

# Existing Water Market Research

## Madera County Groundwater Trading Project

February 2020

### 1. Fox Canyon Groundwater Market, California

#### Description

The Sustainable Groundwater Management Act (SGMA) passed in California in 2014; it delegates responsibility of achieving sustainable groundwater management by 2040 to local Groundwater Sustainability Agencies (GSAs), who develop Groundwater Sustainability Plans (GSPs) that either increase water supply in basin or decrease demand. Oxnard and Pleasant Valley basins were identified as critically overdrawn, and need about 35% decrease in groundwater use to achieve sustainable yields.

Enabling conditions that allowed for a market solution to emerge:

- Water scarcity allows price of water to reflect value to users
- Fixed initial allocations for agricultural pumpers, additional water usage beyond initial allocation must be purchased on the market
- Strong stakeholder support
- Careful design with two pilot phases
- Large capacity/funding

Fox Canyon Groundwater Management Association (FCGMA) used TNC's *GDEs Under SGMA* guidance in its GSP creation with groundwater market in mind. FCGMA existence provided a head-start over other basins that need to form GSAs under SGMA.

#### What is bought and sold (units)

During pilot program, water units are measured in one acre-foot of extraction

#### Platform for trading

Trading administered by an exchange administrator: make/receive payments, keep accurate records of trades, conduct trades via secure online website. Fee of 2% per trade for each buyer and seller to cover administrative costs. Uses algorithmic matching to reduce transaction costs, eliminate market power and max gains from trade.

- Offer includes location of allocation, volume of water available, reservation price
- Bid includes location of application, desired volume, and max price willing to pay
- Expires 10 days if not matched
- Sale point is midway between buyers' max and sellers' reservation

#### Initial Allocation – Still in Deliberation

Current allocations are efficiency-indexed: groundwater allocation varies by crop type with fixed, historically based pumping allocation per well where sum of all fixed allocations equals total extraction allowed for the basin per year. Pilot programs created fixed allocations that participants opted into, forgoing crop-based allocations.

Three methods were deliberated:

1. Historical use: best reflects actual water needs, but rewards those who failed to adopt water saving measures
2. Fixed allocation: allocation per acre of irrigated land; "fair" distribution but historic high water users would have to make proportionally larger cuts

### 3. Hybrid of historical and fixed

Initial negotiations resulted in 60/40% split between ag and municipal and industrial users but later decided to assign allocations to specific wells regardless of water use. Allocation process is ongoing...

#### **Administration: Market Rules and Regulations**

Trades limited to 100% of allocation for annual leases. Permanent transfers are not permitted

Two special management areas (SMAs). The pumpers in SMAs can only purchase more water from other pumpers within the same SMA, but may sell to a pumper outside of SMAs. This ensures transfers of pumping allocation to not result in net increase in pumping within SMAs.

Interannual Flexibility: pumpers can carryover unused allocation from prior years to build a “water savings account.” Allowed up to a 100% of current years’ annual allocation. Decided against borrowing water from future use due to accounting complexity, price skewing, and risk of non-compliance with sustainable yield.

#### **Participation**

Initial pilot only included agricultural users. Phase 1 had only 60 participants, phase 2 expected to have about 100 participants (postponed until 2019).

Non-allocation holders (ag lessees, environmental users, and third parties) may trade to increase demand in full market but not pilot phases

#### **Data and monitoring**

Metering has been required on all wells since 1987. FCGMA moved from system of semiannual self-reporting to telemetric monitoring with advanced metering infrastructure (AMI) by using a rebate program to offset costs of AMI adoption. AMI is managed by third-party vendor to protect business practices, and the vendor reports in aggregate to ensure anonymity of pumpers.

