



CITY OF RIVERSIDE PUBLIC UTILITIES Groundwater Atlas

2024



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Groundwater Atlas

2024





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INTRODUCTION

The Groundwater Atlas aims to provide a comprehensive report on the water quality and quantity conditions of the groundwater basins that provide potable and non-potable water supplies to Riverside Public Utilities' (RPU) customers. This Atlas will support RPU's groundwater management strategies and activities related to managing water supplies in a sustainable and resilient manner.

RPU provides potable, non-potable, and recycled water to the City of Riverside (City). Serving a population of approximately 299,800 residents through 69,340 service connections, the RPU service area spans 75 square miles. In addition, RPU provides surplus potable and non-potable water to Western Municipal Water District, which serves City residents outside of the RPU service area. A small amount of potable water is also supplied to the City of Norco via a wholesale agreement. Since 2009, all of the City's potable water demand has been supplied solely from local groundwater rights as established by the court's Western-San Bernardino 1969 Judgment.

The condition of the groundwater basins is dynamic and influenced by various factors beyond RPU's control, including groundwater contamination from historical agricultural, industrial, and defense practices, natural variations in weather patterns, actions by other agencies,

and evolving State and Federal regulations. These basins are shared with other water providers and their associated water infrastructure, such as well fields, groundwater recharge facilities, and wastewater treatment plants. The operation of these facilities combined with regional hydrologic variance adds to the complexity of managing these resources. To ensure a reliable and sustainable water supply for both current and future generations, RPU closely tracks annual groundwater basin conditions. This 2024 edition of the Groundwater Atlas presents data collected from January 1, 2024, to December 31, 2024, and provides insights into groundwater hydrology, production, recharge, levels, and quality.

The purpose of this Groundwater Atlas is to:

- Characterize groundwater basin conditions and how they change over time.
- Provide readable and reliable data to customers, elected officials, executive management, and staff.
- Provide information and analysis to RPU staff for use in managing the City's water supply.
- Protect RPU's strong water supply position and financial stability.

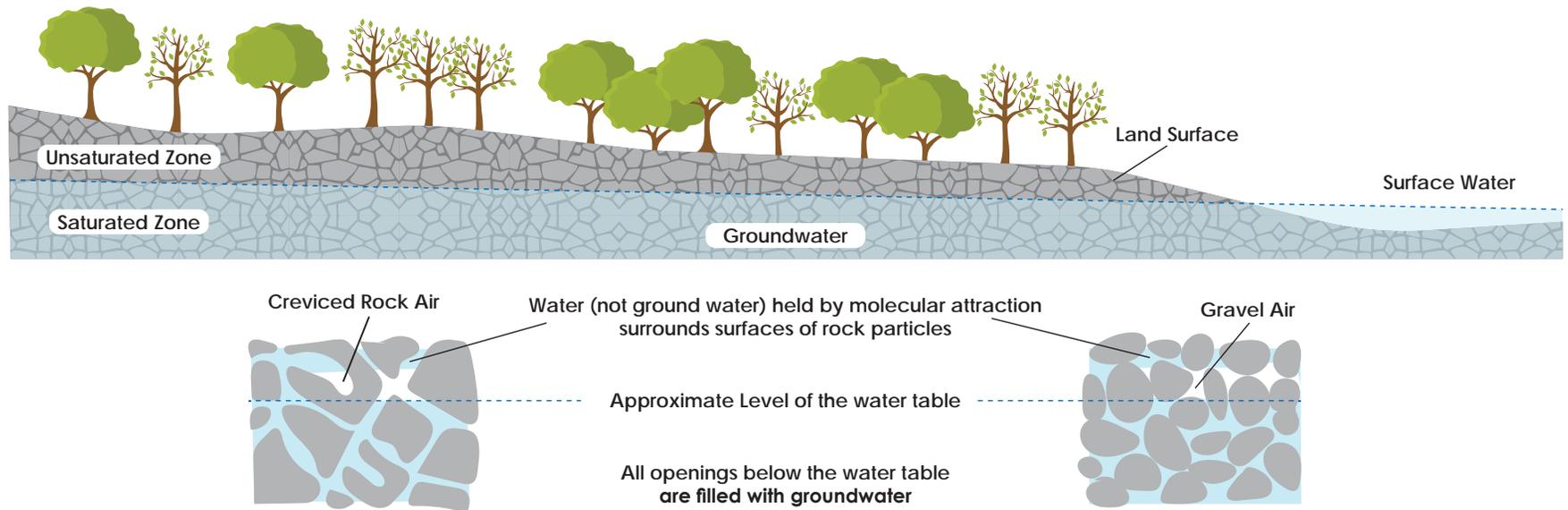


Fairmount Park Monument Sign

ABOUT OUR GROUNDWATER BASINS

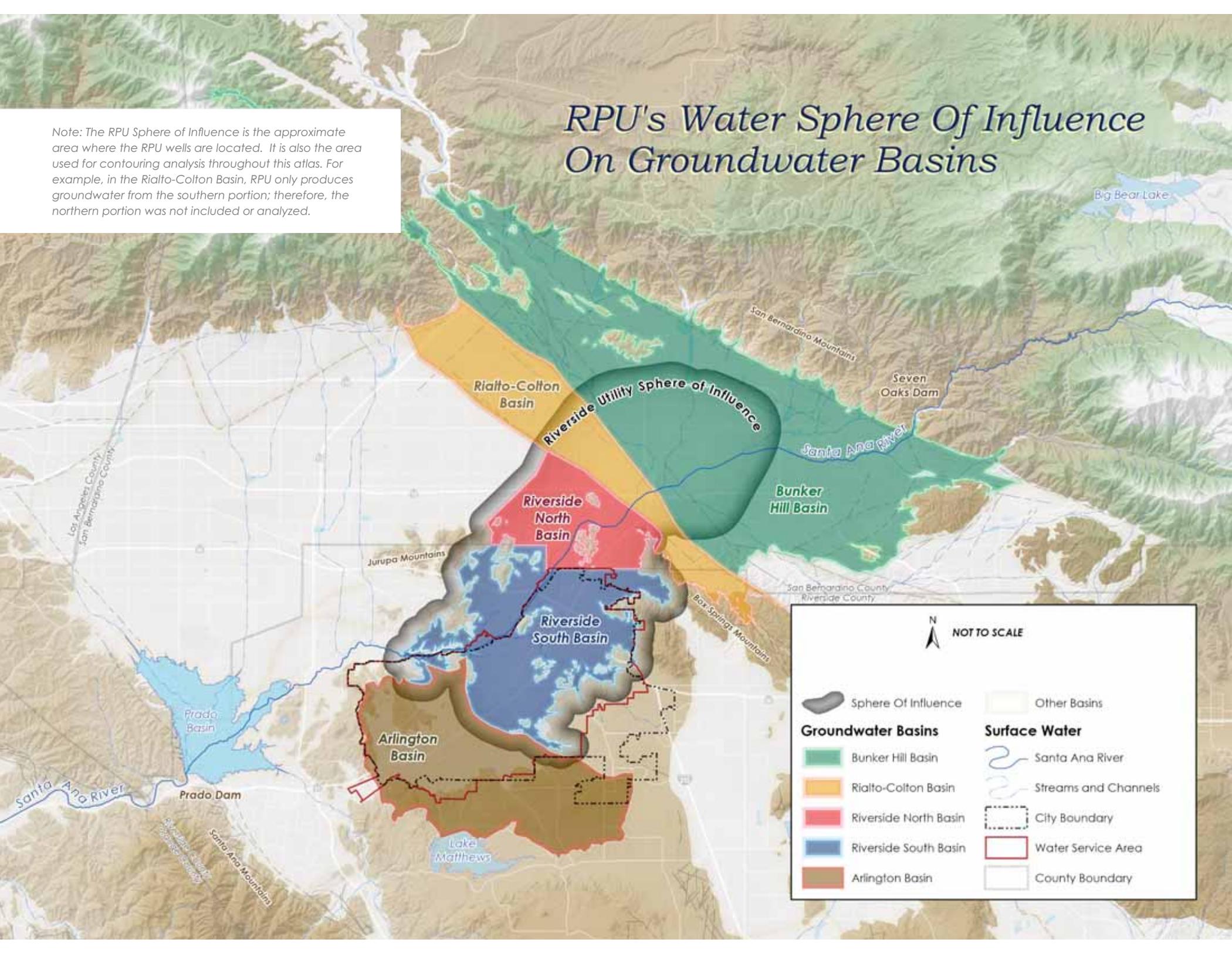
The City of Riverside was developed around the once prolific water supply of the Santa Ana River. Our groundwater basins are significantly influenced by the tectonic forces of the San Andreas and San Jacinto faults. The San Jacinto fault limits the movement of groundwater and forces shallow groundwater to the surface. The San Jacinto Fault, in conjunction with semi-confining clay zone's helped to pressurize portions of the groundwater beneath the City of San Bernardino. As the surface water flows from the Santa Ana River diminished from weather patterns and regional development in the late 1800s, RPU took advantage of the seismically-influenced groundwater basins to drill and construct artesian wells. The artesian wells acted as a conduit, allowing pressurized water to escape freely from the ground. As these pressures and high groundwater levels decreased in the early 1900s, RPU began equipping these groundwater wells with pumps. Today, groundwater levels and pressures have subsided to some of the lowest levels in recent times. However, the aquifer remains a prolific and productive source for local groundwater.

RPU's water supplies come from groundwater basins consisting of underground geologic formations called aquifers that are fed by rain and snow melting in the San Bernardino Mountains and local foothills and is illustrated in the graphic below. RPU produces water from four groundwater basins adjacent to the Santa Ana River including the Bunker Hill, Rialto-Colton, Riverside North and Riverside South Basins as shown in the figure on the adjacent page. Over the years, RPU has constructed infrastructure that enables efficient groundwater management, achieving complete independence from imported water supplies since 2009.



RPU's Water Sphere Of Influence On Groundwater Basins

Note: The RPU Sphere of Influence is the approximate area where the RPU wells are located. It is also the area used for contouring analysis throughout this atlas. For example, in the Rialto-Colton Basin, RPU only produces groundwater from the southern portion; therefore, the northern portion was not included or analyzed.



N
NOT TO SCALE

 Sphere Of Influence	 Other Basins
Groundwater Basins	Surface Water
 Bunker Hill Basin	 Santa Ana River
 Rialto-Colton Basin	 Streams and Channels
 Riverside North Basin	 City Boundary
 Riverside South Basin	 Water Service Area
 Arlington Basin	 County Boundary



Enhanced Recharge Project



01 HYDROLOGIC CONDITIONS

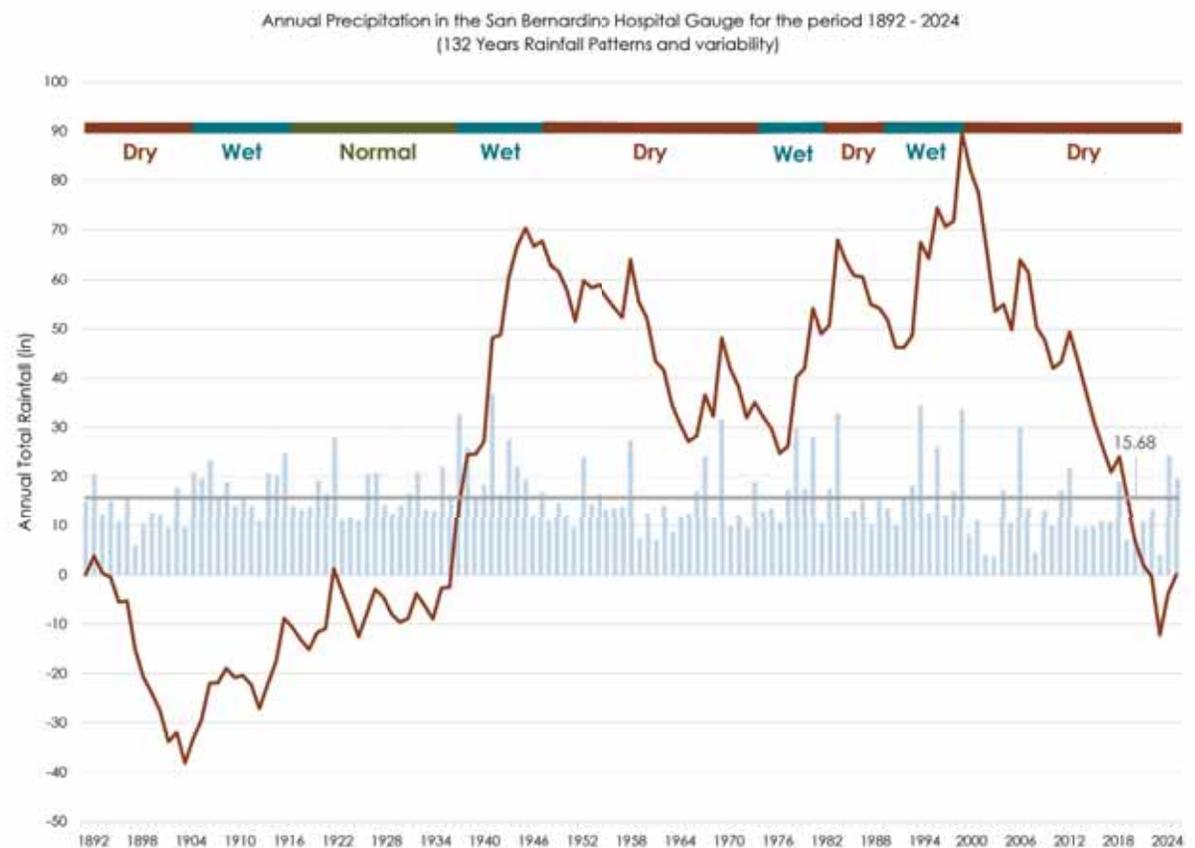
HYDROLOGIC CONDITIONS

Both regional and local hydrologic conditions fluctuate year to year. Understanding the relationships between meteorological, surface water, groundwater, and biological factors that influence the flow, quality, and recharge of water in a groundwater basin is important and can have significant impacts on local water supplies.

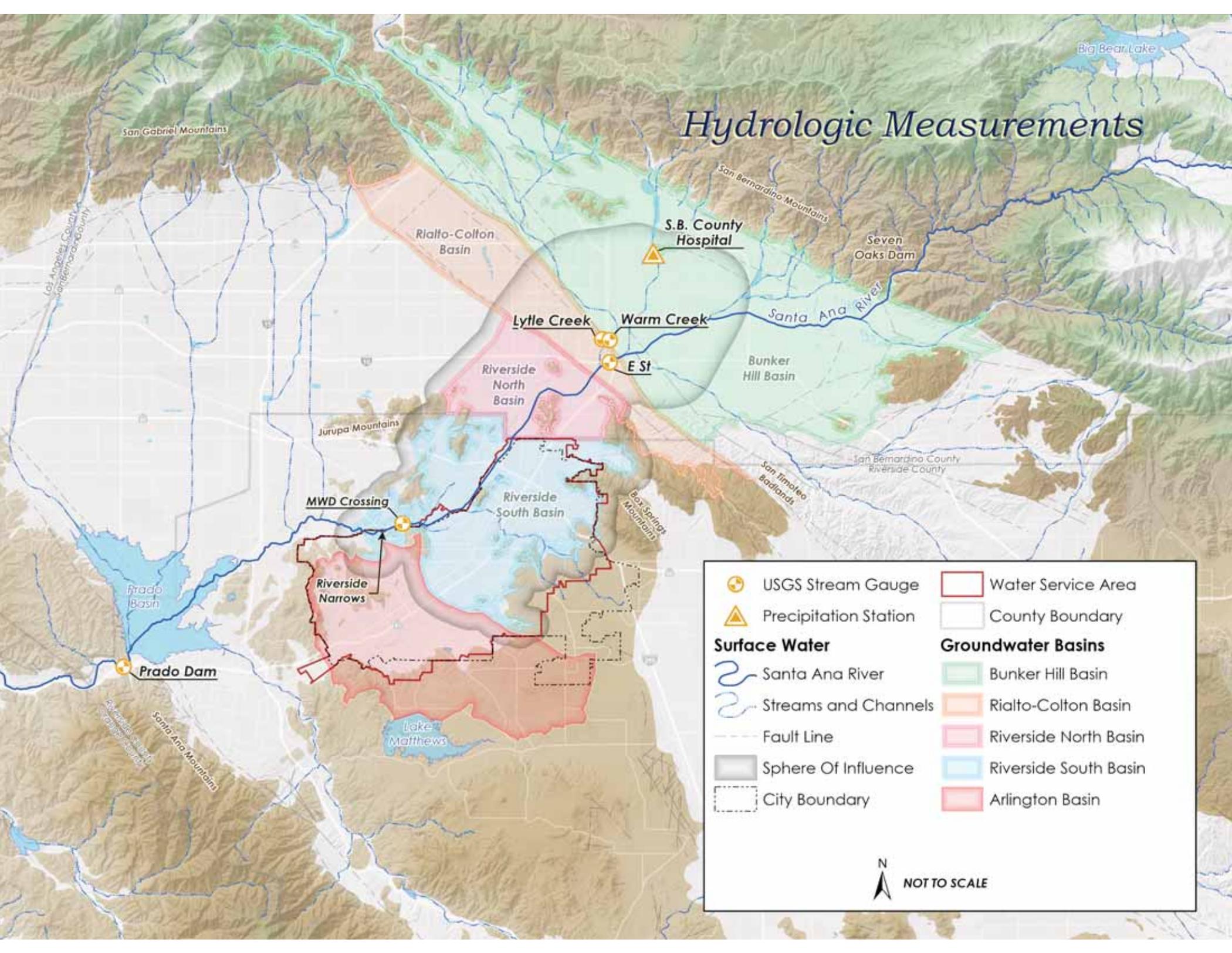
RPU participates in monitoring the hydrologic conditions of the region through measurements of precipitation and flow in the Santa Ana River and its tributaries. The primary source of recharge to the groundwater basins is precipitation. The region uses a precipitation gage of San Bernardino County to characterize long-term meteorological conditions. The average annual rainfall over historical record was about 15.68 inches and 10.6 inches in the last 10 years (2014 -2024) during an extended dry period. The following chart shows the cumulative departure from mean (CDFM) precipitation. The CDFM plot characterize the occurrence and magnitude of wet upward trend), dry (downward trend), and normal periods (flat trend). These trends are labeled at the top of the chart. The period from 1999 until 2024 shows a 26-year dry period with eight wet years during this period.

Historical Annual Precipitation (San Bernardino County Hospital Gage)

San Bernardino's average annual precipitation over the last 132 years is 15.68 inches.



Hydrologic Measurements

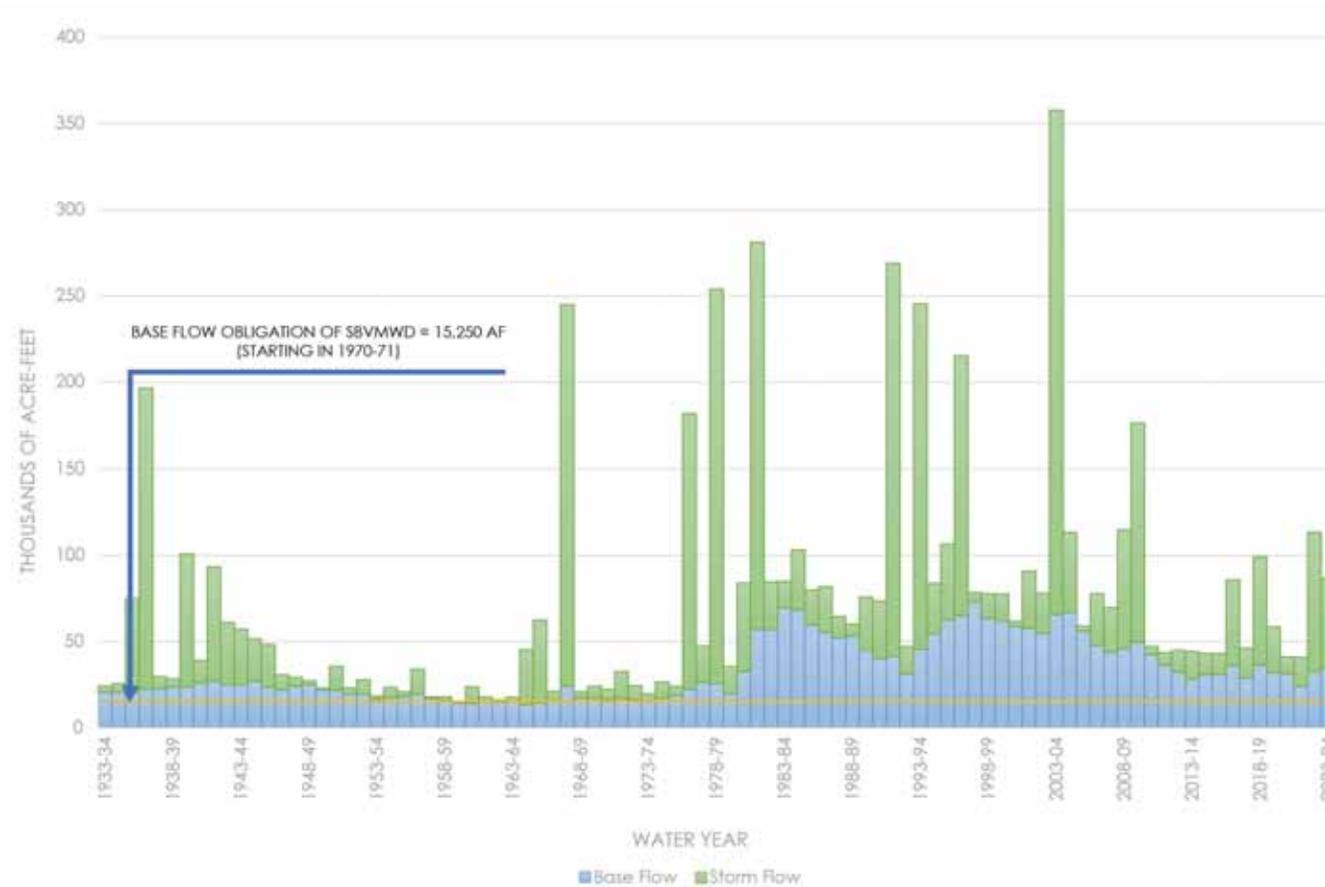


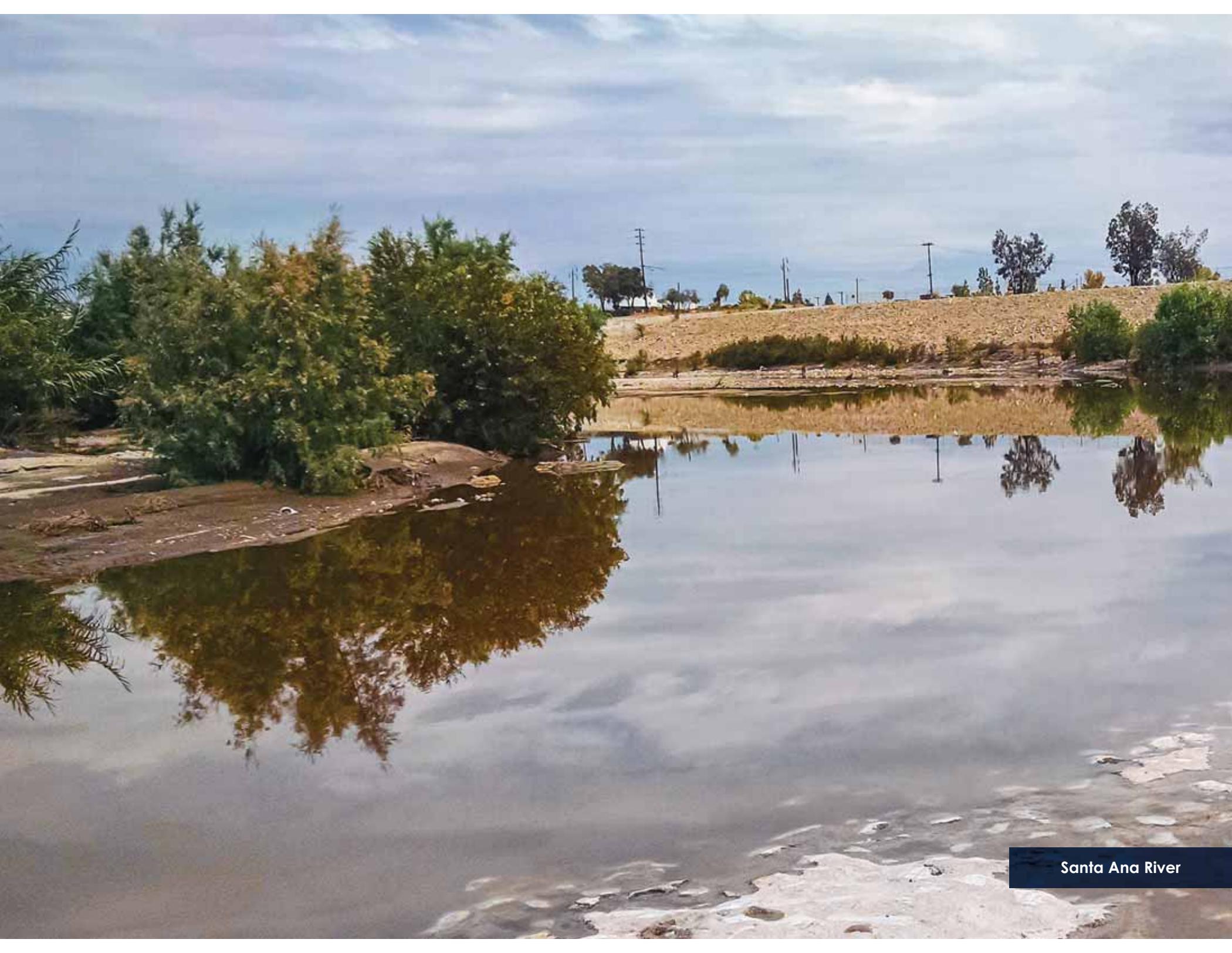
- USGS Stream Gauge
- Precipitation Station
- Surface Water**
 - Santa Ana River
 - Streams and Channels
 - Fault Line
 - Sphere Of Influence
 - City Boundary
- Groundwater Basins**
 - Bunker Hill Basin
 - Rialto-Colton Basin
 - Riverside North Basin
 - Riverside South Basin
 - Arlington Basin
- Water Service Area
- County Boundary

N
NOT TO SCALE

The Santa Ana River Watermasters characterize the hydrology in the region by quantifying the flow in the Santa Ana River at Riverside Narrows, and RPU monitors the data. The flow is measured by the United States Geological Survey (USGS) at a gaging station named Santa Ana River at MWD Crossing (USGS-11066460) near the Riverside narrows. The chart below illustrates the annual time series of the baseflow and stormwater flow at the MWD Crossing station. Baseflow is the portion of streamflow that is sustained between precipitation events and primarily consists of effluent from municipal wastewater treatment plants located along the river as well as groundwater rising to the surface due to shallow bedrock. Minimum baseflow discharges were identified by water managers in the 1960s to ensure that everyone along the Santa Ana River had enough water supplies for beneficial uses. The data is utilized to measure compliance with water rights, ensuring that the Orange County agencies have the quantity and quality that was agreed to in the 1969 Judgment.

