WATER | ENERGY | LIFE

CITY OF RIVERSIDE PUBLIC UTILITIES

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Groundwater Atlas

2021

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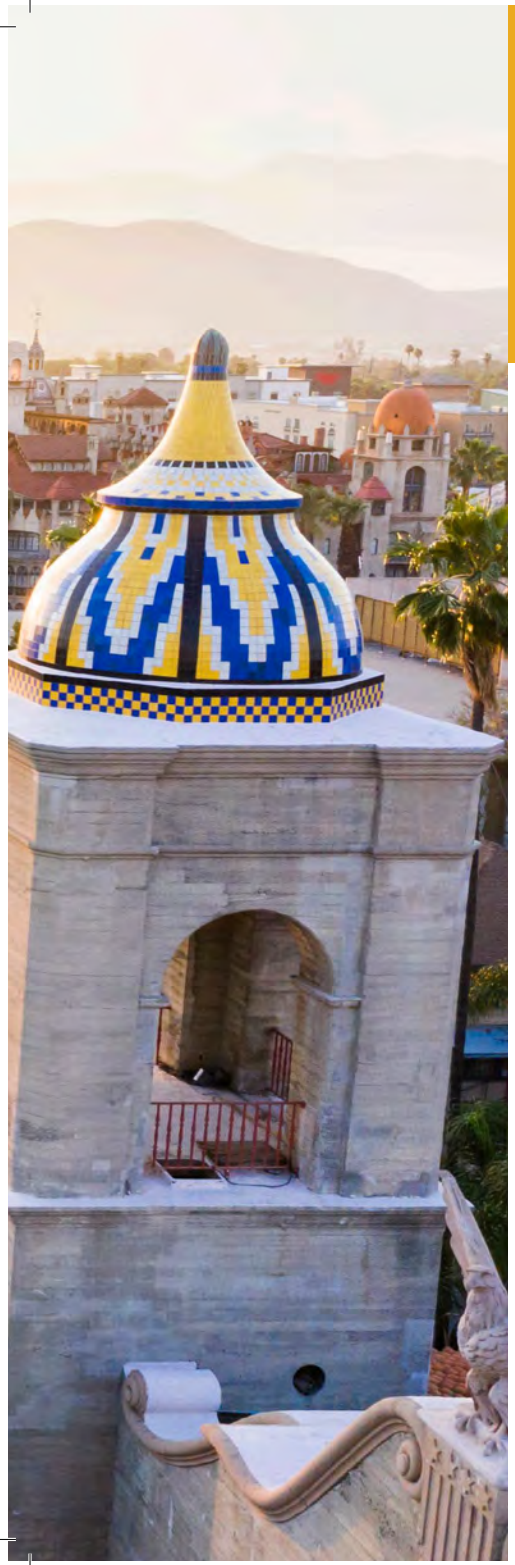
2021



CONTENTS

INTRODUCTION

The purpose of this Groundwater Atlas is to report 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 water, non-potable water, and recycled water to the City of Riverside (City). RPU currently serves water to a population of about 307,000 people through approximately 69,200 service connections within a service area of 75 square miles. In addition, RPU also 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 activities and changes outside of RPU's control, including groundwater contamination from past 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 purveyors and their associated water infrastructure, including 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. This underscores the importance of remaining engaged at both the local and regional levels and for RPU staff to track annual changes in groundwater basins to ensure an adequate and sustainable water supply is available for current and future generations. All data updated in this 2021 Groundwater Atlas was generated from January 1, 2021 to December 31, 2021.

This 2021 Groundwater Atlas illustrates the current condition of the groundwater basins with respect to hydrology, production, recharge, groundwater levels, and groundwater quality. The purpose of this Groundwater Atlas is to:

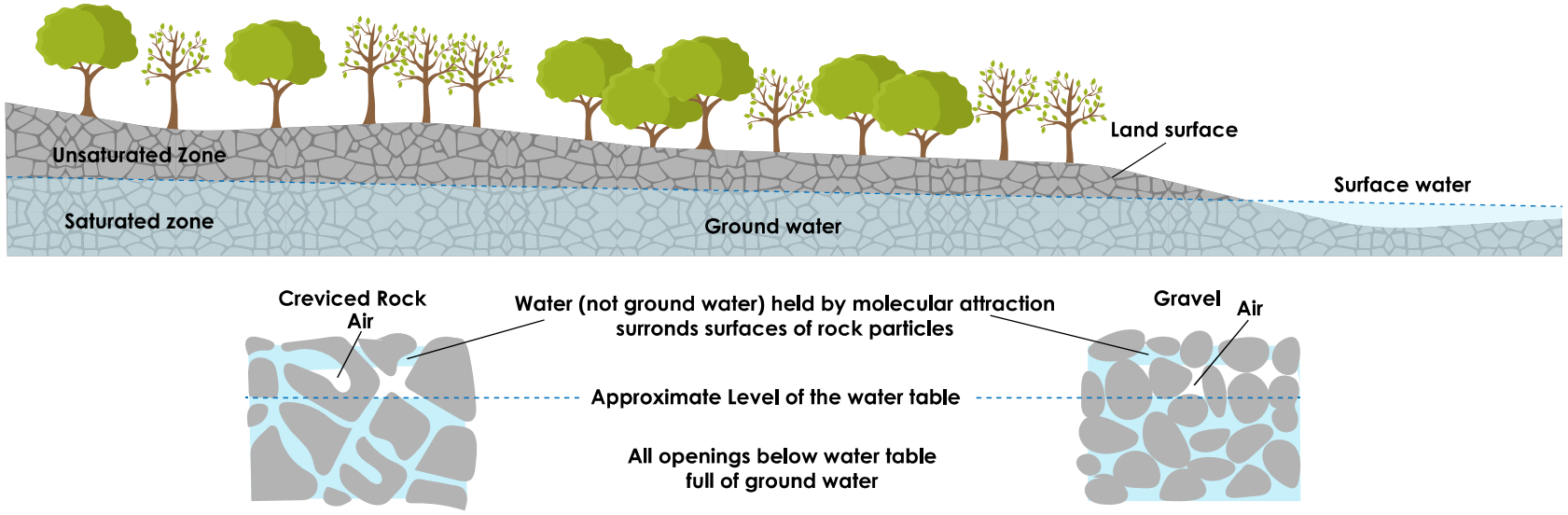
- Characterize groundwater basin conditions and how they change over time.
- Provide readable and reliable data to customers, elected officials, executive management, and staff.
- Provide information and analysis to RPU staff for use in managing the City's water supply.
- Protect RPU's strong water supply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

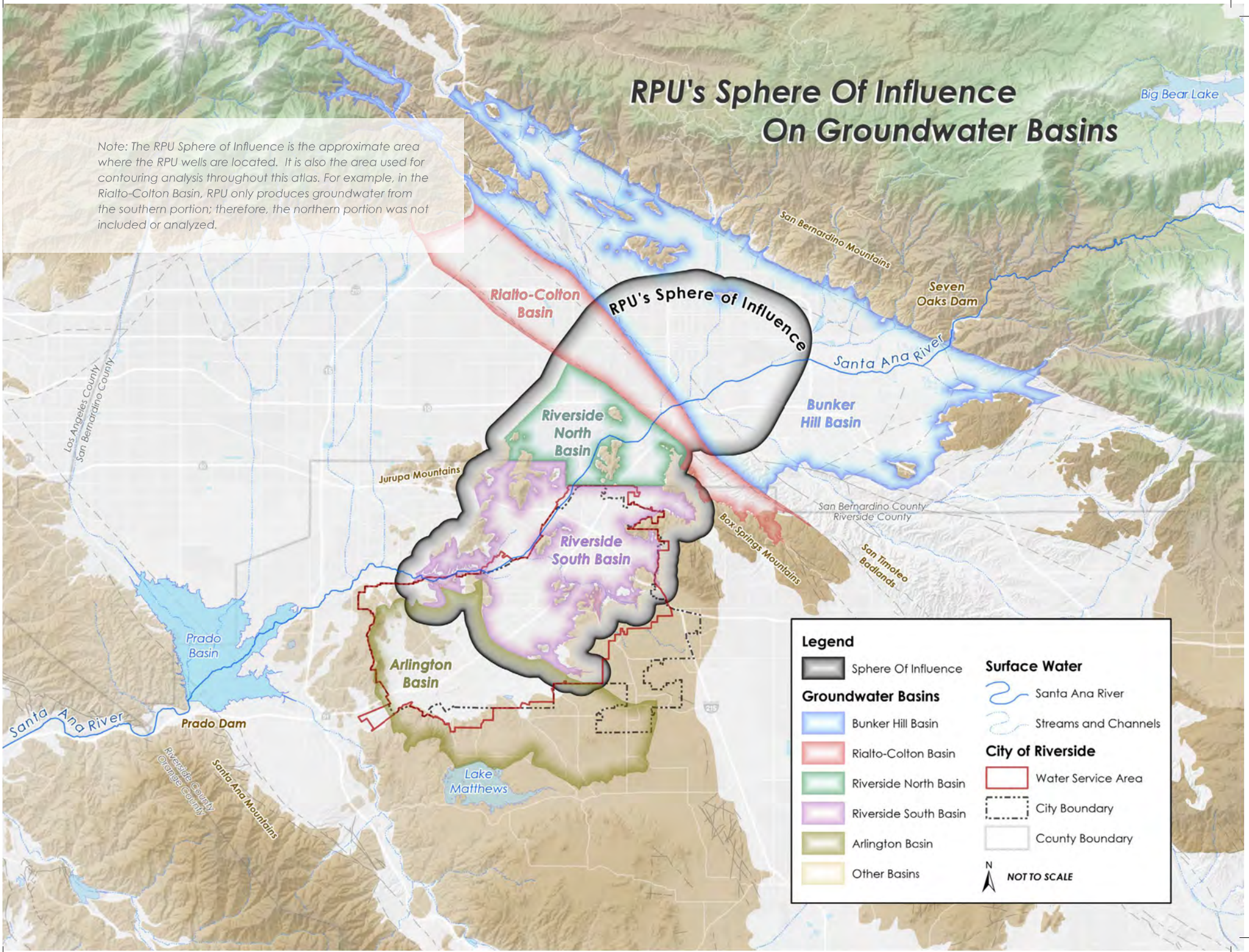
City of Riverside Skyline.