#### **Reduction approach**

Ramp down approach for each individual pumping

$$\frac{B - S}{B} = P \rightarrow A \cdot \frac{P}{20} = R$$

**B** = Base period basin pumping volume

**S** = Sustainable yield for basin

**P** = % pumping reduction required

**A** = Initial Individual pumping allocation (AF)

**R** = Annual individual pumping reduction (AF)

#### **References**

Heard, S., E.J. Remson, M. Fienup and S. King. 2019. SGMA’s First Groundwater Market: An Early Case Study from Fox Canyon. The Nature Conservancy, San Francisco, CA.

\*\*Pg 20: group gathered data, case studies and publications on water markets and posted to group website

## 2. Murray-Darling, Australia

Murray-Darling Basin Authority: <https://www.mdba.gov.au/>

Water Markets Dashboard: <http://www.bom.gov.au/water/dashboards/#/water-markets/state/groundwater/at?s=Groundwater&location=Queensland>

### Description

Murray-Darling Basin Authority established from the 2007 Water Act and developed the Basin Plan (2012) to manage the interconnected system of the basin. Basin Plan sets the sustainable amount of water that can be diverted from the Basin each year.

Basin state governments develop water resource plans. Each plan sets out rules for how water is used at local level

<https://www.mdba.gov.au/basin-plan-roll-out/water-resource-plans>

High degree of hydrological connectivity allows water to be traded between river systems and across state boundaries, resulting in the largest water market in Australia by volume of trades.

### What is bought and sold (units)

Important to note: Groundwater and surface water are both traded in the MDB. Both ground and surface water are traded in both asset categories.

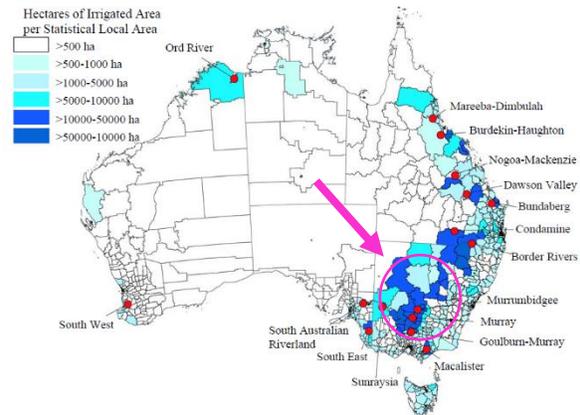
Trade is in Megaliters of water from surface water, water diversions, ground water, or infrastructure from public and private utilities (supplemented irrigation – main form of irrigation water supply in Australia)

Two asset categories:

1. Entitlements are a proportion of shares of water based on total volume available in a basin in any given year. These are permanent, perpetual rights held as permits with state government.
2. Allocations are a specific volume of water traded to deal with immediate supply issues. These are exchanged in one-time transactions between entitlement holders on annual basis.



Figure A.1 Major irrigation districts in Australia



Data source: Australian Bureau of Statistics 1997 data used in NLWRA (2001).

### Platform for trading

Buyers and sellers negotiate prices directly, markets just facilitate transactions and track prices. Trades can also happen between individuals outside of the market or by utilizing water brokers.

### Initial Allocation

Within an irrigation season, each entitlement holder can access a percentage of their entitlement (their 'seasonal allocation'). The percentage is determined annually by irrigation utilities

dependent on availability of water supplies from storages. Seasonal allocations are determined by each

state for every entitlement holder. Since allocations are adjusted every year, based on the volume of water held in storage, the prices for allocation trades are highly dependent on weather.

### **Administration: Market Rules and Regulations**

Important to note: Groundwater and surface water are both traded in the MDB. Regulations differ between ground and surface water trading, and across water management districts, and occasionally it was not clear what regulations applied to which type of water source in which basin.

Groundwater trading only permitted if following conditions are met:

- Sufficient hydraulic connectivity between two locations
- Sustainable diversion limit specified in a water resource place will not be exceeded as a result of the trade
- Water access rights in two locations have substantially similar characteristics of timing, reliability and volume
- Measures are in place to address third party impacts as a result of the trade

Due to the greater limitations of groundwater trading than surface water trading, there is less trading of groundwater rights and the trades are often associated with the sale of land (because properties also have groundwater rights). Groundwater trading only consisted of 3% of all water trades in 2017-2018.