Discharge of Santa Ana River at Riverside Narrows starting with 1934-35





Santa Ana River



Canyon Crest Booster Station



02

**GROUNDWATER
RESOURCES
MANAGEMENT**

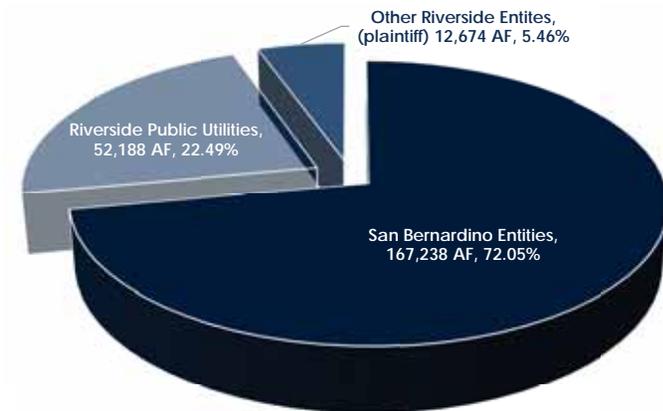
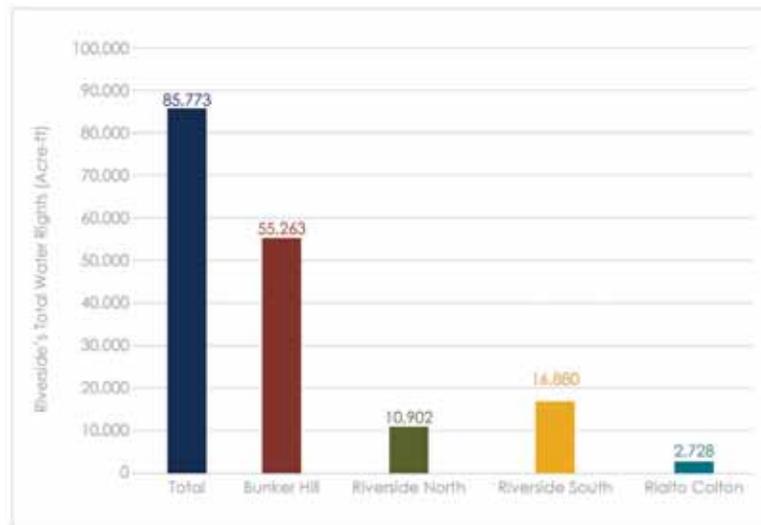
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GROUNDWATER RESOURCES MANAGEMENT

The City started developing water supplies from the region in the 1870s. Since this time, RPU and its customers/owners have continually improved its water conveyance system and have strategically and cost-effectively developed the City's water supply from key locations within the groundwater basins.

RPU keeps its customers and decision-makers informed with the best available data and management practices. In turn, this has preserved the City's strong regional water rights and superior water quality by holding responsible parties accountable. The City actively defends its water rights, which were clearly defined "through the adjudication process of" the 1969 Judgment. RPU management maintains a close dialogue with the Western-San Bernardino Watermaster to ensure groundwater compliance with the Judgment is maintained. As the groundwater conditions continue to change and new challenges emerge, RPU continues to assess the groundwater conditions and inform its customers and public representatives of the conditions and the best management practices to move the City forward with a reliable water supply portfolio of local water supplies. As a plaintiff party to the Western-San Bernardino Judgment, the City's total water right and base period production is 85,773 AF.

The City of Riverside Total Water Right and Base Period Production (in acre-feet) by Basin



The original division of water resources in the San Bernardino Basin Area.

Source: Physical Solution Western-San Bernardino Watermaster

RPU Groundwater Extraction Or Export Rights

Groundwater Basin	Extraction or Export Rights
Bunker Hill	55,263 AFY
Rialto-Colton	2,728 AFY
Riverside North	16,880 AFY
Riverside South	10,902 AFY
TOTAL	85,773 AFY

Surface Water

- Santa Ana River
- Streams and Channels

RPU Groundwater Extraction Rights

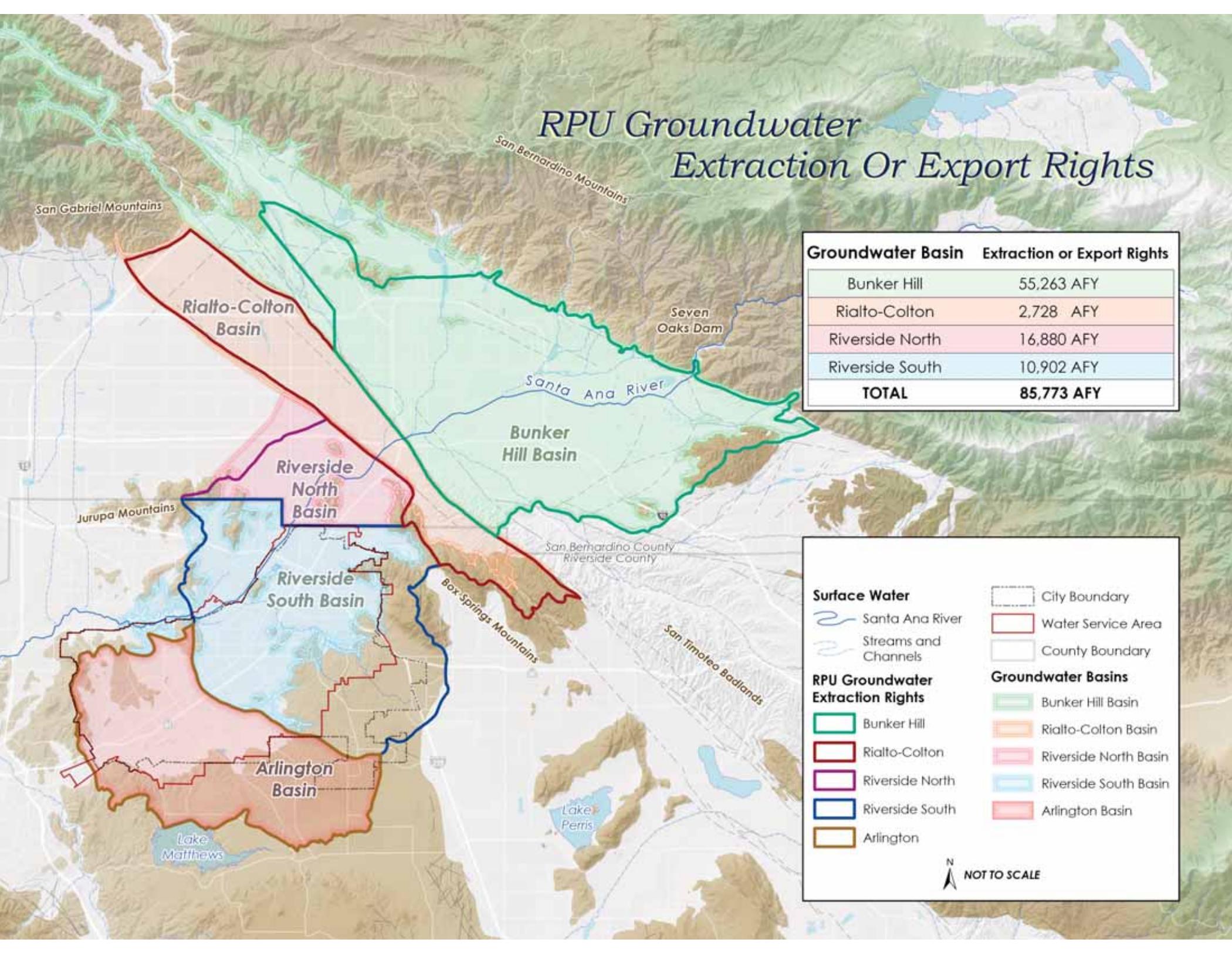
- Bunker Hill
- Rialto-Colton
- Riverside North
- Riverside South
- Arlington

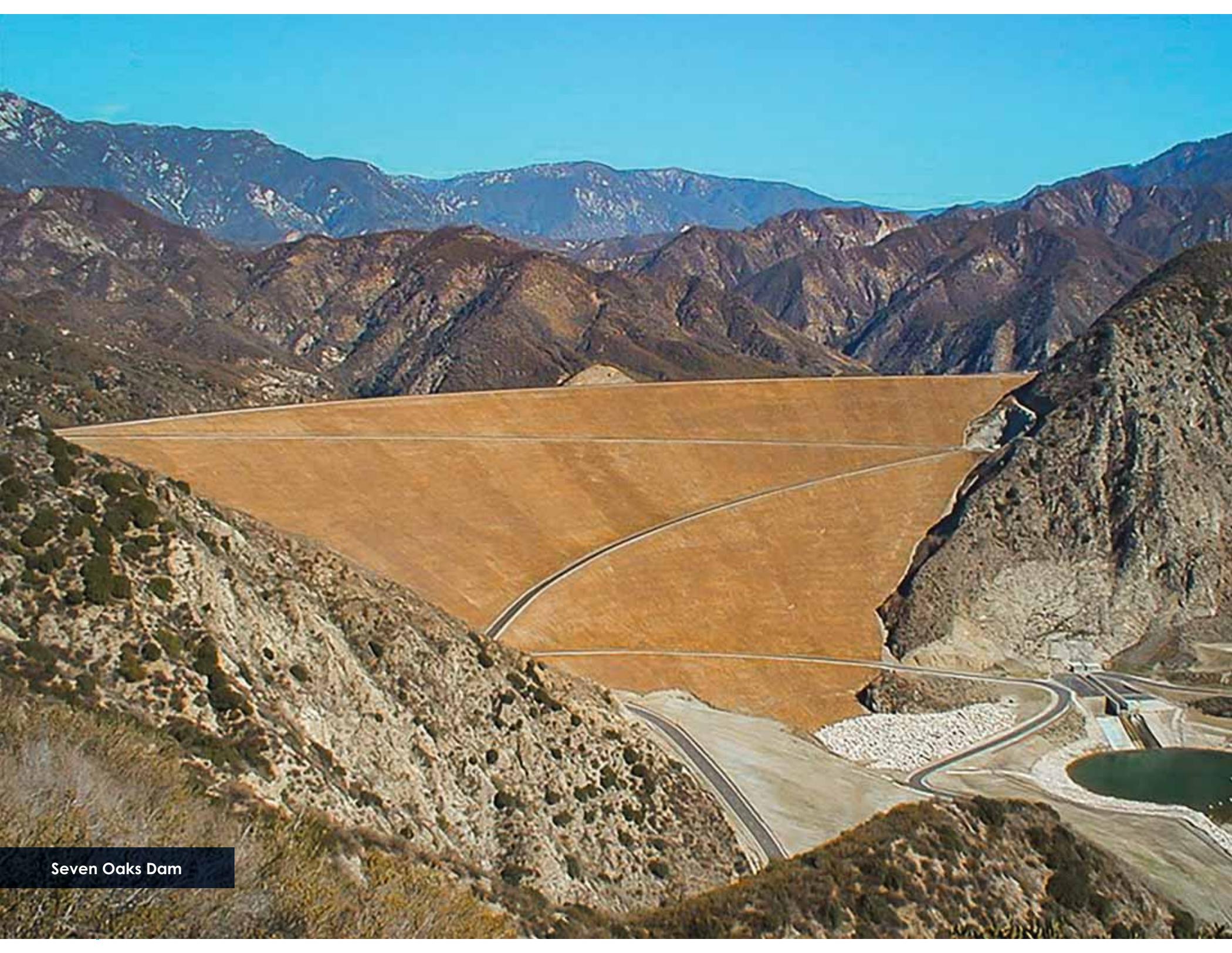
- City Boundary
- Water Service Area
- County Boundary

Groundwater Basins

- Bunker Hill Basin
- Rialto-Colton Basin
- Riverside North Basin
- Riverside South Basin
- Arlington Basin

N
NOT TO SCALE





Seven Oaks Dam



03

**GROUNDWATER
PRODUCTION**

3

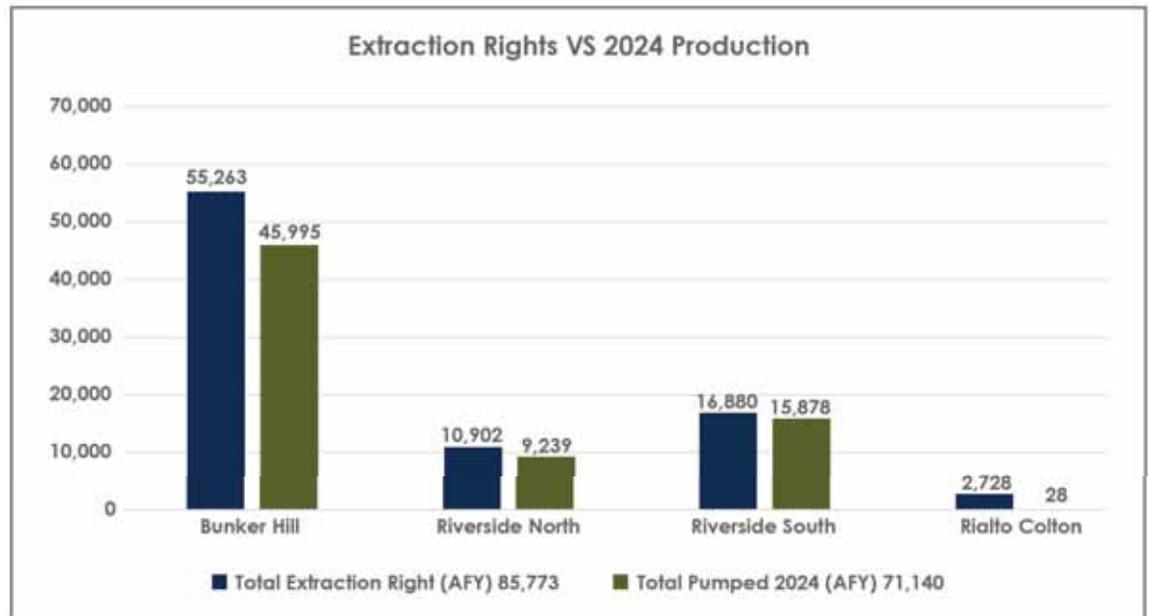
GROUNDWATER PRODUCTION

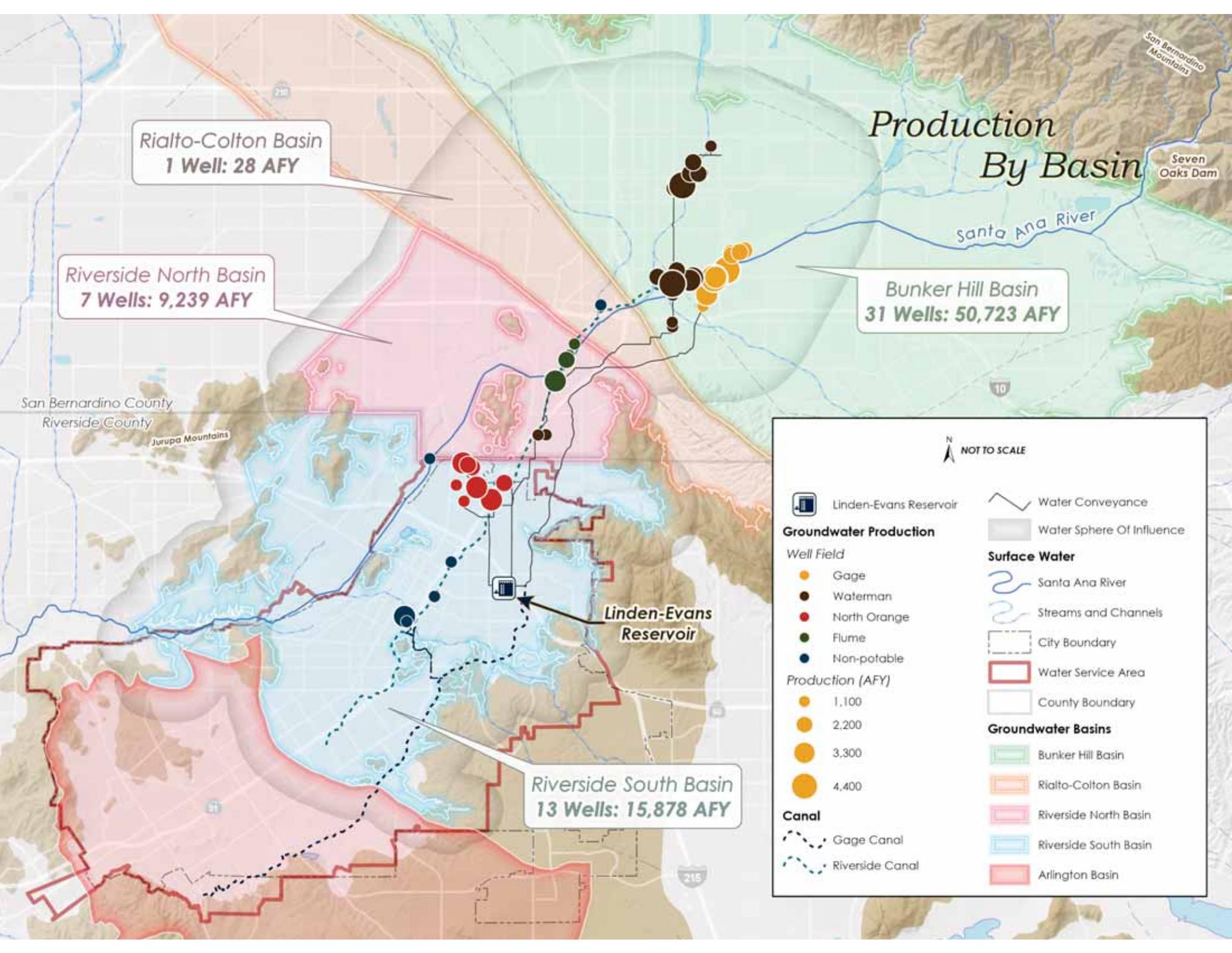
RPU has over 52 active wells located in five well fields that produce groundwater from the Bunker Hill, Rialto-Colton Basin, Riverside North, and Riverside South groundwater basins. The majority of groundwater is produced from the Waterman and Gage well field located in the Bunker Hill Basin.

Groundwater extracted from the groundwater basins is conveyed via pipeline to RPU's potable or non-potable distribution system based on the well location and demand. Raw groundwater from all of RPU's wells receives some form of treatment prior to entering the potable distribution system. In 2024, RPU operated 45 active potable water wells and 7 active non-potable water wells, for a total of 52 active wells. In addition, a portion of the treated potable water produced along the Gage pipeline is used for irrigation purposes by Gage Canal Company (GCC) customers located within Riverside's "Greenbelt".

Since 2009, 100% of RPU's water supplies have originated from the groundwater basins, Flume, Gage, North Orange, Rialto-Colton, and Waterman well fields. RPU's wells are generally located in the section of the basin, with the greatest thickness of water-bearing layers, in which 71,140 AF were pumped in 2024 under the City's water right and the rest 4,727 AF were wheeled to WMWD under their water right. Approximately 75,868 acre-feet, which equal to 24.65 billion gallons, of water were extracted from aquifers in 2024 to supply water to the RPU service area and wheeled water to WMWD. The Western-San Bernardino Watermaster prepares an annual report presenting groundwater production data, while the Santa Ana River Watermaster prepares an annual report on the surface water flows along the Santa Ana River. These annual Watermaster reports are issued and submitted to the court annually to comply with the 1969 Judgment, which set surface water and groundwater rights for the region.