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 highly 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 zones helped to pressurize portions of the groundwater beneath the City of San Bernardino. As the surface waters of the Santa Ana River diminished from weather patterns and development in the region from 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 San Bernardino, Rialto-Colton, Riverside North and Riverside South Basins as shown in the figure on the adjacent page. Over the years, RPU has constructed facilities that have allowed for wise utilization of groundwater resources to become completely independent of imported water supplies.




RPU's 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.
Big Bear Lake
San Bernardino Mountains
Seven Oaks Dam
Rialto-Colton Basin
RPU's Sphere of Influence
Santa Ana River
Bunker Hill Basin
Riverside North Basin
Jurupa Mountains
Los Angeles County
San Bernardino County
San Bernardino County
Riverside County
Box Springs Mountains
San Timoteo Badlands
Riverside South Basin
Prado Basin
Arlington Basin
Santa Ana River
Prado Dam
Riverside County
Orange County
Santa Ana Mountains
Lake Matthews
Legend
Sphere Of Influence
Groundwater Basins
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
Arlington Basin
Other Basins
Surface Water
Santa Ana River
Streams and Channels
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE

Enhanced Recharge on the Santa Ana River

1

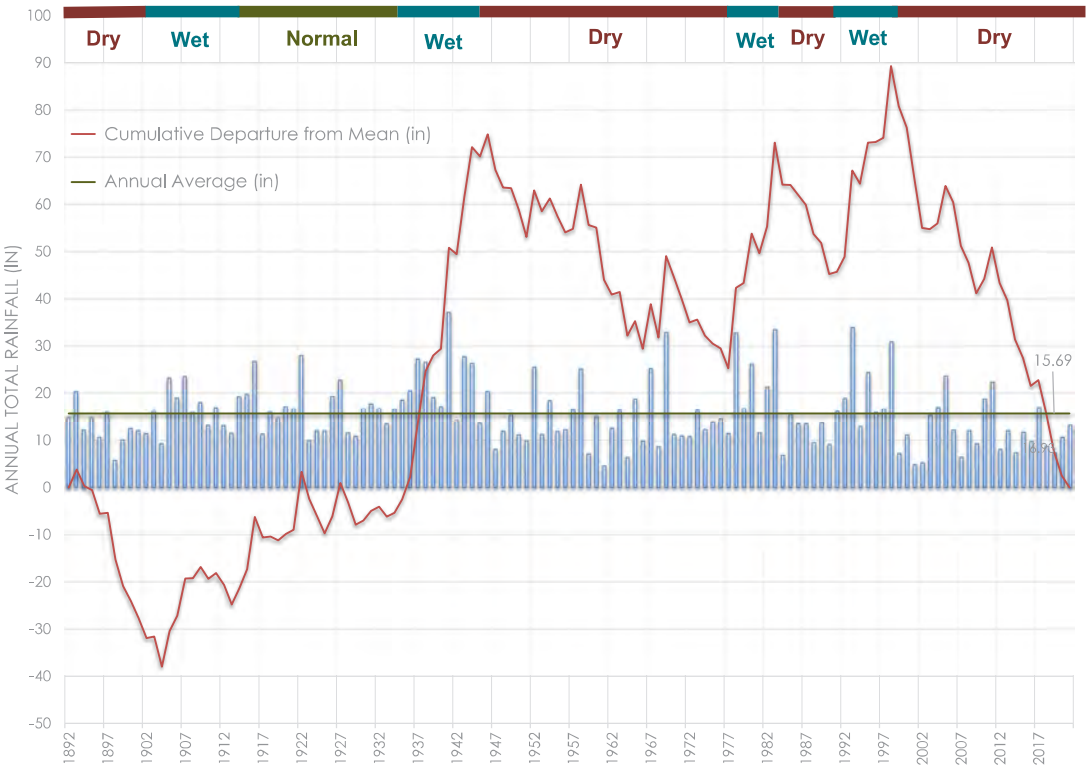
HYDROLOGIC CONDITIONS

1 HYDROLOGIC CONDITIONS

Both regional and local hydrologic conditions vary year to year and 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 15.69 inches and 10.6 inches in the last 10 years (2011 – 2021) 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 2021 shows a 23 year dry period with six wet years during this period.

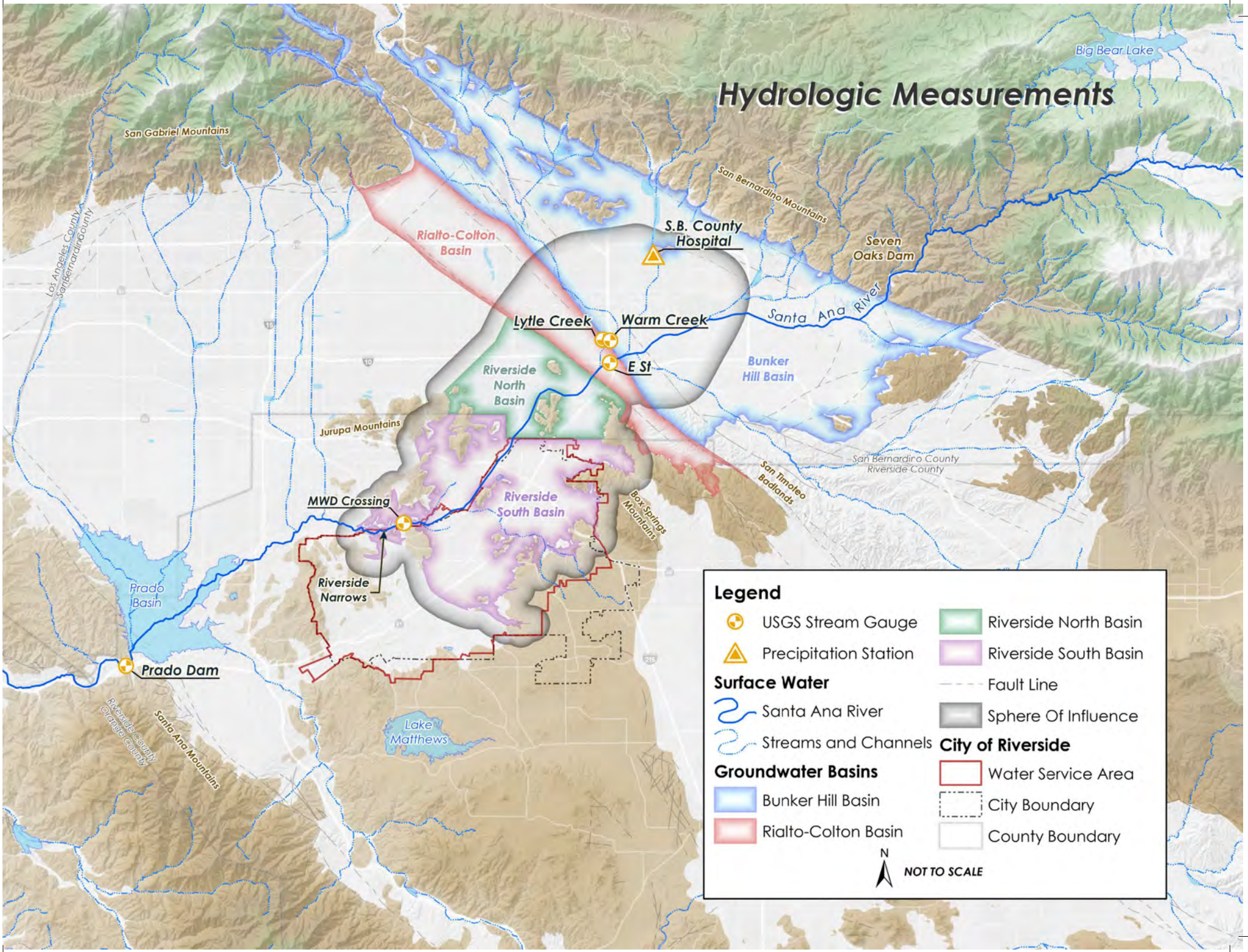
Annual Precipitation in the San Bernardino Hospital Gauge for the period 1892 -2021
(129 Years Rainfall Patterns and variability)



