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Improving California's Water Market

How Water Trading and Banking Can Support Groundwater Management

Technical Appendix B. California's Water Market, By the Numbers: Update 2021

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This appendix serves as an update to the data on surface water trading and groundwater banking provided in the PPIC publication, [California’s Water Market, By the Numbers: Update 2012](#) (Hanak and Stryjewski 2012). In each section, we describe data sources and methods and present summary statistics.

Surface Water Market Trends

This section provides statistics for California’s surface water market for the years 1982–2019, using data collected from various public agency, media, and academic sources.¹

Data Collection

Below, we describe our data collection process, the types of transactions included, and other caveats to interpreting the data.

Included Data Sources

We drew upon a wide range of available sources. Transfers from three large water projects constitute the bulk of the records: (1) the State Water Project (SWP), provided by the Department of Water Resources (DWR), (2) the Central Valley Project (CVP), provided by the US Bureau of Reclamation (USBR), and (3) the Colorado River project, also provided by USBR. Recent years also include (relatively small) traded water volumes within USBR’s Klamath Project. We also consulted National Environmental Policy Act (NEPA) environmental assessment documents, and the State Water Board’s [Temporary Urgency Action](#) orders and [Water Transfers](#) database to locate transactions that may not have been included in the aforementioned sources. Environmental transfers come from DWR, USBR’s Water Acquisitions Program, CALFED’s Environmental Water Account program, and the State Water Board’s online database of [§1707 permits](#) for instream flow dedications.² When traded volumes were not available in public documentation on approved transfers, we contacted water agencies individually to obtain the information.

For transactions that do not require approval from the state and federal agencies listed above, several other sources provided useful information. Lund et al. (1992) was a source for early years. Until the end of its publication in 2010, *The Water Strategist* (formerly the *Water Intelligence Monthly*)—which tracked water markets in 14 western states—provided useful leads on “open market” transfers involving entities other than those in the CVP, SWP, or Colorado River project. We verified these transactions wherever possible through Internet searches and phone contacts with participating agencies. Potential and finalized water deals were also obtained from a variety of local news sources, as reported in DWR’s California Water News service and other water news aggregators.

Because there are often discrepancies between intended transactions and what ultimately occurs, we conducted an intensive cross-checking exercise, comparing sources and contacting the relevant water agencies in the event of questions. For some periods, we also had access to the transfer records of some large water districts active in water trading and banking: the Metropolitan Water District of Southern California (MWD), Westlands Water District, Kern County Water Agency, Yuba Water Agency, and the Glenn-Colusa Irrigation District.

¹ Below we also summarize recent volumes of groundwater trading in four adjudicated basins; these trades are not included in the tables and figures on surface water trading.

² CALFED was a joint federal-state program for environmental water management in the Sacramento–San Joaquin Delta in the 2000s.

We sought to retain only the transfers that were actually approved and carried out, in the amounts transferred from the point of origin, on a calendar year basis. Several adjustments are worth noting:

- **Adjustments for carriage losses.** Purchasing entities often receive smaller volumes of water than the volumes they purchase because of spillage and carriage water losses, especially for transfers that move through the Delta. In cases where we only obtained the traded volumes delivered for transfers that moved through the Delta, we assumed an average 22 percent loss and added this to the volume sold.
- **Dry-year options.** As described in Hanak and Stryjewski (2012), in several years there has been a market for short-term “options” trades, where potential sellers commit to transfer water in exchange for a small up-front payment and additional installments at successive call dates. The temporary transfer data here include volumes actually sold, not the additional amounts for which the options were not exercised.
- **Data updates.** Tracking agencies sometimes update water transfer data records in subsequent years, as part of final accounting. When there was a volume discrepancy, we used the most recent numbers. For this reason, the numbers presented here may differ from PPIC’s previous publications [California’s Water Market, By the Numbers: Update 2012](#), and [California’s Water Market—Just the Facts](#) (2019).
- **Resolving discrepancies between sources.** When there was a discrepancy between the state or federal agency records and those of a transacting party, we reached out to parties to understand the details. When in doubt, we used the most recent numbers from the state or federal agency that was conveying the water.

Types of Included Transactions

In this section, we detail the types of transfers included in our database based on duration, as well as other contract characteristics that are relevant for some transfers.

Transactions by Duration. The data focus on annual flows from transactions categorized under four types of duration: temporary or short-term transfers (leases of one year or less), “deferred exchanges” (described below), long-term transfers (leases of two years or more), and permanent transfers (sales of water rights or contract entitlements).

- **Short-term transfers.** These transfers consist of leases of one year or less, within a calendar year (January–December) or water year (October–September).³ To speed the yearly approval process, annual transfers among contractors under the CVP’s Accelerated Water Transfers Program (AWTP)—a program launched in the early 1990s to facilitate within-CVP transfers—have had five-year programmatic permits since the early 2010s. Here we still treat these transfers as temporary, because they still take place annually and do not involve multi-year commitments between any individual selling and buying parties.
- **Deferred exchanges.** We refer to arrangements in which water is returned after one year or longer as “deferred exchanges.” While temporary transfers typically involve a one-way movement of water for monetary compensation, deferred exchanges refer to a promise that the buyer will return water to the seller at a later date, often in exchange for compensation as well. These agreements often contain some flexibility regarding the year of water repayment to allow for uncertain hydrologic conditions. Deferred exchanges have been most commonly used among SWP contractors, as project operating rules have often made these preferable to outright transfers.⁴ In the data presented below, most of these transactions are counted as short-term transfers. The exceptions are agreements involving repeated transfers over multiple years; these are counted as long-term transfers.
- **Long-term transfers.** Long-term transfers are leasing arrangements where two or more parties agree on the annual transfer of a predetermined volume for at least two years. (Durations generally range between five years to as many as 110 years.) Table B10 includes all long-term transfers in our dataset.

³ Although our discussion of the water market in the main report often uses the general term “sale” to refer to temporary or long-term transfers of water, duration-limited transactions technically involve a lease rather than a sale of the water right or contract.

⁴ As described in the main report, the “[Water Supply Contract Amendments for Water Management](#)”—which most SWP contractor boards have now approved—will increase the flexibility of water transfers and exchanges, and will likely reduce the use of deferred exchanges in favor of transfers without a return obligation.

- **Permanent transfers.** This category includes permanent sales of water rights and contract reassignments. Permanent sales are relatively uncommon in California. More common (but still infrequent) are contract reassignments, where a water contractor with the CVP or the SWP transfers its entitlement to another user. (In these cases, the new contract holder has a long-term contract for water delivery from the project, and the water right is still held by the project.). Table B9 lists all permanent transfers included in our dataset.

A couple of caveats apply to the data reported on transfers of different durations:

- **Flows versus commitments for long-term and permanent transfers.** For both long-term and permanent transfers, there is a difference between the total commitment (the maximum contractual obligation) and actual flows transferred in any given year. These flows are often below the contractual maximum, depending on the seller’s water supply conditions.⁵ In some cases, contracts also foresee raising the amount of water transferred over time to allow for the completion of investments such as canal lining or other factors.⁶ In general, we sought to track flows by obtaining actual delivery amounts for long-term transfers from the contracting parties or the agency overseeing conveyance.⁷ For permanent contract reassignments, we estimated flows based on annual SWP allocations from the SWP Analysis Office and CVP allocations from USBR news releases.⁸ For permanent transfers of non-project water, we assumed that the full amount of the water right is transferred annually; this could overestimate flows in very dry years.⁹
- **Potential underestimation of flows under long-term agreements and overestimation of short-term trades.** As shown below, long-term transfers have been increasing as a share of total volumes traded, especially since the early 2000s. This trend is widespread and includes transfer agreements within the three major water projects as well as non-project water. Within the CVP, however, the available datasets do not track flows under long-term agreements separately, and annual CVP transfer data records do not distinguish by transfer duration. And since many long-term transfer agreements are now umbrella agreements involving multiple buyers and sellers, it is not straightforward to identify annual flows by matching up the transacting parties; annual flows often involve transfers between specific transacting parties within the broader trading groups. We have made every effort to match up the records, but it is still likely that we are undercounting the flows under long-term CVP transfers (and correspondingly overcounting the short-term transfers).¹⁰ This also would result in overcounting the gap between volumes committed and traded under long-term transfers.

Other Contract Characteristics. Some less common contracting arrangements required special treatment. These arrangements include water transfers through banks and pools, transfers with multiple buyers or sellers, and unbalanced exchanges.

- **Water transfers through banks and pools.** Water banks and pools are transfer arrangements where sellers and buyers work through an intermediary, who purchases water and makes it available for sale to other parties. The bank and pool transactions in the database include several run by DWR: (1) drought water

⁵ In dry years, many long-term transfer agreements reduce deliveries in tandem with reductions in the seller’s own supplies. Yet in at least two long-term agreements that focus on drought deliveries, the reverse is true (Yuba Accord transfers to CVP and SWP contractors, and Palo Verde Irrigation District transfers to the Metropolitan Water District of Southern California).

⁶ This is the case for several of the transfers of Colorado River water under the Quantification Settlement Agreement, which took some years to ramp up.

⁷ In a few cases where we could not confirm the annual volumes transferred, we assumed that the full contractual obligation was transferred. This primarily concerns transfers of water from senior water rights-holders, particularly to municipal agencies, for a total of under 10,000 af.

⁸ For example, annual flows for a permanent transfer from Mercy Springs Water District (a CVP contractor in Fresno County) might range from 100 percent of the contract amount in a relatively wet year like 2006 (when CVP contractors received their full contract amounts) to 10 percent in a dry year like 2009 (when CVP contractors south of the Delta received only 10 percent of their contract amounts).

⁹ Although these transfers tend to involve very senior water rights that have high reliability, this assumption may overstate annual flows under permanent transfers in very dry years.

¹⁰ It is also possible that our records are missing some small early long-term CVP transfer agreements, since one important data source—NEPA documents available on USBR’s website—only goes back to the mid-2000s. Larger agreements would have been picked up in water-related media accounts.

banks operated in the early 1990s and again in the 2000s,¹¹ (2) the SWP “turnback” pool,¹² and the SWP multiyear demonstration pool.¹³ Within the CVP, pools have also been run among contractors within the Sacramento Valley. To avoid double-counting these transfers, the tables below include either bank/pool purchases or sales, depending on the purpose of the calculation. When looking at the end use of transfers (e.g., Table B3-B), we include bank/pool sales, which provide information on the water’s final destination. Conversely, when interested in total volumes sold or the source region of water, we include bank/pool purchases (e.g., Tables B6 and B7). In some years, the total volume sold to a bank/pool may differ from the total purchased by other users; the most notable example is DWR’s 1991 drought water bank, which acquired several hundred thousand acre-feet more water than it sold.

- **Transfers with multiple sellers or buyers.** Particularly for long-term transfers, agreements are increasingly made among groups of sellers or buyers rather than between individual water agencies. This can include groups spanning multiple counties and types of members (for instance, the San Luis & Delta–Mendota Water Authority has members in several counties and two regions, with a mix of agricultural and municipal water agencies). Where possible, we sought to determine the volumes sold or purchased in any given year by each entity within these groups. When this was not possible, the transfers were assigned more general attributes of the group as a whole (for instance, groups with both agricultural and municipal members are classified as “mixed purpose”; groups that span more than one region are not assigned county-specific geographic attributes).
- **Unbalanced exchanges.** We identified some unbalanced same-year exchanges in recent years. These transactions typically use a 1:2 ratio and involve exchanges of different types of water (e.g., the buyer receives a certain volume of recycled water in exchange for a lesser amount of river water); most are for purposes of augmenting environmental flows. We entered such unbalanced exchanges with the net traded volume as the delivered amount. For example, if an unbalanced exchange states that A will provide 6,000 acre-feet (af) for 3,000 af from B in return, we entered the traded volume as 3,000 af with A as the seller and B as the buyer.

Omitted Transactions

Our dataset does not include several types of transactions, omitted either in the interest of consistency or due to limitations around data availability. This includes: short-term exchanges for operational purposes, exchanges with intermediary districts, Section 1707 permits for environmental water that are part of regulatory or quasi-regulatory proceedings, transactions within certain user groups, and groundwater transfers within adjudicated basins.

- **Short-term exchanges for operational purposes.** These are same-year exchanges of water among users, generally done for purposes of timing or technical convenience. They are usually of a balanced nature, meaning that the volume exchanged by all parties is the same (1:1 ratio). These include, for example, frequent exchanges between the San Benito Water District and the Santa Clara Valley Water District, which temporarily use some of each other’s water to gain flexibility. This practice is also common among the members of the Friant Unit of the Central Valley Project.¹⁴
- **Exchanges with intermediary districts.** Some transfers are accomplished with the assistance of an intermediary district that shares infrastructure with both the seller and buyer; the intermediary receives water from the seller and releases the same amount of water to the buyer. Although transfer approval records typically include these intermediate transactions, our dataset focuses on transfers between the

¹¹ With these banks, DWR purchased water from various parties in the Sacramento Valley and Delta and made it available for purchase by other parties, mainly in the Bay Area, San Joaquin Valley, and Southern California. This use of the term “bank” is distinct from the concept of “groundwater banking”—a type of underground storage discussed later in this appendix.

¹² This trading pool among SWP contractors was established by the Monterey Agreement in 1994; it allows partial compensation for unused contract amounts made available to other SWP contractors.

¹³ This pilot program enabled SWP contractors to commit to future sales to and purchases from the SWP pool while providing timing flexibility.

¹⁴ In one of our old reports on water market trends, we made adjustments for missing or very low trades between contractors within the Friant Water Users Authority in some years in the 1980s and early 1990s (Hanak 2002). In our subsequent data updates, we have opted not to make those adjustments. Years with no trading activity recorded for this group include 1982–86, 1988–90, and 1993. Friant area trades are unusually high relative to trends (220,000 af) in 1999.

original seller and the buyer, and excludes these intermediary transactions wherever possible. This helps avoid double-counting of volumes sold, and facilitates analysis of trading trends between primary transferring parties.

- **Section 1707 permits that are part of regulatory or quasi-regulatory proceedings.** For instance, we excluded the 35-year permit for instream flows of up to 4.4 million acre-feet per year (afy) from South Sutter Irrigation District and Camp Far West Irrigation District down the Feather River. This change in use was made to meet requirements of the 1995 Bay Delta Plan’s water quality objectives and is therefore not a strictly voluntary water transfer. Similarly, we excluded the flows released as part of the San Joaquin River settlement in the mid-2000s.
- **Transactions within certain user groups.** Our dataset focuses on transfers between parties within different water agencies. To maintain consistency, we exclude transfers within certain user groups that are not picked up systematically by our data sources. This includes transfers among members of wholesale service networks or water management associations. For instance, there is significant local trading—as much as 100,000 af per year—among the local members of the Kern County Water Agency, which holds a large SWP contract. As another example, trading within the Kings River Water Association, a 28-member group that shares water rights on the Kings River, can amount to as much as 20,000 af in some water years. We also exclude trades within the same irrigation district, which are difficult to track, but which can be substantial in some cases.¹⁵ Although many of these transfers resemble temporary exchanges, where water is returned in the same year it is taken, some entail net increases in supplies to the purchasing parties.
- **Adjudicated groundwater basins.** Although our dataset focuses on the state’s surface water market, it is worth noting that some adjudicated basins have active groundwater markets among rights-holders. Here we summarize trading activity in the four Southern California basins where trading is most significant: Mojave, Chino, San Gabriel, and Central basins.¹⁶ The state’s most liquid groundwater market is in the Mojave Basin (described in more detail in Technical Appendix C to this report). Hundreds of trades take place each year there, and roughly 30,000 af per year have been traded annually in recent years (Technical Appendix C, Figure C2). In the Chino Basin, there were an average of seven transfers per year from 2016–2020, averaging roughly 13,000 af/year. Within the San Gabriel Basin recent trading has been in the range of 20,000 to 25,000 af/year, with about 40 transactions annually. Central Basin trading involves 15 to 20 trades annually of about 10,000 af/year. In all four basins, most trading involves the sale of annual pumping rights on the spot market, but some permanent transfers of pumping rights also occur.

Categorizing Sectors and Locations of Trading Parties

The dataset seeks to categorize each transfer by the sector of the seller and buyer, as well as their location. This entailed some simplifications.

- **Traders’ sectors.** We classify water trades into four broad sectors: agriculture, urban, mixed, and environment. Because the specific purpose of a trade is not always known, we generally rely on the primary purpose of the trading party. For example, if less than 5 percent of an irrigation district’s total water served to its customers is dedicated to municipal and industrial uses, we consider the district’s sector to be agriculture, and assume that the purpose of a water purchase would be for agriculture. The exception would be if transfer documents state that water purchased by this district is for municipal use, in which case we entered that purpose. “Mixed purpose” denotes purchases by agencies with significant urban and agricultural uses (usually more than 5% of total water served), such as the Coachella Valley Water District and the San Luis & Delta-Mendota Water Authority. Environmental users mostly consist of state or federal

¹⁵ For example, in the Westlands Water District, one of the state’s largest, UC Berkeley researchers estimated that internal transactions amounted to 300,000 to 400,000 af per year in the mid-1990s, or about one third of the district’s total water supplies (Sunding 2000). Although most of these transfers were to lands held by different members within the same management group, some were to other farms.

¹⁶ Information on the Mojave basin is from its watermaster, as described further in Technical Appendix C. Information on the Chino, San Gabriel and Central basins was provided for the years 2016–2020 by Westwater Research. Trading information for all four basins is included in the [Nasdaq-Veles California water price index](#), along with surface water trades throughout the state.

wildlife agencies and individual refuges. Transfers for agricultural or urban use that provide secondary instream flow benefits are not counted as purchases for the environment.

- **Traders' locations.** We categorized the location of sellers and buyers by (1) counties and (2) regions that they serve. Some simplifications were necessary to handle special cases:
 - **County information.** When we could not identify the county that a trader serves, we classified them as “unspecified.” This includes a handful of historical transfers for which geographic information about the trader was missing; such entries have neither a county nor a regional attribute. It also includes large buyer or seller groups whose collective service area spans multiple counties (described above). These transfers are assigned regional identifiers. A primary county was assigned to water districts that serve more than one county. This practice may have resulted in an underestimation of within-county transfers (and a corresponding overestimation of within-region transfers). For example Glenn-Colusa ID (GCID), which serves both Glenn and Colusa counties, was assigned to Glenn County. The transfers that occurred between GCID and another party in Colusa County would be counted under the within-region category.
 - **Regional information.** We generally assigned traders to regions based on their county information.¹⁷ The regions included in our categorization are the Central Coast, the Far North, Sacramento Valley, San Francisco Bay Area, San Joaquin Valley, and Southern California. Although these roughly approximate California’s main hydrologic regions, we made some simplifications to follow county boundaries.¹⁸
 - **Environmental water purchases.** For these purchases, we generally track the location of the seller and the purpose of the acquisition (e.g., type of environmental use), but not the specific location (e.g., county) where the water is used. Although some of these trades—for instance to wildlife refuges—are very location-specific, many environmental water acquisitions have been intended for use within the larger region, or even adjacent regions.