Groundwater Production by Basin in 2024





Rialto-Colton Basin
1 Well: 28 AFY

Riverside North Basin
7 Wells: 9,239 AFY

Bunker Hill Basin
31 Wells: 50,723 AFY

Riverside South Basin
13 Wells: 15,878 AFY

Linden-Evans Reservoir

NOT TO SCALE

Linden-Evans Reservoir [Reservoir Icon]

Groundwater Production

Well Field

- Gage [Orange Circle]
- Waterman [Black Circle]
- North Orange [Red Circle]
- Flume [Green Circle]
- Non-potable [Blue Circle]

Production (AFY)

- 1,100 [Small Orange Circle]
- 2,200 [Medium Orange Circle]
- 3,300 [Large Orange Circle]
- 4,400 [Very Large Orange Circle]

Canal

- Gage Canal [Dashed Line]
- Riverside Canal [Dotted Line]

Water Conveyance [Line with Ticks]

Water Sphere Of Influence [Shaded Area]

Surface Water

- Santa Ana River [Blue Wavy Line]
- Streams and Channels [Light Blue Wavy Line]

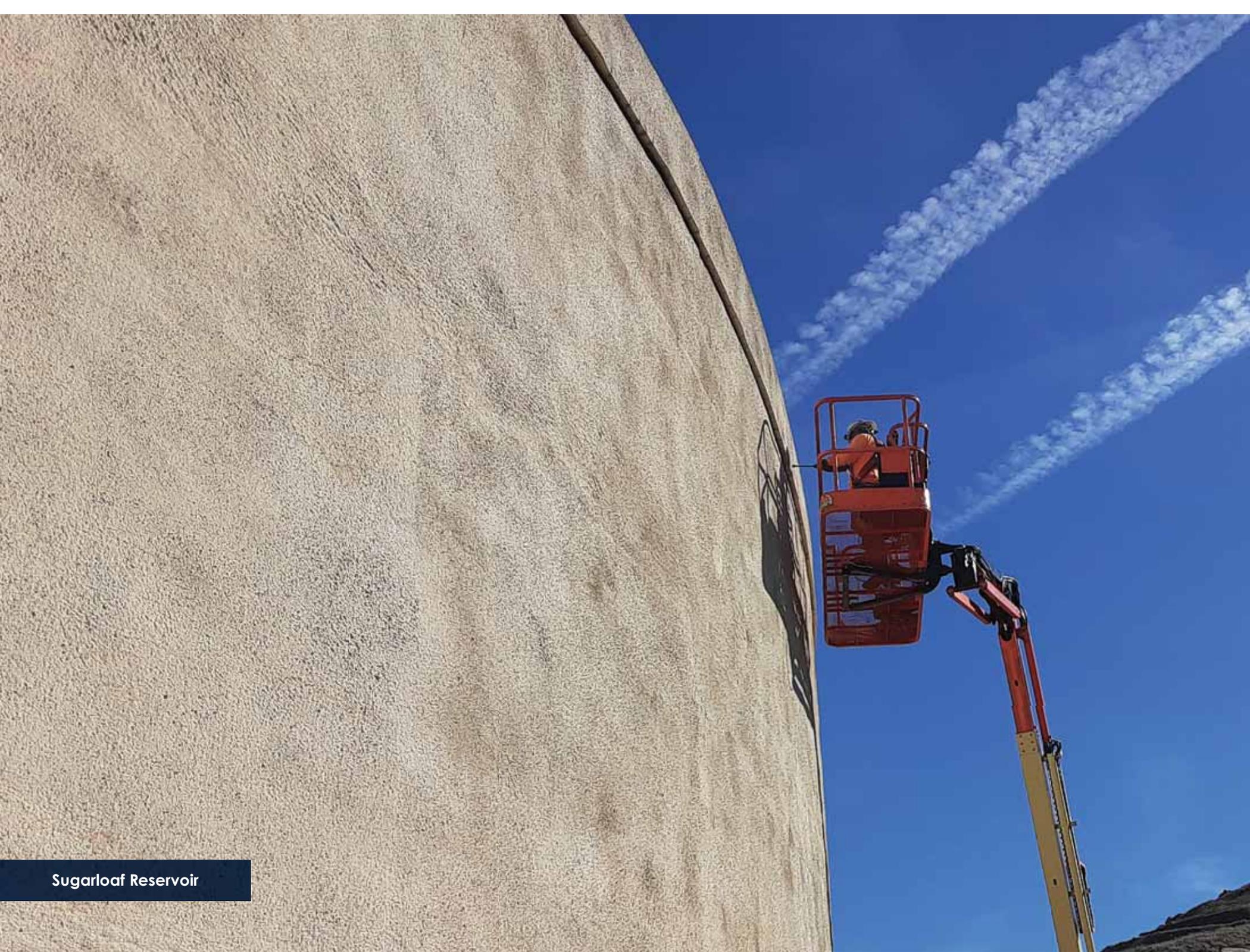
City Boundary [Dashed Line]

Water Service Area [Red Outline]

County Boundary [Grey Outline]

Groundwater Basins

- Bunker Hill Basin [Green Outline]
- Rialto-Colton Basin [Orange Outline]
- Riverside North Basin [Pink Outline]
- Riverside South Basin [Light Blue Outline]
- Arlington Basin [Red Outline]



Sugarloaf Reservoir



04 GROUNDWATER FACILITIES

4

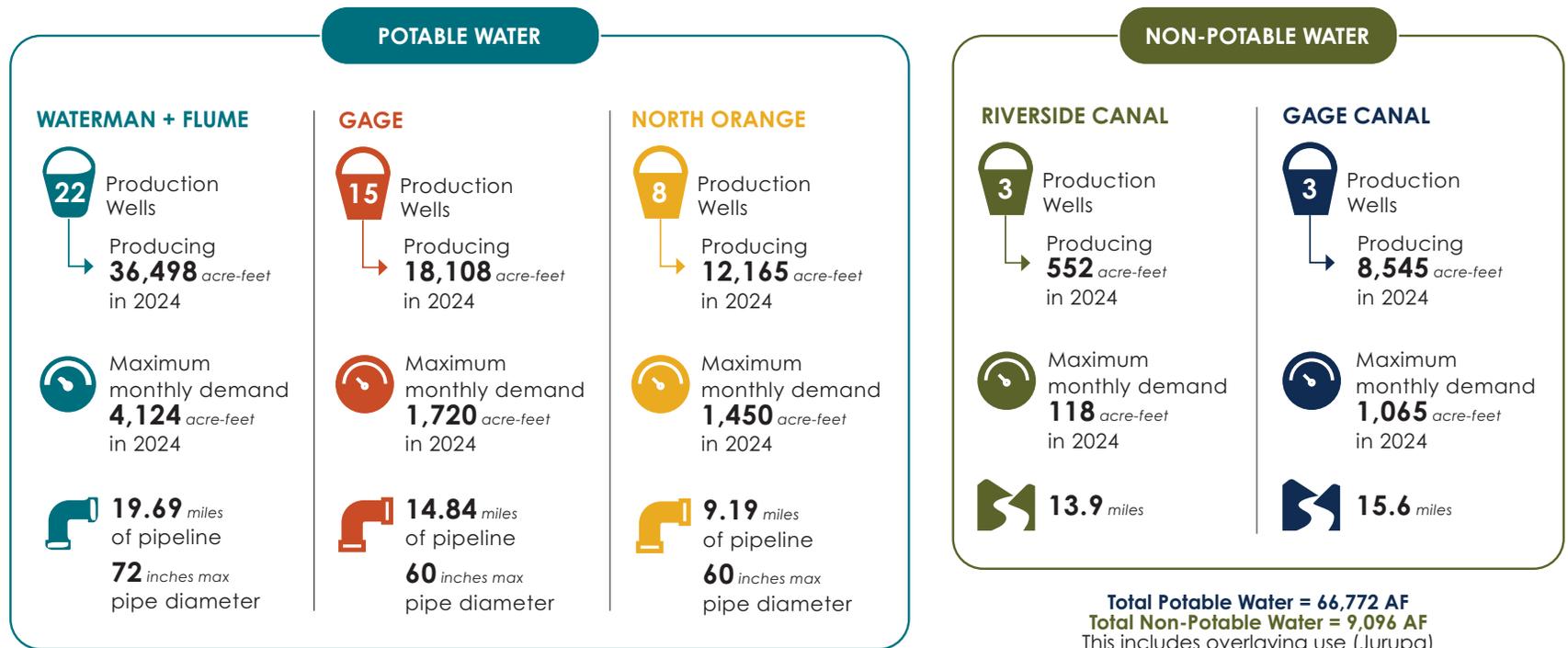
GROUNDWATER FACILITIES

RPU has a vast network of conveyance facilities to deliver the groundwater produced from the basins to its customers through wells, treatment facilities, pipelines, reservoirs, and canals. RPU relies on these facilities and maintains them to ensure a reliable water supply throughout every season of the year.

Since 2009, all the City's water demand has been supplied from local groundwater sources in the Bunker Hill and Riverside basins.

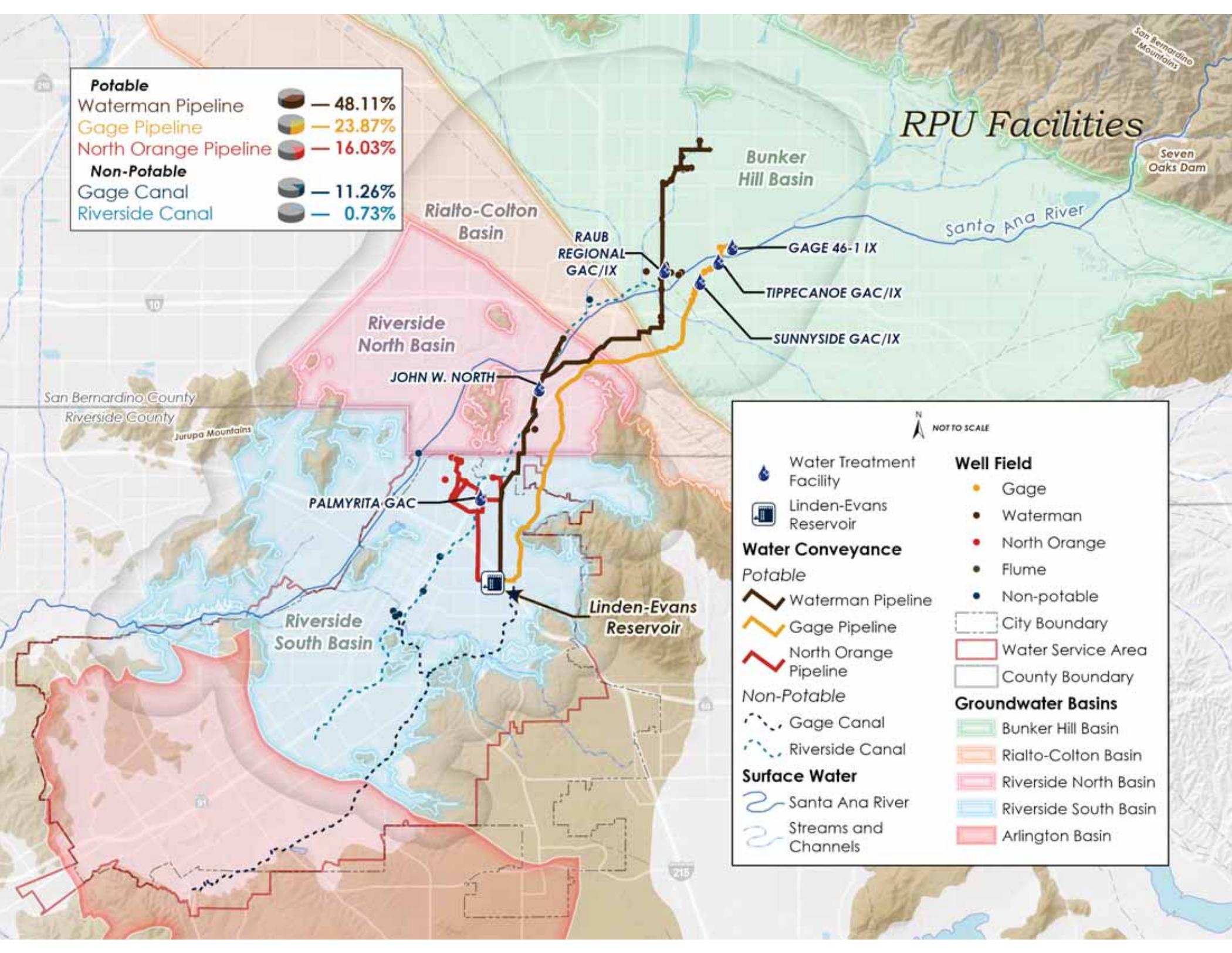
RPU's potable water is conveyed via the Waterman, Gage, and North Orange distribution main pipelines to RPU customers. RPU's non-potable water is delivered by the Riverside and the Gage Canal to the WMWD and GCC respectively. Reports are prepared annually presenting groundwater production data and water quality.

Groundwater Well Production and Pipes



RPU Facilities

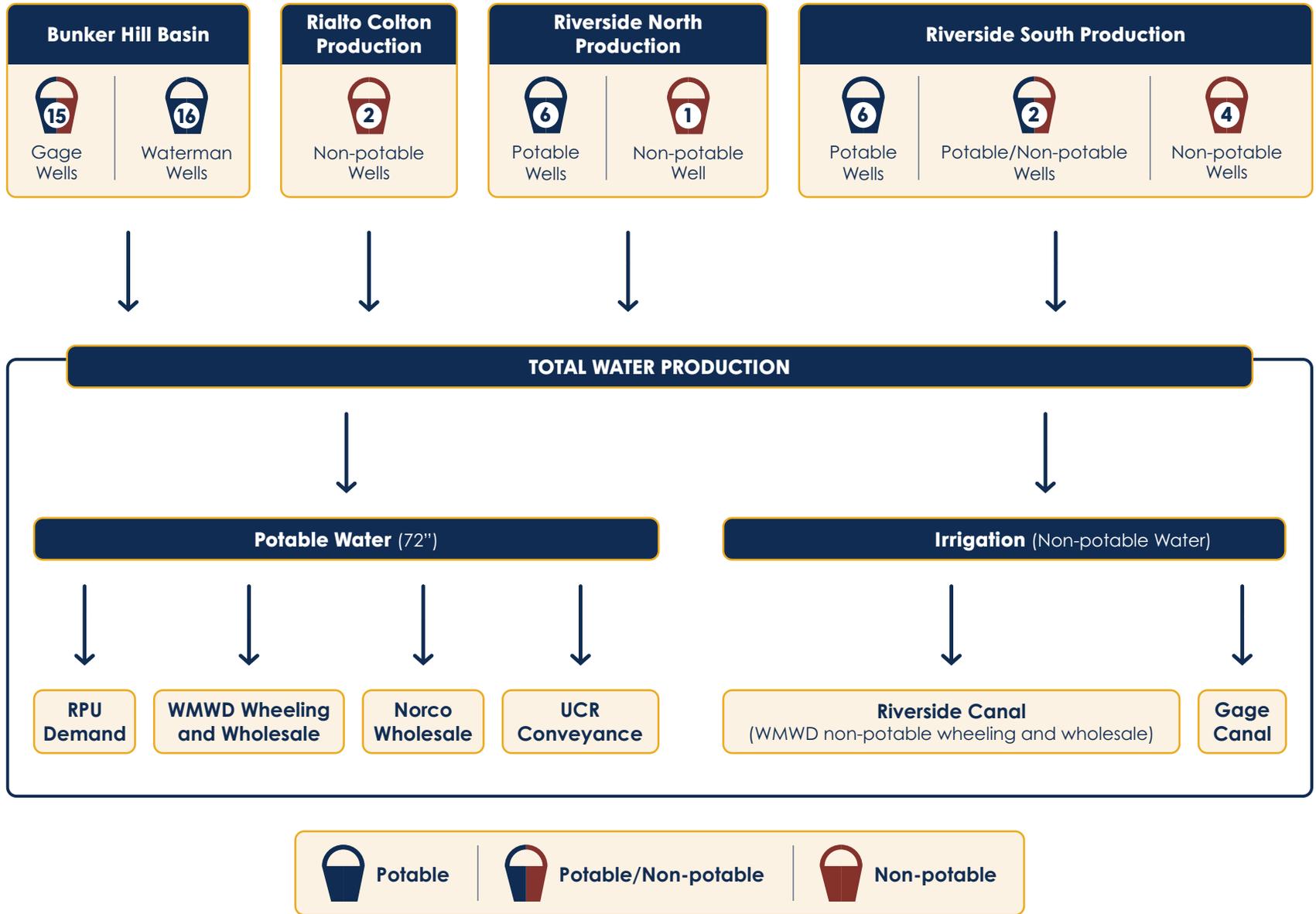
Potable	
Waterman Pipeline	— 48.11%
Gage Pipeline	— 23.87%
North Orange Pipeline	— 16.03%
Non-Potable	
Gage Canal	— 11.26%
Riverside Canal	— 0.73%

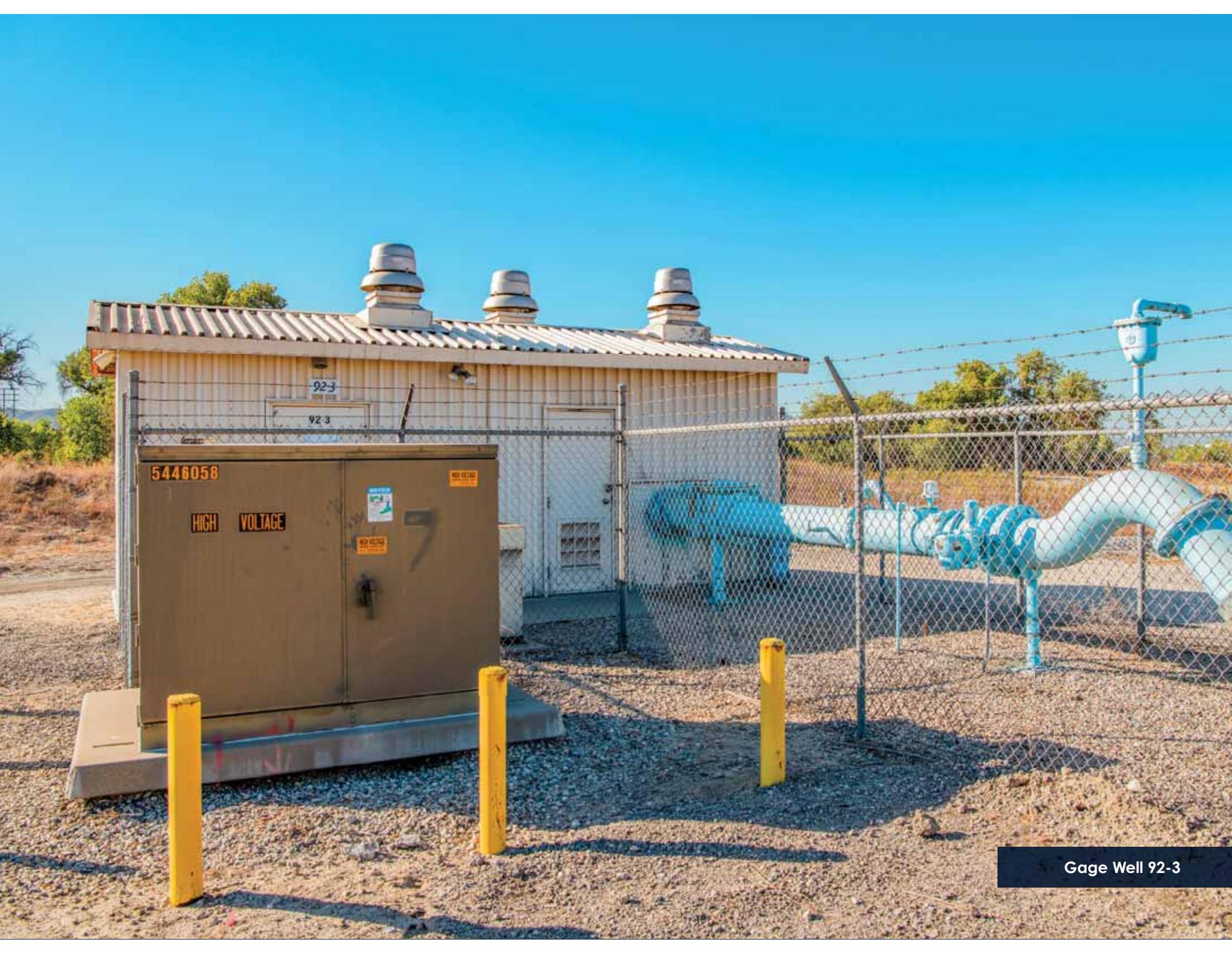


NOT TO SCALE

	Water Treatment Facility	Well Field
	Linden-Evans Reservoir	Gage
Water Conveyance		Waterman
Potable		North Orange
	Waterman Pipeline	Flume
	Gage Pipeline	Non-potable
	North Orange Pipeline	City Boundary
Non-Potable		Water Service Area
	Gage Canal	County Boundary
	Riverside Canal	Groundwater Basins
Surface Water		Bunker Hill Basin
	Santa Ana River	Rialto-Colton Basin
	Streams and Channels	Riverside North Basin
		Riverside South Basin
		Arlington Basin

RPU Water Production





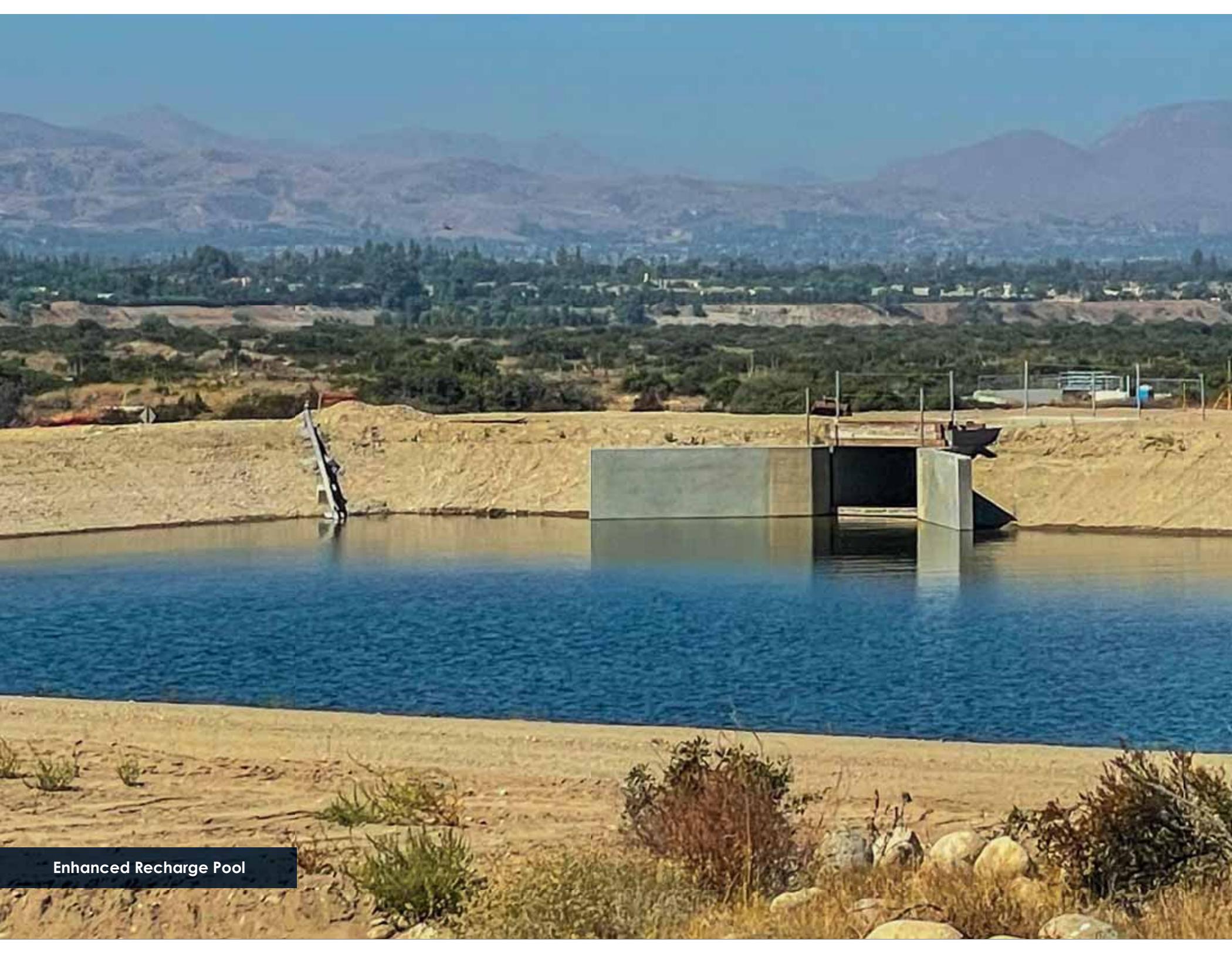
92-3

92-3

5446058

HIGH VOLTAGE

Gage Well 92-3



Enhanced Recharge Pool



05

GROUNDWATER LEVELS

5

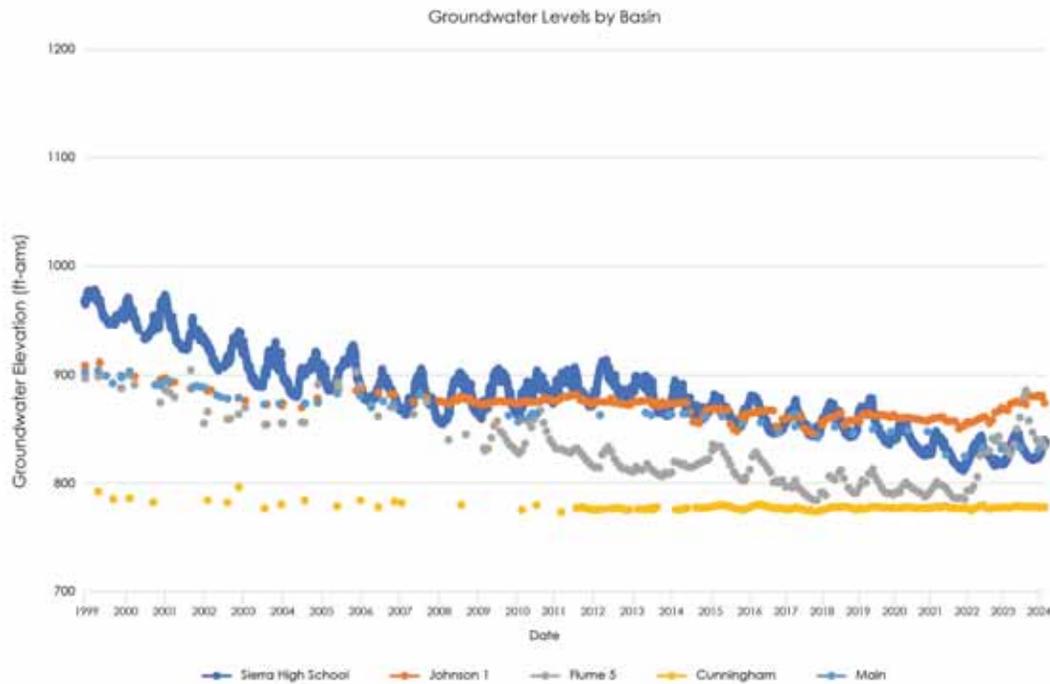
GROUNDWATER LEVELS

Overall groundwater conditions—specifically water levels—are unique to each basin. Tracking water levels throughout a basin can be used to understand how water levels respond to varying conditions (i.e., drought, groundwater pumping, recharge). RPU routinely measures water levels from their wells and uses this data to evaluate both short- and long-term trends. By collecting and evaluating this data, and understanding the factors driving changing conditions, RPU can act as environmental stewards, collaborate effectively with other local water agencies, and strategically plan future investments to ensure a reliable groundwater supply.