Historical Annual Precipitation

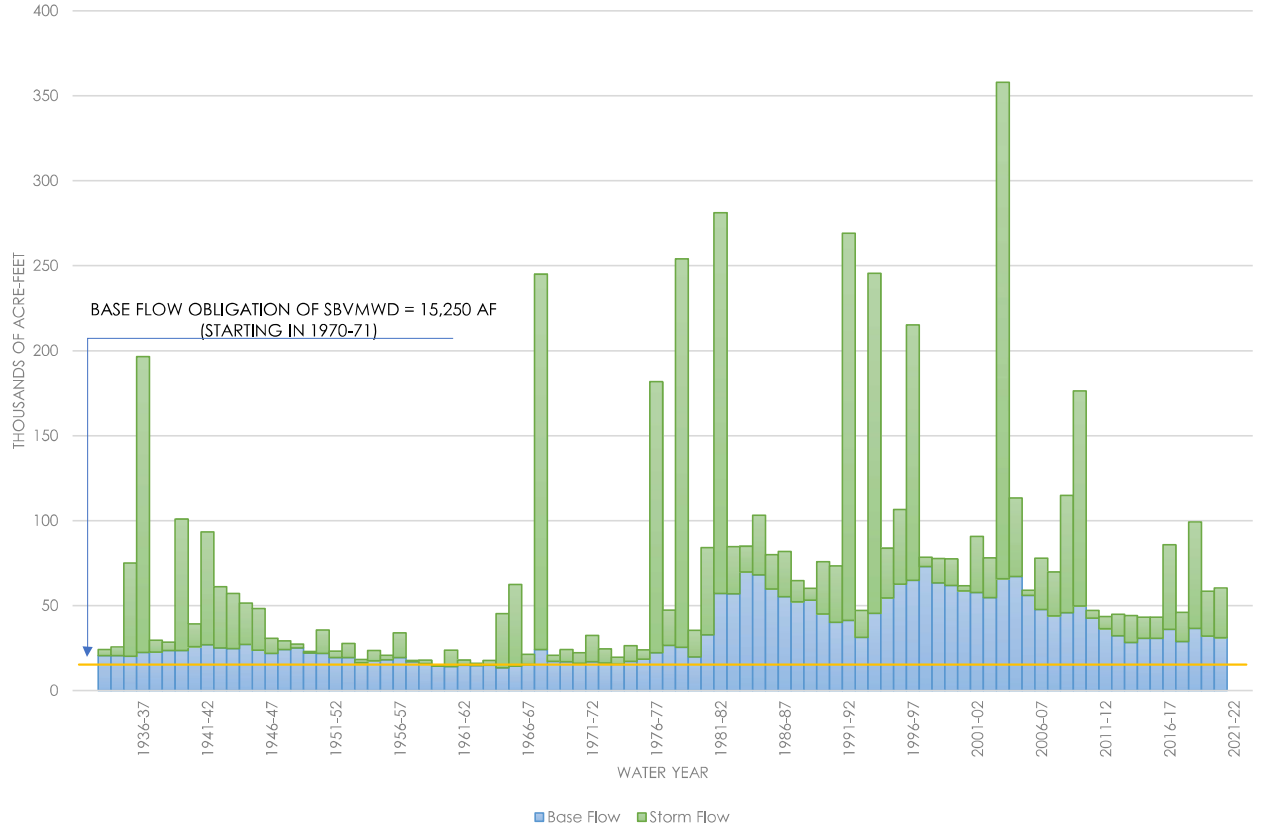
(San Bernardino County Hospital Gage)

San Bernardino's average annual precipitation over the last 129 years is 15.69 inches.


Hydrologic Measurements
Big Bear Lake
San Gabriel Mountains
San Bernardino Mountains
Los Angeles County
San Bernardino County
Rialto-Colton Basin
S.B. County Hospital
Seven Oaks Dam
Lytle Creek
Warm Creek
Santa Ana River
E St
Riverside North Basin
Bunker Hill Basin
Jurupa Mountains
San Bernardino County
Riverside County
San Timoteo Badlands
MWD Crossing
Riverside South Basin
Box Springs Mountains
Riverside Narrows
Prado Basin
Prado Dam
Riverside County
Orange County
Santa Ana Mountains
Lake Matthews
Legend
USGS Stream Gauge
Precipitation Station
Surface Water
Santa Ana River
Streams and Channels
Groundwater Basins
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
Fault Line
Sphere Of Influence
City of Riverside
Water Service Area
City Boundary
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 shows 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 looking downstream

Gage Canal

2

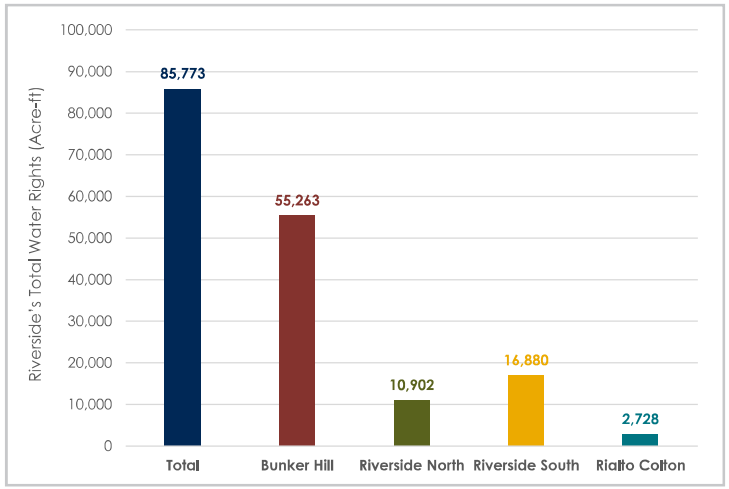
GROUNDWATER RESOURCES MANAGEMENT

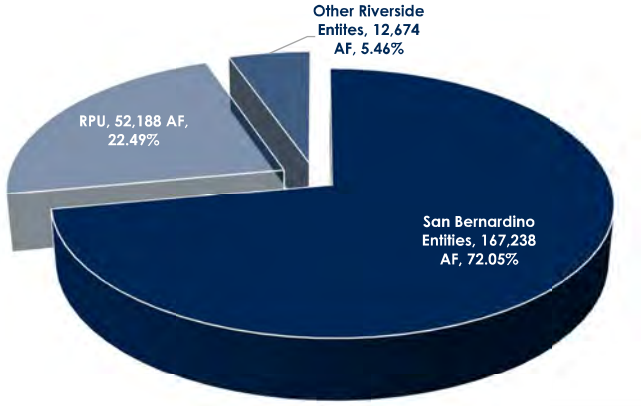
2 GROUNDWATER RESOURCES MANAGEMENT

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 has continued to keep its customers and decision-makers informed with the best available data and best management practices that have led to 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 dialog 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.

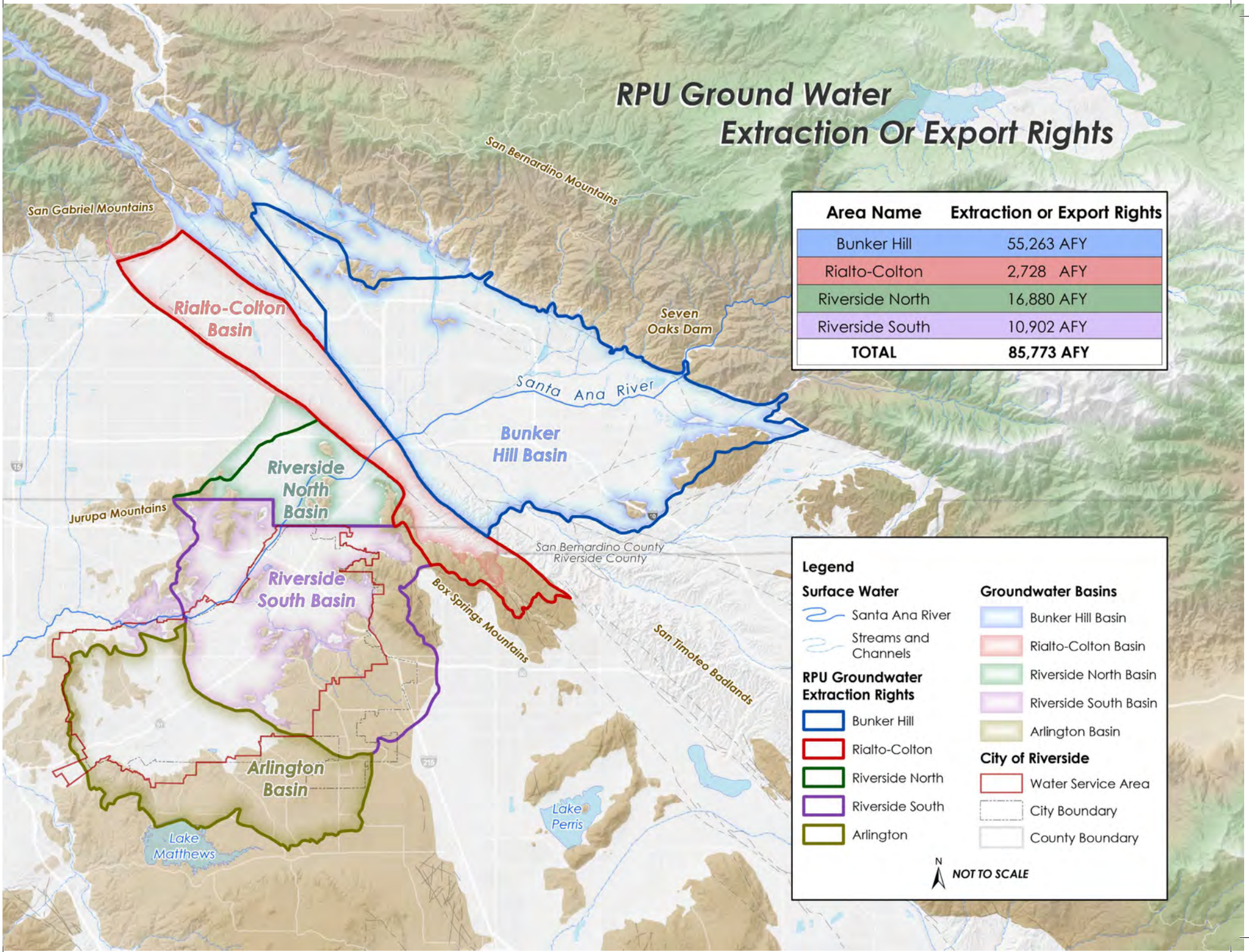
The City of Riverside Total Water Right and Base Period Production (in acre-feet) by Basin