Surface Water Transfers between 1982 and 2019

Below we present trends in surface water transfers by various characteristics: duration, type of market (within or outside the main water projects), sector of origin and destination, environmental water purchases, and various geographic breakdowns of origin and destination. We also provide detailed lists of long-term and permanent transfer agreements in our records. In all cases, we present estimates of total volumes traded (including flows under long-term and permanent agreements); for some breakdowns, we also display total volumes committed under these agreements. In addition to annual values, we present some results by four periods:¹⁹

1. 1987–1994 (the period when the market took off, corresponding to a prolonged drought and increased state purchases);
2. 1995–2002 (a relatively wet period that saw continued market growth, facilitated by changes in the CVP and SWP trading rules and new environmental water purchase programs);
3. 2003–2011 (a period marked by a shift toward long-term transfers, including large transfers of Colorado River water under the Quantification Settlement Agreement); and

¹⁷ For some cases of group trades spanning multiple counties, we assigned the region even when no county was assigned.

¹⁸ Far North includes Humboldt, Lassen, Shasta, Siskiyou, and Trinity; Sacramento Valley includes Butte, Colusa, El Dorado, Glenn, Lake, Placer, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba; San Joaquin Valley includes Calaveras, Fresno, Kern, Kings, Madera, Merced, San Benito, San Joaquin, Stanislaus, and Tulare; San Francisco Bay Area includes Alameda, Contra Costa, Marin, Napa, San Francisco, Santa Clara, Solano, and Sonoma; Central Coast includes Monterey, San Luis Obispo, and Santa Barbara; Southern California includes Imperial, Los Angeles, Riverside, San Bernardino, San Diego, and Ventura. This list excludes counties that do not appear in our dataset. In some cases, this is because no trades were registered for entities in these counties (e.g., Santa Cruz). In others, counties may not appear even though they participated in trading through a multi-county agency, if we considered the agency’s primary county to be elsewhere (e.g., Orange County is part of the MWD service area).

¹⁹ See Hanak and Stryjewski (2012) for further description of the first three periods.

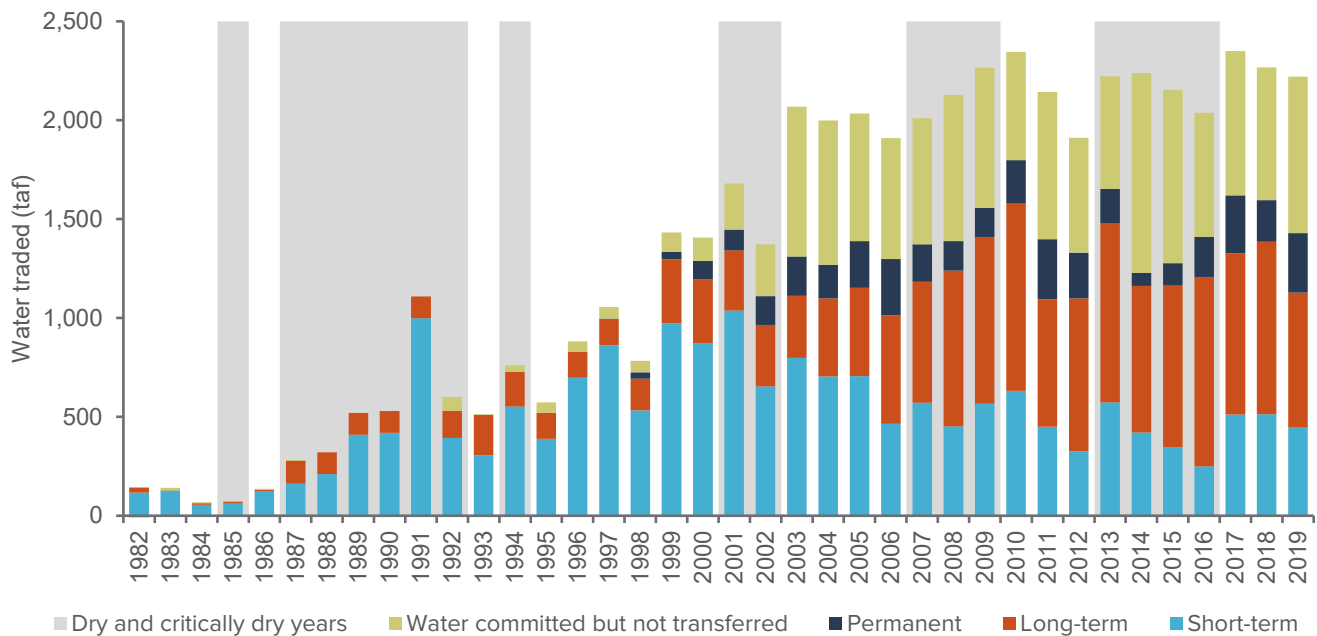
4. 2012–2019 (the most recent period, marked by another prolonged drought, continued expansion of long-term agreements, and a decline in environmental water acquisition programs).

Trends by Duration

California’s surface water market has been evolving since the early 1980s (Figure B1, Table B1). The market grew substantially during the 1987–1992 drought, reflecting significant state purchases and the establishment of a state-run drought water bank. Although short-term transfers were most common in earlier years, long-term agreements have become more common as the market matured. These arrangements require more up-front work to gain approvals but provide more predictability for trading parties. Permanent sales are still not common. The volume of water they make available annually varies with the seniority of the water rights and hydrological and regulatory conditions.

FIGURE B1

Since the early 2000s, long-term transfers have become more common and short-term transfer volumes have declined



SOURCE: PPIC water transfers dataset. See Table B1 for annual data.

NOTES: “Water committed but not transferred” equals commitments under long-term and permanent contracts that were committed but not sold in that year (in 2019, nearly 800,000 af). Dry years are those classified as dry or critically dry for the Sacramento Valley. Although 2016 was a below-normal year, it is also shown as a dry year because it came on the heels of multiple dry years. Volumes are in thousands of acre-feet (taf).

TABLE B1

Water transfers in California by transfer duration (acre-feet)

Year	Total commitments	Total volume traded	Short-term flows	Long-term flows	Permanent flows	Additional committed under long-term transfers	Additional committed under permanent transfers	Sacramento Valley 40-30-30 index	Year type
1982	129,851	142,314	117,157	25,157	-	*(12,463)	-	12.76	Wet
1983	141,604	128,830	128,225	605	-	12,774	-	15.29	Wet
1984	68,442	63,848	55,063	8,785	-	4,594	-	10	Wet
1985	74,045	71,238	61,351	9,887	-	2,807	-	6.47	Dry
1986	135,851	131,526	125,279	6,247	-	4,325	-	9.96	Wet
1987	282,544	278,143	161,972	116,171	-	4,401	-	5.86	Dry
1988	320,872	320,872	210,872	110,000	-	-	-	4.65	Critical
1989	519,122	519,122	409,122	110,000	-	-	-	6.13	Dry
1990	530,128	530,128	420,128	110,000	-	-	-	4.81	Critical
1991	1,108,610	1,108,610	998,610	110,000	-	-	-	4.21	Critical
1992	600,851	531,759	393,351	138,408	-	69,092	-	4.06	Critical
1993	514,107	510,272	306,607	203,665	-	3,835	-	8.54	Above normal
1994	760,095	728,397	552,595	175,802	-	31,698	-	5.02	Critical
1995	573,154	520,726	389,454	131,272	-	52,428	-	12.89	Wet
1996	881,558	829,992	697,858	132,134	-	51,566	-	10.26	Wet
1997	1,055,616	996,343	861,047	134,427	869	59,273	-	10.82	Wet
1998	784,225	725,447	533,356	159,922	32,169	58,778	-	13.31	Wet
1999	1,432,162	1,332,967	972,533	323,883	36,551	97,317	1,878	9.8	Wet
2000	1,407,091	1,288,620	870,322	324,260	94,038	107,080	11,391	8.94	Above normal
2001	1,679,653	1,446,270	1,038,130	304,110	104,030	155,230	78,153	5.76	Dry
2002	1,373,176	1,109,703	653,582	310,693	145,428	223,647	39,826	6.35	Dry
2003	2,067,893	1,310,956	797,775	313,712	199,469	737,935	19,002	8.21	Above normal
2004	1,999,092	1,268,985	703,789	395,224	169,972	669,208	60,899	7.51	Below normal
2005	2,034,350	1,388,671	705,520	446,926	236,225	622,633	23,046	8.49	Above normal
2006	1,910,212	1,298,372	464,476	548,719	285,177	609,840	2,000	13.2	Wet

Year	Total commitments	Total volume traded	Short-term flows	Long-term flows	Permanent flows	Additional committed under long-term transfers	Additional committed under permanent transfers	Sacramento Valley 40-30-30 index	Year type
2007	2,010,102	1,372,950	570,976	611,612	190,361	540,162	96,991	6.19	Dry
2008	2,127,781	1,389,205	451,689	788,527	148,990	575,060	163,515	5.16	Critical
2009	2,265,056	1,557,097	566,312	843,754	147,031	528,369	179,591	5.75	Dry
2010	2,345,159	1,797,837	630,878	946,722	220,238	408,624	138,697	7.08	Below normal
2011	2,145,413	1,399,664	450,234	643,195	304,236	689,648	55,600	10.54	Wet
2012	1,913,339	1,331,350	326,034	772,486	231,205	434,977	146,137	6.89	Below normal
2013	2,222,549	1,653,910	573,243	904,644	175,147	362,819	204,195	5.83	Dry
2014	2,237,600	1,228,482	420,500	742,413	65,569	689,200	317,418	4.08	Critical
2015	2,154,103	1,278,307	346,978	817,129	113,699	597,484	276,313	4.1	Critical
2016	2,038,080	1,411,098	250,095	957,129	202,749	438,344	187,263	7.1	Below normal
2017	2,351,750	1,622,422	512,264	814,807	293,852	629,166	99,161	14.9	Wet
2018	2,269,025	1,596,741	513,217	872,888	209,760	487,406	183,253	7.2	Below normal
2019	2,222,834	1,430,388	444,847	682,799	300,868	699,675	92,145	10.2	Wet
Total	50,687,095	37,651,562	18,685,441	15,048,114	3,907,633	10,646,932	2,376,474		

SOURCE: PPIC water transfers dataset.

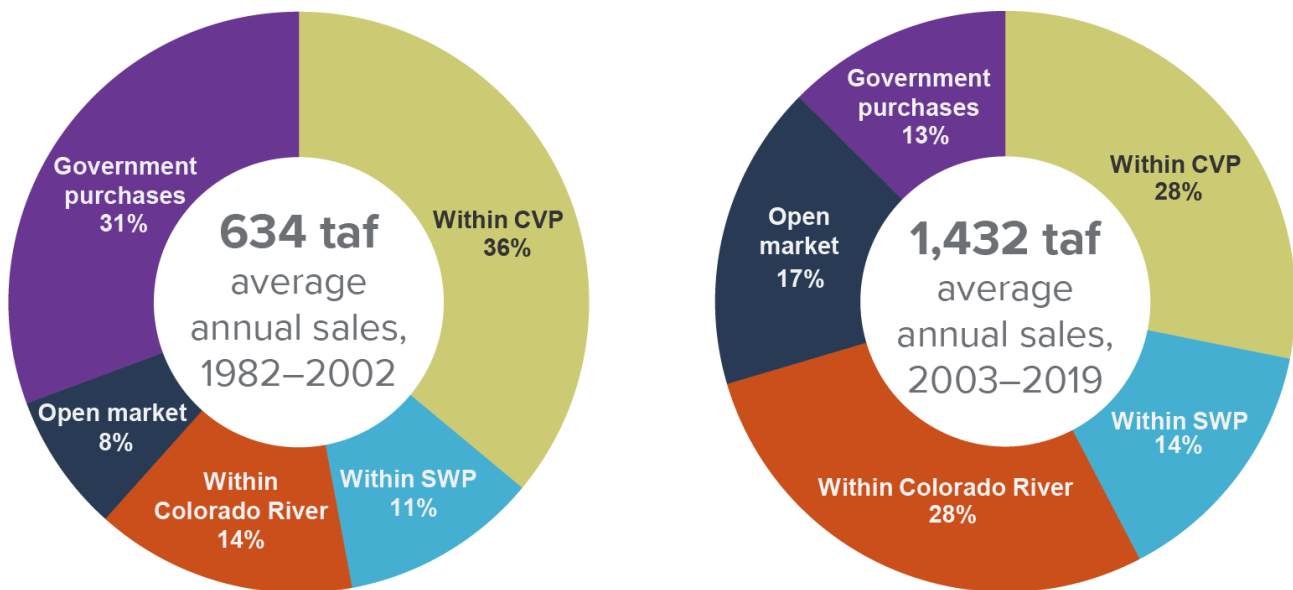
NOTES: "Total volumes traded" is the sum of flows under short-term transfers, long-term transfers, and permanent transfers. "Total commitments" equals the sum of total volumes traded plus additional commitments under long-term and permanent contracts committed but not sold in that year. The table includes purchases by state-run water banks and by various CVP and SWP user pools. *The negative amount under "Additional committed under long-term transfers" in 1982 occurs because committed flows under a 1979 long-term agreement between the MWD and Kern County Water Agency were carried over from 1980 and 1981 and delivered all at once in 1982.

Trends by Market Type

California’s surface water market is dominated by trading among parties within the three large water projects—the CVP, the SWP, and the Colorado River Project—as well as direct purchases by state and federal agencies. A small share of trades can be considered on the open market—involving transactions of non-project water and agencies that are not affiliated with the projects. As California’s water market has grown, its composition has shifted somewhat (Figure B2, Table B2). In the years since 2003, volumes traded are more than double the average of the three preceding decades. Between these two periods, the share of direct government purchases and within-CVP transfers has declined, while Colorado River and open market transfers have become more important. Colorado River transfers’ growth in market share reflects various long-term agreements between urban agencies (MWD and San Diego County Water Authority), and agricultural users of the river, particularly the Palo Verde Irrigation District and Imperial Irrigation District.²⁰

FIGURE B2

Within-project trades dominate the market, but open market transfers have increased as the market has grown



SOURCE: PPIC water transfers dataset. For annual data see Table B2.

NOTES: Taf is thousand acre-feet. “Government purchases” are purchases by federal or state agencies; “Within CVP,” “Within SWP,” and “Within Colorado River Project” are trades between local entities that both operate within those projects. “Open market” includes all other trades.

²⁰ The Coachella Valley Water District—an inland agency with significant municipal and agricultural water use—has also acquired water in these agreements, as has the San Luis Rey Band of Mission Indians. The Bard Irrigation District—a small agricultural district near the river—has also begun transferring water to MWD in recent years.

TABLE B2

Water transfers in California by type of market, volume traded (acre-feet)

Year	Total transfers	Direct government purchases	Within CVP	Within SWP	Within Colorado River project	"Open market"
1982	142,314	-	117,157	25,157	-	-
1983	128,830	-	65,405	605	-	62,820
1984	63,848	4,771	50,292	8,785	-	-
1985	71,238	3,308	51,673	15,489	-	768
1986	131,526	-	123,576	7,950	-	-
1987	278,143	83,100	70,872	6,171	110,000	8,000
1988	320,872	119,031	89,491	300	110,000	2,050
1989	519,122	278,000	118,975	2,691	110,000	9,456
1990	530,128	229,409	168,226	561	110,000	21,932
1991	1,108,610	865,365	86,220	3,902	110,000	43,123
1992	531,759	232,944	132,982	4,919	138,301	22,613
1993	510,272	676	245,491	197	202,989	60,919
1994	728,397	328,850	209,111	1,726	174,688	14,022
1995	520,726	88,614	267,529	4,500	110,000	50,083
1996	829,992	54,023	394,509	207,496	110,000	63,964
1997	996,343	228,412	435,439	66,144	110,000	156,348
1998	725,447	88,091	240,511	226,810	110,000	60,035
1999	1,332,967	277,670	591,852	269,095	110,000	84,350
2000	1,288,620	186,113	522,935	371,005	110,000	98,567
2001	1,446,270	587,638	558,356	69,228	106,880	124,168
2002	1,109,703	424,907	257,136	175,506	104,940	147,214
2003	1,310,956	397,009	319,334	211,602	148,834	234,177
2004	1,268,985	329,720	472,490	158,844	136,900	171,031
2005	1,388,671	224,111	543,775	195,337	255,606	169,842
2006	1,298,372	198,308	435,243	227,889	264,058	172,874
2007	1,372,950	385,338	357,876	158,333	272,956	198,447
2008	1,389,205	214,455	402,565	159,960	315,983	296,242
2009	1,557,097	211,725	364,515	114,786	454,464	411,607
2010	1,797,837	198,889	493,617	310,336	469,691	325,304
2011	1,399,664	136,739	446,875	244,966	435,399	135,685
2012	1,331,350	134,124	295,377	274,688	427,308	199,853
2013	1,653,910	105,337	453,077	226,040	438,097	431,359
2014	1,228,482	76,849	229,390	134,006	483,196	305,041
2015	1,278,307	74,528	289,956	101,418	593,686	218,719
2016	1,411,098	104,046	291,377	179,304	606,632	229,739

Year	Total transfers	Direct government purchases	Within CVP	Within SWP	Within Colorado River project	"Open market"
2017	1,622,422	93,784	510,722	288,064	570,016	159,836
2018	1,596,741	77,811	500,865	204,404	487,498	326,163
2019	1,430,388	99,117	447,804	261,079	471,188	151,200
Total	37,651,562	7,142,812	11,652,596	4,919,293	8,769,310	5,167,551

SOURCE: PPIC water transfers dataset.