In 2024, RPU obtained over 100 water level measurements to determine the depth-to-water, flow direction, and gradient of groundwater in each basin. Groundwater elevations are calculated by subtracting the water level measurement from the surface elevation at each well. This information is then compared to historical data to identify trends in recharge and groundwater usage. Groundwater elevations are also contoured to identify pumping depressions, flow directions, areas of higher gradient, or areas that may be lower at depths to groundwater than anticipated. Over the last 20 years, average groundwater elevations have dropped over 100 feet in the Bunker Hill Basin with some areas having 200 feet in groundwater elevation change.

This section displays a series of maps showing the groundwater levels in 2023 and 2024 and the change in groundwater levels from 2023 to 2024. To illustrate the change in groundwater levels over the last 10 years, corresponding to the most recent drought, groundwater elevation contours were generated for 2014 and 2024 and the change in water levels.

Groundwater Levels by Basin



The figure above shows a time series of groundwater levels from representative wells located in Riverside’s sphere of influence, overlying the groundwater basins from 1999 to the end of 2024. Each dot represents a groundwater level measurement and is plotted over time to identify trends. The chart shows how groundwater basins respond to hydrologic conditions and groundwater pumping. The groundwater levels in the respective basins represent a long-term decline in groundwater levels. Sierra High School, located in the Bunker Hill Basin, shows groundwater level declines of about 4.7 ft/yr. Johnson 1, located in the Rialto-Colton Basin, shows groundwater level declines of about 1.0 ft/yr. Flume 5, located in the Riverside North Basin, shows groundwater level declines of about 2.1 ft/yr. Cunningham, located in the Riverside South Basin, have been relatively stable with groundwater level declines of about 0.3 ft/yr over a 25-year time period.

Rate of Groundwater Level Decline from 1999 to 2024 within RPU’s Sphere of Influence



BUNKER HILL

Decline of about 4.7 ft/yr



RIALTO-COLTON

Decline of about 1.0 ft/yr



RIVERSIDE NORTH

Decline of about 2.1 ft/yr

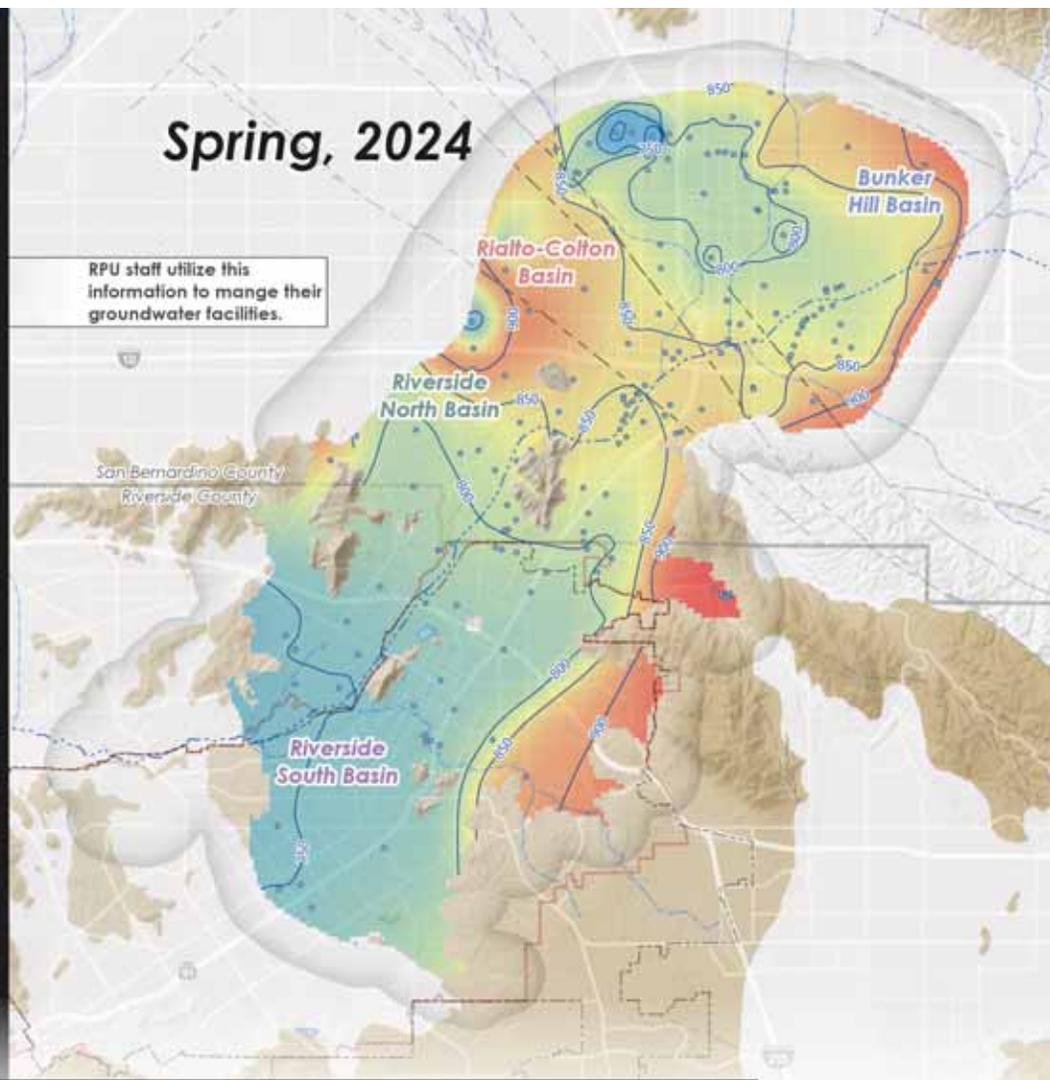
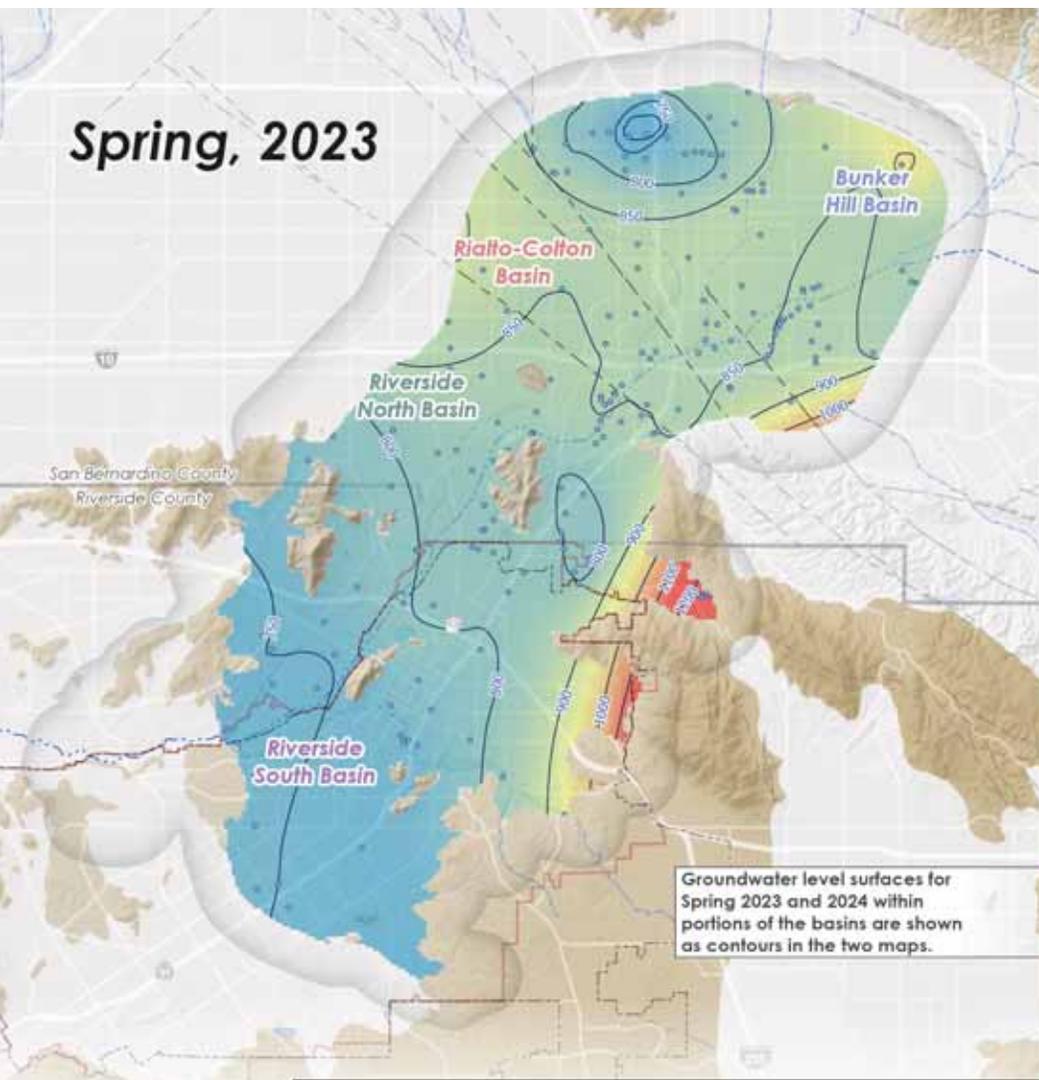


RIVERSIDE SOUTH

Decline of about 0.3 ft/yr

Spring, 2023

Spring, 2024



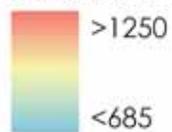
Groundwater level surfaces for Spring 2023 and 2024 within portions of the basins are shown as contours in the two maps.

1-Year Change (Water Level)

Surface Water

- Santa Ana River
- Streams and Channels

Groundwater Elevation (ft-amsl) (feet above mean sea level)



Groundwater Levels

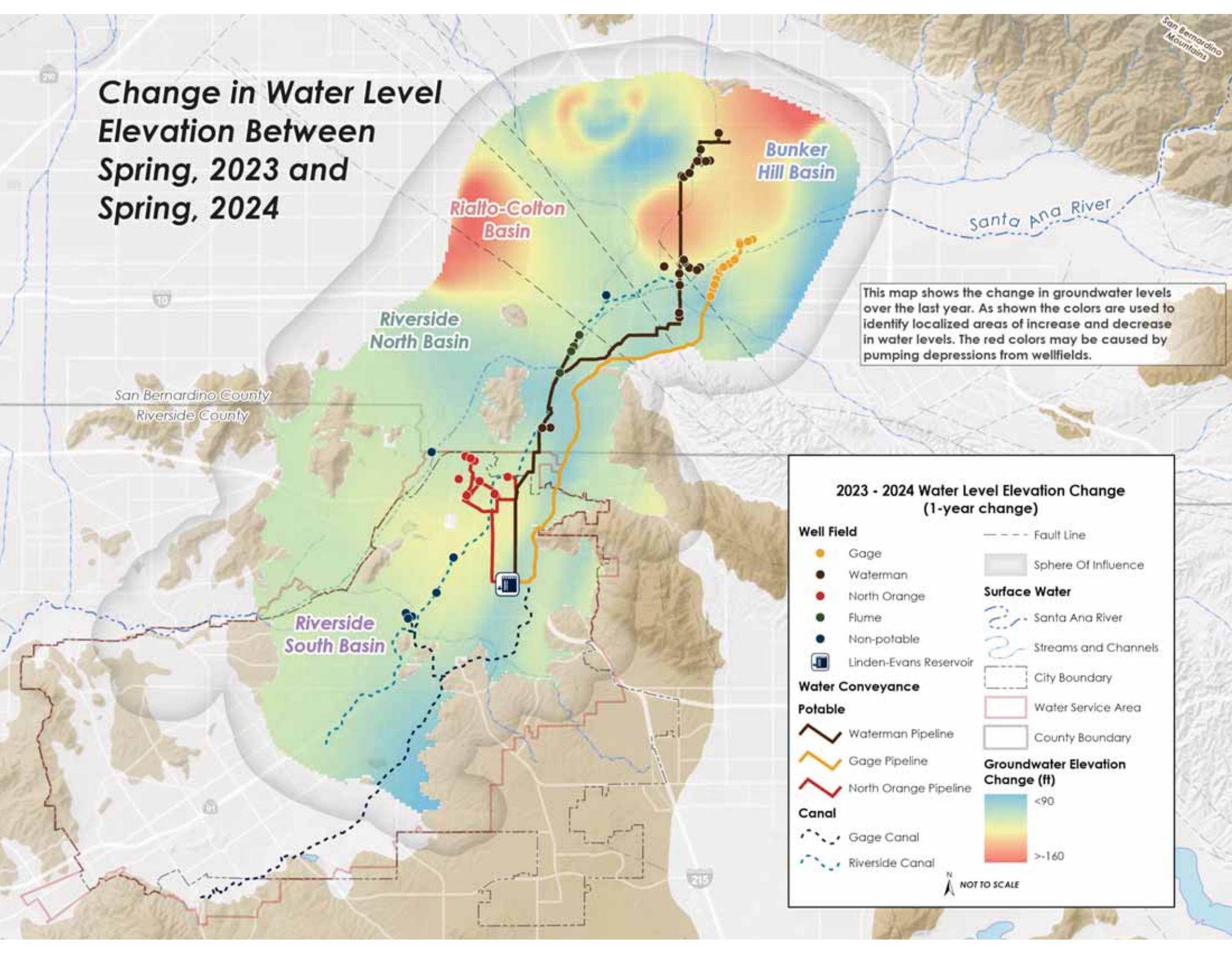
- Groundwater Elevation Point (Regional Wells)
- Groundwater Elevation Contour (50 ft-amsl)



NOT TO SCALE

- Fault Line
- Sphere Of Influence
- City of Riverside**
 - City Boundary
 - Water Service Area
 - County Boundary

Change in Water Level Elevation Between Spring, 2023 and Spring, 2024



This map shows the change in groundwater levels over the last year. As shown the colors are used to identify localized areas of increase and decrease in water levels. The red colors may be caused by pumping depressions from wellfields.

2023 - 2024 Water Level Elevation Change (1-year change)

Well Field	--- Fault Line
● Gage	■ Sphere Of Influence
● Waterman	Surface Water
● North Orange	~ Santa Ana River
● Flume	~ Streams and Channels
● Non-potable	□ City Boundary
■ Linden-Evans Reservoir	□ Water Service Area
Water Conveyance	□ County Boundary
Potable	Groundwater Elevation Change (ft)
— Waterman Pipeline	■ <90
— Gage Pipeline	■ >160
— North Orange Pipeline	
Canal	
~ Gage Canal	
~ Riverside Canal	

NOT TO SCALE

San Bernardino County
Riverside County

San Bernardino Mountains

Bunker Hill Basin

Rialto-Colton Basin

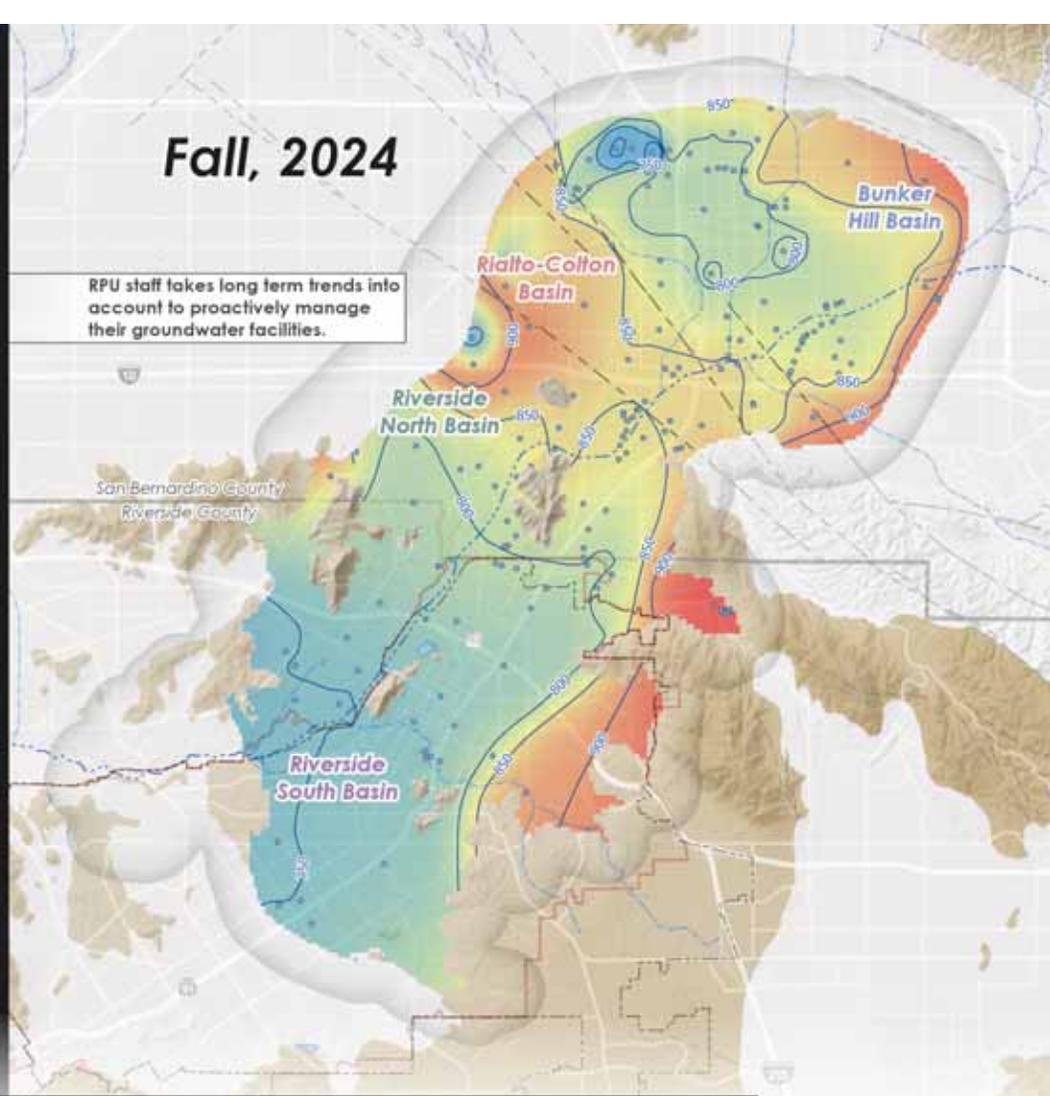
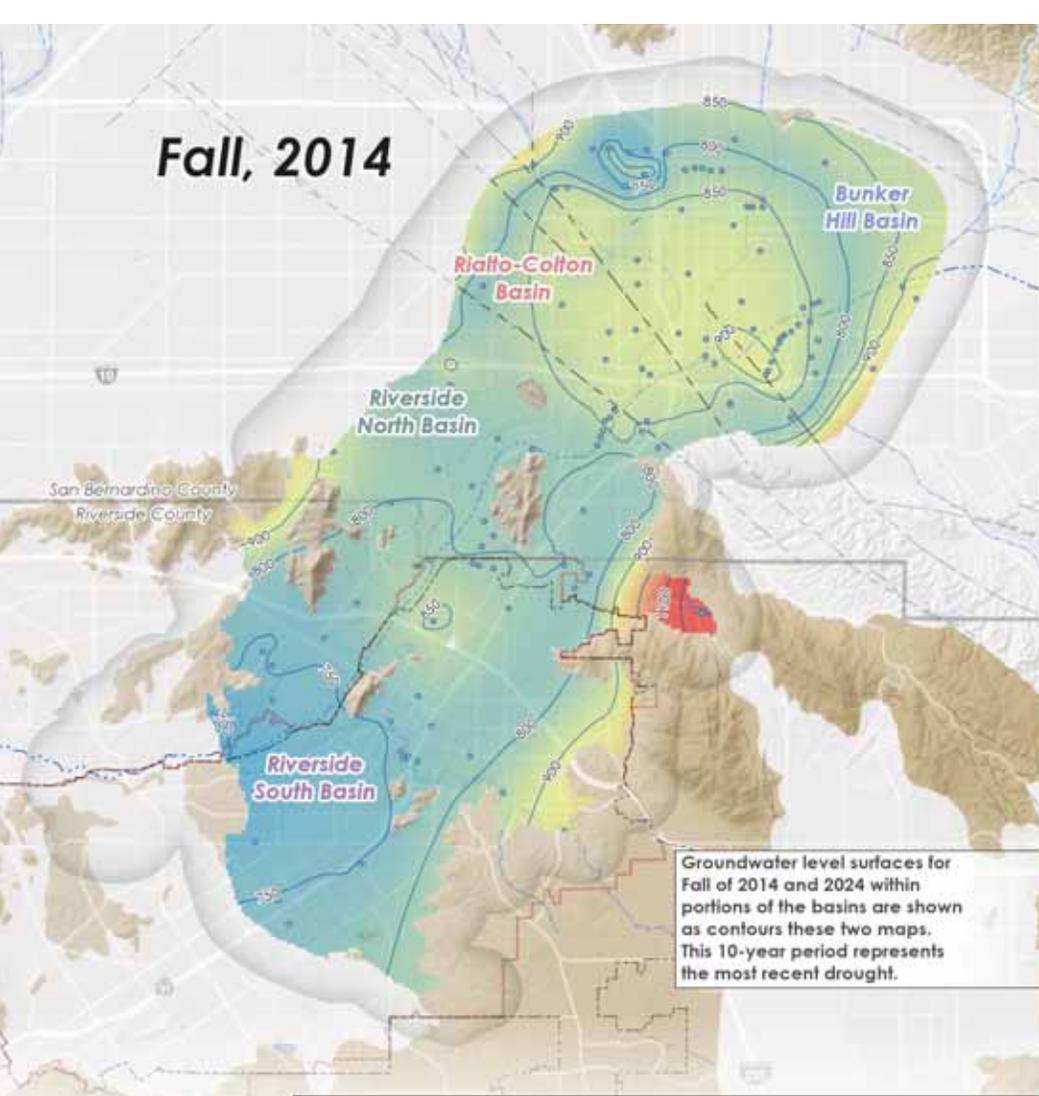
Riverside North Basin

Riverside South Basin

Santa Ana River

Fall, 2014

Fall, 2024



RPU staff takes long term trends into account to proactively manage their groundwater facilities.

Groundwater level surfaces for Fall of 2014 and 2024 within portions of the basins are shown as contours these two maps. This 10-year period represents the most recent drought.