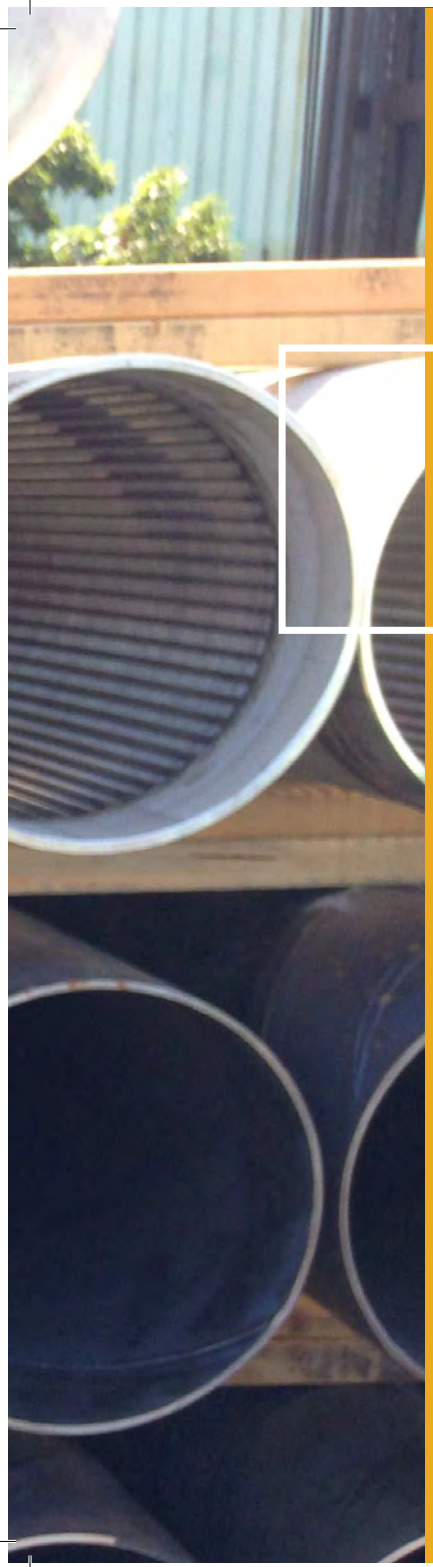


The original division of water resources in the San Bernardino Basin Area.

Source: Physical Solution Western-San Bernardino Watermaster


RPU Ground Water
Extraction Or Export Rights
San Bernardino Mountains
San Gabriel Mountains
Rialto-Colton Basin
Seven Oaks Dam
Santa Ana River
Bunker Hill Basin
Riverside North Basin
Jurupa Mountains
San Bernardino County
Riverside County
Riverside South Basin
Box Springs Mountains
San Timoteo Badlands
Arlington Basin
Lake Perris
Lake Matthews
Area Name | 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
Legend
Surface Water
Santa Ana River
Streams and Channels
RPU Groundwater Extraction Rights
Bunker Hill
Rialto-Colton
Riverside North
Riverside South
Arlington
Groundwater Basins
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
Arlington Basin
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE

Sets of new well wire wrap screen prior to installation into a borehole. The well screen provides a connection from the groundsurface to the suburface aquifers to extract water from the ground.



3

GROUNDWATER PRODUCTION

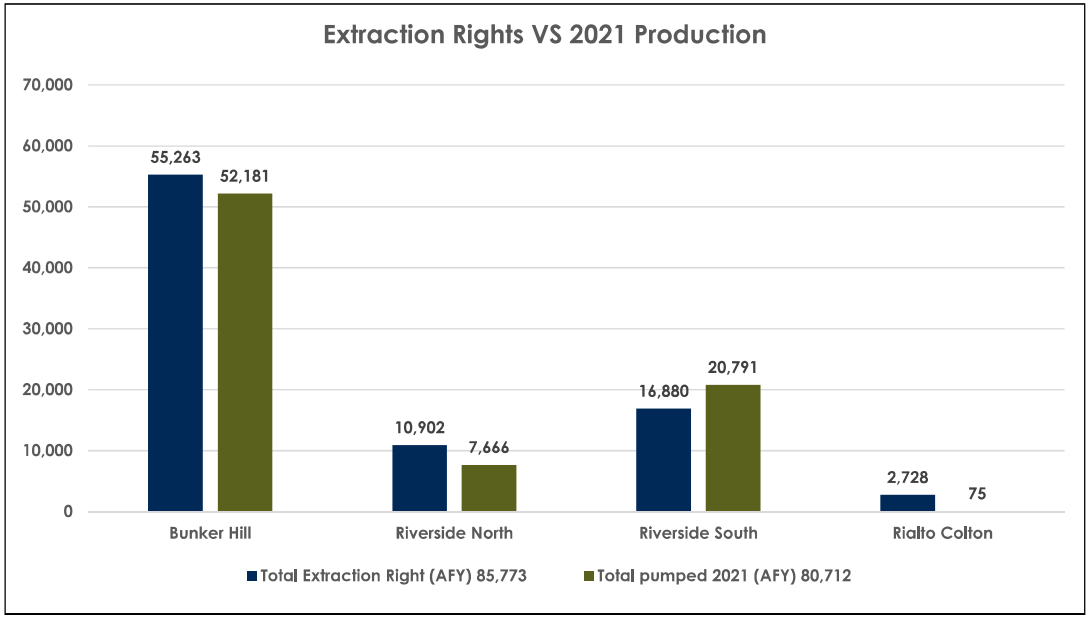
3 GROUNDWATER PRODUCTION

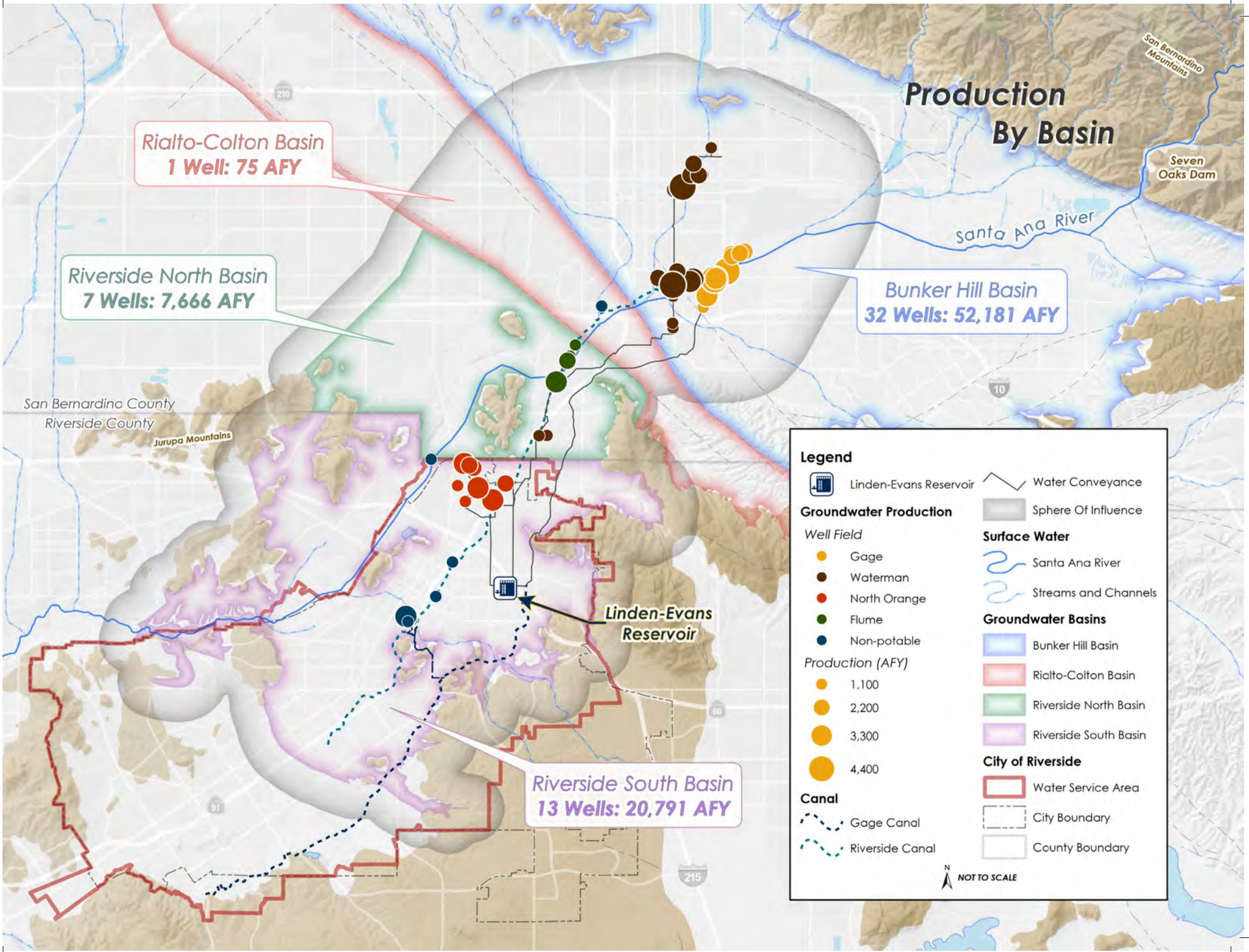
RPU has over 53 active wells located in five well fields that produce groundwater from the Bunker Hill, Rialto-Colton Basin, Riverside North, and Riverside South groundwater basins. The majority of groundwater is produced from the Waterman and Gage well field located in the Bunker Hill Basin.

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 2021, RPU operated 46 active potable water wells and 7 active non-potable water wells, for a total of 53 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".