Rules: <https://www.mdba.gov.au/publications/policies-guidelines/guidelines-water-trading-rules>

Irrigators are allowed to carry over water rights by transferring allocations between seasons, helping to “smooth” price and supply during drought years.

Regulations vary by district (see pg. 75 in Peterson et al). Trade within districts are less constrained by regulation than trade across districts. Trade in seasonal allocations is less constrained than trade in entitlements. Sample restrictions/regulations on trading:

- In some districts, trading is limited to agricultural users and there are restrictions on trades between zones
- Physical capacity constraints i.e. limit on volume of water able to pass through Barmah Choke
- In some districts, entitlements to and allocations of irrigation water can only be transferred between those who own land that can be irrigated
- Constraints on inter-district entitlement trades vary by district, i.e. in Victoria: net permanent trade out of any single district greater than 2% of total volume of water rights are not allowed

In early 2000s: Goulburn-Murray Water District used Watermove to facilitate trading and utilized the following rules. (note: Watermove is no longer a thing)

- Highest price buyer is first buyer eligible to trade, and lowest price buyer is last
- Lowest price seller within a zone is first seller eligible to trade, and highest price seller is last
- Pool price from a zone is calculated to maximize the volume of water traded (subject to zone limits)
- Trading conducted on a weekly basis, usually at 10 am - noon on Thursdays. Offers are placed by noon on Monday and can be changed through noon on Wednesday.
- Each week, a market equilibrium price is established, and all ML of water are traded at that price. When there is an inequality between ML offered for sale and ML demanded, the last offer is reduced to clear the market.

## **Participation**

In this basin, 70% of all extractions is for agricultural use. Ag community has shifted away from seasonal crops toward permanent high-end operations like vineyards.

Mining industry hampered by limited access to water rights, cannot reach full demand potential

Government purchasing water rights for environmental purposes to mitigate water stress caused spikes with water share prices.

In Australia, legal structure does not permit inter-sectoral water transfers (i.e. between manufacturing and urban consumers). The allocated entitlements limit the proportion of water available to any sector in a given year.

## **Data and monitoring**

Compliance: <https://www.mdba.gov.au/basin-plan-roll-out/basin-wide-compliance-enforcement>

MDBA responsible for maintaining sustainable diversion limits by managing non-compliance with auditing, investigations and remote sensing; has an Inspector General for the basin

Recent Australian Standard for non-urban water meters required most meters to be renewed to be in compliance and MDBA ensured compliance

## **References**

Brookes, R. and E. Harris. 2008. "Efficiency gains from water markets: Empirical analysis of Watermove in Australia." *Agricultural Water Management* 95: 391-399.

\*Note Watermove no longer a thing???

Peterson, D., Dwyer, G., Appels, G., Fry, J., 2004. "Modelling water trade in the Southern Murray-Darling Basin." Staff Working Paper. Productivity Commission, Canberra.

Goesch, Donoghoe and Hughes. 2019. "A Snapshot of Australian Water Markets." ABARES Insights, Issue 2. Australian Government Department of Agriculture and Water Resources. Available at: <https://www.agriculture.gov.au/abares/publications/insights/snapshot-of-australian-water-markets#future--scenarios-for-the-southern-mdb-water-market> (accessed 3/2/2020).