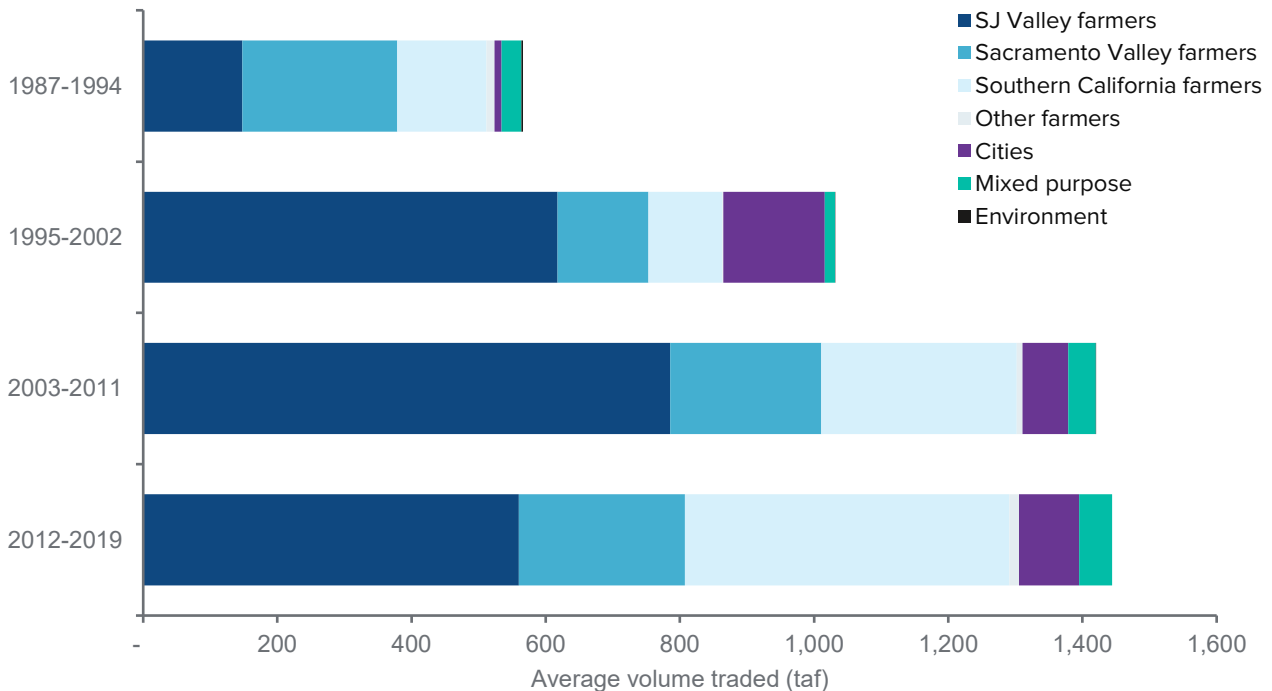
NOTES: The table includes estimated market flows under short-term, long-term, and permanent contracts. The table includes purchases by state-run water banks and by various CVP and SWP user pools. "Direct government purchases" are purchases by federal or state agencies; "Within CVP," "Within SWP," and "Within Colorado River Project" are trades between local entities that both operate within those projects. "Open market" includes all other trades.

Trends in Sales and Purchases by Sector

As the surface water market has evolved, the sectoral distribution of participants has also shifted. As the principal holders of water rights, farmers have been the leading suppliers (Figure B3, Table B3-A). Cities, farms, and the environment all acquire water through the market, although cities' share has increased since the early 2000s, whereas environmental water purchases have decreased over the last decade, after peaking between 2003 and 2011 (Figure B4, Table B3-B).

FIGURE B3

Farmers are the main suppliers of water in the market

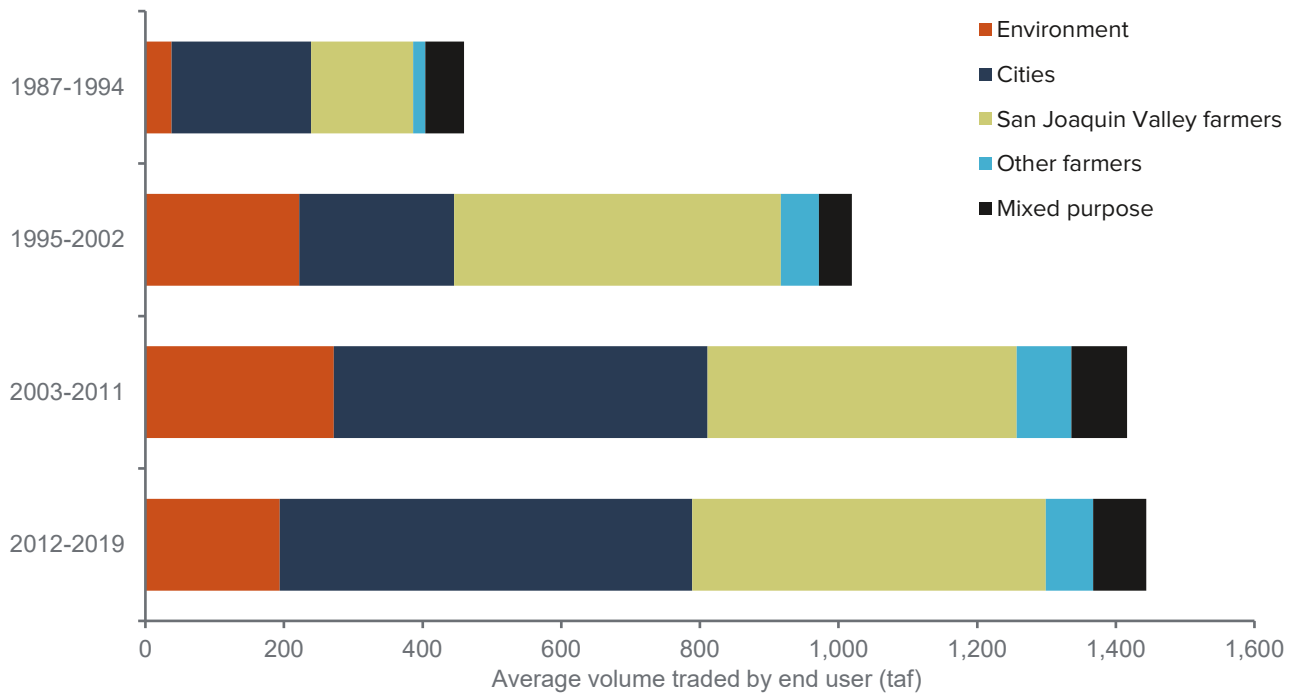


SOURCE: PPIC water transfers dataset. See Table B3-A for annual data.

NOTES: The figure shows the short-term transfers and actual flows under long-term agreements and permanent sales. The "other farmers" category includes farmers in the Bay Delta, Central Coast, and Far North (north of the Sacramento Valley).

FIGURE B4

Cities, farms, and the environment all rely on the market to acquire water



SOURCE: PPIC water transfers dataset. See Table B3-B for annual data.

NOTES: The figure shows the short-term transfers and actual flows under long-term agreements and permanent sales. The "other farmers" category includes farmers in the Bay Delta, Central Coast, Far North (north of the Sacramento Valley), Sacramento Valley, and Southern California.

TABLE B3-A

Water sales by seller sector, volume traded (acre-feet)

Year	Total sales	Environment	Municipal and industrial	San Joaquin Valley farmers	Sacramento Valley farmers	Other farmers	Mixed purpose
1982	142,314	-	25,157	15,987	-	-	101,170
1983	128,830	-	605	66,169	-	-	62,056
1984	63,848	-	8,785	21,841	-	-	33,222
1985	71,238	-	14,887	37,939	750	18	17,644
1986	131,526	-	11,247	63,342	13,740	-	43,197
1987	278,143	-	6,215	43,741	93,450	110,000	24,737
1988	320,872	-	500	38,878	131,397	110,000	40,097
1989	519,122	-	39,000	69,099	301,023	110,000	-
1990	530,128	-	2,440	155,456	222,652	121,500	28,080
1991	1,108,610	-	8,624	238,132	633,231	159,132	69,491
1992	531,759	-	11,643	156,660	190,084	141,835	31,537
1993	510,272	-	11,421	252,952	17,910	227,989	-
1994	728,397	15,856	3,614	226,238	258,038	179,651	45,000
1995	520,726	-	1,568	340,675	10,007	110,667	57,809

Year	Total sales	Environment	Municipal and industrial	San Joaquin Valley farmers	Sacramento Valley farmers	Other farmers	Mixed purpose
1996	829,992	-	206,938	477,274	35,113	110,667	-
1997	996,343	-	49,258	689,311	112,107	110,667	35,000
1998	725,447	-	202,511	336,435	74,501	112,000	-
1999	1,332,967	-	257,163	880,051	81,802	113,951	-
2000	1,288,620	-	315,790	778,972	82,858	111,000	-
2001	1,446,270	15	71,008	781,749	453,601	110,877	29,020
2002	1,109,703	17	106,309	655,926	234,069	113,382	-
2003	1,310,956	15	71,364	831,119	248,728	149,834	9,896
2004	1,268,985	13	70,040	818,448	216,018	140,765	23,701
2005	1,388,671	12	86,963	935,719	92,792	268,178	5,007
2006	1,298,372	19	62,209	813,447	138,707	278,099	5,891
2007	1,372,950	20	57,947	878,959	139,835	263,557	32,632
2008	1,389,205	4,475	52,319	583,625	386,265	299,978	62,543
2009	1,557,097	-	40,073	580,631	427,440	433,797	75,156
2010	1,797,837	-	99,725	851,521	266,633	451,270	128,689
2011	1,399,664	-	70,683	776,134	108,395	416,187	28,265
2012	1,331,350	-	120,424	570,486	197,489	414,512	28,439
2013	1,653,910	-	145,074	593,100	379,143	421,998	114,595
2014	1,228,482	-	32,448	283,257	350,292	490,061	72,424
2015	1,278,307	-	39,031	264,515	357,722	576,642	40,397
2016	1,411,098	-	96,763	531,359	161,535	595,392	26,049
2017	1,622,422	-	147,250	770,006	98,870	554,777	51,519
2018	1,596,741	-	60,642	706,167	327,179	474,432	28,320
2019	1,430,388	-	74,312	761,568	107,597	456,290	30,621
Total	37,651,562	20,442	2,681,950	17,876,888	6,950,973	8,739,105	1,382,204

SOURCE: PPIC water transfers dataset.

NOTES: The table includes estimated market flows under short-term, long-term, and permanent contracts. The volumes include purchases by state-run water banks and by various CVP and SWP user pools.

TABLE B3-B

Water purchases by end user sector, volume traded (acre-feet)

Year	Total purchases	Environment	Municipal and industrial	San Joaquin Valley farmers	Sacramento Valley farmers	Other farmers	Mixed purpose
1982	142,141	-	-	41,144	-	-	100,997
1983	125,466	-	62,820	3,954	-	-	58,692
1984	61,306	4,771	-	25,855	-	-	30,680
1985	75,781	3,308	5,000	44,518	-	768	22,187
1986	156,669	-	5,000	69,589	13,740	-	68,340
1987	278,143	-	110,044	49,912	10,350	-	107,837

Year	Total purchases	Environment	Municipal and industrial	San Joaquin Valley farmers	Sacramento Valley farmers	Other farmers	Mixed purpose
1988	320,872	-	110,500	38,878	12,366	-	159,128
1989	362,674	78,000	131,043	123,412	30,219	-	-
1990	417,071	1,500	145,535	126,621	34,415	-	109,000
1991	672,286	64,612	477,292	124,167	5,365	850	-
1992	493,413	49,308	197,473	166,090	12,763	400	67,379
1993	509,448	676	233,208	263,697	11,867	-	-
1994	621,878	107,098	203,997	286,724	24,029	30	-
1995	520,726	88,614	132,667	291,438	8,007	-	-
1996	829,992	54,023	201,189	506,548	29,113	-	39,119
1997	995,171	228,412	176,848	440,822	14,084	-	135,005
1998	626,804	88,091	205,956	212,079	65,678	-	55,000
1999	1,333,047	277,670	196,254	754,769	72,582	10	31,762
2000	1,288,620	186,113	249,725	742,943	72,057	-	37,782
2001	1,454,912	448,832	322,808	514,175	121,645	-	47,452
2002	1,106,201	402,857	304,448	306,339	57,696	6	34,856
2003	1,310,840	385,654	432,214	342,229	49,686	94	100,963
2004	1,243,296	343,190	301,442	449,543	80,394	2,233	66,494
2005	1,368,673	238,231	454,168	535,876	54,350	1,476	84,572
2006	1,298,133	213,808	467,599	456,987	67,705	1,123	90,911
2007	1,380,330	403,359	444,862	382,024	66,994	1,068	82,024
2008	1,389,205	239,229	537,624	411,140	120,519	298	80,396
2009	1,557,096	176,554	743,826	429,330	138,707	695	67,984
2010	1,797,837	254,795	861,989	525,796	71,180	-	84,077
2011	1,399,664	189,785	609,033	481,061	55,898	26	63,862
2012	1,331,350	164,071	637,603	404,784	60,388	373	64,130
2013	1,653,910	200,906	565,704	745,509	88,901	190	52,699
2014	1,228,482	199,098	476,356	434,317	61,625	1,744	55,341
2015	1,278,307	239,961	561,229	338,967	54,439	515	83,196
2016	1,411,098	268,670	618,553	368,503	75,581	197	79,590
2017	1,622,422	232,924	673,997	571,658	64,281	-	79,562
2018	1,596,741	111,640	601,850	722,499	64,121	1,163	95,467
2019	1,430,388	132,946	624,883	494,016	73,040	100	105,404
Total	36,690,393	6,078,706	13,084,739	13,227,913	1,843,785	13,359	2,441,888

SOURCE: PPIC water transfers dataset.

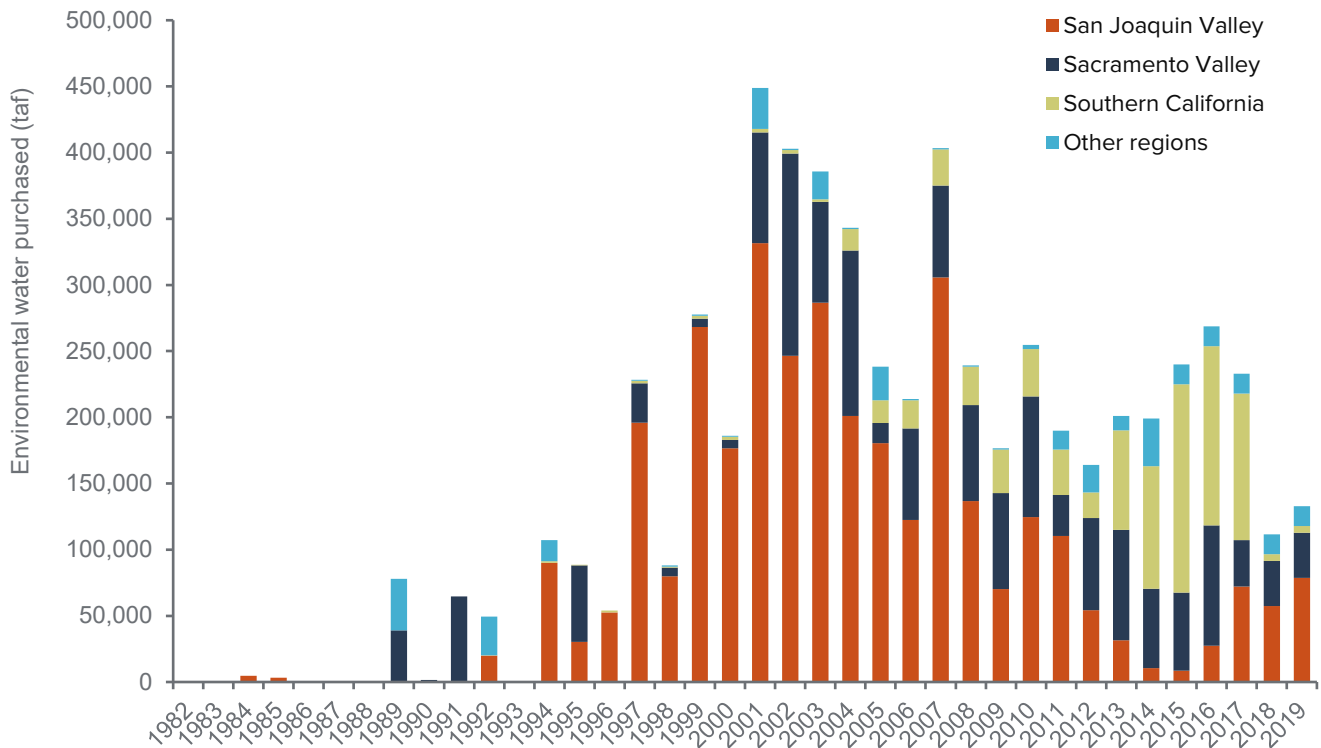
NOTES: The table includes estimated market flows under short-term, long-term, and permanent contracts. The volumes include sales by state-run water banks and by various CVP and SWP user pools. In some years, these volumes are lower than totals including purchases by banks and pools (e.g., Technical Appendix B Table B1) because the banks and pools did not sell the entire volume purchased. In 1991, there is a particularly large discrepancy because DWR did not sell roughly 400,000 af of water it acquired through the drought water bank.

Regional Trends in Environmental Water Purchases

Environmental water purchases occur across the state. Most of this water is used within the region where the water is acquired; though some purchases within the Sacramento and San Joaquin valleys have provided environmental flows that ultimately go to the Delta. After a period of considerable growth, environmental water purchases have been in sharp decline in recent years, reflecting the end of large programs in several regions (Figure 5, Table B4). This includes purchases of water in the San Joaquin Valley for an instream flow program on the San Joaquin River, which ended in the early 2010s. The more recent decline in Southern California marks the end of the program to mitigate salinity impacts of water transfers on the Salton Sea in 2018. The drop in the Sacramento Valley after 2016 marks the end of transfers for instream flows under the Yuba Accord (60,000 af/year). At present, most environmental water transfers within the Central Valley are for wildlife refuges; in other regions, there are small programs to support instream flows on smaller rivers and streams.

FIGURE B5

Source regions for environmental water purchases, volume traded (acre-feet)



SOURCE: PPIC water transfers dataset. See Table B4 for annual data.

NOTE: Other regions include the Central Coast, Far North, San Francisco Bay Area, and undetermined locations.