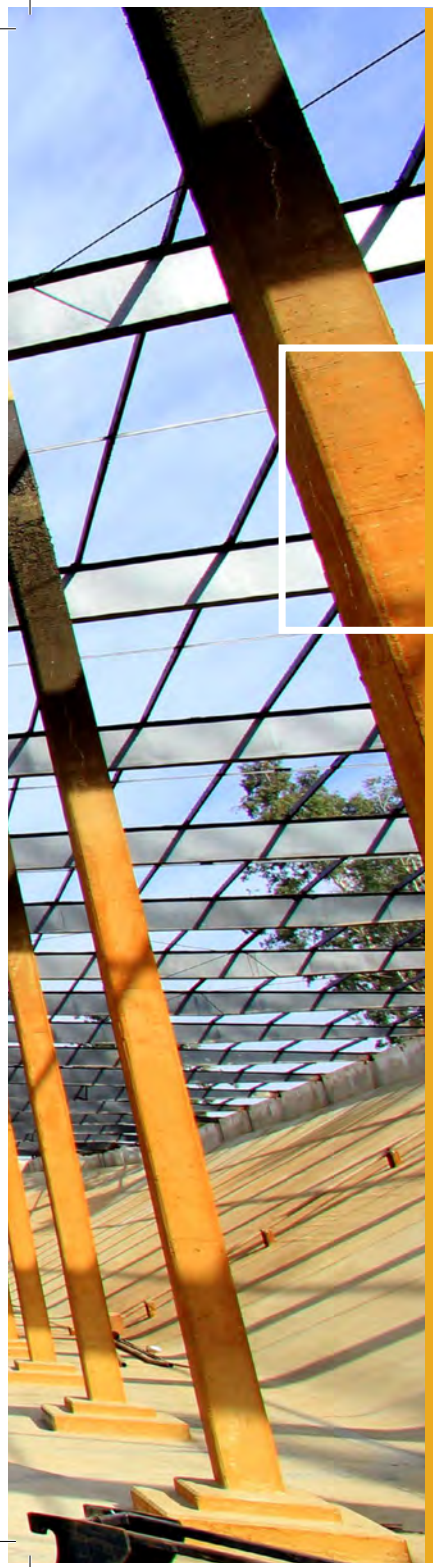
Since 2009, 100% of RPU's water supplies have mainly originated from the groundwater basins, Flume, Gage, North Orange, Rialto-Colton, and Waterman well fields. RPU's wells are generally located in the section of the basin with the greatest thickness of water-bearing layers in which 80,712 AF were pumped in 2021 under the City's water right and the rest 4,727 AF were wheeled to WMWD under their water right. Approximately 85,439 acre-feet, which equal to 27.84 billion gallons, of water were extracted from aquifers in 2021 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 2021




Production By Basin
Rialto-Colton Basin
1 Well: 75 AFY
Riverside North Basin
7 Wells: 7,666 AFY
Bunker Hill Basin
32 Wells: 52,181 AFY
Riverside South Basin
13 Wells: 20,791 AFY
Linden-Evans Reservoir
San Bernardino Mountains
Seven Oaks Dam
Santa Ana River
San Bernardino County
Riverside County
Jurupa Mountains
210
10
60
91
215
Legend
Linden-Evans Reservoir
Groundwater Production
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Production (AFY)
1,100
2,200
3,300
4,400
Canal
Gage Canal
Riverside Canal
Water Conveyance
Sphere Of Influence
Surface Water
Santa Ana River
Streams and Channels
Groundwater Basins
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE

Linden Reservoir



4

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 mainly 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

POTABLE WATER

WATERMAN + FLUME

- 22 Production Wells
- Producing **36,740** *acre-feet* in 2021
- Maximum monthly demand **3,735** *acre-feet* in 2021
- **16.69** *miles* of pipeline
- **72** *inches max* pipe diameter

GAGE

- 16 Production Wells
- Producing **20,039** *acre-feet* in 2021
- Maximum monthly demand **2,126** *acre-feet* in 2021
- **14.84** *miles* of pipeline
- **60** *inches max* pipe diameter

NORTH ORANGE

- 8 Production Wells
- Producing **14,912** *acre-feet* in 2021
- Maximum monthly demand **1,590** *acre-feet* in 2021
- **9.19** *miles* of pipeline
- **60** *inches max* pipe diameter

NON-POTABLE WATER

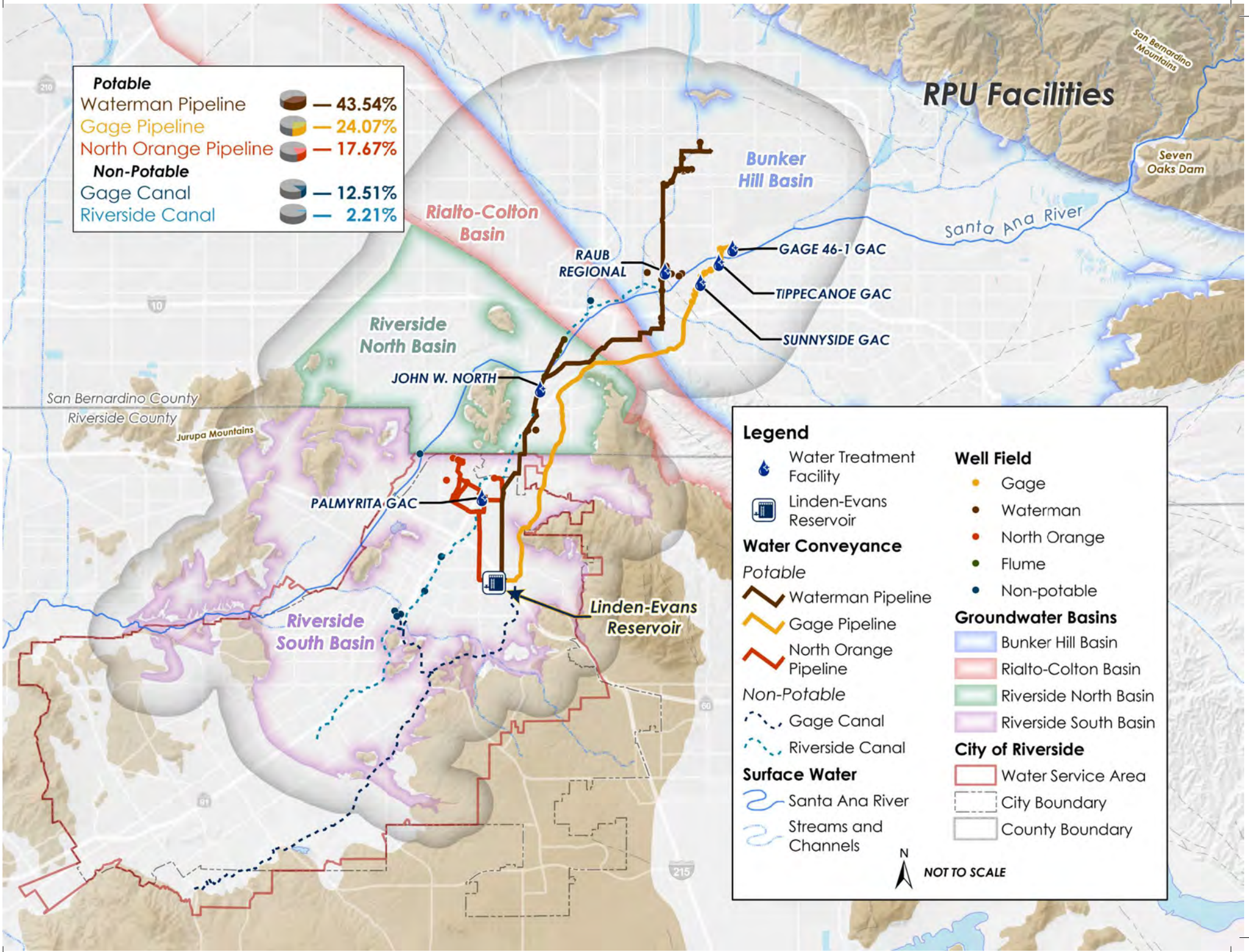
RIVERSIDE CANAL

- 4 Production Wells
- Producing **1,865** *acre-feet* in 2021
- Maximum monthly demand **360** *acre-feet* in 2021
- **13.9** *miles*

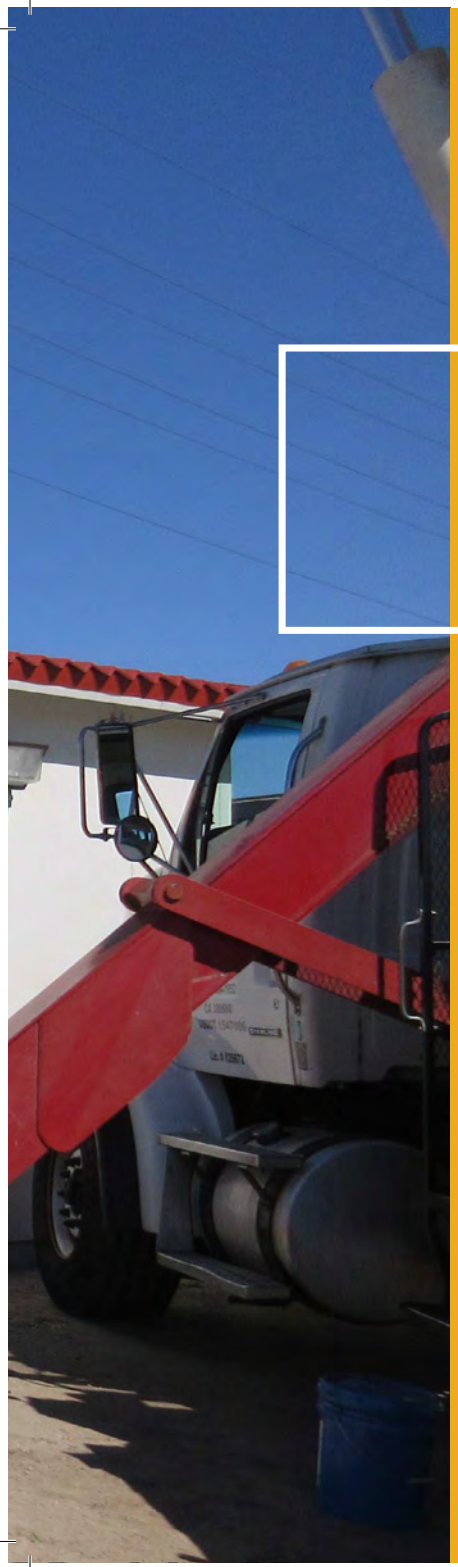
GAGE CANAL

- 3 Production Wells
- Producing **10,833** *acre-feet* in 2021
- Maximum monthly demand **1,235** *acre-feet* in 2021
- **15.6** *miles*