10-Year Change (Water Level)

Surface Water

- Santa Ana River
- Streams and Channels

Groundwater Elevation (ft-amsl) (feet above mean sea level)



Groundwater Levels

- Groundwater Elevation Point (Regional Wells)
- Groundwater Elevation Contour (50 ft-amsl)

- Fault Line
- Sphere Of Influence

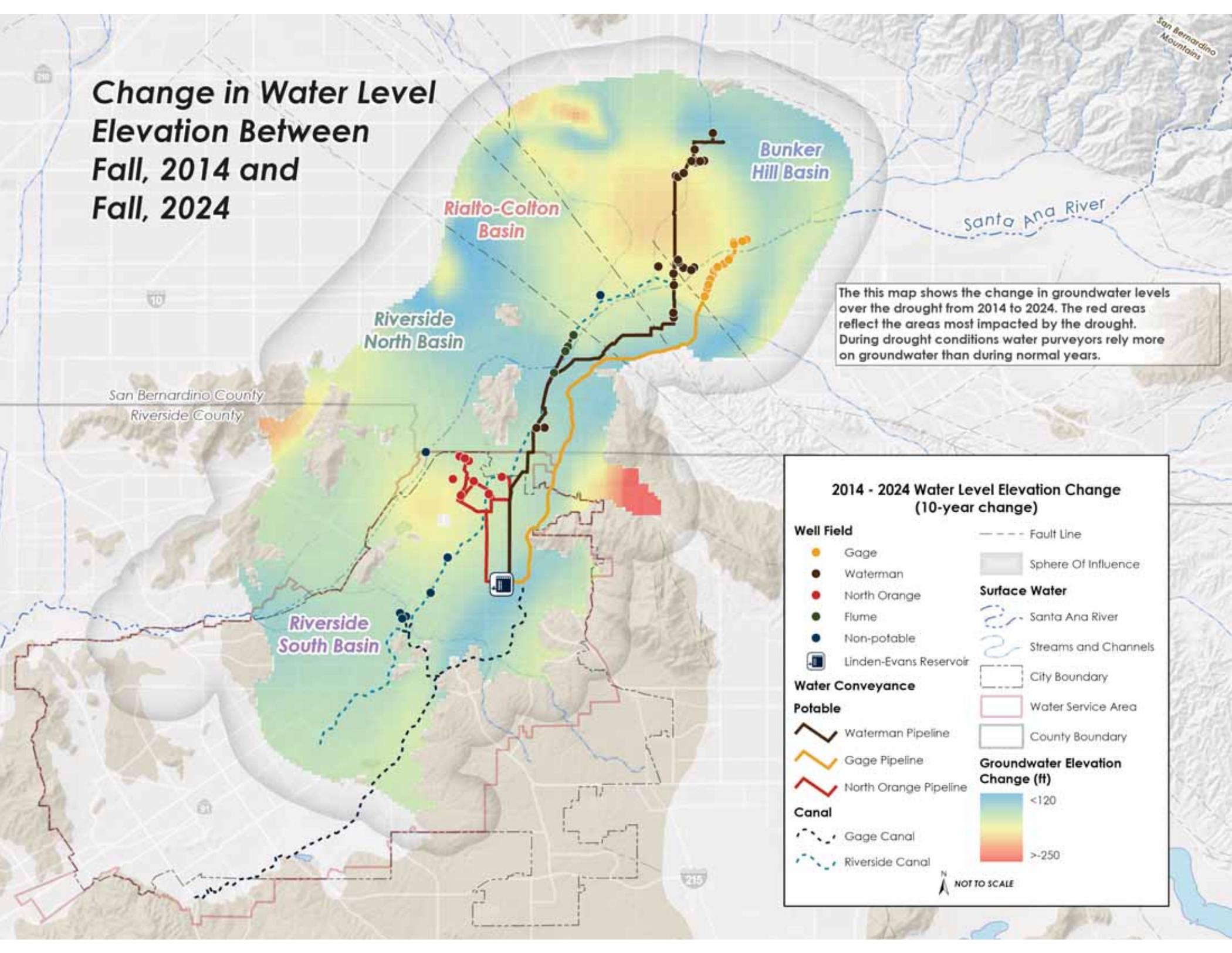
City of Riverside

- City Boundary
- Water Service Area
- County Boundary



NOT TO SCALE

Change in Water Level Elevation Between Fall, 2014 and Fall, 2024



The this map shows the change in groundwater levels over the drought from 2014 to 2024. The red areas reflect the areas most impacted by the drought. During drought conditions water purveyors rely more on groundwater than during normal years.

2014 - 2024 Water Level Elevation Change (10-year change)

Well Field	--- Fault Line
● Gage	☐ Sphere Of Influence
● Waterman	Surface Water
● North Orange	~ Santa Ana River
● Flume	~ Streams and Channels
● Non-potable	☐ City Boundary
☑ Linden-Evans Reservoir	☐ Water Service Area
Water Conveyance	☐ County Boundary
Potable	Groundwater Elevation Change (ft)
— Waterman Pipeline	☐ <120
— Gage Pipeline	☐ >250
— North Orange Pipeline	
Canal	
~ Gage Canal	
~ Riverside Canal	

N
NOT TO SCALE

San Bernardino County
Riverside County

Riverside South Basin

Riverside North Basin

Rialto-Colton Basin

Bunker Hill Basin

Santa Ana River

San Bernardino Mountains

210

10

215



Enhanced Recharge Project



06

**GROUNDWATER
IN STORAGE**

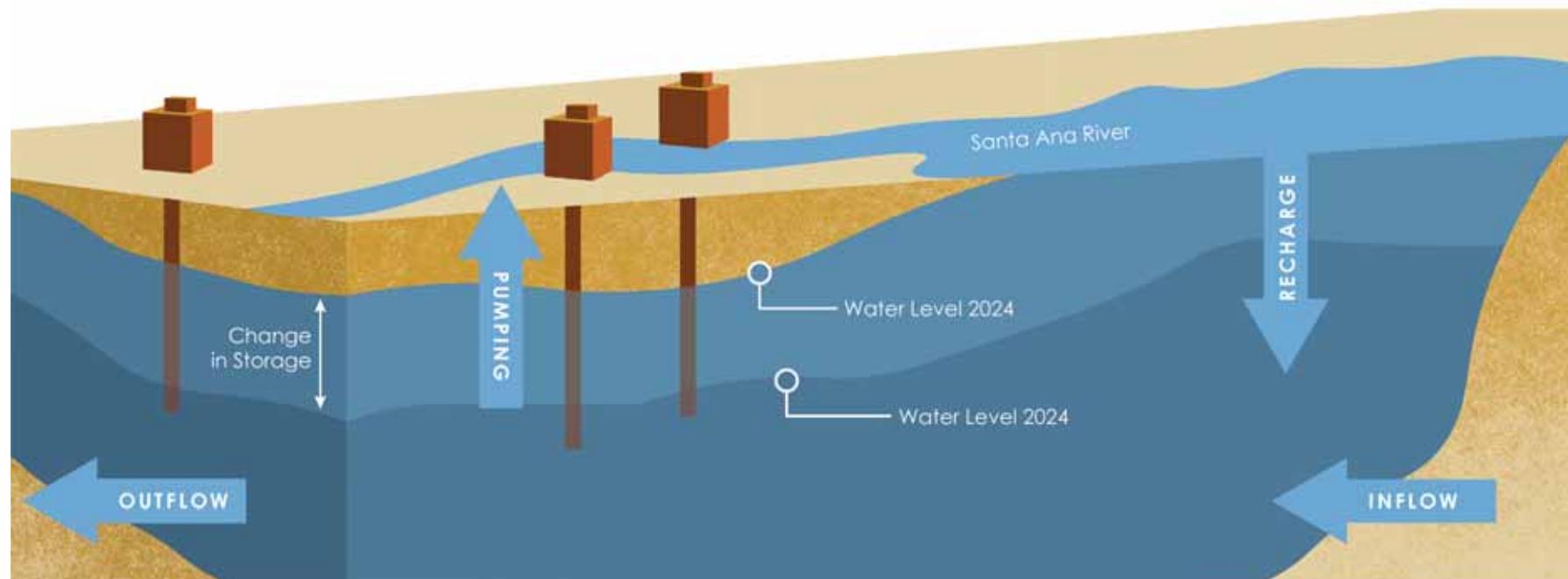
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GROUNDWATER IN STORAGE

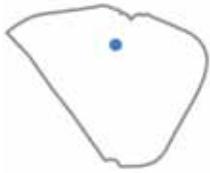
RPU tracks the quantity of groundwater in storage in each basin area as another tool to monitor groundwater conditions. Changes in storage can be used to better understand groundwater production and demands from each of RPU's wellfields distributed across the groundwater basins, and to make future decisions on where to replace and locate groundwater wells.

The change in storage over a time period is calculated by multiplying the change in groundwater level, by the specific yield of the aquifer materials over which the water-level change occurred, and by the area where the change occurred. The graphic below is a 3D representation of what a groundwater basin such as the Bunker Hill Basin may look like when comparing the change in storage that occurred over the 10-year period corresponding to drought conditions. Water levels decreased possibly due to a combination of items such as urbanization, cultural conditions, changes in pumping patterns from other agencies, lower amounts of recharge, and less rainfall in general.

The volume of groundwater for each basin is summarized in the graphic below. The preceding pages show the spatial distribution of the volume of groundwater in each basin.



Summary of Groundwater in Storage by Basin within RPU's Sphere of Influence *(Acre-Feet)*



BUNKER HILL

Fall 2014 Total Volume: 1,988,000
Spring 2023 Total Volume: 1,982,000
Spring 2024 Total Volume: 1,946,000
Fall 2024 Total Volume: 1,938,000
Spring 2023-2024 Volume Change: -36,000
Fall 2014 to 2024 Volume Change: -50,000



RIALTO-COLTON

Fall 2014 Total Volume: 467,000
Spring 2023 Total Volume: 470,000
Spring 2024 Total Volume: 446,000
Fall 2024 Total Volume: 466,000
Spring 2023-2024 Volume Change: -24,000
Fall 2014 to 2024 Volume Change: -1,000



RIVERSIDE NORTH

Fall 2014 Total Volume: 441,000
Spring 2023 Total Volume: 444,000
Spring 2024 Total Volume: 438,000
Fall 2024 Total Volume: 438,000
Spring 2023-2024 Volume Change: -6,000
Fall 2014 to 2024 Volume Change: -3,000



RIVERSIDE SOUTH

Fall 2014 Total Volume: 333,000
Spring 2023 Total Volume: 352,000
Spring 2024 Total Volume: 355,000
Fall 2024 Total Volume: 366,000
Spring 2023-2024 Volume Change: 3,000
Fall 2014 to 2024 Volume Change: 33,000

TOTAL VOLUME

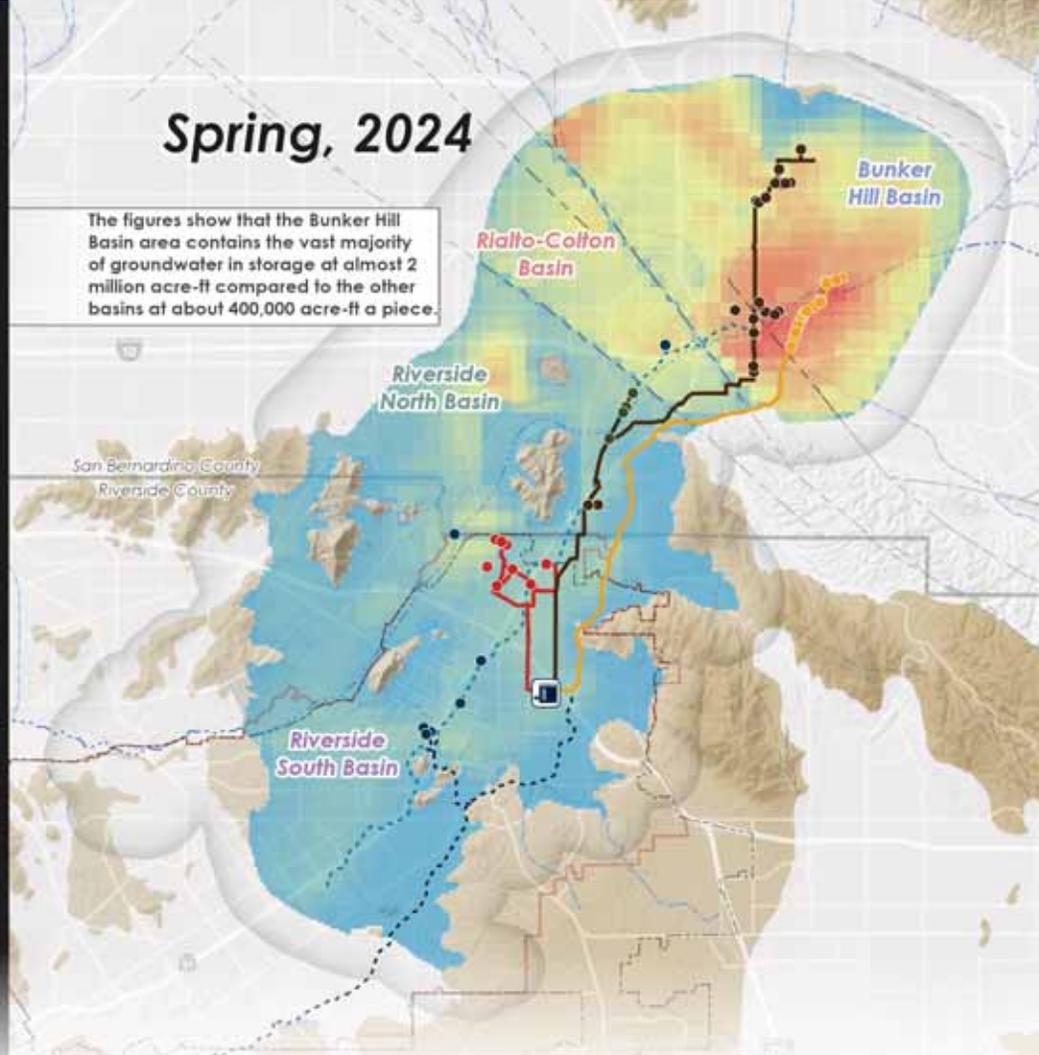
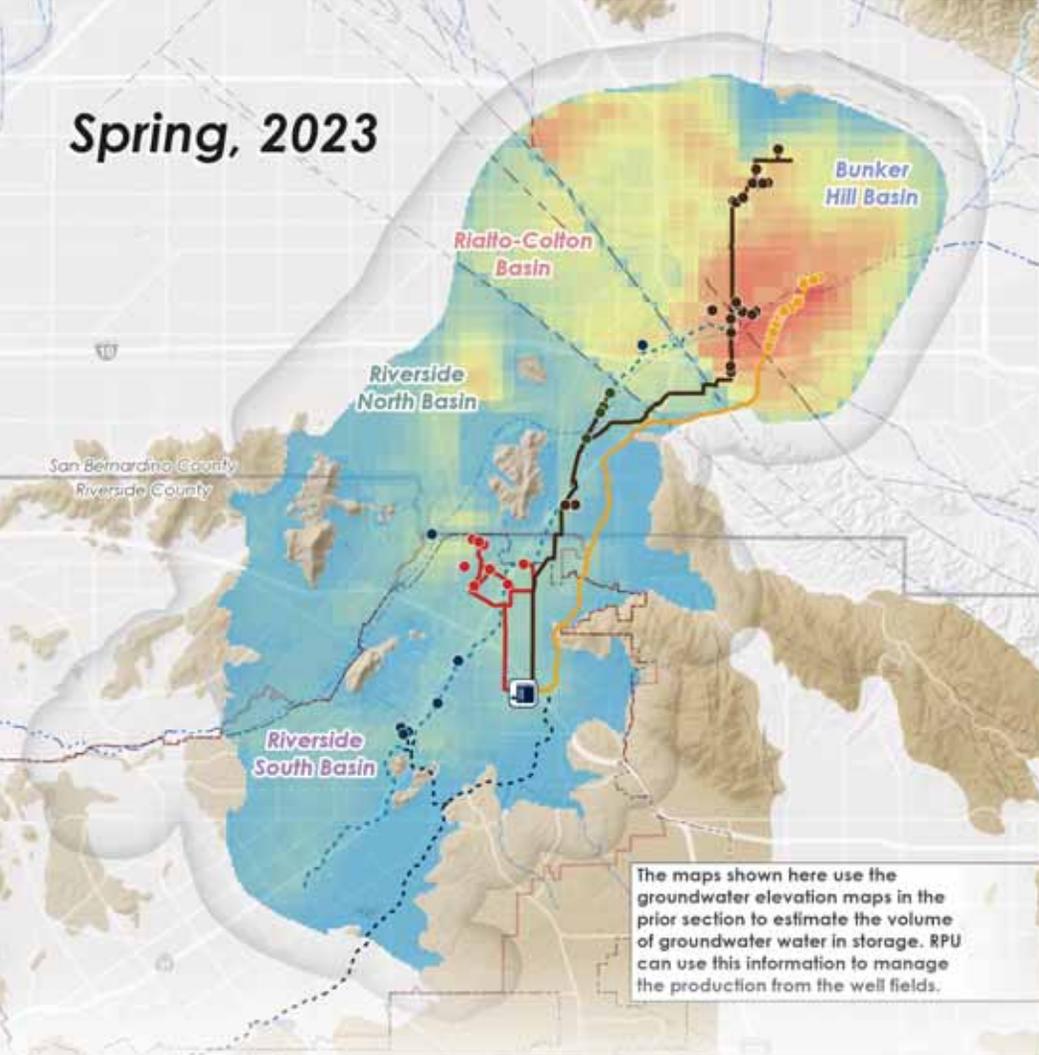
Fall 2014 Total Volume: 3,228,000
Spring 2023 Total Volume: 3,249,000
Spring 2024 Total Volume: 3,186,000
Fall 2024 Total Volume: 3,208,000
Spring 2023-2024 Volume Change: -63,000
Fall 2014 to 2024 Volume Change: -20,000



Note: The groundwater basin boundaries used in the storage calculations represent only a portion of each basin in the vicinity of RPU's well fields.

Spring, 2023

Spring, 2024



The figures show that the Bunker Hill Basin area contains the vast majority of groundwater in storage at almost 2 million acre-ft compared to the other basins at about 400,000 acre-ft a piece.

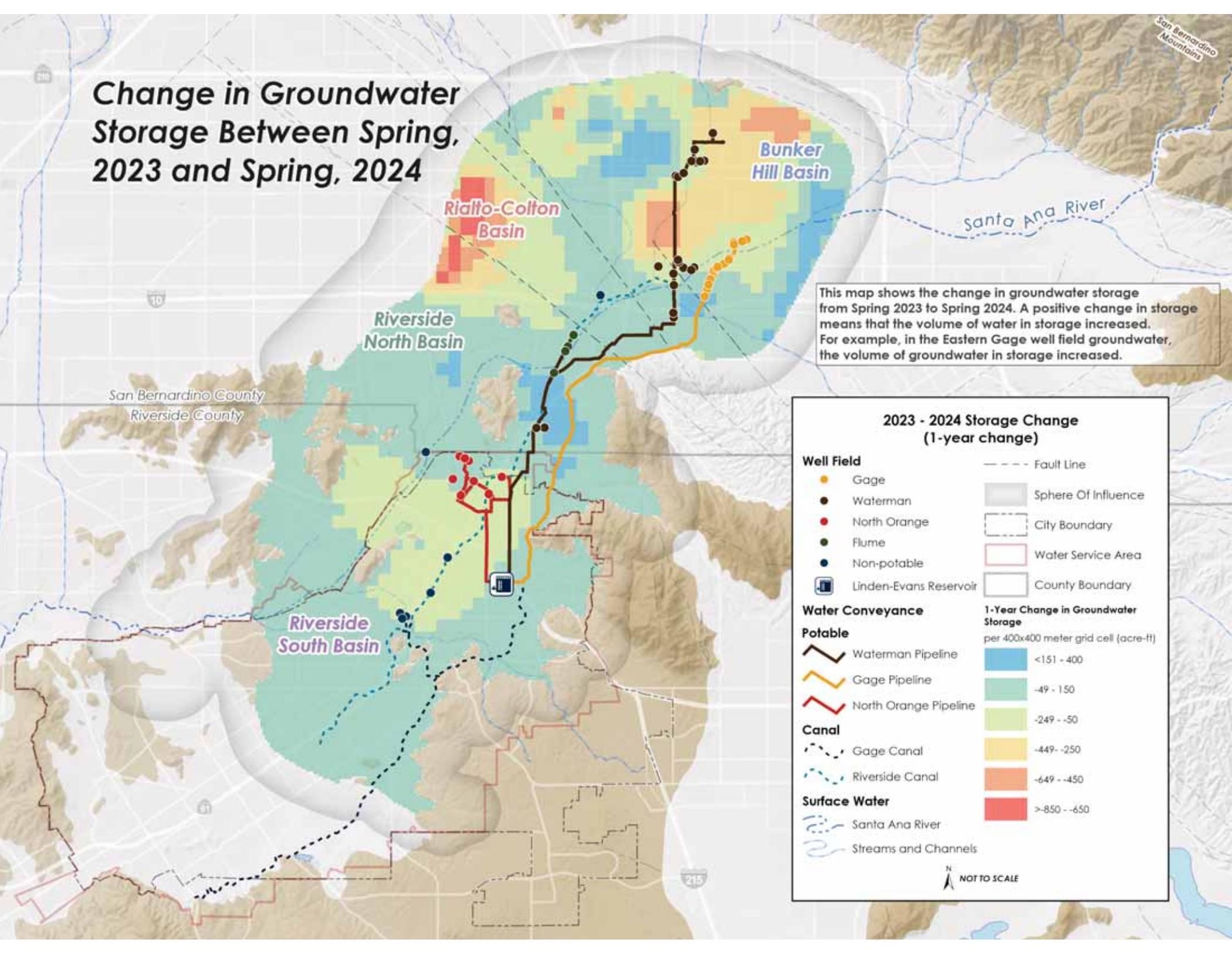
The maps shown here use the groundwater elevation maps in the prior section to estimate the volume of groundwater water in storage. RPU can use this information to manage the production from the well fields.

1-Year Change (Storage)

<p>Volume of Groundwater per 400x400 meter grid cell</p> <p><7400 acre-ft</p> <p>>0 acre-ft</p> <p> Linden-Evans Reservoir</p> <p>Well Field</p> <ul style="list-style-type: none"> Gage Waterman 	<ul style="list-style-type: none"> North Orange Flume Non-potable <p>Water Conveyance</p> <p>Potable</p> <ul style="list-style-type: none"> Waterman Pipeline Gage Pipeline North Orange Pipeline 	<p>Non-Potable</p> <p>Canal</p> <ul style="list-style-type: none"> Gage Canal Riverside Canal <p>Surface Water</p> <ul style="list-style-type: none"> Santa Ana River <p>Water Bodies</p> <ul style="list-style-type: none"> Streams and Channels 	<ul style="list-style-type: none"> Fault Line Sphere Of Influence <p>City of Riverside</p> <ul style="list-style-type: none"> City Boundary Water Service Area County Boundary
---	---	---	---

NOT TO SCALE

Change in Groundwater Storage Between Spring, 2023 and Spring, 2024



This map shows the change in groundwater storage from Spring 2023 to Spring 2024. A positive change in storage means that the volume of water in storage increased. For example, in the Eastern Gage well field groundwater, the volume of groundwater in storage increased.