TABLE B4

Source regions for environmental water purchases, volume traded (acre-feet)

Year	Sacramento Valley	Central Coast	San Joaquin Valley	Southern California	San Francisco Bay Area	Far North	Other	Total
1982	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-
1984	-	-	4,771	-	-	-	-	4,771
1985	-	-	3,308	-	-	-	-	3,308
1986	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-
1989	39,000	-	-	-	39,000	-	-	78,000
1990	1,500	-	-	-	-	-	-	1,500
1991	64,612	-	-	-	-	-	-	64,612
1992	-	-	20,000	107	4,736	-	24,465	49,308
1993	-	-	-	676	-	-	-	676
1994	-	-	90,128	1,114	-	-	15,856	107,098
1995	57,809	-	30,200	605	-	-	-	88,614
1996	-	-	52,556	1,467	-	-	-	54,023
1997	29,800	-	195,983	1,760	869	-	-	228,412
1998	6,300	-	80,000	922	869	-	-	88,091
1999	6,300	-	268,116	2,385	869	-	-	277,670
2000	6,300	-	176,628	2,316	869	-	-	186,113
2001	83,780	-	331,544	2,624	30,869	-	15	448,832
2002	152,958	-	246,380	2,633	869	-	17	402,857
2003	76,214	-	286,526	2,030	20,869	-	15	385,654
2004	125,000	-	200,921	16,387	869	-	13	343,190
2005	15,344	-	180,474	17,028	25,373	-	12	238,231
2006	69,300	-	122,322	21,298	869	-	19	213,808
2007	69,300	-	305,756	27,414	869	-	20	403,359
2008	72,408	-	136,798	29,153	869	-	-	239,228
2009	72,411	-	70,226	32,938	979	-	-	176,554
2010	91,024	-	124,718	35,760	1,092	2,201	-	254,795
2011	31,026	-	110,311	34,254	11,988	2,206	-	189,785
2012	69,679	-	54,298	19,345	11,988	8,762	-	164,072
2013	83,268	-	31,561	75,328	1,988	8,762	-	200,907
2014	60,000	-	10,499	92,649	1,988	33,963	-	199,099
2015	59,132	132	8,517	157,320	2,278	12,582	-	239,961
2016	91,024	132	27,397	135,261	2,274	12,582	-	268,670
2017	34,894	132	72,268	110,785	2,263	12,582	-	232,924

Year	Sacramento Valley	Central Coast	San Joaquin Valley	Southern California	San Francisco Bay Area	Far North	Other	Total
2018	34,023	132	57,446	5,179	2,278	12,582	-	111,640
2019	34,026	132	78,680	5,250	2,276	12,582	-	132,946
Total	1,536,432	660	3,378,332	833,988	170,060	118,804	40,432	6,078,708

SOURCE: PPIC water transfers dataset.

NOTES: The table includes estimated market flows under short-term, long-term, and permanent contracts. It includes sales by various banks and pools. "Other" includes transfers for which the location is unavailable.

Transfer Trends by Regions of Origin and Destination

More generally, regional patterns of sales and purchases vary somewhat with hydrologic conditions (Table B5). For example, water users in the San Joaquin Valley increase their market share as both sellers and buyers in wet years, when supplies are more ample, whereas traded volumes are lower during droughts, when supplies are scarce. The Sacramento Valley's role as a net seller tends to increase during droughts, most recently during the 2012–2016 drought. The San Francisco Bay Area stands out as a net buyer regardless of water conditions, though we observe an uptick in imports in drought years. Southern California shows some variation in its import/export balance over the years, becoming a net exporter in some years and a net importer in others.

TABLE B5

Water transfers by region of origin and region of destination, volume traded (acre-feet)

Year	Sales by water users (including environmental water)						Purchases by non-environmental water users					
	Sacramento Valley	San Joaquin Valley	Southern California	San Francisco Bay Area	Central Coast	Other	Sacramento Valley	San Joaquin Valley	Southern California	San Francisco Bay Area	Central Coast	Other
1982	12,480	104,677	25,157	-	-	-	12,480	129,661	-	-	-	-
1983	3,845	124,380	605	-	-	-	122	62,524	62,820	-	-	-
1984	11,035	44,028	8,785	-	-	-	4,282	52,253	-	-	-	-
1985	4,823	51,510	9,887	5,018	-	-	4,943	61,762	750	5,018	-	-
1986	13,740	106,539	6,247	5,000	-	-	13,740	137,929	-	5,000	-	-
1987	93,450	68,478	116,171	44	-	-	10,350	74,649	110,000	44	-	83,100
1988	131,397	78,975	110,500	-	-	-	12,366	78,975	110,500	-	-	119,031
1989	301,023	69,099	110,000	39,000	-	-	30,219	123,412	110,000	21,043	-	-
1990	252,892	155,456	110,000	11,700	-	80	34,415	126,621	110,000	35,535	-	109,000
1991	703,117	240,132	111,206	53,905	-	250	5,365	124,167	325,736	152,156	-	250
1992	221,621	156,660	142,471	11,007	-	-	12,763	166,090	152,364	45,509	-	67,379
1993	17,910	252,952	208,760	30,650	-	-	11,867	263,697	202,989	30,219	-	-
1994	303,038	226,638	177,902	4,933	-	15,886	26,298	287,124	175,568	25,760	-	30
1995	67,816	341,638	110,605	667	-	-	10,007	311,438	110,000	667	-	-
1996	41,113	559,282	145,967	20,267	63,363	-	33,113	526,548	215,641	667	-	-
1997	149,109	710,161	119,868	10,860	6,345	-	114,084	460,827	191,181	667	-	-
1998	74,901	410,315	221,820	4,869	13,542	-	68,378	232,179	232,156	6,000	-	-
1999	91,992	945,833	249,481	10,519	35,132	10	75,582	775,377	198,026	2,000	-	4,392
2000	91,799	831,132	332,867	5,869	26,953	-	72,057	793,243	187,926	45,212	-	4,069
2001	483,949	786,196	127,744	48,366	-	15	128,121	585,536	234,823	49,384	5,149	3,067
2002	245,373	657,203	192,711	13,554	845	17	57,696	370,220	228,614	42,109	324	4,382
2003	273,089	831,219	182,764	23,869	-	15	55,184	424,574	371,536	68,434	43	5,415
2004	244,434	823,497	195,302	5,739	-	13	85,635	540,835	235,374	33,758	122	4,382
2005	99,979	937,561	301,764	49,250	105	12	59,357	635,565	376,300	53,619	260	5,341

Year	Sales by water users (including environmental water)						Purchases by non-environmental water users					
	Sacramento Valley	San Joaquin Valley	Southern California	San Francisco Bay Area	Central Coast	Other	Sacramento Valley	San Joaquin Valley	Southern California	San Francisco Bay Area	Central Coast	Other
2006	147,859	815,051	324,146	10,769	528	19	74,416	564,965	381,743	53,413	528	9,260
2007	144,842	885,467	331,970	10,540	111	20	72,442	488,649	367,187	38,452	111	10,130
2008	439,035	587,264	326,641	28,771	411	7,083	131,015	514,987	450,920	40,099	451	12,504
2009	495,270	581,281	460,493	10,286	6,335	3,432	146,312	526,160	654,826	46,259	6,360	626
2010	368,889	875,311	499,675	48,079	251	3,432	73,033	615,373	779,643	72,065	111	2,817
2011	112,400	776,134	465,739	25,995	13,758	3,432	57,586	556,532	539,112	51,530	111	5,008
2012	201,316	607,097	492,945	17,688	111	3,432	62,036	488,265	570,567	44,422	111	1,878
2013	471,710	606,426	525,971	15,402	22,208	3,432	92,049	823,569	475,092	60,930	111	1,252
2014	397,353	284,366	494,735	13,674	959	3,432	67,866	493,633	428,427	31,962	7,495	-
2015	380,015	267,046	602,214	12,024	993	3,432	85,987	388,659	508,155	51,841	3,704	-
2016	192,021	561,859	638,687	2,274	243	3,432	81,151	435,274	566,178	51,423	8,085	317
2017	128,551	811,518	623,778	2,263	16,405	27,325	65,908	652,989	624,745	34,966	4,631	6,260
2018	348,910	730,196	493,989	4,122	243	5,706	73,873	801,451	570,549	34,993	111	3,130
2019	142,706	783,006	479,513	3,326	243	9,012	80,645	570,579	595,332	47,332	111	3,443
Total	7,904,802	18,685,583	10,079,080	560,299	209,084	92,919	2,102,743	15,266,291	11,454,780	1,282,488	37,929	466,463

SOURCE: PPIC water transfers dataset.

NOTES: The table includes estimated market flows under short-term, long-term, and permanent contracts. "Sales" include purchases by various banks and pools as well as transfers to the environment. "Purchases" include sales by banks and pools, and exclude purchases of environmental water. "Other" includes transfers for which the region is unavailable (including the SWP turnback pool and the state-run drought water bank).

Trends in Cross-Regional Trading Patterns

Tables B6-A through B6-D break the regional trading patterns down further, showing flows both within and between regions, as well as sales to the environment and to banks and pools, for four periods: 1987–1994, 1995–2002, 2003–2011, and 2012–2019. The final row of these tables shows each region’s net status as an importer or exporter on the water market, excluding environmental water sales.

The Sacramento Valley is the only region that has consistently been a net exporter, particularly during the first (Table B6-A) and fourth periods (Table B6-D), both of which included significant droughts (1987–1992 and 2012–2016). Transfer recipients have shifted over time, starting with statewide banks and pools, and then direct transfers to other regions, including the Bay Area, Southern California, and most recently large transfers to the San Joaquin Valley. In contrast to most other regions, this relatively wet region does not purchase water from other regions, but within-region trades are important.

Within-region trades are also important within the San Joaquin Valley, a relatively dry region heavily reliant on surface water imports from the CVP and SWP. Somewhat surprisingly, this region also became a net exporter on the transfer market during the third period (2003–2011), with long-term and permanent sales predominantly to Southern California and the Bay Area (Table B6-C). The region again became a net importer since 2012, as purchases from the Sacramento Valley increased.

Southern California and the Bay Area have always been net importers, but in Southern California the volume of within-region trades has increased dramatically since the early 2000s, reflecting the large transfers of Colorado River water.

Also of note, the Central Coast—a region with limited water demand and limited within-region storage—became active on the market in the mid-1990s, principally as an exporter. Following the Monterey Agreement, the region began delivering unused SWP water to the statewide turnback pool. In more recent periods, it has continued to be a net exporter in a more limited way, although water users now also import small quantities from other regions as well.

TABLE B6-A

Average annual transfers by region of origin and destination: 1987–1994 (acre-feet)

Region of origin	Region of destination								Total sales	Total non-environmental exports
	San Francisco Bay Area	Central Coast	Sacramento Valley	Region unknown	Southern California	San Joaquin Valley	Environment	Statewide bank/pool purchases		
San Francisco Bay Area	4,351	-	-	1,000	-	1,459	5,467	6,629	18,905	9,088
Central Coast	-	-	-	-	-	-	-	-	-	-
Sacramento Valley	8,854	-	59,451	32,207	-	5,897	13,139	154,980	274,528	201,938
Region unknown	-	-	-	35	-	10	-	-	45	10
Southern California	-	-	-	-	133,880	1,759	237	-	135,876	1,759
San Joaquin Valley	636	-	-	14,107	-	102,931	13,766	32,713	164,153	47,456
Environment	-	-	-	-	-	-	1,982	-	1,982	-
Statewide bank/pool sales	24,943	-	-	-	28,265	51,640	3,058	-	107,905	
Total purchases	38,783	-	59,451	47,349	162,145	163,696	37,649	194,322	703,395	
Total non-environmental imports	34,433	-	-	47,314	28,265	60,765	-			
Total net non-environmental imports (exports)	25,345	-	(201,938)	47,304	26,506	13,309	-			

SOURCE: PPIC water transfers dataset.

NOTES: The table includes estimated market flows under short-term, long-term, and permanent contracts. The "region unknown" category includes trades outside of banks or pools for which the location could not be identified. "Total sales" correspond to regional sales in Technical Appendix Table B5, with the exception of the Sacramento Valley, for which totals here were calculated using sales by Sacramento Valley CVP pools (which sometimes sell to out-of-region entities). (Table B5 sales include purchases by these pools.) The discrepancy arises because these pools do not operate in balance in all years (sometimes purchasing more than they sell, especially in the first period, 1987–1994). In some years, total sales by the statewide banks and pools also exceeded volumes they acquired. The discrepancy was particularly high for the state-run drought water bank in 1991 (Hanak and Stryjewski 2012). "Total purchases" correspond to regional average purchases in Table B5. "Total net non-environmental imports" include purchases from statewide banks and pools, which could originate in the region in which end-users purchased them. Likewise, "total non-environmental exports" includes sales of water to statewide banks and pools that could end up being sold to end-users in the region in which they are acquired. "Total net non-environmental imports (exports)" equals "total non-environmental imports" minus "total non-environmental exports."

TABLE B6-B

Average annual transfers by region of origin and destination: 1995–2002 (acre-feet)

Region of origin	Region of destination									
	San Francisco Bay Area	Central Coast	Sacramento Valley	Region unknown	Southern California	San Joaquin Valley	Environment	Statewide bank/pool purchases	Total sales	Total non-environmental exports
San Francisco Bay Area	1,740	-	-	-	1,875	2,783	4,402	3,572	14,371	8,230
Central Coast	-	-	-	-	-	118	-	18,154	18,273	18,272
Sacramento Valley	1,053	-	78,491	-	1,872	16,505	42,906	24,069	164,896	43,499
Region unknown	-	-	-	1	-	-	-	-	1	-
Southern California	-	-	-	-	116,077	2,650	1,839	67,067	187,633	69,717
San Joaquin Valley	14,613	-	-	1,988	29,573	398,137	172,676	38,233	655,220	84,407
Environment	-	-	-	-	-	-	4	-	4	-
Statewide bank/pool sales	931	684	-	-	50,399	86,728	-	-	138,743	
Total purchases	18,338	684	78,491	1,989	199,796	506,921	221,826	151,095	1,179,140	
Total non-environmental imports	16,597	684	-	1,988	83,719	108,784	-			
Total net non-environmental imports (exports)	8,367	(17,588)	(43,499)	1,988	14,002	24,377	-			

SOURCE: PPIC water transfers dataset.

NOTE: See notes to Table B6-A.

TABLE B6-C

Average annual transfers by region of origin and destination: 2003–2011 (acre-feet)

Region of origin	Region of destination								Statewide bank/pool purchases	Total sales	Total non-environmental exports
	San Francisco Bay Area	Central Coast	Far North	Sacramento Valley	Region unknown	Southern California	San Joaquin Valley	Environment			
San Francisco Bay Area	3,216	-	-	-	-	5,782	7,238	7,086	377	23,700	13,397
Central Coast	-	857	-	-	-	-	1,516	-	16	2,389	1,532
Far North	-	-	-	-	-	-	-	490	-	490	-
Sacramento Valley	5,833	-	-	88,242	1,113	54,328	27,472	69,114	12,852	258,954	101,598
Region unknown	1,525	-	-	-	-	406	-	-	-	1,931	1,931
Southern California	-	-	-	-	1,111	303,900	1,596	24,029	12,530	343,166	15,237
San Joaquin Valley	38,759	-	-	-	3,930	85,226	491,060	170,895	440	790,310	128,355
Environment	-	-	-	497	-	-	-	9	-	506	497
Statewide bank/pool sales	1,514	43	-	1,263	10	12,207	11,968	-	-	27,005	
Total purchases	50,848	900	-	90,002	6,165	461,849	540,849	271,623	26,215	1,448,450	
Total non-environmental imports	47,631	43	-	1,263	6,164	157,949	49,790	-			
Total net non-environmental imports (exports)	34,234	(1,489)	-	(100,335)	4,233	142,712	(78,565)	(497)			

SOURCE: PPIC water transfers dataset.

NOTE: See notes to Table B6-A.

TABLE B6-D

Average annual transfers by region of origin and destination: 2012–2019 (acre-feet)

Region of origin	Region of destination										
	San Francisco Bay Area	Central Coast	Far North	Sacramento Valley	Region unknown	Southern California	San Joaquin Valley	Environment	Statewide bank/pool purchases	Total sales	Total non-environmental exports
San Francisco Bay Area	2,643	-	-	-	-	-	2,050	3,416	738	8,846	2,788
Central Coast	-	311	-	-	-	2,020	-	83	2,762	5,176	4,782
Far North	-	-	124	-	-	-	-	14,300	-	14,424	-
Sacramento Valley	6,573	565	-	76,068	1	15,651	125,710	58,256	-	282,823	148,499
Region unknown	3,432	-	-	121	-	-	3,847	-	-	7,400	7,400
Southern California	1,000	365	-	-	-	451,807	1,883	75,140	13,785	543,979	17,032
San Joaquin Valley	28,993	1,748	-	-	2,035	66,861	439,219	42,583	-	581,439	99,637
Environment	-	-	-	-	-	-	-	-	-	-	-
Statewide bank/pool sales	2,093	57	-	-	-	6,041	9,094	-	-	17,284	-
Total purchases	44,734	3,045	124	76,189	2,035	542,381	581,802	193,777	17,284	1,461,372	
Total non-environmental imports	42,091	2,734	-	121	2,035	90,574	142,584	-	-	-	
Total net non-environmental imports (exports)	39,304	(2,048)	-	(148,378)	(5,365)	73,541	42,946	-	-	-	

SOURCE: PPIC water transfers dataset.

NOTE: See notes to Table B6-A.

Trends in Trading Patterns within the San Joaquin Valley

Tables B7-A through B7-D provide similar breakdowns among different groups of water districts within the San Joaquin Valley, where within-region trading is very important. The groups on the westside source their surface water principally from the CVP and the SWP, whereas groups on the eastside source water principally from local rivers and the main stem of the San Joaquin River through the Friant branch of the CVP. There is also a diversity of water rights seniority on both sides of the valley.

Across all four periods, senior water rights holders on both the east and west sides of the valley exported water to other groups within the valley (Tables B7-A through D). Meanwhile, the “westside, other” group—which includes contractors with the CVP and the SWP whose deliveries are most vulnerable to being cut due to hydrology and regulatory factors—was a consistent net importer of water from others within the region. The “eastside, other” group—consisting mainly of the Friant contractors—were also net exporters until the most recent period, when they also faced significant cutbacks in deliveries during the 2012–2016 drought.