Australian Water Markets Report 2017–18: All Other Water Systems Section. ISSN: 2207-1733 Published by the Bureau of Meteorology 2019. Available at: [http://www.bom.gov.au/water/market/documents/AWMR\\_All\\_other\\_water\\_systems.pdf](http://www.bom.gov.au/water/market/documents/AWMR_All_other_water_systems.pdf) (accessed 3/2/2020)

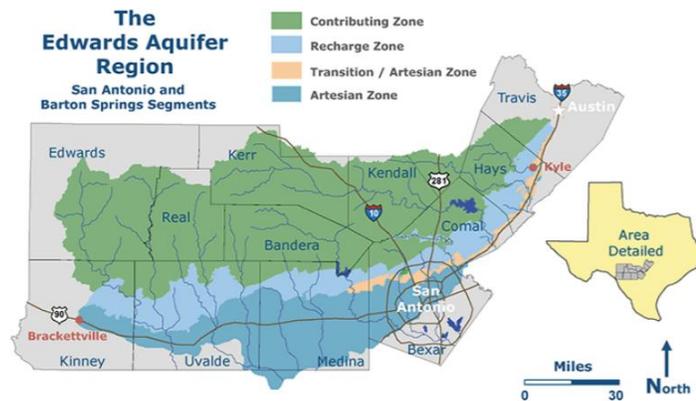
### 3. Edwards Aquifer, Texas

<http://www.ampinsights.com/rock-report>

#### Description

Edwards Aquifer Authority (EAA) Act effective 1996. Texas legislature has envisioned the “voluntary redistribution of existing water supply” since the creation of EAA but the ambiguity of legal scope of a water rights is not resolved (as of 2017).

There are 99 Groundwater Conservation Districts in Texas that follow political boundary lines. The 16 groundwater management areas were created using aquifer boundaries, including EAA.



A lawsuit filed on behalf of endangered species that rely on Edwards Aquifer water flows caused EAA to implement a firm aquifer-wide pumping limit as a result.

A statewide water market is limited by infrastructure to transport water (i.e. cannot pump water from San Antonio to Dallas).

#### What is bought and sold (units)

#### Platform for trading

No centralized marketplace for transactions. EAA does not manage or track sales, just provides a location for willing sellers to list their permits and contact information. Purchasing and leasing is a private contract transaction with no recorded data. Typically, only small leases are negotiated through the website. Prices are voluntarily reported. Large water purchases are transacted through private conveyance using a warrantee deed.

#### Initial Allocation

Ownership of groundwater is a real private property right held by landowners, established through arbitration. Starting in the 1990s, permits were allocated to respond to the mandated pumping cap. Permit exemptions for livestock wells, domestic wells and federal facilities.

Initial permit allocations were free and issued to those who could show they used water from Edwards Aquifer “in a beneficial way without waste for one calendar year” between 1972 and 1993. Users who showed they used water for 3+ consecutive years of this period were permitted the average amount used annually. If user accessed unmetered water, permit issued for 2 acre feet per acre per year. 50% of total permitted water is considered a base permit that can only be used on the land for which it was historically used and not on any other property. Historic users have preference over new users.

When mandated pumping limits took effect, the Edwards Aquifer water pumping was capped to the sum of all permits as of 1/1/2005. No additional permits are sold moving forward.

#### Administration: Market Rules and Regulations

Originally water could be transferred between users located at opposite ends of the aquifer but there were concerns about large water transfers from East to West impacting spring flows. Cibolo Creek

Prohibition puts obligations on transfers from west side of the creek to the East side. A user on the east side wishing to purchase water from the west side must demonstrate that the springs' flow will not be impacted. This created a market within a market: water sold on the east side of the creek is twice the price because purchaser is free of the burden to demonstrate effects on spring flows.

Water is prohibited to be exported for use outside the aquifer.

Only a portion of irrigation permits can be bought and sold in the market. A minimum of 50% of irrigation permits cannot be sold except as part of a sale that includes the surface real estate. A plot of land will forever have at least 50% of its original water allocation attached to the property rights.

During critical periods (draught years), a management plan is put in place to increase restrictiveness of the water pumping from the aquifer. Multiple "stages" of response. All permit holders are required to submit withdrawal reports monthly. (see <https://www.edwardsaquifer.org/business-center/groundwater-permit-holder/critical-period-drought-management/>)

### **Participation**

Most users are agriculture, but municipalities are the largest buyers, as their populations grow.