2023 - 2024 Storage Change (1-year change)

Well Field	--- Fault Line
● Gage	☐ Sphere Of Influence
● Waterman	☐ City Boundary
● North Orange	☐ Water Service Area
● Flume	☐ County Boundary
● Non-potable	
☑ Linden-Evans Reservoir	
Water Conveyance	1-Year Change in Groundwater Storage
Potable	per 400x400 meter grid cell (acre-ft)
☐ Waterman Pipeline	☐ <151 - 400
☐ Gage Pipeline	☐ -49 - 150
☐ North Orange Pipeline	☐ -249 - -50
Canal	☐ -449 - -250
☐ Gage Canal	☐ -649 - -450
☐ Riverside Canal	☐ >-850 - -650
Surface Water	
☐ Santa Ana River	
☐ Streams and Channels	

N
NOT TO SCALE

San Bernardino County
Riverside County

San Bernardino Mountains

Santa Ana River

Rialto-Colton Basin

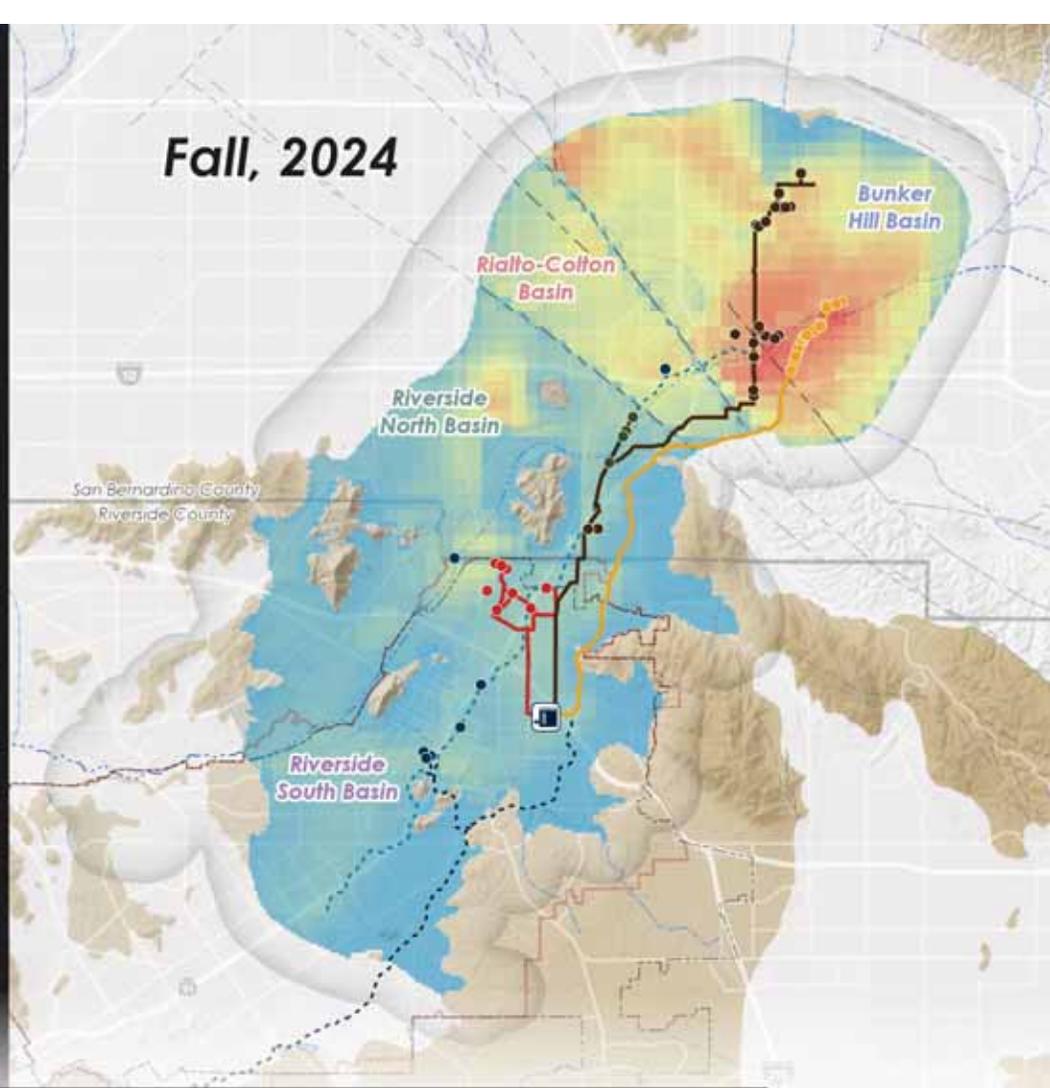
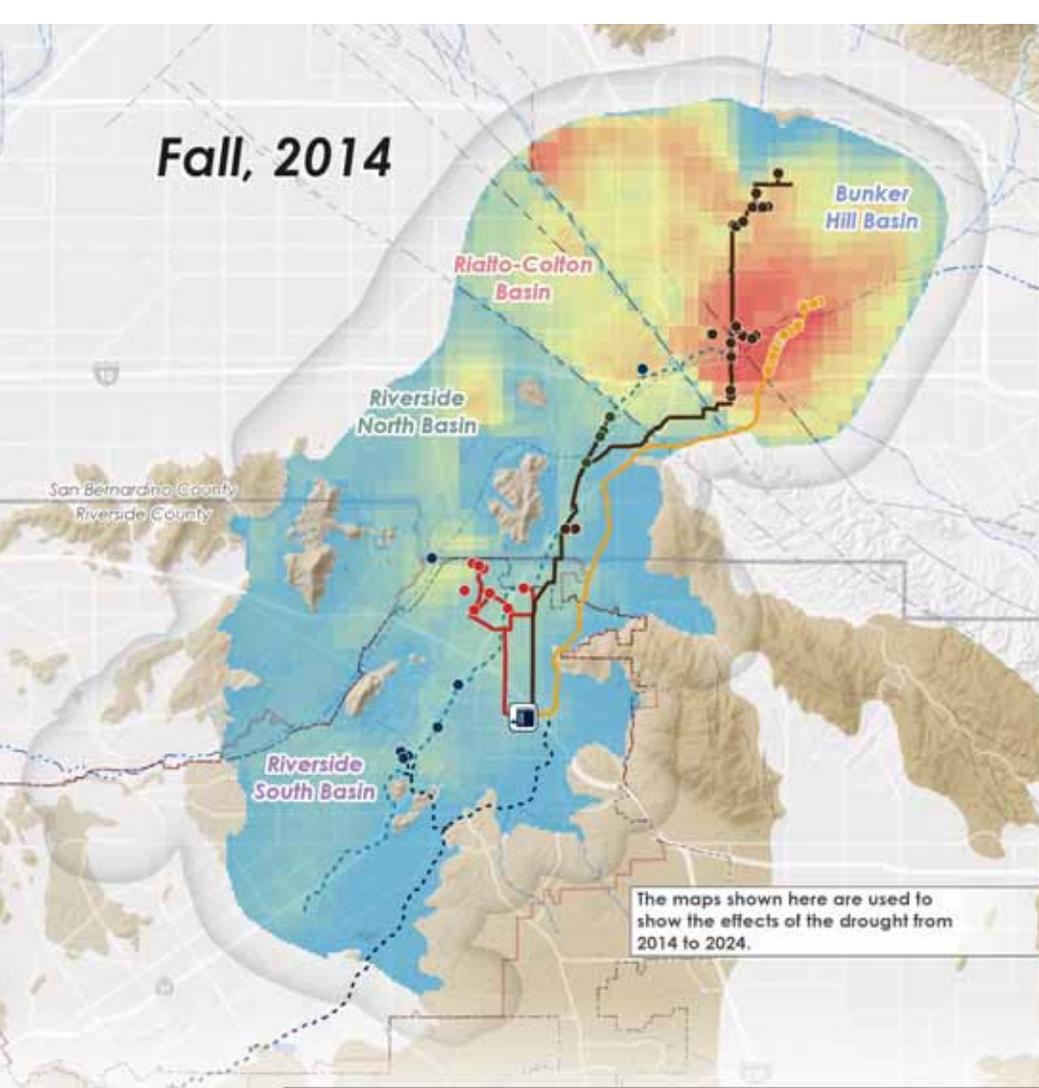
Bunker Hill Basin

Riverside North Basin

Riverside South Basin

Fall, 2014

Fall, 2024

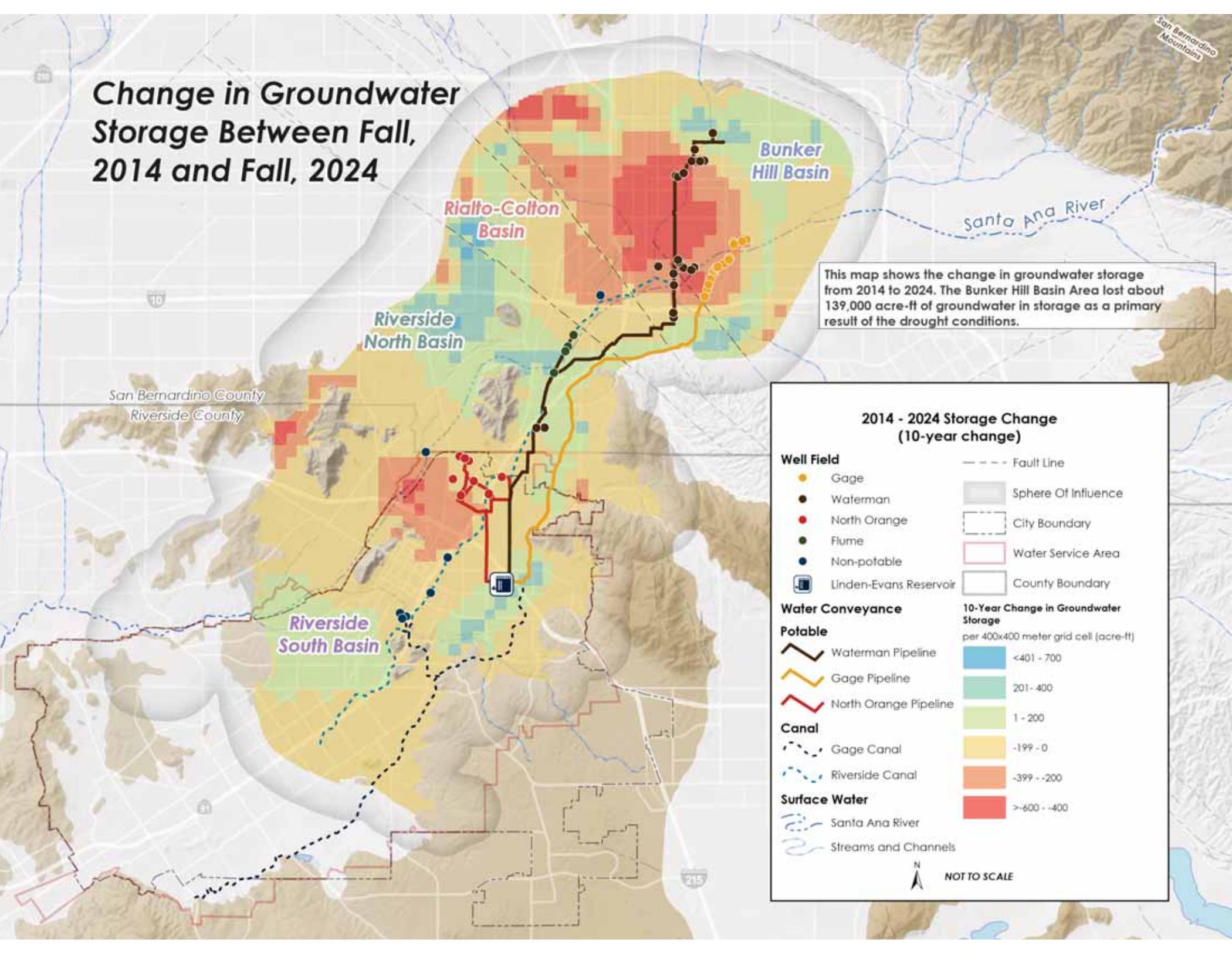


The maps shown here are used to show the effects of the drought from 2014 to 2024.

10-Year Change (Storage)

<p>Volume of Groundwater Storage 400x400 meter grid cell</p> <p> <7450 acre-ft</p> <p> >0 acre-ft</p> <p> Linden-Evans Reservoir</p> <p>Well Field</p> <p> Gage</p>	<p> Waterman</p> <p> North Orange</p> <p> Flume</p> <p> Non-potable</p> <p>Water Conveyance</p> <p>Potable</p> <p> Waterman Pipeline</p> <p> Gage Pipeline</p>	<p> North Orange Pipeline</p> <p>Canal</p> <p> Gage Canal</p> <p> Riverside Canal</p> <p>Surface Water</p> <p> Santa Ana River</p> <p> Streams and Channels</p>	<p> Fault Line</p> <p> Sphere Of Influence</p> <p>City of Riverside</p> <p> City Boundary</p> <p> Water Service Area</p> <p> County Boundary</p> <p> N</p> <p>NOT TO SCALE</p>
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Change in Groundwater Storage Between Fall, 2014 and Fall, 2024



This map shows the change in groundwater storage from 2014 to 2024. The Bunker Hill Basin Area lost about 139,000 acre-ft of groundwater in storage as a primary result of the drought conditions.

2014 - 2024 Storage Change (10-year change)

Well Field	--- Fault Line
● Gage	☐ Sphere Of Influence
● Waterman	☐ City Boundary
● North Orange	☐ Water Service Area
● Flume	☐ County Boundary
● Non-potable	
☑ Linden-Evans Reservoir	
Water Conveyance	10-Year Change in Groundwater Storage
Potable	per 400x400 meter grid cell (acre-ft)
— Waterman Pipeline	☐ <401 - 700
— Gage Pipeline	☐ 201 - 400
— North Orange Pipeline	☐ 1 - 200
Canal	☐ -199 - 0
— Gage Canal	☐ -399 - -200
— Riverside Canal	☐ >-600 - -400
Surface Water	
— Santa Ana River	
— Streams and Channels	

NOT TO SCALE

San Bernardino County
Riverside County

San Bernardino Mountains

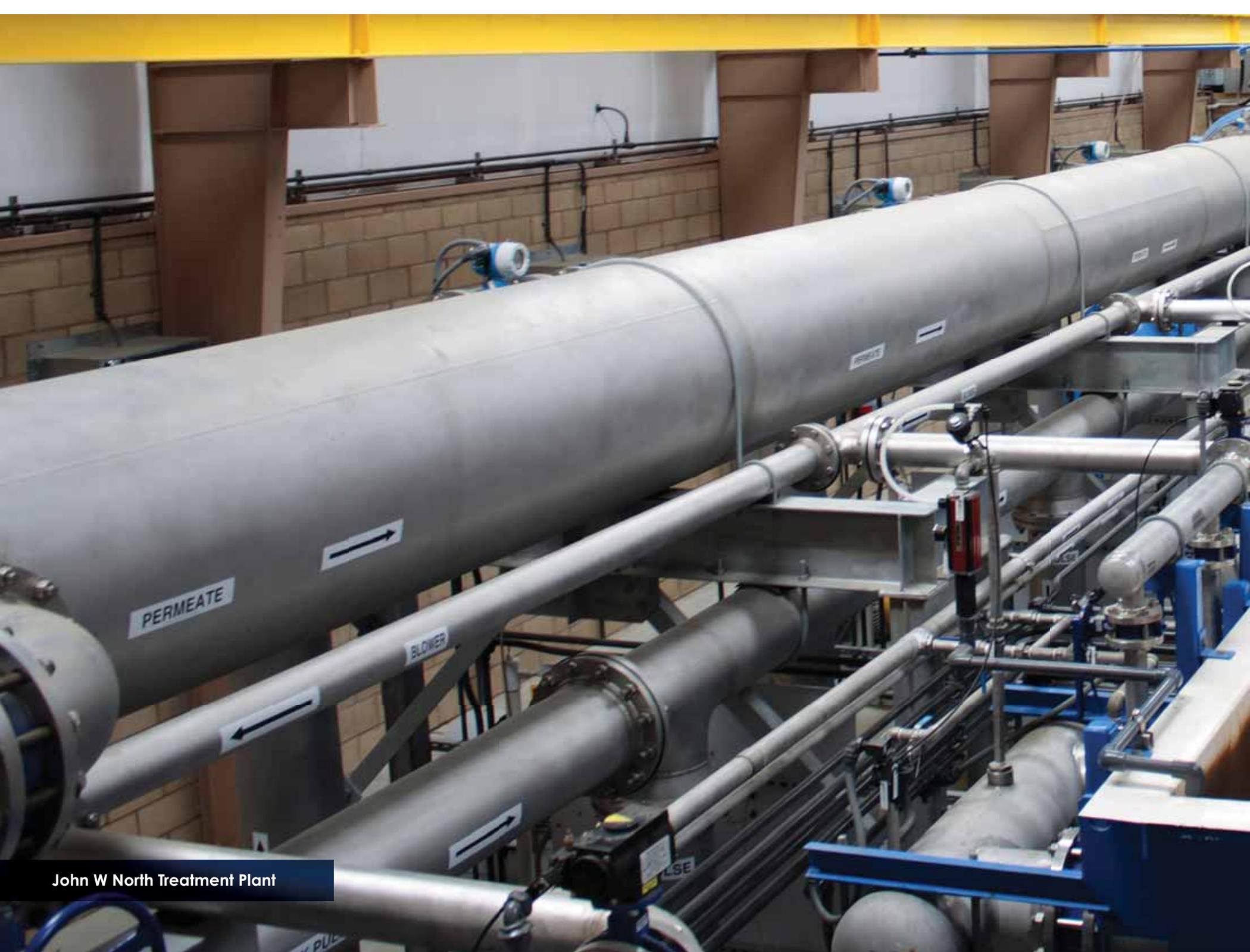
Santa Ana River

Riverside North Basin

Bunker Hill Basin

Rialto-Colton Basin

Riverside South Basin



John W North Treatment Plant



07

**GROUNDWATER
QUALITY**

7

GROUNDWATER QUALITY

Most groundwater produced throughout the southern and inland California region requires treatment. RPU continuously monitors the water quality of its drinking water wells to ensure the water it serves meets both federal and state drinking water standards. This proactive approach allows RPU to quickly identify changes in groundwater quality conditions so we may pursue additional investigations, communicate with stakeholders, and take remedial action if necessary.

The Safe Drinking Water Act was originally passed by Congress in 1974 to protect public health by regulating public drinking water supplies. Since then, additional amendments and measures have been implemented by Federal and State Officials to ensure public water supply systems deliver safe and reliable drinking water for public consumption. Historical waste disposal practices and chemical application of now-banned chemicals that were once legally and regularly used, have created localized contaminant plumes that have impacted the region's groundwater basins and at times, the City's supply. The City of Riverside has actively litigated against known entities that have impacted Riverside's groundwater supplies and has successfully obtained funding for construction and maintenance of facilities used to remove the constituents of concern from its groundwater supply. RPU has developed mutually beneficial relationships with some of the known entities to work collaboratively to intentionally capture a plume with select wells to limit the spread of the plume and protect downstream wells, and to provide treatment at the capture wells to remove the constituents of concern. Extensive monitoring occurs in areas of known plumes to ensure plume containment is always maintained. In addition, RPU strategically locates and constructs new wells to extract water from deeper, cleaner zones within the groundwater basin. The following figures depict some of the constituents RPU closely tracks.

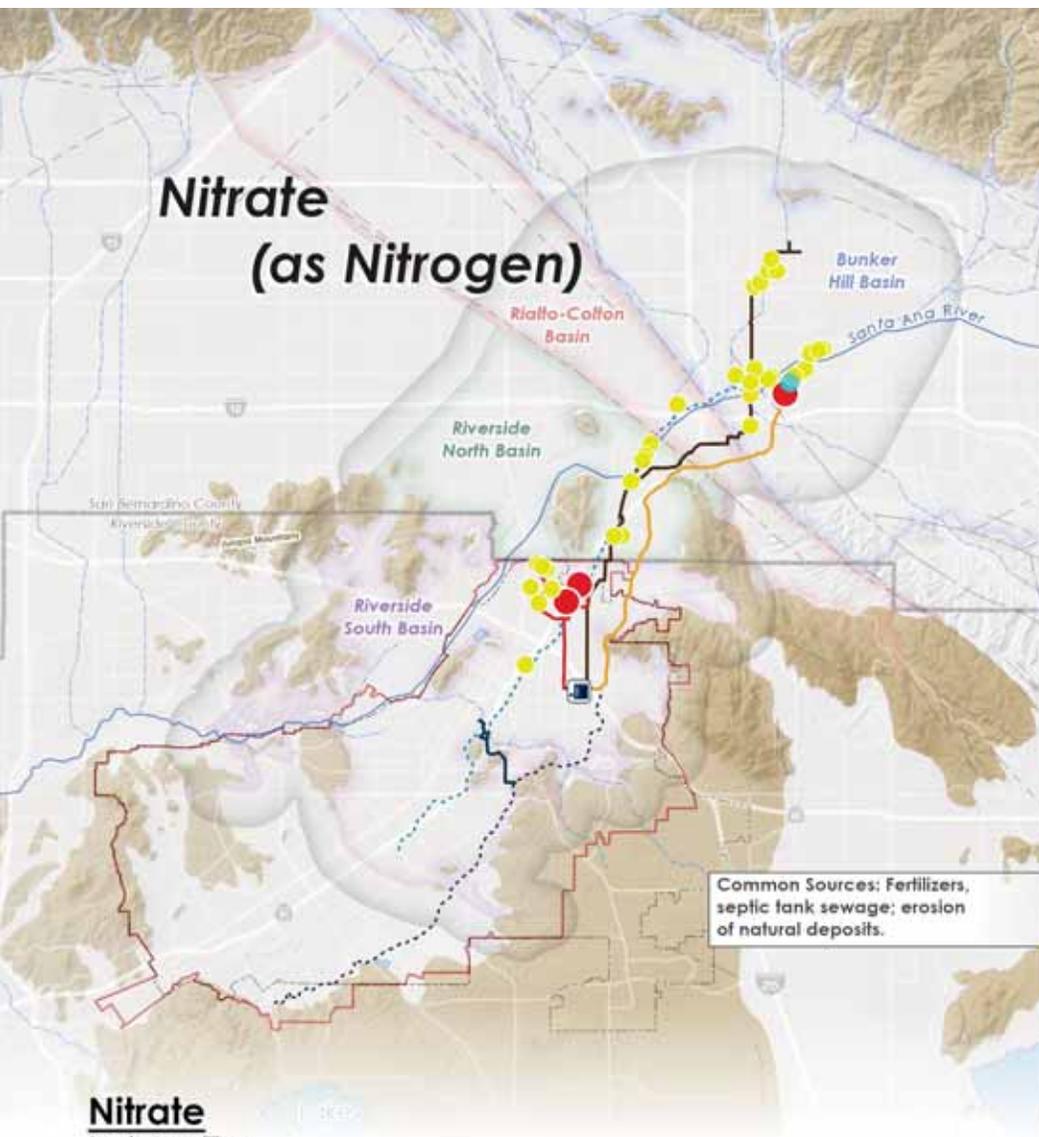
2024 RPU Groundwater Sampling





Raub Water Treatment Plant

Nitrate (as Nitrogen)



Common Sources: Fertilizers, septic tank sewage; erosion of natural deposits.