TABLE B7-A

Average annual transfers within the San Joaquin Valley by sub-region of origin and destination: 1987–1994 (acre-feet)

Sub-region of origin	Sub-region of destination						Statewide bank/pool purchases	Total sales
	Eastside, other	Eastside, senior	Other region	Westside, other	Westside, senior	Environment		
Eastside, other	19,998	-	14,107	20,862	-	-	-	54,966
Eastside, senior	-	-	611	424	-	11,446	7,713	20,195
Other region	-	-	-	9,125	-	-	25,000	34,125
Westside, other	1,837	-	25	47,501	191	796	-	50,350
Westside, senior	38	71	-	11,383	628	1,524	-	13,643
Environment	-	-	-	-	-	-	-	-
Statewide bank/pool sales	-	-	-	51,421	219	-	-	51,640
Total purchases	21,872	71	14,743	140,716	1,038	13,766	32,713	224,918
Net imports (exports)	(33,094)	(20,124)	(19,382)	90,366	(12,605)	13,766	(18,927)	

SOURCE: PPIC water transfers dataset.

NOTES: The table includes estimated market flows under short-term, long-term, and permanent contracts. “Eastside, senior” includes pre-1914 water rights-holders on San Joaquin River tributaries and some entities located on the eastern side of the valley with senior access to CVP flows under “settlement” contracts. “Westside, senior” includes entities on the western side of the valley with senior access to CVP flows under “settlement” or “exchange” contracts. “Westside, other” includes CVP service contractors located on the western side of the San Joaquin Valley and all SWP contractors and sub-contractors, whether located on the eastern or western side of the valley. “Eastside, other” includes entities on the eastern side of the San Joaquin Valley not falling into the other categories. “Net imports (exports)” equal “total purchases” minus “total sales.”

TABLE B7-B

Average annual transfers within the San Joaquin Valley by sub-region of origin and destination: 1995–2002 (acre-feet)

Sub-region of origin	Sub-region of destination						Statewide bank/pool purchases	Total sales
	Eastside, other	Eastside, senior	Other region	Westside, other	Westside, senior	Environment		
Eastside, other	96,949	-	6,058	79,190	-	916	-	183,112
Eastside, senior	32,500	-	-	4,015	-	100,395	-	136,910
Other region	375	-	-	21,522	-	-	-	21,897
Westside, other	1,057	-	40,116	155,055	458	33,960	38,233	268,879
Westside, senior	138	-	-	28,844	91	37,406	-	66,479
Environment	-	-	-	-	-	-	-	-
Statewide bank/pool sales	-	-	-	86,728	-	-	-	86,728
Total purchases	131,018	-	46,174	375,354	549	172,676	38,233	764,004
Net imports (exports)	(52,094)	(136,910)	24,277	106,475	(65,930)	172,676	(48,495)	

SOURCE: PPIC water transfers dataset.

NOTE: See notes to Table B7-A.

TABLE B7-C

Average annual transfers within the San Joaquin Valley by sub-region of origin and destination: 2003–2011 (acre-feet)

Sub-region of origin	Sub-region of destination						Statewide bank/pool purchases	Total sales
	Eastside, other	Eastside, senior	Other region	Westside, other	Westside, senior	Environment		
Eastside, other	135,042	-	5,095	96,487	5	5,149	-	241,778
Eastside, senior	76,493	-	-	17,436	-	72,720	-	166,649
Other region	-	-	-	37,623	199	-	-	37,821
Westside, other	1,367	267	119,229	111,602	4,724	53,605	440	291,235
Westside, senior	1,471	-	3,591	46,134	31	39,420	-	90,647
Environment	-	-	-	-	-	-	-	-
Statewide bank/pool sales	-	-	-	11,968	-	-	-	11,968
Total purchases	214,373	267	127,915	321,250	4,959	170,895	440	840,099
Net imports (exports)	(27,405)	(166,382)	90,094	30,015	(85,688)	170,895	(11,528)	

SOURCE: PPIC water transfers dataset.

NOTE: See notes to Table B7-A.

TABLE B7-D

Average annual transfers within the San Joaquin Valley by sub-region of origin and destination: 2012–2019 (acre-feet)

Sub-region of origin	Sub-region of destination						Statewide bank/pool purchases	Total sales
	Eastside, other	Eastside, senior	Other region	Westside, other	Westside, senior	Environment		
Eastside, other	107,259	-	4,126	67,852	275	-	-	179,512
Eastside, senior	59,259	1,955	863	18,336	-	7,432	-	87,844
Other region	3,506	-	832	136,437	-	1,548	-	142,323
Westside, other	11,025	-	95,541	97,953	726	13,089	-	218,334
Westside, senior	4,359	-	26,126	35,887	30	20,515	-	86,917
Environment	-	-	-	-	-	-	-	-
Statewide bank/pool sales	-	-	-	9,094	-	-	-	9,094
Total purchases	185,408	1,955	127,488	365,558	1,030	42,583	-	724,023
Net imports (exports)	5,896	(85,889)	(14,835)	147,224	(85,886)	42,583	(9,094)	

SOURCE: PPIC water transfers dataset.

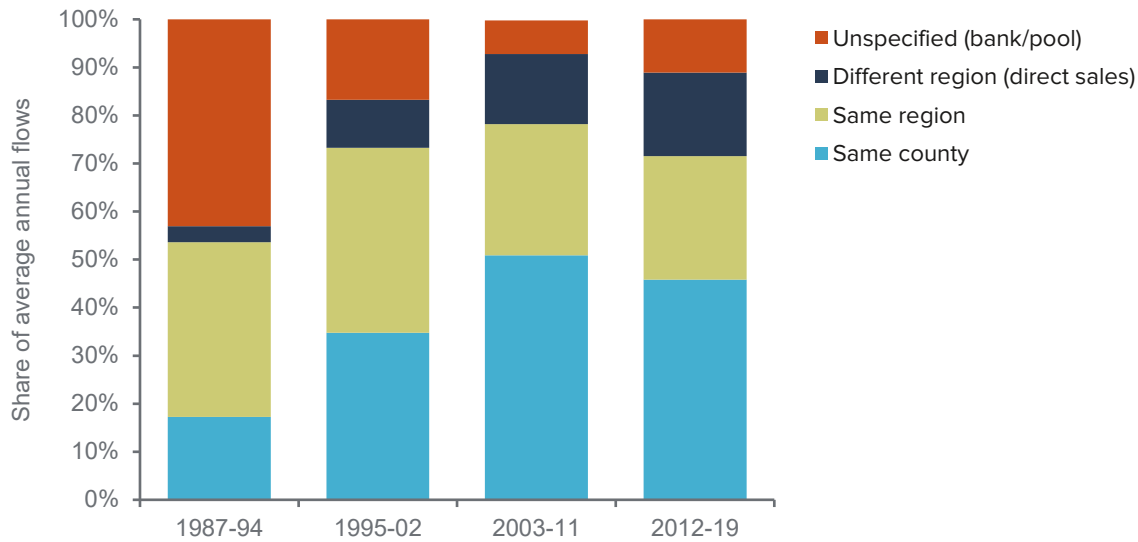
NOTE: See notes to Table B7-A.

Trends in Transfers by Proximity

We observe that most trades occur within the same county or region, but cross-regional direct sales have also been growing in volume (Figure B6, Table B8). The high share of trades going to unspecified regions in the early years reflects the prevalence of drought water banks and pools, where the buyers were not known to the sellers. The more recent uptick in this category reflects the growth in multi-party transfer agreements, with buyers located in more than one region. The recent increase in the share of cross-regional trades reflects the Sacramento Valley's increased role as an exporter during the 2012–2016 drought.

FIGURE B6

Share of non-environmental volume traded by proximity in California



SOURCE: PPIC water transfers dataset.

NOTES: The figure reports the destination of non-environmental water transfers (actual flows). "Unspecified (bank/pool)" includes bank and pool transfers, which go directly to a bank or pool, who may subsequently sell the water within a different region. For multicounty agencies, transactions are considered to be within the same county if the buyers and sellers share at least one county.

TABLE B8

Non-environmental volume traded by proximity in California (acre-feet)

Year	Within same county	Within same region	Across regions	Unspecified	Total
1982	15,759	101,398	25,157	-	142,314
1983	3,005	62,400	63,425	-	128,830
1984	13,195	37,097	8,785	-	59,077
1985	22,047	35,246	10,637	-	67,930
1986	50,849	74,430	6,247	-	131,526
1987	24,829	164,043	6,171	83,100	278,143
1988	32,070	169,771	-	119,031	320,872
1989	50,316	186,848	3,958	200,000	441,122
1990	48,821	209,766	42,052	227,989	528,628
1991	30,734	158,864	53,397	820,915	1,063,910
1992	83,573	193,117	22,125	208,101	506,916
1993	207,558	291,293	10,745	-	509,596
1994	182,363	214,258	2,896	221,782	621,299
1995	152,447	279,665	-	-	432,112
1996	228,525	342,403	2,100	202,941	775,969
1997	128,296	542,810	34,281	62,544	767,931
1998	131,374	256,106	51,156	198,720	637,356
1999	377,538	411,845	28,000	237,914	1,055,297

Year	Within same county	Within same region	Across regions	Unspecified	Total
2000	264,941	421,760	133,501	282,305	1,102,507
2001	345,087	270,939	224,367	157,046	997,439
2002	316,363	228,253	94,929	67,302	706,847
2003	420,414	198,183	265,580	41,125	925,302
2004	488,386	326,994	92,640	17,775	925,795
2005	726,024	245,884	166,472	12,060	1,150,440
2006	652,303	234,737	160,264	37,260	1,084,564
2007	512,027	331,406	110,158	16,000	969,591
2008	503,422	316,134	305,661	20,285	1,145,502
2009	584,094	399,283	317,631	79,534	1,380,542
2010	681,910	422,883	423,446	14,803	1,543,042
2011	571,973	402,851	200,562	34,493	1,209,879
2012	521,453	431,901	202,753	11,172	1,167,279
2013	461,557	490,276	398,703	102,467	1,453,003
2014	305,436	428,110	291,655	4,182	1,029,383
2015	324,951	410,729	296,233	6,432	1,038,345
2016	462,665	514,782	146,545	18,436	1,142,428
2017	701,886	472,207	175,330	40,075	1,389,498
2018	524,118	628,657	326,619	5,706	1,485,100
2019	588,786	514,335	185,309	9,012	1,297,442
Total	11,741,095	11,421,664	4,633,895	1,679,589	31,612,756

SOURCE: PPIC water transfers dataset.

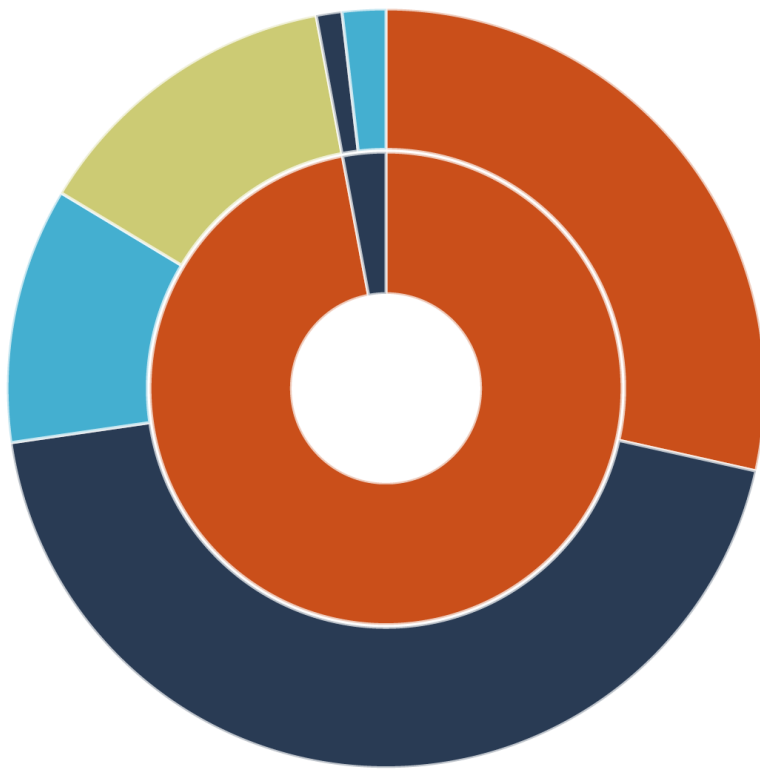
NOTES: The table reports the destination of non-environmental water transfers (actual flows). "Unspecified" includes bank and pool transfers, which go directly to a bank or pool, which may subsequently sell the water within a different region. Transfers from multicounty agencies are coded to their primary county, so transactions with an entity in another county that is part of the service are counted as being in the same region, but not the same county.

Permanent Transfer Agreements Established from 1997 to 2021

Figure B7 shows the sectoral distribution of permanent transfers over the years. It shows that almost all of the permanent sales were from agricultural users. The main purchasers of this water from the agricultural sector were urban users, followed by other agricultural users, mixed-use districts, and the environment.

FIGURE B7

Most permanent water sales originate from agriculture; multiple sectors purchase this water



■ Agriculture
 ■ Urban
 ■ Environment
 ■ Mixed use

SOURCE: PPIC water transfers dataset.

NOTES: The figure shows the sectoral distribution of permanent water sales. The inner circle represents the sector of origin, the outer circle represents the sector of destination.

Table B9 lists the permanent transfers included in our dataset. Permanent transfers that occur after 2019 are not yet included in our data analysis, which ends in that year. Such agreements are marked with an asterisk.

TABLE B9

Permanent transfers of water rights or contract entitlements to another party

Year	Seller	Buyer	Maximum delivery (af)	Purpose	Region of origin	Region of destination	Within project
1997	City of Petaluma	CDF&G,	869	M&I to Env	Bay Delta	Bay Delta	No project
1998	Berrenda Mesa WD	Mojave WA	25,000	Agr to M&I	SJ Valley	SoCal	SWP
1998	Coming WD	USF&W	2,300	Agr to Env	Sac Valley	Unknown	CVP
1998	Proberta WD	USF&W	2,000	Agr to Env	Sac Valley	Unknown	CVP
1998	Thomes Creek WD	USF&W	2,000	Agr to Env	Sac Valley	Unknown	CVP
1999	Mercy Springs WD	Pajaro Valley WMA, Santa Clara Valley WD, Westlands	6,260	Agr to All	SJ Valley	Bay Delta	CVP
2000	Belridge WSD	Palmdale WD	4,000	Agr to M&I	SJ Valley	SoCal	SWP
2000	Berrenda Mesa WD	Alameda Cty FCWCD	7,000	Agr to M&I	SJ Valley	Bay Delta	SWP

Year	Seller	Buyer	Maximum delivery (af)	Purpose	Region of origin	Region of destination	Within project
2000	Lost Hills WD	Alameda Cty FCWCD	15,000	Agr to M&I	SJ Valley	Bay Delta	SWP
2000	Wheeler Ridge-Maricopa WSD	Castaic Lake WA	41,000	Agr to M&I	SJ Valley	SoCal	SWP
2001	Belridge WSD	Alameda Cty FCWCD	10,000	Agr to M&I	SJ Valley	Bay Delta	SWP
2001	Belridge WSD	Napa Cty FCWCD	4,025	Agr to M&I	SJ Valley	Bay Delta	SWP
2001	Belridge WSD	Solano Cty WA	5,756	Agr to M&I	SJ Valley	Bay Delta	SWP
2001	Tulare Lake Basin WSD	Dudley Ridge WD	3,973	Agr	SJ Valley	SJ Valley	SWP
2001	Olcese WD	Kern Cty WA	50,000	Agr	SJ Valley	SJ Valley	No project
2001	Tulare Lake Basin WSD	Antelope Valley-East Kern WA	3,000	Agr to M&I	SJ Valley	SJ Valley	SWP
2002	Lower Tule Riv ID	Orange Cove, City of	2,000	Agr to M&I	SJ Valley	SJ Valley	CVP
2002	Mercy Springs WD	Westlands WD	1,071	Agr	SJ Valley	SJ Valley	CVP
2003	Angiola WD	Westlands WD	5,000	Agr	SJ Valley	SJ Valley	No project
2003	Banta-Carbona ID	Tracy, City of	3,750	Agr to M&I	SJ Valley	SJ Valley	CVP
2003	Belridge WSD	Alameda Cty FCWCD	2,219	Agr to M&I	SJ Valley	Bay Delta	SWP
2003	Berrenda Mesa WD	West Kern WD	6,500	Agr to M&I	SJ Valley	SJ Valley	SWP
2003	Centinella WD	Westlands WD	2,400	Agr	SJ Valley	SJ Valley	CVP
2003	Mercy Springs WD	Westlands WD	4,198	Agr	SJ Valley	SJ Valley	CVP
2003	Tulare Lake Basin WSD	Kings, Cty of	5,000	Agr	SJ Valley	SJ Valley	SWP
2003	Tulare Lake Basin WSD	Alameda Cty FCWCD	400	Agr to M&I	SJ Valley	Bay Delta	SWP
2003	Westside ID	Tracy, City of	3,750	Agr to M&I	SJ Valley	SJ Valley	CVP
2004	Tulare Lake Basin WSD	Coachella Valley WD	9,900	Agr to All	SJ Valley	SoCal	SWP
2004	Centinella WD	Westlands WD	2,500	Agr	SJ Valley	SJ Valley	CVP
2005	Berrenda Mesa WD	Coachella Valley WD	16,000	Agr to All	SJ Valley	SoCal	SWP
2005	Berrenda Mesa WD	Dublin San Ramon SD	6,000	Agr to M&I	SJ Valley	Bay Delta	SWP
2005	Pebble Beach Co	Del Monte Forest residential property owners	105	M&I	Central Coast	Central Coast	No project
2005	Tulare Lake Basin WSD	Kings, Cty of	305	Agr	SJ Valley	SJ Valley	SWP
2005	Widren WD	Westlands WD	2,990	Agr	SJ Valley	SJ Valley	CVP
2005	Anderson-Cottonwood ID	USF&W	3,000	Agr to Env	Sac Valley	Unknown	CVP
2006	Broadview WD	Westlands WD	27,000	Agr	SJ Valley	SJ Valley	CVP
2006	Pebble Beach Co	Del Monte Forest residential property owners	2	M&I	Central Coast	Central Coast	No project
2006	Pebble Beach Co	Del Monte Forest residential property owners	4	M&I	Central Coast	Central Coast	No project
2006	Santa Monica, City of	Golden State Wco	900	M&I	SoCal	SoCal	No project
2007	Monica Real Estate Holdings	Borrego WD	150	Agr to Env	Unknown	SoCal	No project
2007	Monica Real Estate Holdings	Developer	25	Agr to M&I	Unknown	Unknown	No project
2008	Shell Oil	Tesoro Refining & Marketing Co	3,432	M&I	Unknown	Bay Area	No project
2008	M&T Inc & Parrot Investment Co	CDF&G, NOAA Fisheries	21,721	Agr to Env	Sac Valley	Unknown	No project