Exempt wells are not metered: domestic or irrigation wells, federal facilities, and limited production wells. Limited production wells must be metered but do not need a permit. Domestic and livestock wells can pump up to a threshold, but otherwise are unregulated.

### **Data and monitoring**

All wells required to have meters since 1996 except exempt wells. EAA responsible for monitoring and enforcing permit limits. Water permit holders apply for a permit transfer for any groundwater rights sale or lease.

### **References**

Water Rights Transfers: <https://www.edwardsaquifer.org/business-center/groundwater-permit-holder/transfer-buying-selling-and-leasing-water-rights/>

Hardgerger, Amy. 2016. "Texas Groundwater Markets and the Edwards Aquifer: A case study for the political economy of water markets project." AMP Insights. Available at: <http://www.ampinsights.com/rock-report>

## 4. Twin Platte NRD, Nebraska

### **Description**

Endangered species led to a cooperative agreement between CO, NB and WY to reduce negative impacts to stream flows. The Twin Platte Natural Resource District (TPNRD) implemented district-wide well drilling moratorium and restricted growth of irrigated acres in 2007.

TPNRD capped, certified and allowed for trading of certified irrigated acres to form the regulations of a groundwater market.

### **What is bought and sold (units)**

Certified irrigated acres (CIAs) – only “works” because of homogenous crop water requirements (soy and corn). That is to say, every farmer has essentially the same water requirement on a per acre basis, and there is no incentive to over water as it comes at the additional cost of pumping. All transfers are permanent sales of property, no leases occur because there is no incentive to lease extra or excess water.

After almost 10 years of permanent transfers, fewer jointly profitable trades exist because all acres have been allocated to the most efficiently managed use

### **Platform for trading**

There is no platform. Most transfers have happened between a single buyer and seller in a private capacity. This is practically challenging and economically inefficient.

Transfer fees are \$200/application and the costs of completing a transaction are high because of the time and effort of identifying a willing and eligible buyer or seller. Real estate agents hired by the buyer have an additional 7% premium on the sales price.

Since 2018: TPNRD first area to adopt Mammoth Trading’s smart water market. Unsure where this stands currently.

<https://venturewell.org/water-market-mammoth-trading/>

Alternatively: The South Platte NRD allows both temporary and permanent transfers of allocations (in acre-feet of water for surface flows and certified irrigated acres for ground water) as well as pooling agreements. “Although Mammoth Trading operates a smart market in the district, staff at the South Platte NRD estimate that the district receives only one or two transfers per year as a result of their stringent transfer rules.”

<https://apps.wr.ecology.wa.gov/docs/WaterRights/wrwebpdf/WaterBankingandWaterMarketinginSelectWesternStates.pdf>

### **Initial Allocation**

Based on acreage; no volume-based allocations

### **Administration: Market Rules and Regulations**

Ag producers interested in expanding their own production must obtain appropriate offsets from producers who already have certified irrigated acres.

All transfers of CIAs must occur within the same basin, and all transfers are subject to an adjustment of the right based on the difference in Stream Depletion Factor between the place of origin and the place

of transfer. Transfer limitation zones place restrictions on transfers based on diversion points along the basin (i.e. groundwater users can transfer CIAs across zones, but upstream transfers are only permitted within a zone).

Water trading is attached to land so only permanent transfers are allowed. Cost to buying equipment and begin producing on a farm is too high for growers to engage in the short term, so no new market participation.

### **Participation**

TPNRD is responsible for acquiring groundwater rights for municipal growth, which is accomplished through the permanent retirement of CIAs. They have not faced this issue as municipality demand hasn't grown enough yet.

Industrial users must acquire their own CIAs and are subject to adjustments based on the comparative consumptive uses between irrigated agriculture and new industrial use.