Total Potable Water = 72,226 AF
Total Non-Potable Water = 13,748 AF
This includes overlaying use (Jurupa)


RPU Facilities
Potable
Waterman Pipeline — 43.54%
Gage Pipeline — 24.07%
North Orange Pipeline — 17.67%
Non-Potable
Gage Canal — 12.51%
Riverside Canal — 2.21%
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
San Bernardino Mountains
Seven Oaks Dam
Santa Ana River
RAUB REGIONAL
GAGE 46-1 GAC
TIPPECANOE GAC
SUNNYSIDE GAC
JOHN W. NORTH
PALMYRITA GAC
Linden-Evans Reservoir
San Bernardino County
Riverside County
Jurupa Mountains
Legend
Water Treatment Facility
Linden-Evans Reservoir
Water Conveyance
Potable
Waterman Pipeline
Gage Pipeline
North Orange Pipeline
Non-Potable
Gage Canal
Riverside Canal
Surface Water
Santa Ana River
Streams and Channels
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Groundwater Basins
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE

Warren 4R Groundwater Well Project



5

GROUNDWATER LEVELS

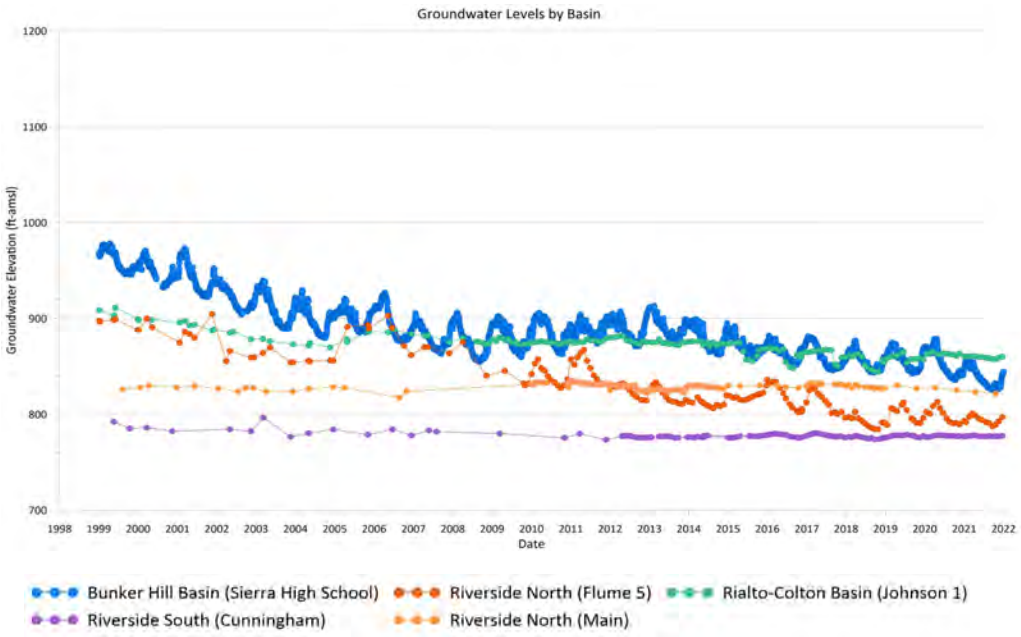
5 GROUNDWATER LEVELS

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 what is driving the changing conditions, RPU can be environmental stewards and better plan, work collaboratively with other local water agencies, and focus future investments to ensure a reliable groundwater supply for the future.

In 2021, 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 2020 and 2021 and the change in groundwater levels from 2020 to 2021. To illustrate the change in groundwater levels over the last 10 years, corresponding to the most recent drought, groundwater elevation contours were generated for 2011 and 2021 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 2021. 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 Bunker Hill Basin represent a lowering trend of groundwater levels. For example, Sierra High School located in the Bunker Hill Basin shows groundwater level declines of about 5.6 ft/yr, Flume 5 located in the Riverside North Basin shows groundwater level declines of about 4.6 ft/yr, Johnson 1 located in the Rialto-Colton basin shows groundwater level declines of about 2.2 ft/yr, and Cunningham located in the Riverside South has been relatively stable with water level declines of less than 1 ft/yr over a 23-year time period.

Rate of Groundwater Level Decline from 1999 to 2021 within RPU's Sphere of Influence