Year	Seller	Buyer	Maximum delivery (af)	Purpose	Region of origin	Region of destination	Within project
2009	Dudley Ridge WD	Mojave WA	14,000	Agr to M&I	SJ Valley	SoCal	SWP
2009	PG&E	CDF&G	6.6	Agr to Env	Sac Valley	Unknown	No project
2009	Warren T Weber, Paradise Valley Ranch and New Land Fund Pine Gulch Creek Watershed Enhancement Project	CDF&G, NMFS, Marin RCD, State Coastal Conservancy, NOAA Fisheries, Pt Reyes National Seashore, Trout Unlimited, Sustainable Conservation	110	Agr to Env	Bay Area	Bay Area	No project
2010	Dudley Ridge WD	Mojave WA	7,000	Agr to M&I	SJ Valley	SoCal	SWP
2010	John Spencer	CDF&G, Scott River Trust	188	Agr to Env	Far North	Far North	No project
2010	Ed Gozarino et al.	CDF&G, Scott River Trust	13	Agr to Env	Far North	Far North	No project
2010	Kern Cty WA	Coachella Valley WD	12,000	Agr to All	SJ Valley	SoCal	SWP
2010	Kern Cty WA	Desert WA	4,000	Agr to M&I	SJ Valley	SoCal	SWP
2010	Tulare Lake Basin WSD	Coachella Valley WD	5,250	Agr to All	SJ Valley	SoCal	SWP
2010	Tulare Lake Basin WSD	Desert WA	1,750	Agr to M&I	SJ Valley	SoCal	SWP
2010	John Letton	CDF&G	2,000	Agr to Env	Far North	Far North	No project
2010	North Marin WD	CDF&G, Lagunitas Creek Watershed Working Group, NMFS	112.9	M&I to Env	Bay Area	Bay Area	No project
2011	Eastern MWD	CDF&G	2,500	M&I to Env	SoCal	Unknown	No project
2011	Hayden Ranch, FLP	CDF&G, Scott River Trust	5	Agr to Env	Far North	Far North	No project
2011	US National Park Service	CDF&G, Giacomini Wetland Restoration Project	896	Agr to Env	Bay Area	Bay Area	No project
2012	Oro Loma WD	Westlands WD	4,000	Agr	SJ Valley	SJ Valley	CVP
2012	Southern San Joaquin MUD	Kern-Tulare WD	5,000	Agr	SJ Valley	SJ Valley	CVP
2012	Exeter ID	Tri-Valley WD	400	Agr	SJ Valley	SJ Valley	CVP
2012	Lewis Creek WD	Hills Valley ID	250	Agr	SJ Valley	SJ Valley	CVP
2012	Porterville ID	Hills Valley ID	1,000	Agr	SJ Valley	SJ Valley	CVP
2012	Tea Pot Dome WD	Saucelito ID	300	Agr	SJ Valley	SJ Valley	CVP
2012	The Nature Conservancy	CDF&G, Shasta River	6,556	Agr to Env	Far North	Far North	No project
2013	Lower Tule Riv ID	Fresno Cty WW	2,000	Agr to M&I	SJ Valley	SJ Valley	CVP
2014	Dudley Ridge WD	Antelope Valley-East Kern WA	1,993	Agr to M&I	SJ Valley	SJ Valley	SWP
2014	Montague WCD	CDF&G, Shasta River	200	Agr to Env	Far North	Far North	No project
2014	Southern Humboldt Unified School District	CDF&G, Mattole River	1	M&I to Env	Far North	Far North	No project
2014	Tulare Lake Basin WSD	Antelope Valley-East Kern WA	1,451	Agr to M&I	SJ Valley	SJ Valley	SWP
2015	Beckstoffer Vineyards	CDF&G, Russian River	274	M&I to Env	Bay Area	Bay Area	No project
2015	Clint Eastwood and Margaret Eastwood Trust	CDF&G, Carmel River	132	M&I to Env	Central Coast	Central Coast	No project
2015	Dudley Ridge WD	Mojave WA	3,000	Agr to M&I	SJ Valley	SoCal	SWP
2015	PacifiCorp	CDF&G, Klamath River	3,619	M&I to Env	Far North	Far North	No project

Year	Seller	Buyer	Maximum delivery (af)	Purpose	Region of origin	Region of destination	Within project
2017	Corning WD	USF&W	3,000	Agr to Env	Sac Valley	Unknown	CVP
2017	Westminster Woods Camp and Conference Center	CDF&G, NOAA Fisheries	1	M&I to Env	Bay Area	Unknown	No project
*2020	Corning WD	USBR	5,000	Agr to All	Sac Valley	Unknown	CVP
*2021	San Luis WD	Santa Nella County WD	4,456	Agr to M&I	SJ Valley	SJ Valley	CVP

SOURCE: PPIC water transfers dataset.

NOTES: **Seller and Buyer acronyms:** California Department of Fish and Game (CDF&G), East Bay Municipal Utilities District (EBMUD), flood control and water conservation district (FCWCD), irrigation district (ID), limited liability corporation (LLC), Metropolitan Water District of Southern California (MWD), municipal utility district (MUD), National Marine Fisheries Service (NMFS), resource conservation district (RCD), services district (SD), U.S. Fish and Wildlife Service (USF&WS), water agency (WA), water district (WD), water management authority (WMA), water storage district (WSD). **Purpose abbreviations:** agriculture (Agr), environment (Env), municipal and industrial (M&I), mixed use (All). **Regional abbreviations:** Sacramento Valley (Sac Valley), San Francisco Bay Area (Bay Area), San Joaquin Valley (SJ Valley), Southern California (SoCal), north of the Sacramento Valley (Far North). An "unknown" location indicates a trader whose exact location could not be identified or possibly spans a large region. Although the region of destination for environmental water transfers is denoted as "unknown," most of these transfers are used for environmental purposes within the region of origin. **Project information:** "Within project" shows whether the trade occurred exclusively among a project's clients. "CO River" refers to traders with Colorado River entitlements. "No project" means that at least one of the parties is not a contractor of SWP, CVP, or Colorado River. *Asterisk indicates a transfer that is not yet included in the analysis.

Long-Term Transfers Recorded between 1979 and 2020

Table B10 lists the long-term transfers included in our dataset. Transfers approved after 2019 are not included in our analysis. For transfers approved in earlier years that are marked with an asterisk, we could not verify if trading had begun, because we were not able to identify annual transfer volumes. (This is an issue for some agreements within the CVP, as described above.) The data on commitments under long-term transfers (Figure B1 and Table B1) includes these transfers, but the data on volumes traded does not. This includes most transfers approved after 2019—the year our analysis ends—as well as some transfers approved earlier, for which we could not verify that trading had begun.

TABLE B10

Long-term transfer agreements

Year	Seller	Buyer	Maximum annual delivery (af)	Duration (years)	Purpose	Region of origin	Region of destination	Within project
1979	MWD	Kern Cty WA	10,572	9	M&I to Agr	SoCal	SJ Valley	SWP
1982	MWD	Dudley Ridge WD	2,122	4	M&I to Agr	SoCal	SJ Valley	SWP
1983	MWD	Devil's Den WD	685	2	M&I to Agr	SoCal	SJ Valley	No project
1987	Imperial ID	MWD	110,000	35	Agr to M&I	SoCal	SoCal	Co River
1992	Palo Verde ID	MWD	93,000	3	Agr to M&I	SoCal	SoCal	Co River
1992	Eastern MWD	CDF&G	4,500	25	M&I to Env	SoCal	Unknown	No project
1995	Byron-Bethany ID	Zone 7 WA	2,000	5	Agr to M&I	Bay Area	Bay Area	No project
1995	Modesto ID	Modesto, City of	67,200	10	Agr to M&I	SJ Valley	SJ Valley	No project
1997	Solano Cty WA	Mojave WA	10,000	10	M&I	Bay Area	SoCal	SWP
1998	Westside WD	Colusa Cty WD	25,000	25	Agr	Sac Valley	Sac Valley	CVP
1999	Byron-Bethany ID	Zone 7 WA	5,000	15	Agr to M&I	Bay Area	Bay Area	No project
1999	Merced ID	USF&W	12,500	13	Agr to Env	SJ Valley	Unknown	No project
1999	Oakdale ID	Stockton East WD	15,000	11	Agr to All	SJ Valley	SJ Valley	No project
1999	Oakdale ID	USF&W	15,000	13	Agr to Env	SJ Valley	Unknown	No project
1999	San Joaquin Riv Group Auth	USF&W	110,000	13	Agr to Env	SJ Valley	Unknown	CVP
1999	South San Joaquin ID	Stockton East WD	15,000	11	Agr to all	SJ Valley	SJ Valley	No project
1999	Glenn-Colusa ID	Colusa Drain Mutual WCo	30,000	6	Agr	Sac Valley	Sac Valley	CVP
2000	Oakdale ID	USF&W	11,000	12	Agr to Env	SJ Valley	Unknown	No project
2000	Dudley & Indart	Westlands WD	1140	4	Agr	SJ Valley	SJ Valley	CVP
2001	Kern Cty WA	Western Hills WD	8,000	35	Agr to M&I	SJ Valley	SJ Valley	No project
2001	San Bernardino Valley Municipal WD	MWD	20,000	14	M&I	SoCal	SoCal	SWP
2002	South San Joaquin ID	Escalon, Manteca, Lathrop	75,000	30	Agr to M&I	Bay Area	Bay Area	No project
2003	Coachella Valley WD	MWD and SLR Indians	4,500	110	All to M&I	SoCal	SoCal	Co River
2003	Coachella Valley WD	San Diego Cty WAAuth	21,500	110	All to M&I	SoCal	SoCal	No project
2003	Imperial ID	Coachella Valley WD	103,000	75	Agr to All	SoCal	SoCal	Co River
2003	Imperial ID	MWD and SLR Indians	11,500	110	Agr to M&I	SoCal	SoCal	Co River
2003	Imperial ID	San Diego Cty WAAuth	58,200	110	Agr to M&I	Sac Valley	SoCal	No project
2003	Imperial ID	San Diego Cty WAAuth	100,000	75	Agr to M&I	SoCal	SoCal	No project
2003	Imperial ID	Salton Sea (mitigation water), part of IID-San Diego	100,000	15	Agr to Env	SoCal	SoCal	Co River
2003	Nickel, LLC	Newhall Land and Farming Co	1,607	30	Agr to M&I	SJ Valley	SoCal	No project
2003	Palo Verde ID	MWD	111,000	35	Agr to M&I	SoCal	SoCal	Co River
2003	Woodbridge ID	Lodi, City of	6,000	44	Agr to M&I	SJ Valley	SJ Valley	No project

Year	Seller	Buyer	Maximum annual delivery (af)	Duration (years)	Purpose	Region of origin	Region of destination	Within project
2004	Cucamonga Valley WD	Santa Margarita WD	4,250	3	M&I	SoCal	SoCal	No project
2004	Kings, Cty of	LeMoore Naval Air Station	5,000	31	Agr to M&I	SJ Valley	SJ Valley	SWP
2004	Stevinson WD	USF&W	4,675	3	Agr to Env	SJ Valley	Unknown	CVP
2005	Modesto ID	Modesto, City of	67,200	45	Agr to M&I	SJ Valley	SJ Valley	No project
2005	Stony Creek WD	Colusa, Cty of	127	5	Agr	Sac Valley	Sac Valley	CVP
2005	SJRECWA	CVP Contractors	130,000	9	Agr	SJ Valley	SJ Valley	CVP
2005	Glenn-Colusa ID	Colusa Drain Mutual WCo	35,000	6	Agr	Sac Valley	Sac Valley	CVP
2006	San Joaquin Riv Exchange Contractors WAuth	San Luis Delta Mendota Wauth	80,000	8	Agr	SJ Valley	SJ Valley	CVP
2006	Dudley Ridge WD	Kern Cty WA	9,000	5	Agr	SJ Valley	SJ Valley	SWP
2007	Buena Vista-Rosedale	Castaic Lake WA	11,000	40	Agr to M&I	SJ Valley	SoCal	SWP
2007	Dudley & Indart	Westlands WD	1,140	4	Agr	SJ Valley	SJ Valley	CVP
2008	Grassland WD	USF&W	10,000	3	Agr to Env	SJ Valley	Unknown	CVP
2008	San Bernardino Valley Municipal WD	Crestline-Lake Arrowhead WA	1,650	10	M&I	SoCal	SoCal	SWP
2008	Sand City, City of	California-America Water Co	300	15	M&I	Central Coast	Central Coast	No project
2008	Stevinson WD	USF&W	8,863	3	Agr to Env	SJ Valley	Unknown	CVP
2008	Yuba Cty WA	CDWR & USBR	200,000	17	Agr to All	Sac Valley	Unknown	No project
2009	Anderson-Cottonwood ID	Bella Vista WD	1,536	36	Agr to All	Sac Valley	Sac Valley	CVP
2009	Tranquility ID	San Luis WD	7,500	2	Agr	SJ Valley	SJ Valley	CVP
2010	Patterson ID	Santa Clara Valley WD	13,350	4	Agr to M&I	SJ Valley	Bay Area	CVP
2011	Palmdale WD	Antelope Valley-East Kern WA	10,000	3	M&I	SoCal	SJ Valley	SWP
2011	Stevinson WD; Eastside Canal Irrigation Co; San Luis Canal Co	Panoche WD	5,000	10	Agr	SJ Valley	SJ Valley	CVP
2011	Tranquility ID	San Luis WD	7,500	2	Agr	SJ Valley	SJ Valley	CVP
2011	Madera ID	Root Creek WD	10,000	25	Agr	SJ Valley	SJ Valley	No project
2012	Merced ID	USF&W	25,000	2	Agr to Env	SJ Valley	Unknown	No project
2012	Central California ID	San Luis, Panoche, Del Puerto, Westlands	20,500	2	Agr	SJ Valley	SJ Valley	CVP
2012	Firebaugh Canal WD	San Luis WD or Westlands WD	5,000	2	Agr	SJ Valley	SJ Valley	CVP
2012	Byron Bethany ID	Westlands WD	5,000	5	Agr	SJ Valley	SJ Valley	CVP
2012	Stevinson Water District, East Side Canal and Irrigation Company	San Luis Canal Company	5,000	10	Agr	SJ Valley	SJ Valley	CVP
2012	Madera ID	Root Creek WD	10,000	23	Agr	SJ Valley	SJ Valley	No project
2012	Butte County	Westside districts (Dudley Ridge, Belridge, Berrenda Mesa, Lost Hills,	24,832	2	Agr	Sac Valley	SJ Valley	No project

Year	Seller	Buyer	Maximum annual delivery (af)	Duration (years)	Purpose	Region of origin	Region of destination	Within project
		Wheeler Ridge-Maricopa)						
2012	Butte County	Palmdale WD	10,429	2	Agr	Sac Valley	SoCal	SWP
2012	Woodbridge ID	Stockton, City of	6,500	40	Agr to M&I	SJ Valley	SJ Valley	No project
2012	Empire West Side ID	Westlands WD	2,000	16	Agr	SJ Valley	SJ Valley	No project
2012	Tulare Lake Basin WSD	Westlands WD	8,000	15	Agr	SJ Valley	SJ Valley	No project
2012	Glenn-Colusa ID, Hothouse WD	County of Colusa (for Colusa Generating Station)	180	30	Agr to M&I	Sac Valley	Sac Valley	CVP
2012	Mercy Springs WD	Angiola WD	1,300	9	Agr	SJ Valley	SJ Valley	No project
2012	Fresno Slough WD	Angiola WD	4,000	9	Agr	SJ Valley	SJ Valley	No project
2012	Dudley & Indart	Westlands WD	1,140	9	Agr	SJ Valley	SJ Valley	CVP
2013	Tulare Lake Basin WSD	Dudley Ridge WD	15,000	23	Agr	SJ Valley	SJ Valley	SWP
2013	Glenn-Colusa ID	Colusa Drain Mutual WCo	45,000	5	Agr	Sac Valley	Sac Valley	CVP
2014	Patterson ID	Santa Clara Valley WD	36,000	10	Agr to M&I	SJ Valley	Bay Area	CVP
2014	4-S Ranch Partners, LLC and SHS Family Limited Partnership	Del Puerto WD	26,000	2	Agr	SJ Valley	SJ Valley	No project
2014	Butte, Cty of	Dudley Ridge WD, Kern Cty WA, Palmdale WD	24,000	7	M&I to Agr	Sac Valley	SJ Valley	SWP
2014	North San Joaquin WCD	Lodi, City of	1,000	5	Agr to M&I	SJ Valley	SJ Valley	No project
2014	San Joaquin Riv Exchange Contractors WA	San Luis Delta Mendota WA	150,000	25	Agr	SJ Valley	SJ Valley	CVP
2014	Tranquility ID	San Luis WD	7,500	5	Agr	SJ Valley	SJ Valley	CVP
2014	Firebaugh Canal WD	Pacheco, Panoche, San Luis, Westlands Water Districts	7,500	5	Agr	SJ Valley	SJ Valley	CVP
2014	Central California ID	Del Puerto, Panoche, San Luis and Westlands Water Districts	20,500	5	Agr	SJ Valley	SJ Valley	CVP
2015	Pacific Gas & Electric	Butte, Cty of	3,000	13	M&I to Agr	Unknown	Sac Valley	No project
2016	Arvin-Edison WSD, Terra Bella ID, Lower Tule ID	Fresno County WW	2,290	9	Agr to M&I	SJ Valley	SJ Valley	CVP
2016	Bard WD	MWD	4,570	2	Agr to M&I	SoCal	SoCal	No project
2017	CVP contractors	Poso Creek members	50,000	4	Agr	SJ Valley	SJ Valley	CVP
2017	San Luis WD	USF&W	3,000	5	Agr to Env	SJ Valley	SJ Valley	CVP
2018	San Luis WD, Grassland WD	USF&W	8,250	15	Agr to Env	SJ Valley	SJ Valley	CVP
*2018	Glenn-Colusa ID	Colusa Drain Mutual Water Co	45,000	5	Agr	Sac Valley	Sac Valley	CVP
2018	CVP contractors	Harris Farms, Shows Family Farms	15,000	9	Agr	SJ Valley	SJ Valley	No project
*2019	Sacramento MUD	Roseville, City of	6,000	3	M&I	Sac Valley	Sac Valley	No project

Year	Seller	Buyer	Maximum annual delivery (af)	Duration (years)	Purpose	Region of origin	Region of destination	Within project
*2019	Anderson-Cottonwood ID	Shasta Lake, City of	2,000	5	Agr to M&I	Sac Valley	Sac Valley	CVP
*2019	Central California ID	Del Puerto WD, Panoche WD, Pacheco WD, Patterson ID, Grassland WD, San Luis WD, Westlands WD	20,500	5	Agr	SJ Valley	SJ Valley	CVP
*2019	Firebaugh Canal WD	Pacheco WD, San Luis WD, Westlands WD	7,500	5	Agr	SJ Valley	SJ Valley	CVP
*2019	Santa Barbara, City of	Montecito WD	1,430	50	M&I	Central Coast	Central Coast	CVP
*2019	San Luis Canal Co	Del Puerto WD, Panoche WD, Pacheco WD, Patterson ID, Grassland WD, San Luis WD, Westlands WD	5,500	5	Agr	SJ Valley	SJ Valley	CVP
2019	San Luis WD; Grassland WD	USF&W	7,541	5	Agr to Env	SJ Valley	SJ Valley	CVP
*2020	CVP contractors	Poso Creek members	50,000	21	Agr	SJ Valley	SJ Valley	CVP
*2020	North of Delta potential sellers	South of Delta potential buyers	250,000	10	All	Sac Valley	SJ Valley	No project
*2020	Stevinson WD; Eastside Canal Irrigation Co; San Luis Canal Co	USF&W, CVP Contractors, Kern Cty WA, Santa Clara Valley WD, East Bay MUD, Contra Costa WD, Aliso WD, Clayton WD, Farmers WD, Lone Tree MWC, Triangle T WD, Turner Island WD	9,000	9	All	SJ Valley	SJ Valley	No project

SOURCE: PPIC water transfers dataset.

