Water Board.