BUNKER HILL

Decline of about 5.6 ft/yr

RIALTO-COLTON

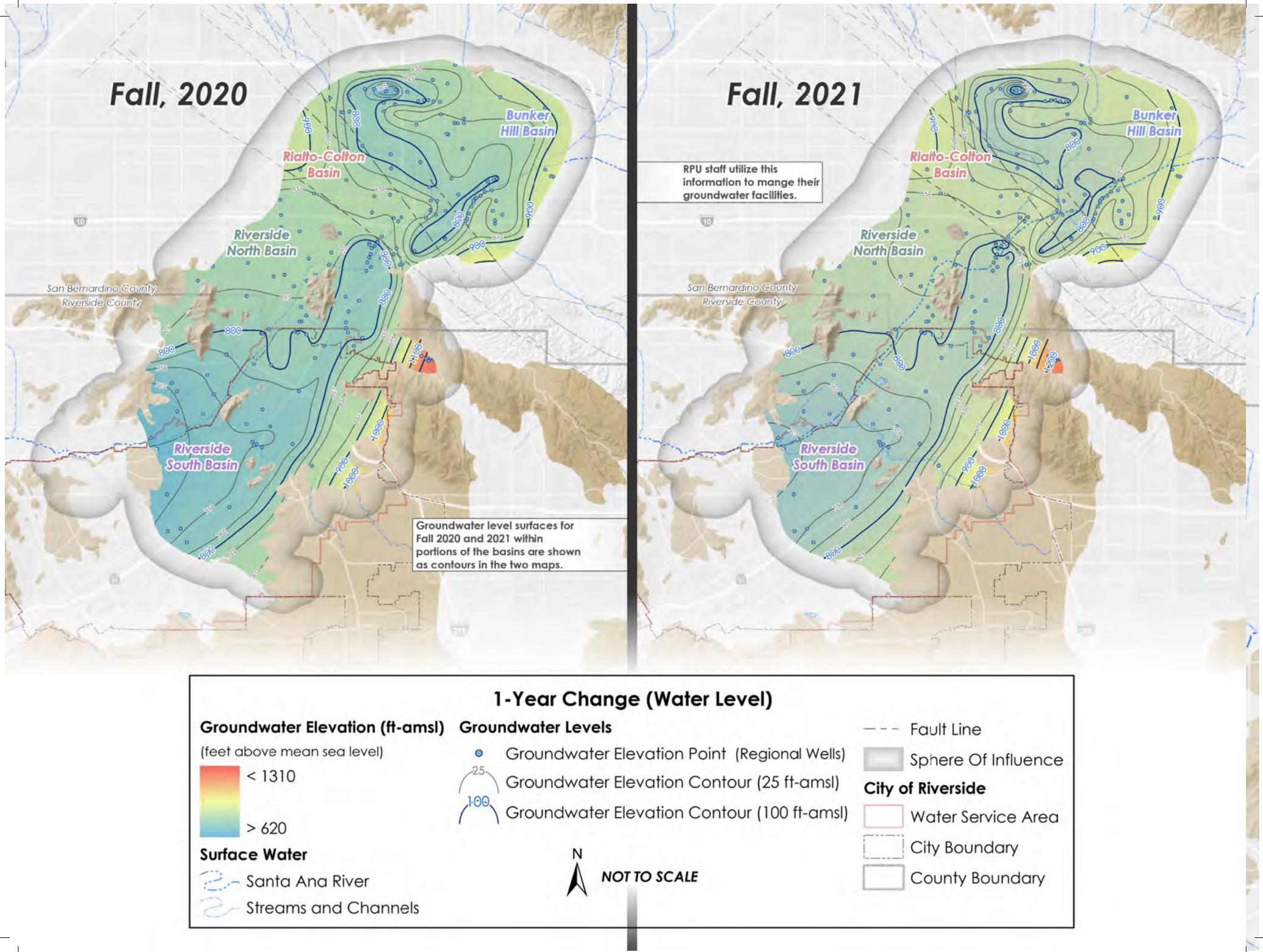
Decline of about 2.2 ft/yr

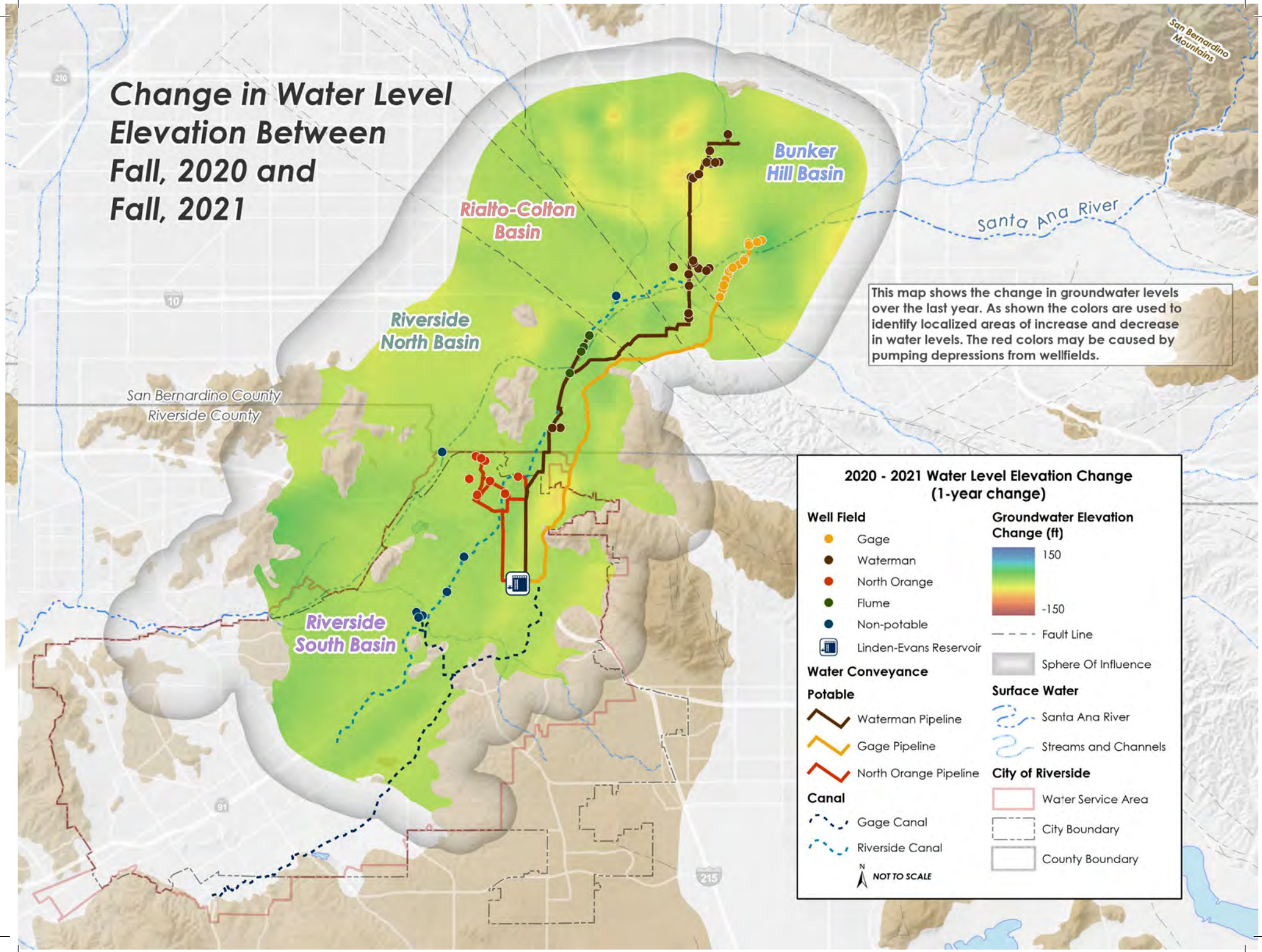
RIVERSIDE NORTH

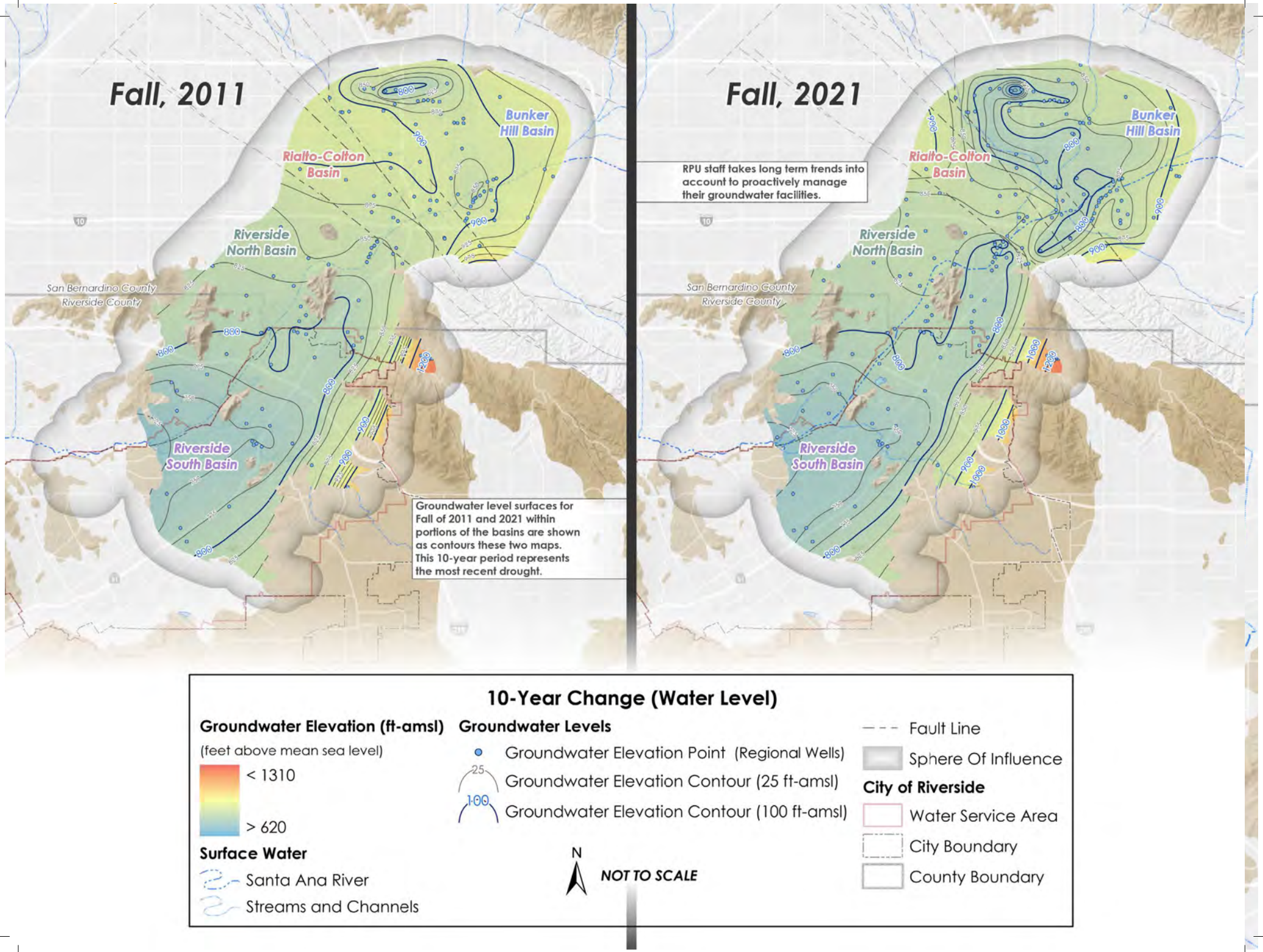
Decline of about 4.6 ft/yr

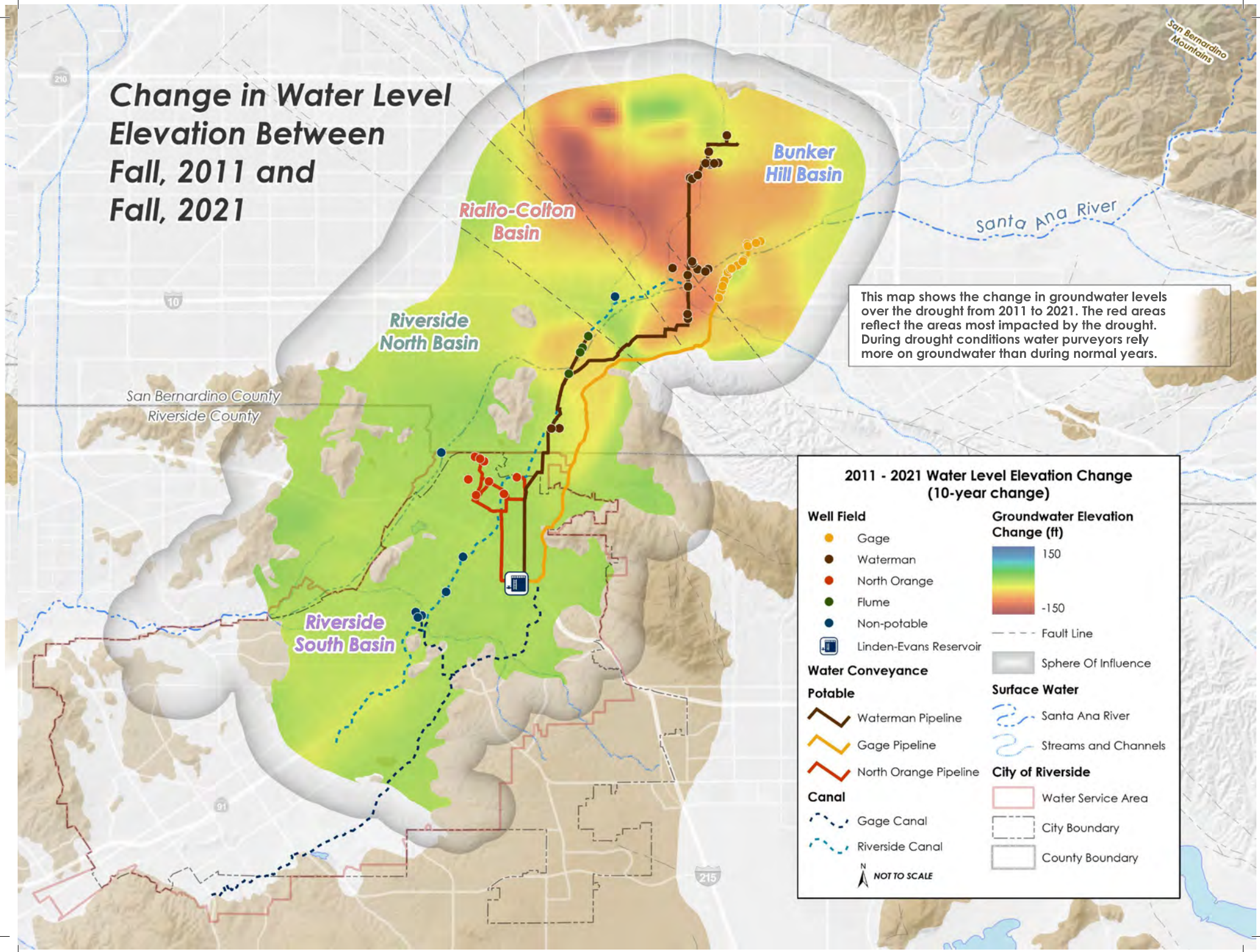
RIVERSIDE SOUTH

Decline of about 0.7 ft/yr

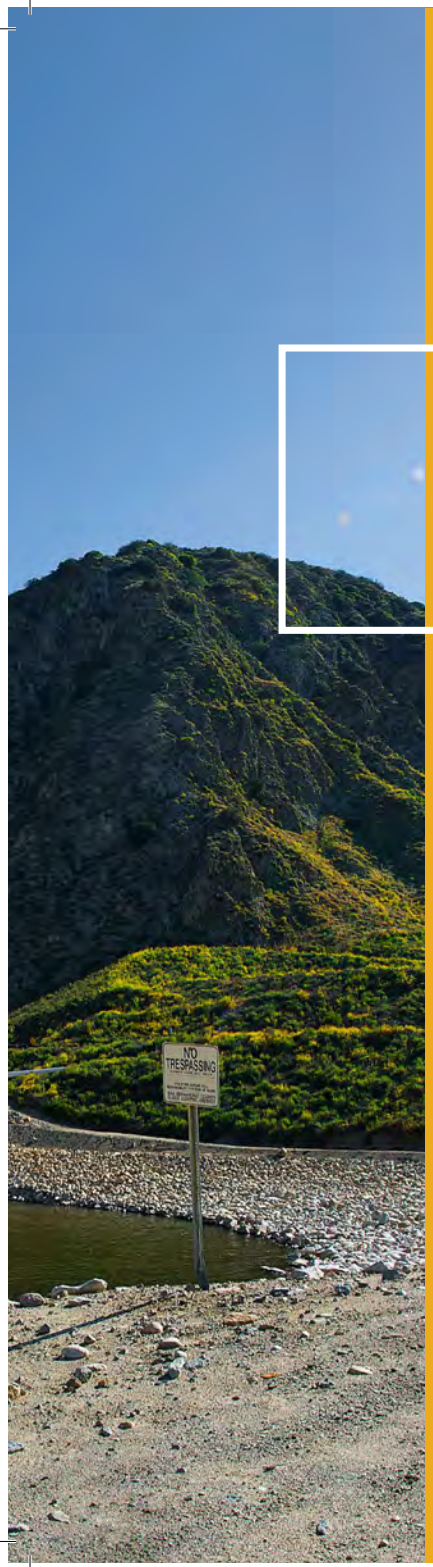

Fall, 2020
Fall, 2021
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
San Bernardino County
Riverside County
RPU staff utilize this information to mange their groundwater facilities.
Groundwater level surfaces for Fall 2020 and 2021 within portions of the basins are shown as contours in the two maps.
1-Year Change (Water Level)
Groundwater Elevation (ft-amsl)
(feet above mean sea level)
< 1310
> 620
Surface Water
Santa Ana River
Streams and Channels
Groundwater Levels
Groundwater Elevation Point (Regional Wells)
Groundwater Elevation Contour (25 ft-amsl)
Groundwater Elevation Contour (100 ft-amsl)
N
NOT TO SCALE
Fault Line
Sphere Of Influence
City of Riverside
Water Service Area
City Boundary
County Boundary


Change in Water Level Elevation Between Fall, 2020 and Fall, 2021
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
Santa Ana River
San Bernardino Mountains
San Bernardino County
Riverside County
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.
2020 - 2021 Water Level Elevation Change (1-year change)
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Linden-Evans Reservoir
Water Conveyance
Potable
Waterman Pipeline
Gage Pipeline
North Orange Pipeline
Canal
Gage Canal
Riverside Canal
NOT TO SCALE
Groundwater Elevation Change (ft)
150
-150
Fault Line
Sphere Of Influence
Surface Water
Santa Ana River
Streams and Channels
City of Riverside
Water Service Area
City Boundary
County Boundary


Fall, 2011
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
San Bernardino County
Riverside County
Riverside South Basin
Groundwater level surfaces for Fall of 2011 and 2021 within portions of the basins are shown as contours these two maps. This 10-year period represents the most recent drought.
Fall, 2021
RPU staff takes long term trends into account to proactively manage their groundwater facilities.
10-Year Change (Water Level)