NOTES: See notes to Table B9. Under the seller and buyer columns, "WD" is water district; "ID" is irrigation district; "WCD" is water conservation district; "Cty" is county; "Co" is company; "MWC" is mutual water company; "MUD" is municipal utility district; "WW" is water and wastewater; USF&W is U.S. Fish and Wildlife; "WA" is water authority. Under the "Purpose" column "Agr" is agriculture; "M&I" is urban; "Env" is environment; and "All" is mixed use. Under the regions of origin and destination, "Sac Valley" is Sacramento Valley; "SJ Valley" is San Joaquin Valley. Under the "Within project" column, "SWP" is State Water Project; "CVP" is Central Valley Project. *Asterisk indicates a transfer that is not yet included in the detailed analysis; for transfers approved before 2020, the maximum annual deliveries are included in volumes committed under long-term transfers in Figure B1 and Table B1.

Groundwater Banking in California

In this section, we provide the groundwater banking data we collected from local water agencies in Kern County and Southern California for the period 1990 to 2020.

Data Sources and Caveats

Agencies Included

Kern County Banks. The agencies included in this analysis are the primary groundwater banks within the San Joaquin Valley portion of Kern County: Arvin Edison Water Storage District (WSD), Cawelo Water District (WD), Kern Delta WD, Kern Water Bank Authority, North Kern WSD, Rosedale-Rio Bravo WSD,²¹ Semitropic WSD, West Kern WD, and Buena Vista WSD.²² This analysis does not include banking data for Berrenda Mesa WSD and City of Bakersfield, which store only for their own use, or the Antelope Valley-East Kern Water Agency (AVEK)—located in the high desert to the southeast of the valley floor—which began an active banking program involving partner agencies in the early 2010s.²³

Metropolitan Water District of Southern California Banks. MWD stores water in Southern California groundwater banks within and outside of its service area. We include the following MWD storage programs: Conjunctive Use Programs (CUP) with MWD’s member agencies,²⁴ the Desert Water Agency/Coachella Valley Water District Advance Delivery Account (for Colorado River water),²⁵ and the Mojave Water Agency water storage program, which has allowed MWD to bank its SWP entitlement in the Mojave Basin since 2003.

In addition, MWD also stores water in some Kern County banks, such as Arvin Edison Water Storage District, Kern Delta Water District, and Semitropic Water Storage District; this storage is reported in the Kern groundwater banking data.

Other Banks. We also reached out to several other entities designated as [CVP-acknowledged groundwater banks by the USBR](#), but were not able to acquire any information on their activities; several indicated they had not yet begun banking activities. That said, interest in expanding groundwater recharge and formal groundwater banking is growing, so it is likely the total volume of water stored in banking programs may be higher than what is reported here.

Loss Factors and Leave-Behinds

In many instances, water storage districts apply a loss factor to the banked volumes to account for evaporation and other losses, which varies from district to district and can be anywhere from 6 to 11 percent. In addition, some storage districts require their clients to leave behind additional water as part of the transaction. As an example, the Cawelo Water District applies a 50 percent leave-behind rate that is distinct from evaporation and other loss factors. The water balances presented here represent the net amount available for extraction by clients.

Client Categorization for Kern County Banks

In addition to reporting overall changes in water stored in Kern County banks on behalf of their clients, we report information on clients by sector and region. Our effort tracks banking on behalf of formal clients, mainly parties located off-site. For the Kern Water Bank, this includes all parties storing water at the bank. For other banks, we may not be capturing all the water stored for the benefit of local parties, particularly when it is done on an informal basis.

²¹ The 2020 data for Rosedale-Rio Bravo WSD were not available at the time of writing, so we assumed that bank behaved similarly to other Kern banks in that year.

²² For Buena Vista, we only include aggregate groundwater banking data, as data on the amount of water stored by client was not available.

²³ AVEK is an SWP contractor, and its [website](#) reports cumulative recharge of nearly 140,000 af since the banking operations started in the early 2010s.

²⁴ CUPs have allowed MWD to store water in the following basins over the years: Chino, Compton, Elsinore, Foothill, Las Posas, Live Oak, Long Beach, Long Beach-Lakewood, Orange County, and Upper Claremont. The Chino Basin CUP is currently the most active, with the most water stored.

²⁵ This storage is permitted under an agreement that allows MWD to store its Colorado River water somewhere other than Lake Mead.

Sectoral categories. As with water transfers, clients were categorized by sector according to their principal use of water. The category “unknown” indicates either a government entity like the State of California or a private client whose water use type we were not able to determine.

Location. Clients’ locations were determined based approximately on the hydrologic region of their service area. Our Southern California region is defined a bit larger than the South Coast hydrologic region. For example, for the sake of simplicity, we included an agency located along the Santa Barbara County coastline.²⁶ Some private companies we were not able to locate were assigned the label “unknown.” So was the State of California, which also participates in some storage programs. Since private clients typically store negligible water balances in a given year, most of the water categorized under unknown, either in terms of use or location, can be attributed to the State of California.

Groundwater Banking Trends from 1990 to 2020

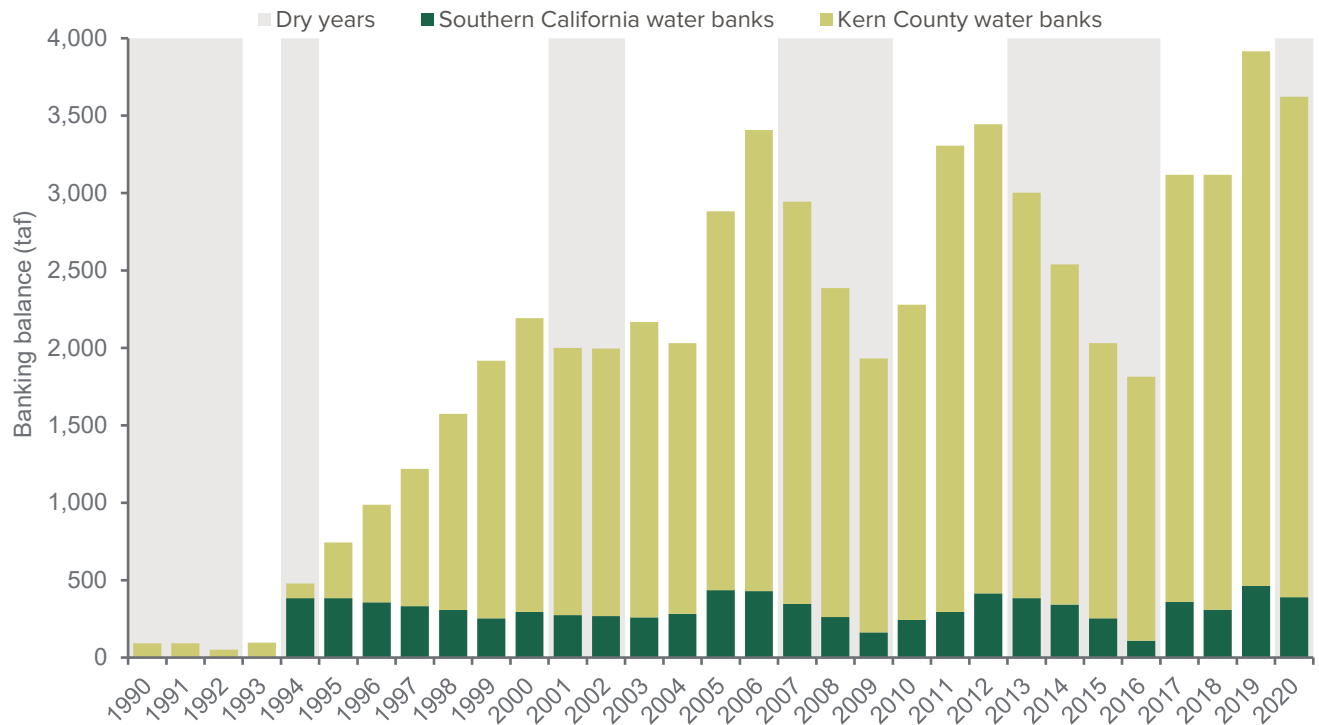
Underground storage transactions in California have been growing in volume since the mid-1990s, with fluctuations in total amount stored in dry periods, when the banks retrieve stored water, and wet periods, when they are able to put the most water back into storage.

As of 2020, the banks in Kern County store around 90 percent of the total (Figure B8). Most of the growth in volume stored occurred in Kern County, from the mid-1990s to the mid-2000s. After significant depletion of banked water towards the end of the 2012–2016 drought, Kern banks recovered thanks to very wet years in 2017 and 2019, which ended with a record amount of water stored.

²⁶ Montecito Water District is currently the only Central Coast water banking client classified in Southern California, and its water banking portfolio is small.

FIGURE B8

Groundwater bank balances by bank location



SOURCE: PPIC groundwater banking dataset. For details see Table B11 (Kern banks) and Table B13 (Southern California).

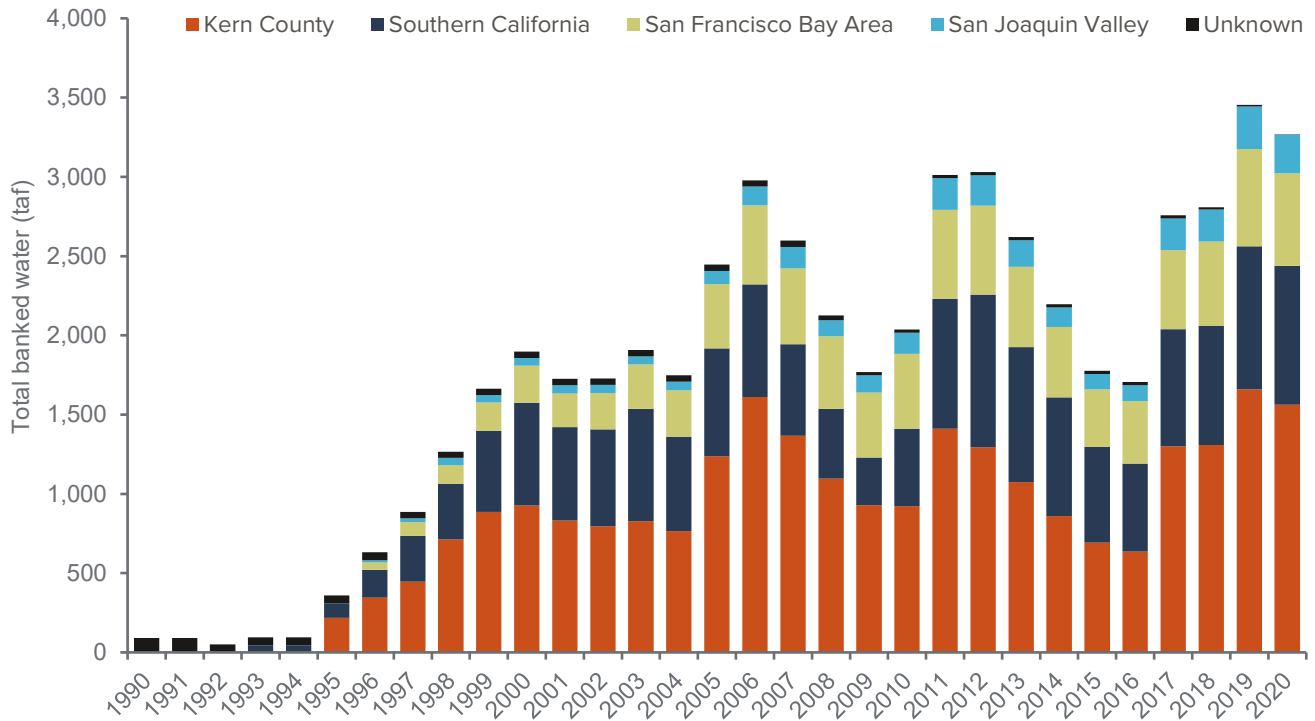
NOTES: The figure shows groundwater bank balances in each location. For Kern County, the data are for all clients we were able to track (see text for description). For Southern California, the data show water stored for MWD.

Trends in Kern County Groundwater Banks

Storage by region. Within Kern County banks, local clients are leading the other regions, with roughly half of the total volume stored as of 2020. Southern California and SF Bay Area are also important clients, and some parties in other parts of the San Joaquin Valley also have some water stored in Kern (Figure B9, Table B11). Kern Water Bank, the county’s largest bank, stores most of the water for local clients.

FIGURE B9

Clients across the southern half of the state utilize Kern County groundwater banks



SOURCE: PPIC groundwater banking dataset. For details see Table B11.

NOTES: Kern County clients represent those within the jurisdictional boundaries of Kern County. San Joaquin Valley clients are those located in the rest of the eight-county region (in this case, primarily Fresno and Kings). Southern California includes all seven counties south of Kern, plus Santa Barbara (see text). The San Francisco Bay Area includes the seven Bay Area counties (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara.) Clients in the “unknown” category include some private companies and the State of California. The data From Buena Vista WSD was not included here due to lack of data by client region.

TABLE B11

Kern County bank balances by clients’ regions, 1990 to 2020 (acre-feet)

Year	Volume of banked water by clients’ regions (af)					Total	Kern Water Bank’s clients by region	
	Kern County	San Joaquin Valley	Southern California	SF Bay Area	Unknown		Kern County	Kings County (Dudley Ridge)
1990	0	0	0	0	91,663	91,663	0	0
1991	0	0	0	0	91,663	91,663	0	0
1992	0	0	0	0	50,164	50,164	0	0
1993	0	0	45,377	0	50,164	95,541	0	0
1994	0	0	45,377	0	50,164	95,541	0	0
1995	217,744	1,492	90,377	0	50,164	359,777	215,591	1,492
1996	344,390	14,805	175,877	46,080	50,164	631,316	337,533	14,805

Year	Volume of banked water by clients' regions (af)						Kern Water Bank's clients by region	
	Kern County	San Joaquin Valley	Southern California	SF Bay Area	Unknown	Total	Kern County	Kings County (Dudley Ridge)
1997	445,316	24,437	289,709	86,580	40,131	886,173	436,557	24,437
1998	712,320	45,795	351,725	116,775	40,131	1,266,746	703,443	45,795
1999	886,150	47,024	511,592	178,884	40,131	1,663,781	735,758	47,024
2000	927,273	47,919	648,090	233,829	40,131	1,897,242	772,766	47,919
2001	831,077	52,117	591,027	211,285	40,131	1,725,637	698,337	46,293
2002	794,537	51,414	612,627	228,998	40,131	1,727,707	685,093	45,590
2003	827,016	51,369	708,470	281,468	40,131	1,908,454	677,173	45,545
2004	764,414	53,190	596,095	293,834	40,131	1,747,664	647,424	46,566
2005	1,236,994	82,686	680,147	406,390	40,131	2,446,348	963,483	65,906
2006	1,610,747	117,674	711,030	498,890	40,131	2,978,472	1,210,451	84,639
2007	1,367,588	134,121	576,821	478,784	40,131	2,597,445	1,006,367	80,615
2008	1,096,268	100,696	440,209	457,751	30,098	2,125,022	799,589	60,081
2009	929,169	108,351	299,367	411,215	20,065	1,768,167	660,890	42,753
2010	922,017	132,912	489,850	472,006	20,065	2,036,850	656,897	29,008
2011	1,411,445	199,525	819,067	561,265	20,065	3,011,368	1,037,107	69,113
2012	1,293,848	191,030	963,370	561,169	20,065	3,029,482	932,006	67,177
2013	1,074,384	166,402	850,883	508,169	20,065	2,619,904	750,325	62,125
2014	860,215	124,361	749,267	442,889	20,065	2,196,798	586,793	44,981
2015	692,151	97,200	604,179	363,178	20,065	1,776,774	452,405	30,351
2016	635,713	99,932	555,390	394,543	20,065	1,705,644	427,067	30,211
2017	1,299,561	200,932	739,824	497,963	20,155	2,758,436	955,123	68,532
2018	1,307,327	200,932	754,401	531,303	14,592	2,808,555	931,880	67,026
2019	1,660,116	267,979	902,684	613,498	10,212	3,454,490	1,225,800	91,782
2020	1,562,261	244,177	876,811	582,797	180	3,266,227	1,138,416	84,223

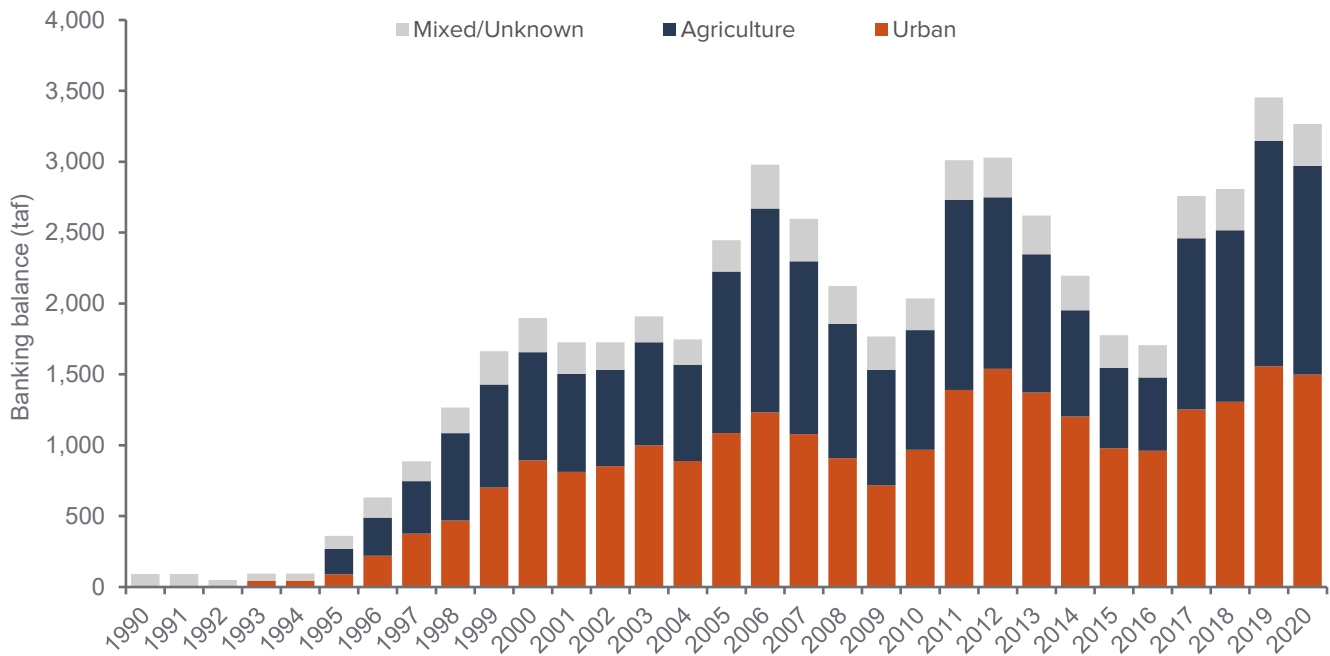
SOURCE: PPIC groundwater banking dataset.