Nitrate
(parts per million)

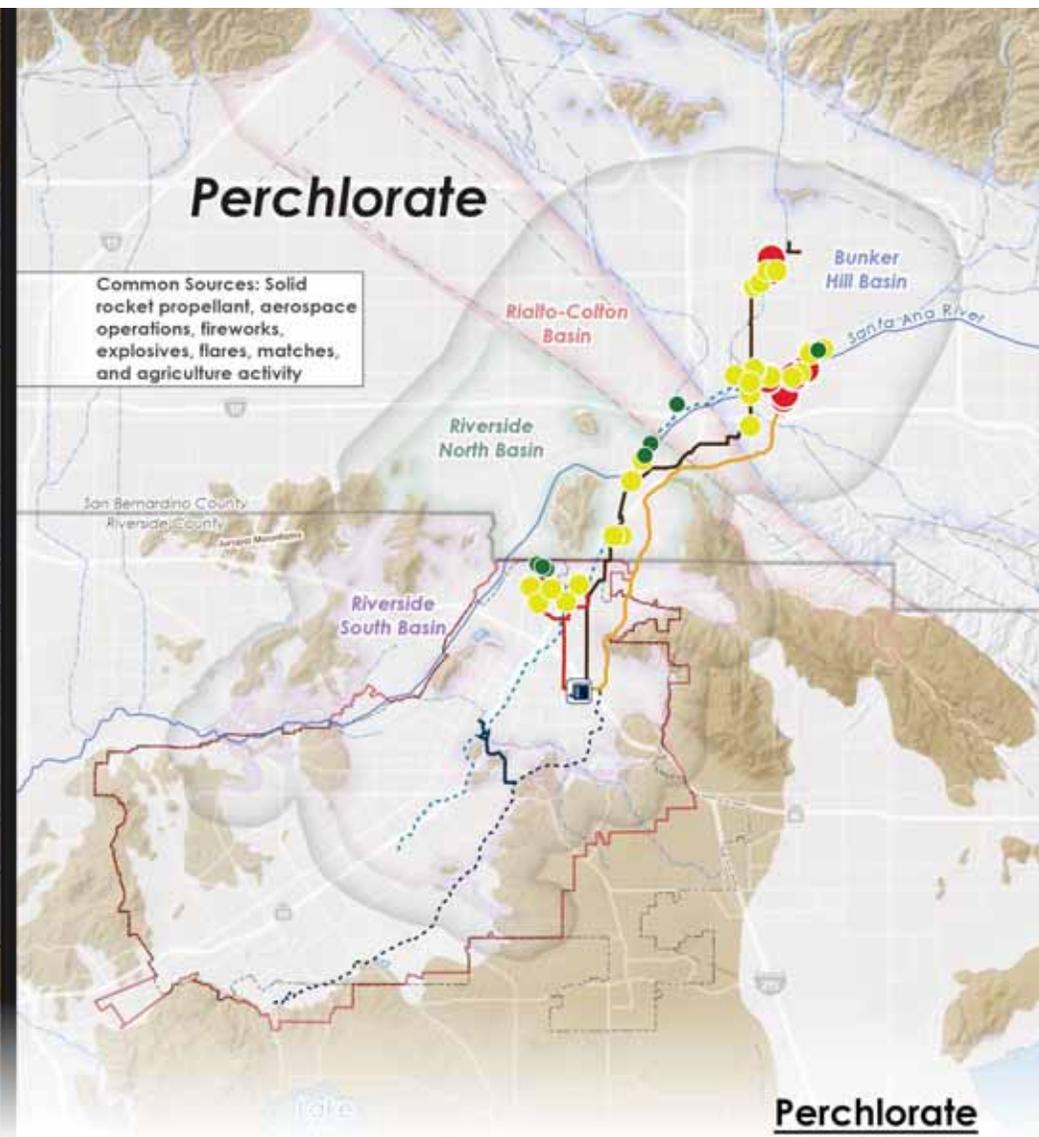
California DLR = 0.4 ppm
(Detection Level Report)

California MCL = 10 ppm
(Maximum Contaminant Level)

RPU Wells Above MCL = 3

Highest Detection = 13 ppm

Perchlorate



Common Sources: Solid rocket propellant, aerospace operations, fireworks, explosives, flares, matches, and agriculture activity

Perchlorate
(parts per billion)

California DLR = 1 ppb
(Detection Level Report)

California MCL = 6 ppb
(Maximum Contaminant Level)

RPU Wells Above MCL = 11

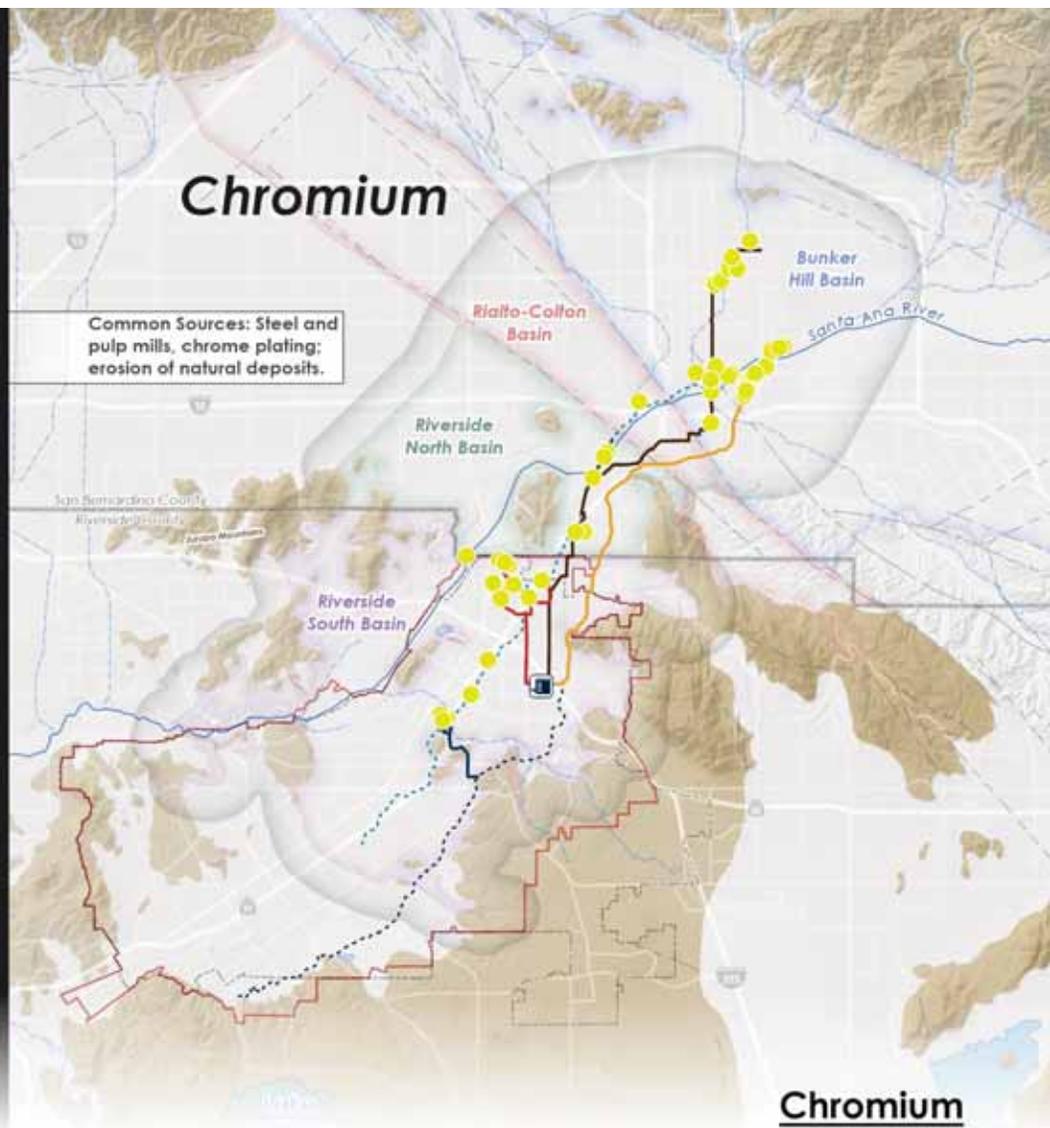
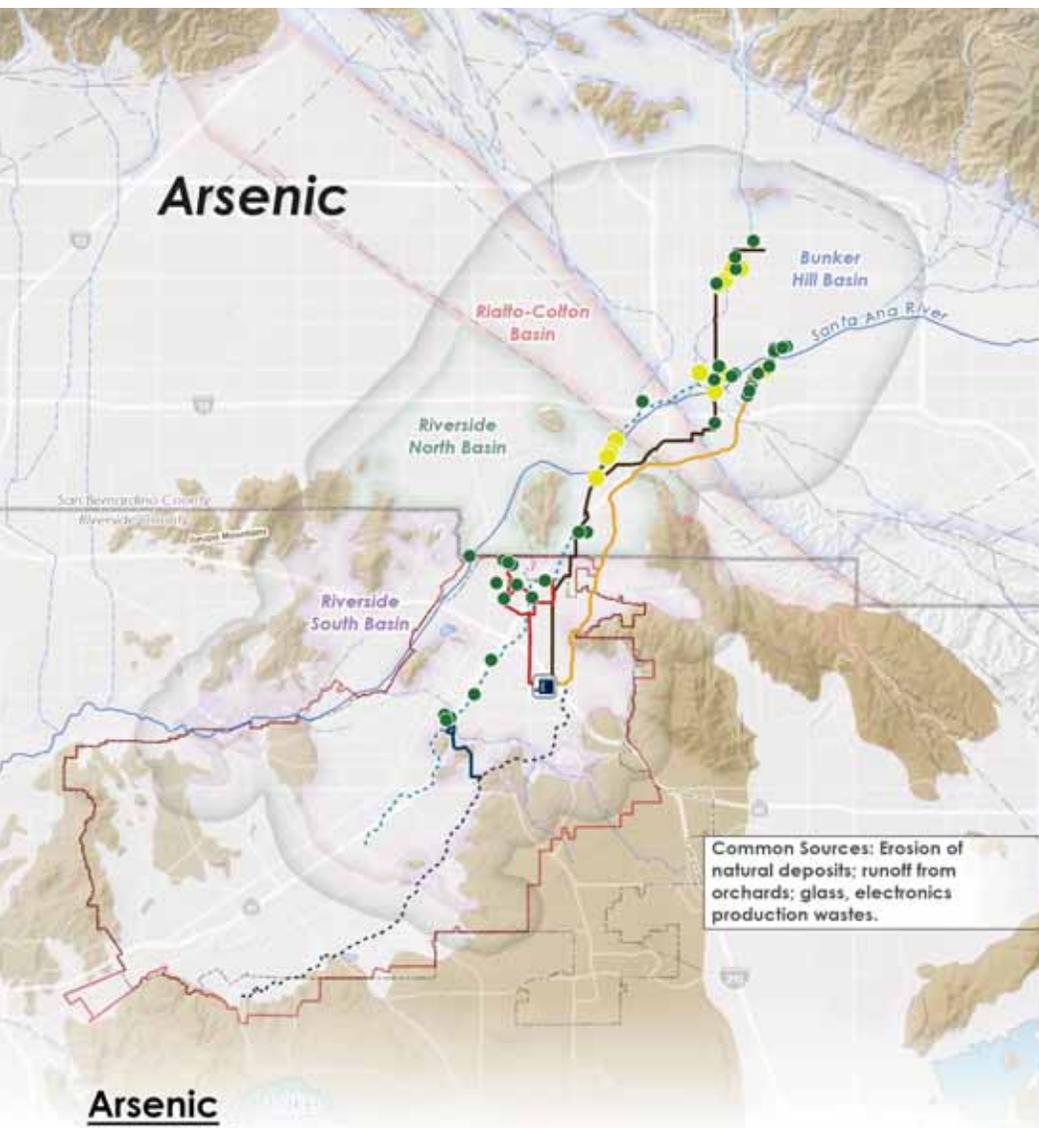
Highest Detection = 33 ppb

Legend			
Well Contaminate Level	Water Conveyance	Canal	Groundwater Basins
● < Detection Level Reporting	— Waterman Pipeline	⋯ Gage Canal	□ Bunker Hill Basin
● > Detection Level Reporting & ≤ Maximum Contaminant Level	— Gage Pipeline	⋯ Riverside Canal	□ Rialto-Colton Basin
● > Maximum Contaminant Level	— North Orange Pipeline	Surface Water	□ Riverside North Basin
☑ Linden-Evans Reservoir	— Flume Pipeline	— Santa Ana River	□ Riverside South Basin
	— Non-potable	— Streams and Channels	City of Riverside
		— Fault Line	□ City Boundary
			□ Water Service Area

NOT TO SCALE Data shown in the figures above shows raw groundwater prior to treatment and delivery to RPU customers.

Arsenic

Chromium



Arsenic

(parts per billion)

California DLR = 2 ppb
(Detection Level Report)

California MCL = 10 ppb
(Maximum Contaminant Level)

RPU Wells Above MCL = 0

Highest Detection = 6.9 ppb

Chromium

(parts per billion)

California DLR = 10 ppb
(Detection Level Report)

California MCL = 50 ppb
(Maximum Contaminant Level)

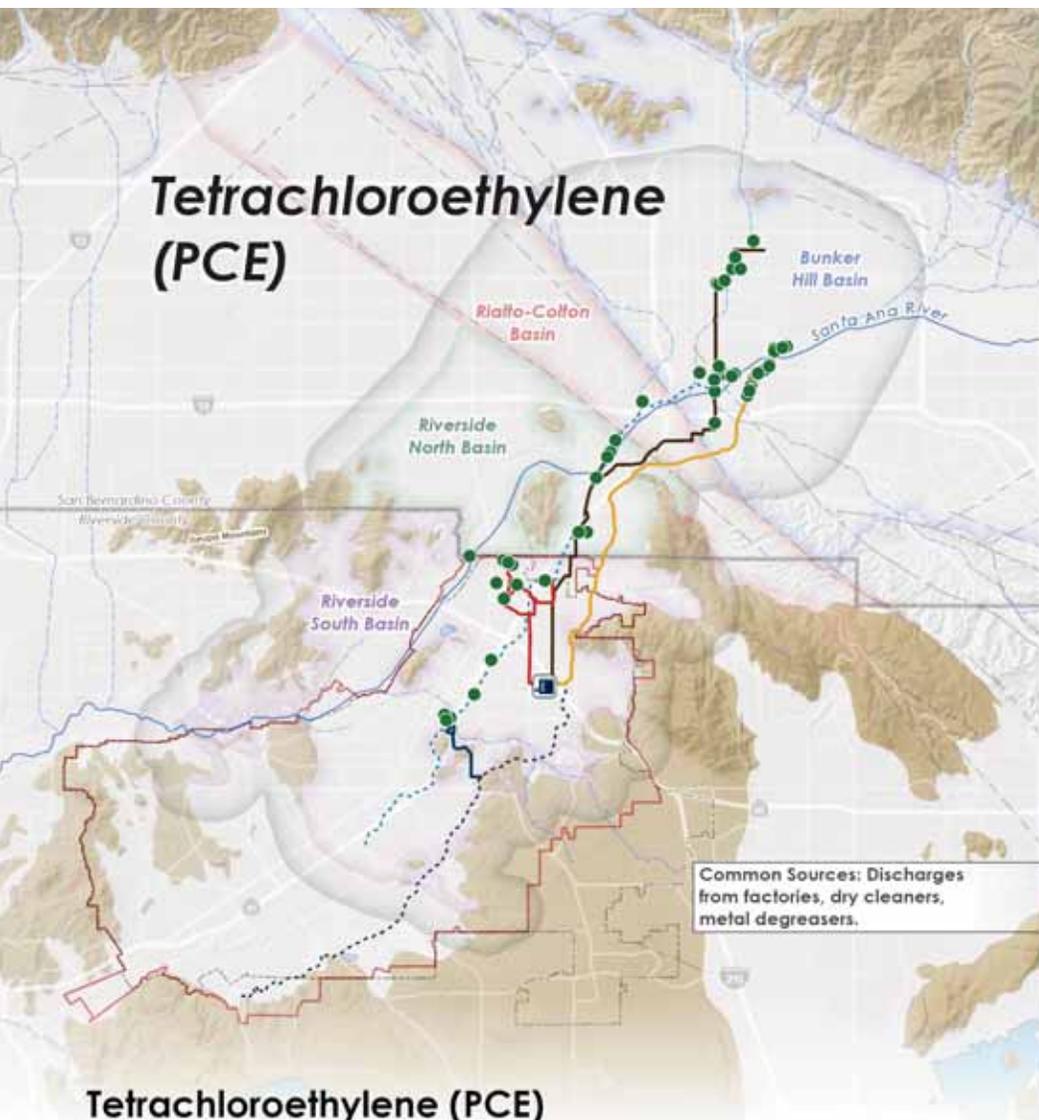
RPU Wells Above MCL = 0

Highest Detection = 6.7 ppb

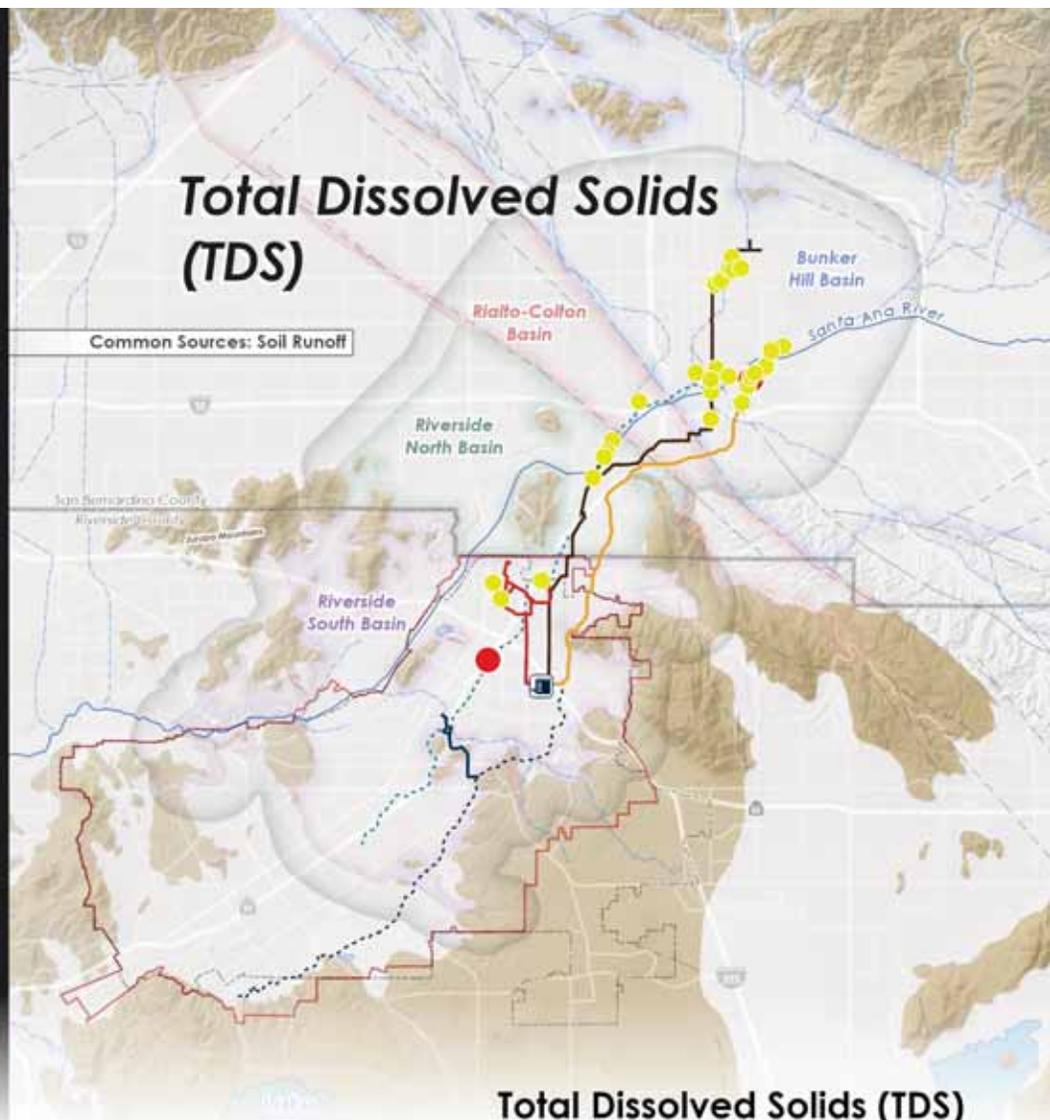
Legend			
Well Contaminate Level	Water Conveyance	Canal	Groundwater Basins
● < Detection Level Reporting	~ Waterman Pipeline	⋯ Gage Canal	□ Bunker Hill Basin
● > Detection Level Reporting & ≤ Maximum Contaminant Level	~ Gage Pipeline	⋯ Riverside Canal	□ Rialto-Colton Basin
● > Maximum Contaminant Level	~ North Orange Pipeline	~ Surface Water	□ Riverside North Basin
■ Linden-Evans Reservoir	~ Flume Pipeline	~ Santa Ana River	□ Riverside South Basin
	~ Non-potable	~ Streams and Channels	City of Riverside
		~ Fault Line	□ City Boundary
			□ Water Service Area

NOT TO SCALE Data shown in the figures above shows raw groundwater prior to treatment and delivery to RPU customers.

Tetrachloroethylene (PCE)



Total Dissolved Solids (TDS)



Tetrachloroethylene (PCE)

(parts per billion)

California DLR = 0.5 ppb
(Detection Level Report)

California MCL = 5 ppb
(Maximum Contaminant Level)

RPU Wells Above MCL = 0

Highest Detection < 0.5 ppb

Total Dissolved Solids (TDS)

(parts per million)

California U-SMCL = 1,000 ppm
(Upper Secondary Maximum Contaminant Level)

California SMCL = 500 ppm
(Recommended Secondary Maximum Contaminant Level)

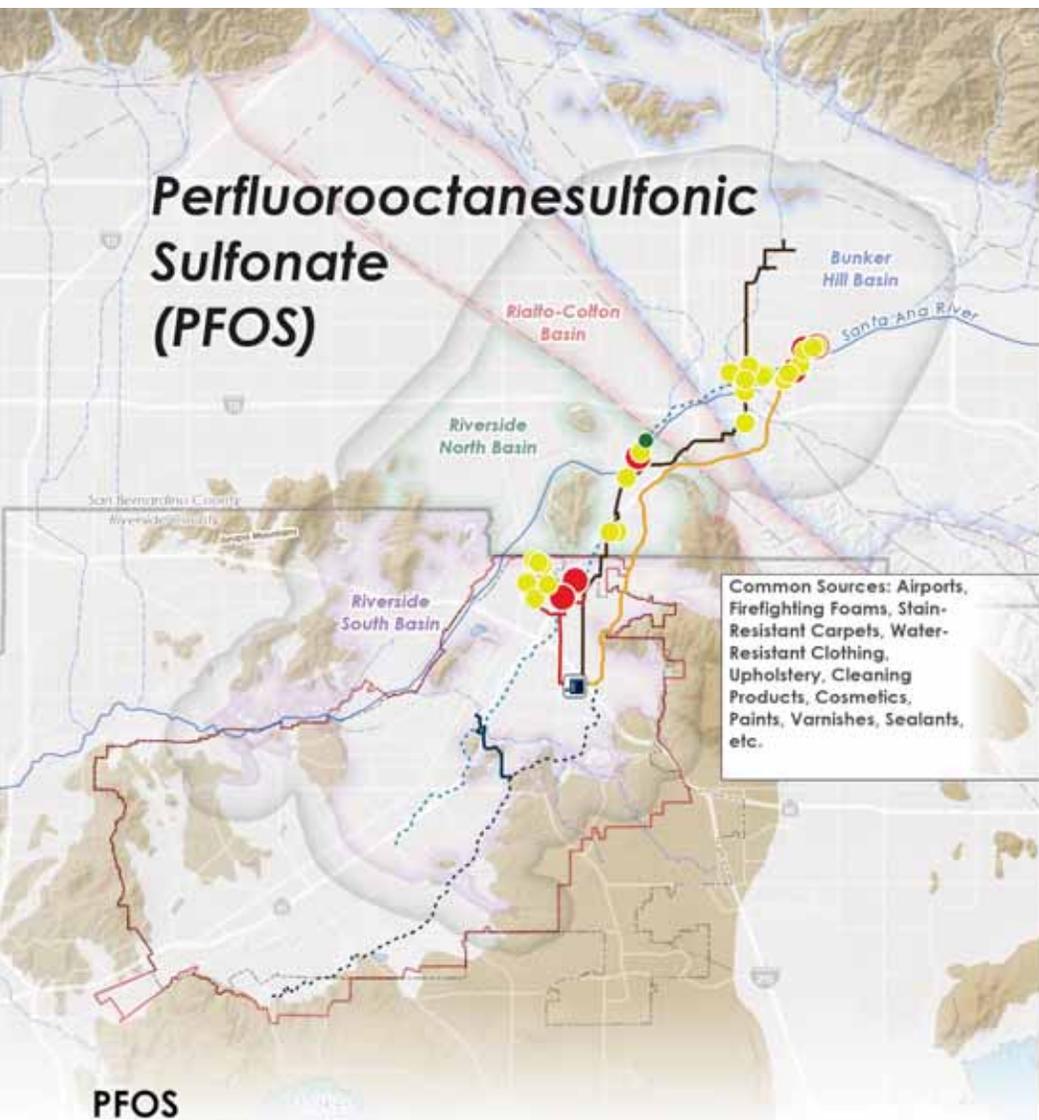
RPU Wells Above U-SMCL = 0
RPU Wells Above SMCL = 2

Highest Detection = 550 ppm

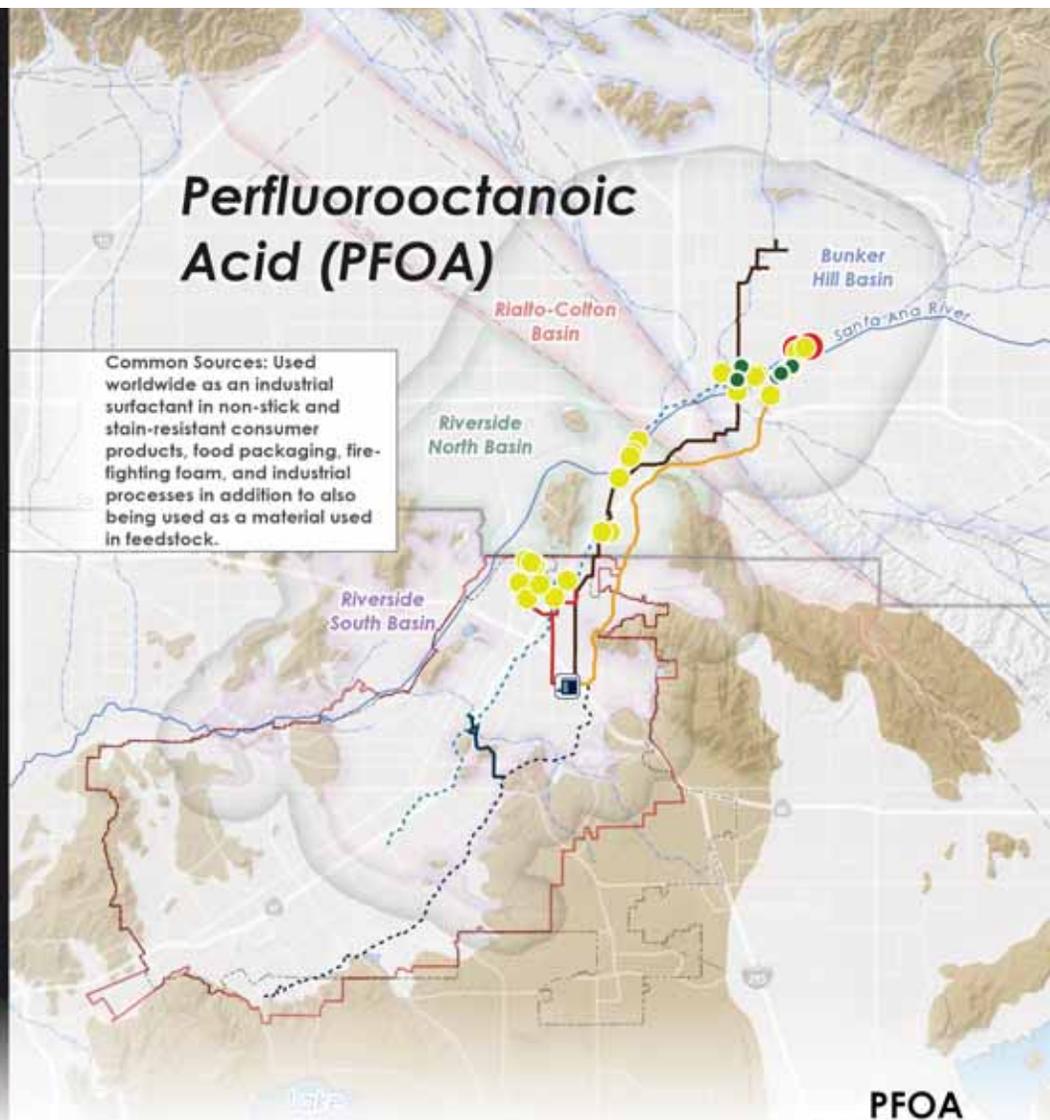
Legend			
Well Contaminate Level	Water Conveyance	Canal	Groundwater Basins
● < Detection Level Reporting	~ Waterman Pipeline	⋯ Gage Canal	□ Bunker Hill Basin
● > Detection Level Reporting & ≤ Maximum Contaminant Level	~ Gage Pipeline	⋯ Riverside Canal	□ Rialto-Colton Basin
● > Maximum Contaminant Level	~ North Orange Pipeline	~ Santa Ana River	□ Riverside North Basin
□ Linden-Evans Reservoir	~ Flume Pipeline	~ Streams and Channels	□ Riverside South Basin
	~ Non-potable	~ Fault Line	City of Riverside
			□ City Boundary
			□ Water Service Area

NOT TO SCALE Data shown in the figures above shows raw groundwater prior to treatment and delivery to RPU customers.