Groundwater rights have been moving towards farms with better irrigation tech and to producers who are more tech savvy. Trading activity and pricing is influenced by commodity prices (i.e. CIA price goes down when corn prices are depressed).

Clear rules and transparency aid in education and builds trust with landowners.

### **Data and monitoring**

Metering is extremely unpopular and political infeasible, so Twin Platte only monitors irrigated acreage of farms in the jurisdiction. Anyone caught irrigating uncertified land is subject to penalties. No cap on groundwater usage. Use areal images and flyovers for monitoring – very low cost.

### **References**

Young, Richael. 2016. "Smart Markets for Groundwater Trading in Western Nebraska: The Twin Platte. A case study for the political economy of water market project." AMP Insights. Available at:

<http://www.ampinsights.com/rock-report>

Ebelin, E. Z. Kearl, E. Weaver, N. Wentzel. 2019. "Water Banking and Water Marketing in Select Western States." State of Washington Department of Ecology. Available at:

<https://apps.wa.gov/ecology/docs/WaterRights/wrwebpdf/WaterBankingandWaterMarketinginSelectWesternStates.pdf> (accessed 3/2/2020).

\*\*\*Really good conclusion section here\*\*\*

## 5. Central Arizona

### Description

In 1994, AZ created long-term storage credits (LTSCs) through aquifer recharge within the Colorado River. LTSCs are a quantity of water that an owner is entitled to recover and use once the water has remained underground for a full calendar year. Owners can sell their LTSCs to others by a credit account transfer. Water can be stored in underground storage facilities and groundwater saving facilities. Entities are provided LTSCs for the groundwater that is saved.

Active management areas' (AMAs) groundwater use is regulated by Arizona Dept of Water Resources (ADWR). There are 5 AMAs with boundaries determined by hydrologic considerations.

Demand for a market was driven by expanding population: new community developments must demonstrate a 100-year assured water supply. AMAs have "safe-yield" goals meaning that amount of groundwater withdrawn must balance with the recharge.



### What is bought and sold (units)

Long-term storage credits  
1 LTSC = 1 acre food of water

### Platform for trading

Not clear how trading has occurred previously, but US Bureau of Reclamation awarded a Water Marketing Strategy Grant to the Central Arizona Water Clearinghouse in 2019 to facilitate future water market transactions. The Clearinghouse will provide a market platform and hub for water managers to access water supply information and pursue water marketing opportunities.

See <https://www.usbr.gov/watersmart/watermarketing/docs/2019/2019-11-08-Water-Marketing-Grants.pdf>

### Initial Allocation

Groundwater Management Act grants groundwater rights to specific users in the AMAs:

- Grandfathered irrigation rights for ag users, which may be converted to "type 1 rights" for non-irrigation purposes and can be conveyed with the land to new owners
- "Service area rights" for municipal providers to provide service to customers
- Type 2 rights are industrial sector rights
- Landowners can apply for right to pump groundwater for non-irrigation uses

In Tucson and Phoenix AMAs, municipal providers that began providing water before Feb 1995 are granted a groundwater allowance based on their 1994 water supply multiplied by an allocation factor; Pinal AMA granted municipalities established before 2007 their groundwater allowance by multiplying 473L per capita per day by the service area population for 365 days. Allocations will not decrease but as populations increase, municipalities must seek renewable supplies

### Administration: Market Rules and Regulations

Currently the market in AZ is murky and not well defined. Transactions occur but price data is unavailable, and transfers occur without listing monetary value as well.

Any groundwater pumped above the limit specified for each AMA is reported annually, and the quantity of excess groundwater pumped must be replenished within the same aquifer. Water is replenished by storing an equal amount of water in the aquifer, or by extinguishing an equal amount of LTSC on the users' account.