NOTE: See notes to Figure 8.

Storage by sector. There is a nearly equal split between the volume of water stored by urban and agricultural users (Figure B10, Table B12). Storage and extraction trends for both sectors also show similar patterns and correlate to dry year conditions. Agricultural clients tend to use the banks more actively than urban clients, storing more water in wet years and extracting more in dry years compared to water stored for urban use. The amount of water stored by mixed-use clients remain relatively stable and show a gradual increase.

FIGURE B10

Agricultural clients of Kern County banks rely on banked water more than other sectors in drought periods



SOURCES: PPIC groundwater banking dataset. For details see Table B12.

NOTES: Clients in the “urban” category use almost all of their water for urban use, and clients in the “agriculture” category include irrigation districts and other water districts that supply most of their water to farms. “Mixed-use” clients supply both agricultural and urban uses. The data From Buena Vista WSD was not included here due to lack of data by client sector.

TABLE B12

Kern County bank balances by clients’ sectors, 1990 to 2020 (acre-feet)

Year	All banks			Total	Kern Water Bank	
	Urban	Agriculture	Mixed		Agriculture	Mixed
1990	-	-	91,663	91,663	-	-
1991	-	-	91,663	91,663	-	-
1992	-	-	50,164	50,164	-	-
1993	45,377	-	50,164	95,541	-	-
1994	45,377	-	50,164	95,541	-	-
1995	90,377	178,921	90,479	359,777	176,768	40,315

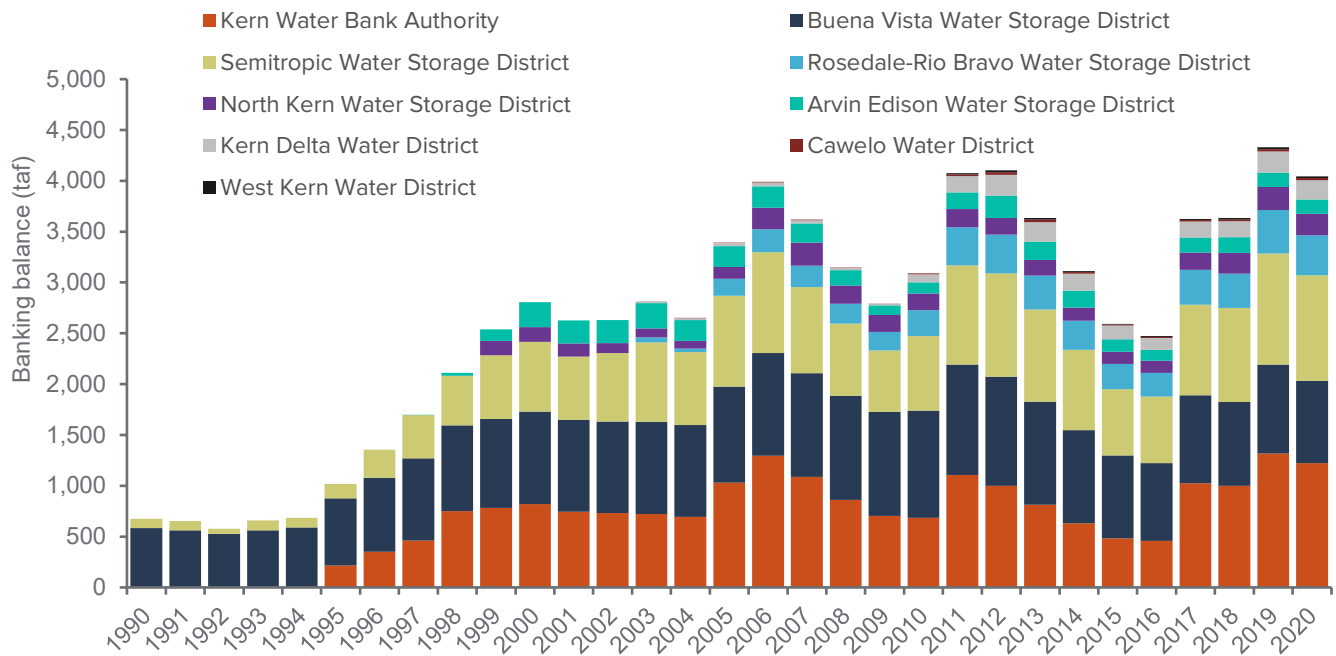
Year	All banks				Kern Water Bank	
	Urban	Agriculture	Mixed	Total	Agriculture	Mixed
1996	221,957	267,473	141,886	631,316	260,616	91,722
1997	376,289	370,904	138,980	886,173	362,145	98,849
1998	468,500	617,921	180,325	1,266,746	609,044	140,194
1999	701,344	727,110	235,327	1,663,781	642,274	140,508
2000	892,787	764,295	240,160	1,897,242	678,396	142,289
2001	813,180	689,240	223,217	1,725,637	609,597	135,033
2002	852,493	680,629	194,585	1,727,707	600,345	130,338
2003	1,000,806	725,631	182,017	1,908,454	591,929	130,789
2004	889,929	677,792	179,943	1,747,664	562,653	131,337
2005	1,086,537	1,139,718	220,093	2,446,348	859,848	169,541
2006	1,231,420	1,439,011	308,041	2,978,472	1,088,178	206,912
2007	1,077,905	1,219,983	299,557	2,597,445	885,257	201,725
2008	909,410	947,262	268,350	2,125,022	669,538	190,132
2009	716,657	816,514	234,996	1,768,167	523,243	180,400
2010	967,931	844,913	224,006	2,036,850	503,134	182,771
2011	1,391,283	1,339,362	280,724	3,011,368	865,791	240,429
2012	1,538,389	1,210,369	280,724	3,029,482	758,754	240,429
2013	1,372,903	975,593	271,409	2,619,904	582,916	229,534
2014	1,203,633	748,209	244,957	2,196,798	422,391	209,383
2015	978,834	567,619	230,322	1,776,774	287,976	194,780
2016	961,410	516,319	227,916	1,705,644	264,904	192,374
2017	1,252,064	1,208,363	298,009	2,758,436	761,278	262,377
2018	1,306,512	1,211,064	290,979	2,808,555	737,996	260,910
2019	1,558,313	1,587,683	308,494	3,454,490	1,034,777	282,805
2020	1,498,709	1,471,856	295,662	3,266,227	942,634	280,005

SOURCES: PPIC groundwater banking dataset.

NOTE: See Figure B9.

Storage by Individual Banks. The Kern Water Bank and Semitropic Water Storage District were the earliest banks to get underway in Kern County, and they also store the most water (Figure B11). Other banks collectively store a similar volume to these two major banks.

FIGURE B11
Storage balances by individual groundwater banks in Kern County



SOURCES: PPIC groundwater banking dataset.

NOTES: The figure reports storage for offsite parties. For entities other than the Kern Water Bank, some additional storage may be occurring for the entities themselves.

Groundwater Banking Programs of MWD

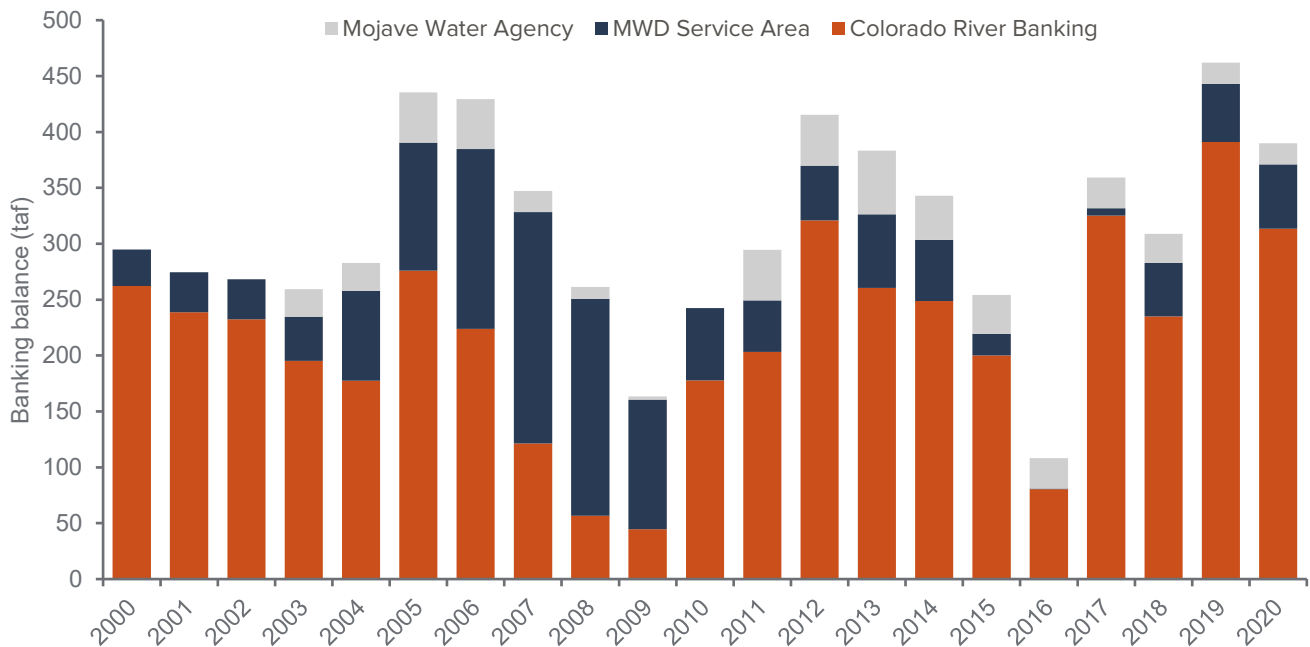
The volume of water stored by MWD under its various storage programs fluctuates over the years (Figure B12 and Table B13). The water stored within MWD’s service area in CUPs saw peak storage in the mid-2000s, followed by a decline. Of the main CUP participants from this period (Orange County, Las Posas, and Chino Basin), only Chino Basin has been actively storing a noteworthy volume of water since the 2012–2016 drought (Figure B13). Much smaller amounts have been introduced in Elsinore, Long Beach, and Upper Claremont banks. Metropolitan staff indicated that there are several reasons for this. First, Chino Basin CUP has the largest total storage capacity at 100,000 acre-feet. Second, MWD prioritizes storage programs based on factors such as supply and demand, regional needs, and currently stored amount. Lastly, there are operational constraints such as infrastructure maintenance and competition for recharge capacity with other sources like stormwater runoff in wet years.

Colorado River water storage with the Desert Water Agency and Coachella Valley Water District, on the other hand, has followed the drought trends in the state, with depletion in dry years and replenishment in wet years; 2019 storage reached volumes not seen since the mid-1990s. MWD’s Kern County programs also follow this pattern, with strong recharge volumes in wet years, followed by depletion in dry periods. MWD has also used

more of its storage in the Mojave Basin during past droughts, but volumes have not recovered since the 2012–2016 drought.

FIGURE B12

Annual water balance of MWD in banking programs in Southern California



SOURCE: PPIC groundwater banking dataset.

NOTE: The figure shows storage for MWD in the Mojave Basin, in the Coachella Valley (Colorado River Banking), and with member agencies within its own service area. Storage at the Mojave Water Agency and within the MWD service area is recorded in fiscal years (July 1 through June 30), and the Colorado River banking is recorded in calendar years.

TABLE B13

Annual water balance of MWD in banking programs between 1994 and 2020

Year	Mojave Basin	MWD service area (CUPs)	Colorado River	Total banking balances in Southern California	MWD Kern County banking balances
1994	-	-	383,299	383,299	45,377
1995	-	-	383,417	383,417	90,377
1996	-	-	356,842	356,842	175,877
1997	-	-	332,188	332,188	289,709
1998	-	-	308,286	308,286	351,725
1999	-	-	253,206	253,206	505,301
2000	-	32,742	262,198	294,940	639,244
2001	-	35,617	238,795	274,412	586,944
2002	-	35,617	232,565	268,182	586,944

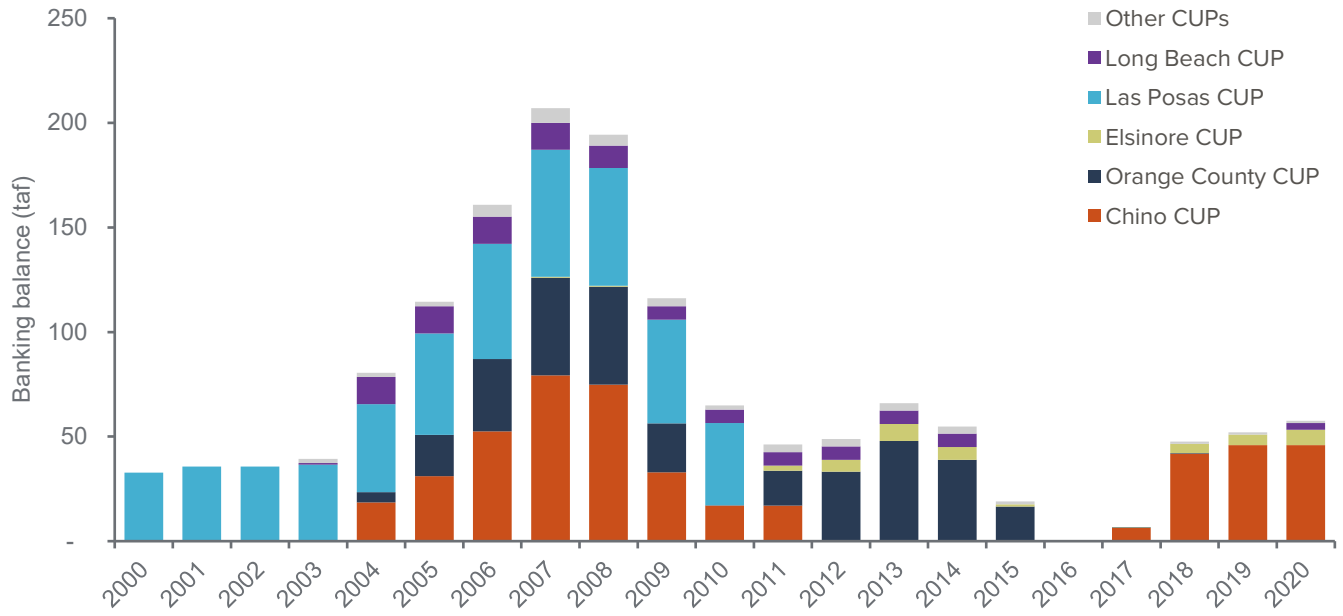
Year	Mojave Basin	MWD service area (CUPs)	Colorado River	Total banking balances in Southern California	MWD Kern County banking balances
2003	24,874	39,335	195,267	259,476	682,787
2004	24,874	80,444	177,400	282,718	541,142
2005	44,874	114,487	276,069	435,430	583,095
2006	44,874	160,775	223,829	429,478	592,499
2007	18,874	206,991	121,387	347,252	428,967
2008	10,379	194,321	56,518	261,218	274,792
2009	2,891	116,089	44,601	163,581	149,153
2010	-	64,936	177,623	242,559	298,910
2011	45,048	46,190	203,267	294,505	542,233
2012	45,500	48,901	321,031	415,432	683,173
2013	57,000	66,000	260,413	383,413	577,684
2014	39,500	54,744	248,804	343,048	506,971
2015	35,114	19,040	200,161	254,315	383,435
2016	27,392	468	80,410	108,270	337,140
2017	27,392	6,787	325,108	359,287	482,127
2018	26,167	47,662	235,025	308,854	486,812
2019	18,812	52,003	391,155	461,970	604,390
2020	18,812	57,581	313,400	389,793	587,570

SOURCE: PPIC groundwater banking dataset.

NOTES: See notes to Figure 11. MWD Kern County Banking Balances refers to the sum of the MWD water stored with Arvin Edison Water Storage District, Kern Delta Water District, and Semitropic Water Storage District.

FIGURE B13

Annual water balance of MWD in conjunctive use programs with its member agencies



SOURCE: PPIC groundwater banking dataset.

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