Perfluorooctanesulfonic Sulfonate (PFOS)



Perfluorooctanoic Acid (PFOA)



PFOS
(parts per trillion)

California NL = 6.5 ppt
(Notification Level)

USA Federal MCL = 4 ppt
(Maximum Contaminant Level)

RPU Wells Above MCL = 32

Highest Detection = 26 ppt

PFOA
(parts per trillion)

California NL = 5.1 ppt
(Notification Level)

USA Federal MCL = 4 ppt
(Maximum Contaminant Level)

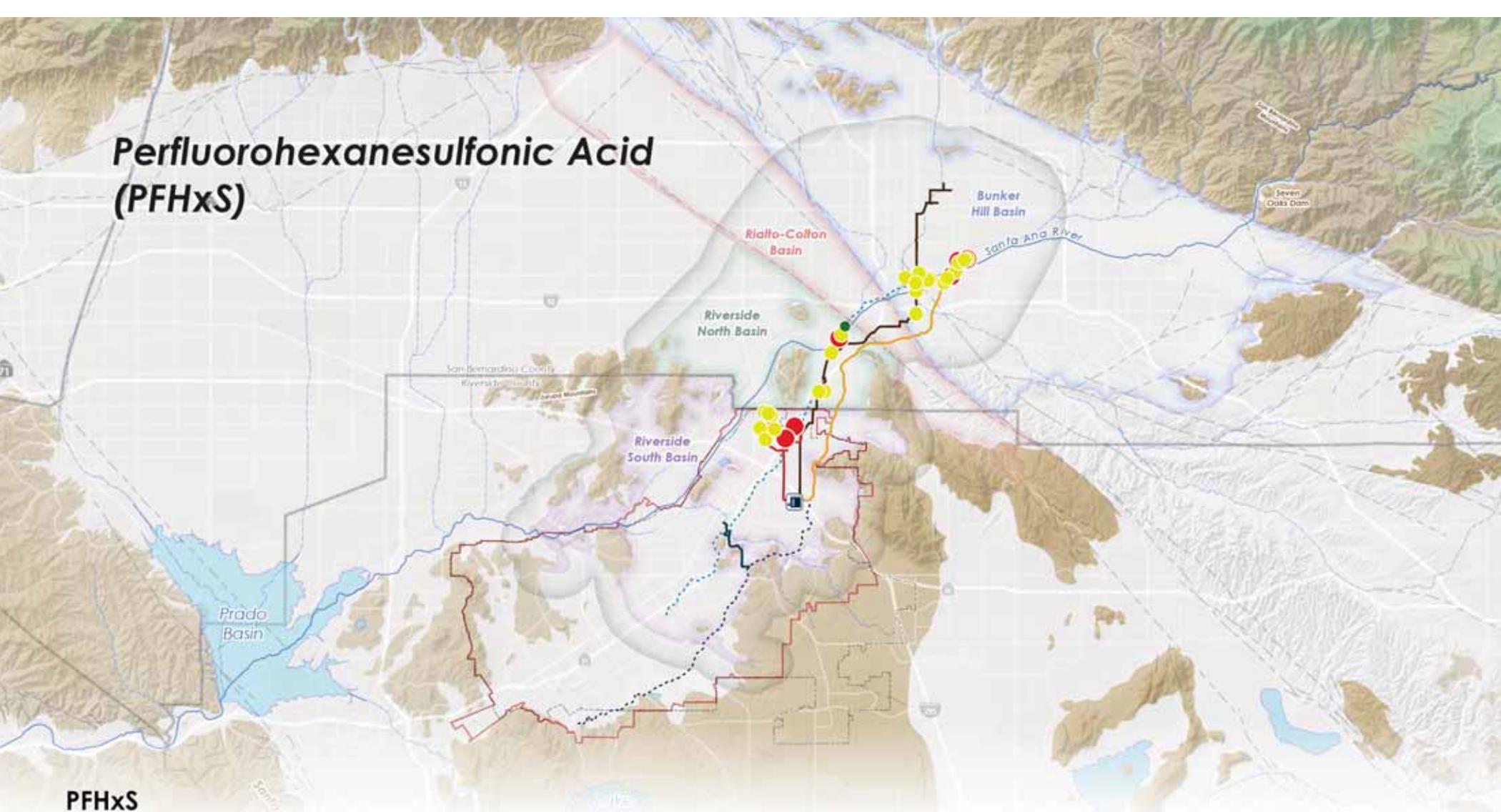
RPU Wells Above MCL = 27

Highest Detection = 23 ppt

Legend			
Well Contaminate Level	Water Conveyance	Canal	Groundwater Basins
● < Notification Level	~ Waterman Pipeline	--- Gage Canal	□ Bunker Hill Basin
● > Notification Level & ≤ 15ppt Contaminant Level	~ Gage Pipeline	--- Riverside Canal	□ Rialto-Colton Basin
● > 15ppt Max Contaminant Level	~ North Orange Pipeline	~ Santa Ana River	□ Riverside North Basin
■ Linden-Evans Reservoir	~ Flume Pipeline	~ Streams and Channels	□ Riverside South Basin
	~ Non-potable	--- Fault Line	□ City Boundary
N NOT TO SCALE			□ Water Service Area

PFOS and PFOA Data shown in the figures above are for raw well data prior to treatment and delivery. The State and Federal regulations are met at the compliance point below Linden-Evans Reservoir. EPA compliance required by 2029.

Perfluorohexanesulfonic Acid (PFHxS)



PFHxS
(parts per trillion)

California NL = 3 ppt
(Notification Level)

USA Federal MCL = 10 ppt
(Maximum Contaminant Level)

RPU Wells Above MCL = 9

Highest Detection = 83 ppt

Legend			
Well Contaminate Level	Water Conveyance	Canal	Groundwater Basins
● < Notification Level	~ Watermain Pipeline	--- Gage Canal	□ Bunker Hill Basin
● > Notification Level & ≤ 10ppt Contaminant Level	~ Gage Pipeline	--- Riverside Canal	□ Rialto-Colton Basin
● > 10ppt Max Contaminant Level	~ North Orange Pipeline	~ Santa Ana River	□ Riverside North Basin
■ Linden-Evans Reservoir	~ Flume Pipeline	~ Streams and Channels	□ Riverside South Basin
▲ NOT TO SCALE	~ Non-potable	--- Fault Line	□ City of Riverside
			□ City Boundary
			□ Water Service Area

PFHxS Data shown in the figures above are for raw well data prior to treatment and delivery. The State and Federal regulations are met at the compliance point below Linden-Evans Reservoir.

Common Sources: Water and Stain Protective Coatings used for carpets, textiles, paper, packaging, electronics, etc. In addition, used in cleaning and polishing products, water-proofing agents, aqueous film-forming foam (AFFF), etc.



DANGER

CONFINED SPACE
AUTHORIZED
PERSONNEL ONLY

NOTICE

LINED TANK,
DO NOT WELD,
BURN, OR TAP

C

DANGER

CONFINED SPACE
AUTHORIZED
PERSONNEL ONLY

NOTICE

LINED TANK,
DO NOT WELD,
BURN, OR TAP

E

DANGER

CONFINED SPACE
AUTHORIZED
PERSONNEL ONLY

NOTICE

LINED TANK,
DO NOT WELD,
BURN, OR TAP

Palmyrita Treatment Plant



08

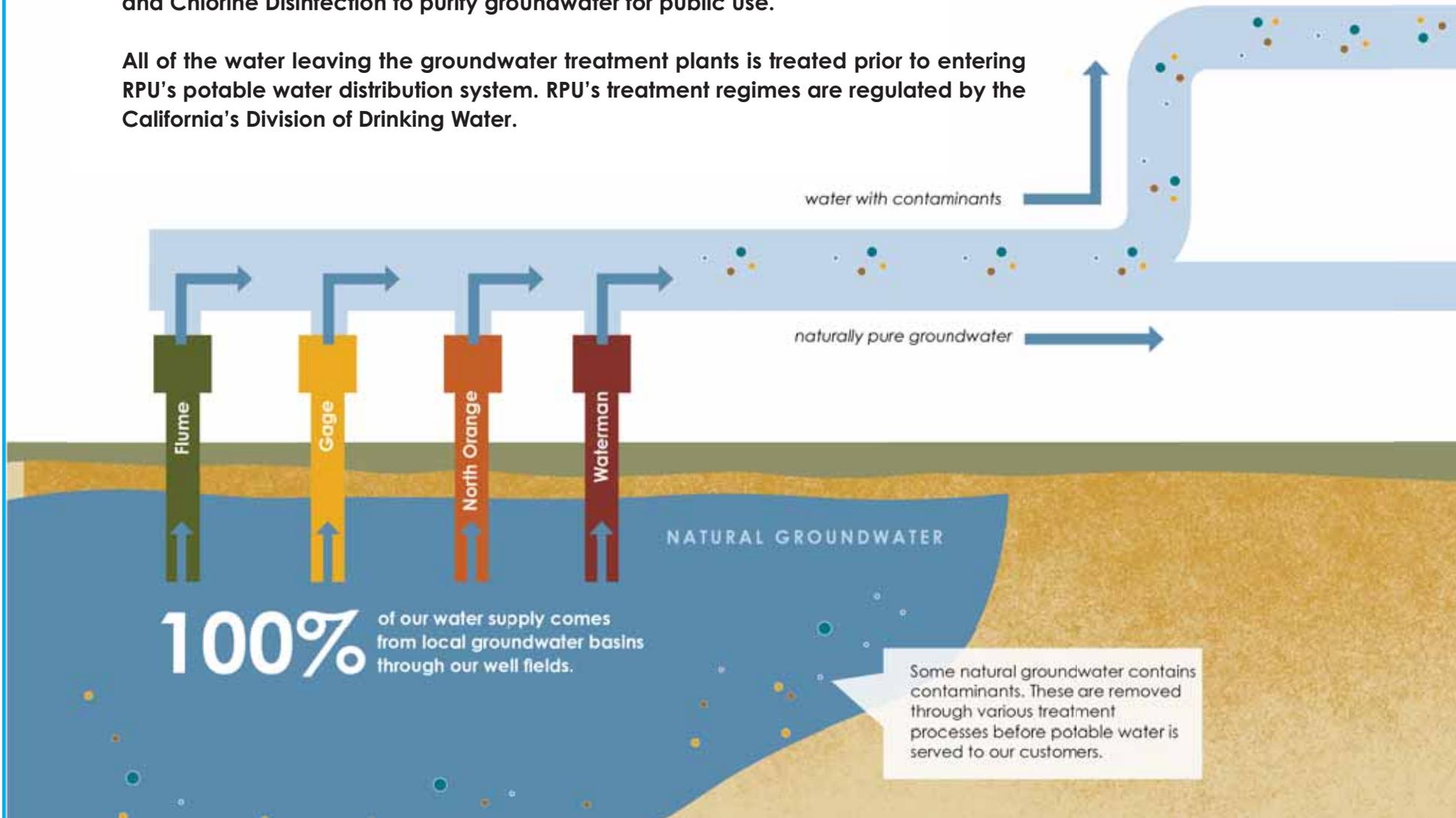
**GROUNDWATER
TREATMENT**

8

GROUNDWATER TREATMENT

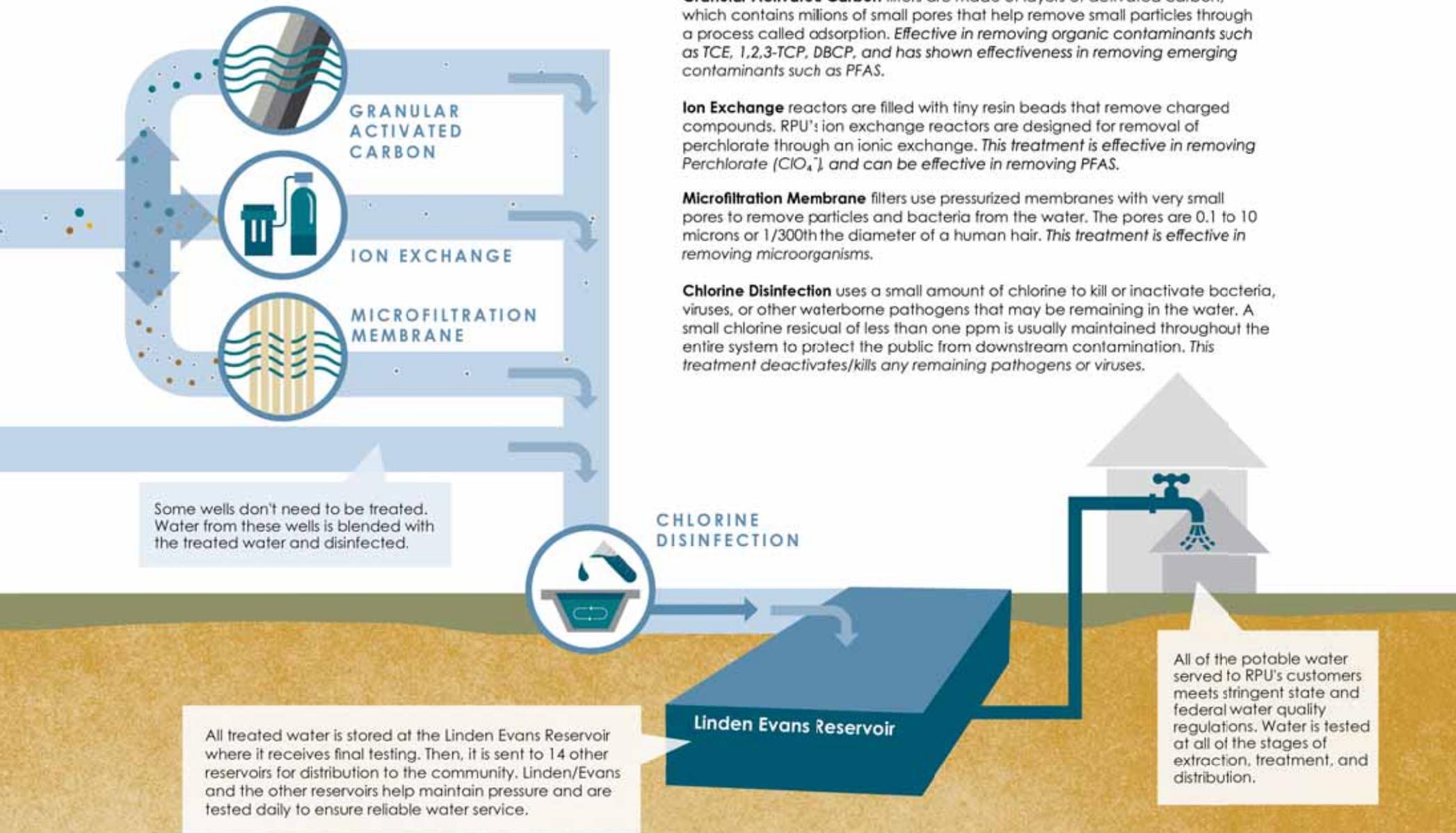
To ensure the City's drinking water is of highest quality, RPU operates 6 treatment facilities and 7 Disinfection facilities to produce safe, clean water. RPU's treatment plants use a combination of Ion Exchange, Granular Activated Carbon, Microfiltration Membranes and Chlorine Disinfection to purify groundwater for public use.

All of the water leaving the groundwater treatment plants is treated prior to entering RPU's potable water distribution system. RPU's treatment regimes are regulated by the California's Division of Drinking Water.



100% of our water supply comes from local groundwater basins through our well fields.

RPU routinely monitors each groundwater well for contaminants and provides targeted treatment.



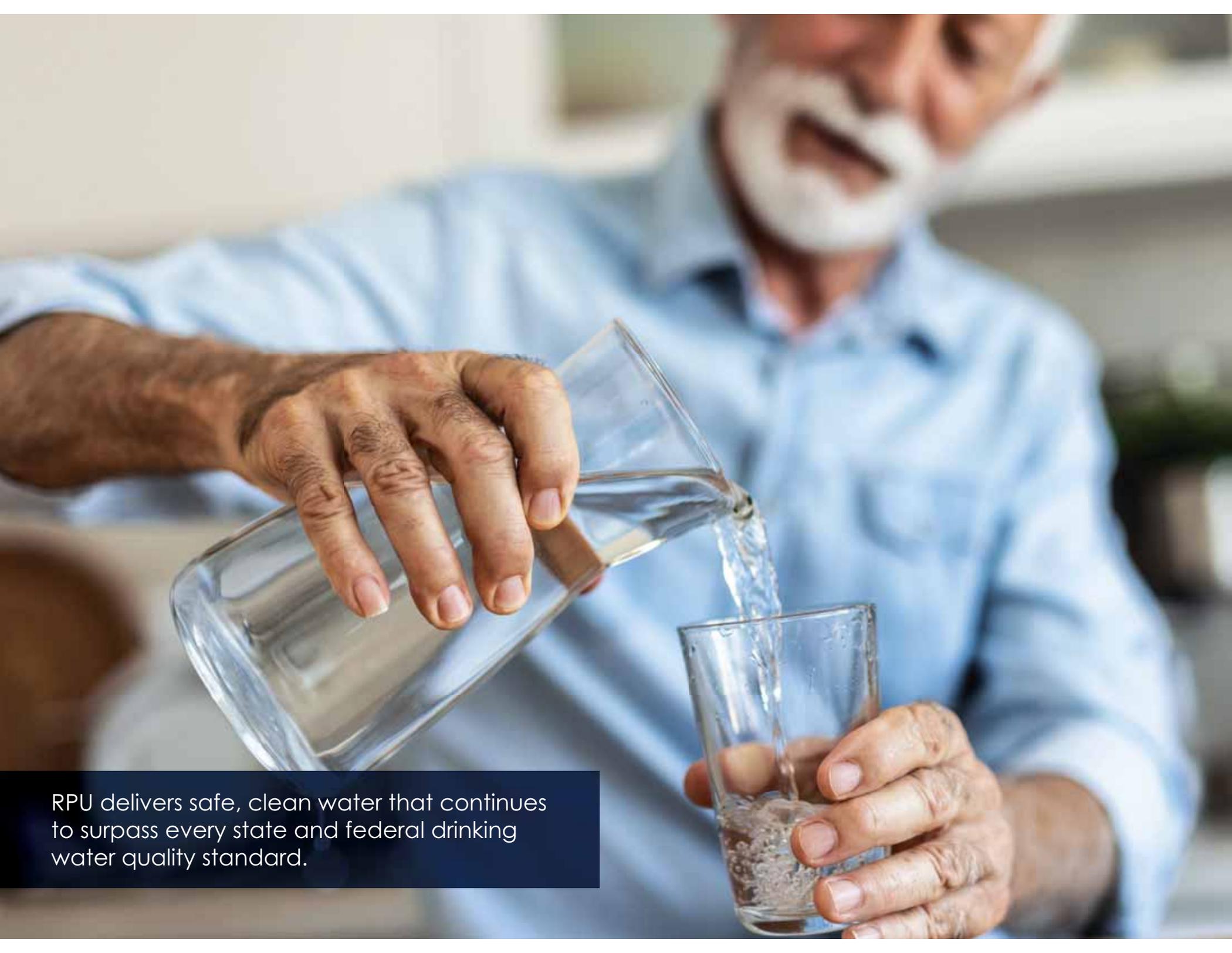
GROUNDWATER TREATMENT

Granular Activated Carbon filters are made of layers of activated carbon, which contains millions of small pores that help remove small particles through a process called adsorption. Effective in removing organic contaminants such as TCE, 1,2,3-TCP, DBCP, and has shown effectiveness in removing emerging contaminants such as PFAS.

Ion Exchange reactors are filled with tiny resin beads that remove charged compounds. RPU's ion exchange reactors are designed for removal of perchlorate through an ionic exchange. This treatment is effective in removing Perchlorate (ClO_4^-) and can be effective in removing PFAS.

Microfiltration Membrane filters use pressurized membranes with very small pores to remove particles and bacteria from the water. The pores are 0.1 to 10 microns or 1/300th the diameter of a human hair. This treatment is effective in removing microorganisms.

Chlorine Disinfection uses a small amount of chlorine to kill or inactivate bacteria, viruses, or other waterborne pathogens that may be remaining in the water. A small chlorine residual of less than one ppm is usually maintained throughout the entire system to protect the public from downstream contamination. This treatment deactivates/kills any remaining pathogens or viruses.



RPU delivers safe, clean water that continues to surpass every state and federal drinking water quality standard.

ACKNOWLEDGMENTS

Riverside Public Utilities Board of Directors:

- Rebeccah A. Goldware (Board Chair), Ward 2
- Brian D. Siana (Board Vice-Chair), City Wide/Ward 2
- Warren Avery, Ward 3
- Gary Montgomery, Ward 4
- Tom Evans, Ward 5
- Mikael Becker, Ward 7
- Peter Wohlgemuth, Citywide/Ward 1

Riverside Public Utilities Executives:

- David Garcia, General Manager
- Daniel Honeyfield, Assistant General Manager
Energy Delivery
- Robin Glenney, Assistant General Manager Water
- Dr. Scott Lesch, Assistant General Manager
Power Resources
- Brian Seinturier, Assistant General Manager
Finance and Administration
- Tracy Sato, Assistant General Manager
Strategic Initiatives and Customer Engagement

The 2024 City of Riverside Public Utilities Groundwater Atlas was prepared by the RPU team

- Farid Boushaki, P.E., PhD.
- Jolie Matta, E.I.T.
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- Drew Faherty
- Amy Navas-Lopez
- Reginald Agunwah
- Noemi Martinez

With the assistance of the Water Systems Consulting, Inc.

- Michael Cruikshank, P.G., C.H.G, M.S.
- Irvin Matamoros, GIT
- Eric Fregoso