LTSCs may be resold, retained in storage, recovered or extinguished for replenishment. ADWR tracks every LTSC generated and completes yearly summaries of LTSCs for every entity that owns these credits. LTSCs can be shifted between accounts, considered "transfers."

### Participation

Municipal water providers, investment firms, governmental entities (such as CAGR and US Bureau of Reclamation), industrial users and Native American are all participants. Municipal providers, investment firms and governmental entities represent 96% of purchases and 92% of sales. Investment firms act as LTSC brokers for many transactions.

Table 1. Long-term storage credits owned by category in 2016 in Central Arizona Active Management Areas (AMAs). Data source: [63].

Category	Phoenix AMA	Tucson AMA	Pinal AMA	Central Arizona AMAs
Governmental Entities	43.0%	61.0%	66.4%	51.4%
Municipal Water Providers	36.3%	26.8%	3.0%	26.8%
Industries	6.4%	2.6%	3.3%	5.1%
Native American Tribes	5.6%	7.0%	7.9%	6.4%
Gila River Water Storage	2.1%	0.0%	19.3%	5.9%
Investment Firms	6.3%	1.2%	0.2%	4.0%
Others	0.2%	1.4%	0.0%	0.4%

### Data and monitoring

Central Arizona Groundwater Replenishment District (CAGR) facilitates compliance by replenishing groundwater on behalf of members. Members join if they do not have access to a renewable water supply; they report their excess groundwater use every year and pay a fee for CAGR to replenish. CAGR can either add water to the aquifer or extinguish LTSCs to fulfil replenishment obligations.

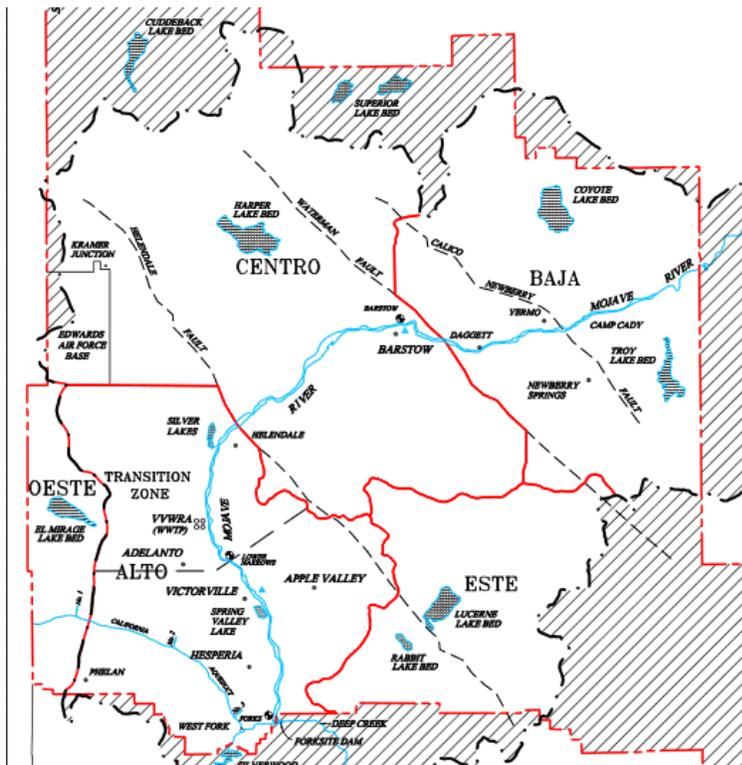
ADWR provides a central authority for quantifying LTSCs, maintaining transaction records and ensuring compliance but does not currently organize sales or dictate prices.

### References

Bernat, R.F.A., S. B. Megdal and S. Eden. February 2020. "Long-Term Storage Credits: Analyzing Market-Based Transactions to Achieve Arizona Water Policy Objectives." *Water* 2020 12:2, p 568. Available at: <http://dx.doi.org/10.3390/w12020568> (accessed 3/17/2020).

## 6. Mojave Groundwater Market, CA

### Description



1990 – Litigation over water users upstream in urban areas using too much surface water, but larger outcome included development of individual limits on groundwater pumping and tradeable water rights within those limits.

The Judgement: divided Mojave county into 5 subareas, every subarea responsible for monitoring average groundwater flow into adjacent subareas. If flow is less than determined amount, the responsible subarea needs to make up the difference. Each subarea needs to balance demands with water supply. Pay for any excess with water bought from imported water from state water board.

The Mojave Water Agency was designated the Watermaster, responsible for monitoring and verifying water production, collecting assessments, conducting studies and preparing annual reports for the courts. Watermaster also acts as a clearing house.

### What is bought and sold (units)

Base Annual Production rights are assigned to producers, who have the option to transfer the BAP right or a portion of their BAP right. Amounts transferred are in acre-feet via “paper” water rights. Can be permanent or temporary trades. The paper right only allows landowners to sell pumping rights to another user overlying same groundwater resource, does not allow a physical transfer of water.

### Platform for trading

Watermaster acts as the clearinghouse for recording water transfers, maintaining records for the transfers and reporting changes in ownership of BAPs.

### Initial Allocation

Judgment establishes decreasing Free Production Allowance (FPA) in each subarea during the first five years. FPA is allocated among producers in the subarea based on each producers’ percentage share of the FPA. All water produced in excess of any producer’s share of the FPA must be replaced by the producer, either through payment to the watermaster (with funds sufficient to purchase replacement water) or by transfer of unused FPA from another Producer.

Each producer’s percentage share of FPA in a subarea was determined by first verifying the maximum annual water production (base annual production, BAP) for each producer during the 5-year base period (1986-1990). Each producers percentage share of the total BAP was calculated, and each percentage

allocation are of equal priority. The sum of the BAPs equal the FPA.

### **Administration: Market Rules and Regulations**

Water users are required to report water production to the Watermaster and pay administrative and biological assessments on that production on a quarterly basis. Replacement and make-up water assessments are applicable when withdrawals from producers exceed their BAP allotment. Watermaster mails a quarterly report and invoice every quarter.

Water that is not used can be carried over into the next year (carryover FPA). Carryover FPA is considered the first water pumped in the current water year, and can be transferred to other users. Carryover FPA must be used within the current year or else it is considered “expired.” Water cannot be ‘borrowed’ from the future.

When property is sold, the base annual production right does not have to be sold to the new owner.

Each producers BAP right must be ramped down in order to mitigate the overdraft conditions in Mojave basin and provide for a scheduled reduction in pumping to balance water production.

Prohibition on physical water transfers (i.e. cannot move water from one place to another, only “paper” transfers of pumping rights), and limits are placed on trading across space and time. Rights tradeable within subareas, such that each subarea acts as it’s own water market.

Groundwater levels stabilize after 1996 but the agricultural revenue declines. 280% increase in property values associated with water rights transactions.

### **Participation**

Any person or entity producing more than 10 acre-feet of water per year by any means (ground or surface water) within the drainage area and Mojave Water Agency boundaries is subject to bound by terms of the court judgment. This includes community districts, investment businesses, recreational associations, land trusts, water districts and private individuals.

### **Data and monitoring**

All water producers must have an accurate way of measuring their water production, per the judgement. This can include flow measuring device, electrical pump test, or other approved method. The Watermaster verifies the water production and reports annually to the courts.

### **References**

Ayres, Andrew B., Kyle C. Meng, and Andrew J. Plantinga. *Do Property Rights Alleviate the Problem of the Commons? Evidence from California Groundwater Rights*. No. w26268. National Bureau of Economic Research, 2019. Available at <https://pdfs.semanticscholar.org/573d/98c3e7adfae6c539d415a254887037df4947.pdf> (accessed 4/13/2020)

Mojave Water Agency. <https://www.mojavewater.org/watermaster.html>.