Groundwater Elevation (ft-amsl)
(feet above mean sea level)
< 1310
> 620
Surface Water
Santa Ana River
Streams and Channels
Groundwater Levels
Groundwater Elevation Point (Regional Wells)
Groundwater Elevation Contour (25 ft-amsl)
Groundwater Elevation Contour (100 ft-amsl)
N
NOT TO SCALE
Fault Line
Sphere Of Influence
City of Riverside
Water Service Area
City Boundary
County Boundary


Change in Water Level Elevation Between Fall, 2011 and Fall, 2021
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
Santa Ana River
San Bernardino Mountains
San Bernardino County
Riverside County
This map shows the change in groundwater levels over the drought from 2011 to 2021. The red areas reflect the areas most impacted by the drought. During drought conditions water purveyors rely more on groundwater than during normal years.
2011 - 2021 Water Level Elevation Change (10-year change)
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Linden-Evans Reservoir
Water Conveyance
Potable
Waterman Pipeline
Gage Pipeline
North Orange Pipeline
Canal
Gage Canal
Riverside Canal
NOT TO SCALE
Groundwater Elevation Change (ft)
150
-150
Fault Line
Sphere Of Influence
Surface Water
Santa Ana River
Streams and Channels
City of Riverside
Water Service Area
City Boundary
County Boundary

Seven Oaks Dam



6

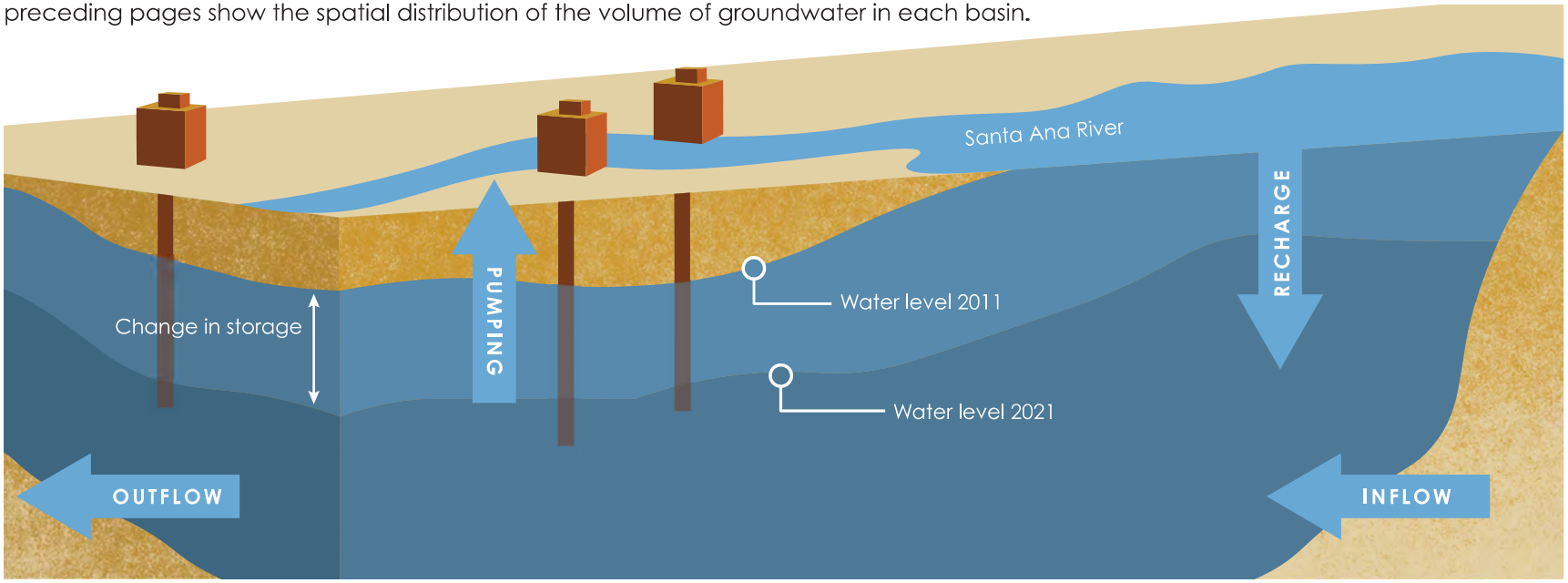
GROUNDWATER IN STORAGE

6 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 to the right. 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 2011 Total Volume: 2,098,000
Spring 2020 Total Volume: 2,021,000
Fall 2020 Total Volume: 1,966,000
Spring 2021 Total Volume: 1,978,000
Fall 2021 Total Volume: 1,959,000
Spring 2020-2021 Volume Change: -43,000
Fall 2020-2021 Volume Change: -7,000
Fall 2011 to 2021 Volume Change: -139,0000

RIALTO-COLTON

Fall 2011 Total Volume: 493,000
Spring 2020 Total Volume: 468,000
Fall 2020 Total Volume: 468,000
Spring 2021 Total Volume: 469,000
Fall 2021 Total Volume: 468,000
Spring 2020-2021 Volume Change: 1,000
Fall 2020-2021 Volume Change: 0
Fall 2011 to 2021 Volume Change: -24,000

RIVERSIDE NORTH

Fall 2011 Total Volume: 443,000
Spring 2020 Total Volume: 436,000
Fall 2020 Total Volume: 433,000
Spring 2021 Total Volume: 437,000
Fall 2021 Total Volume: 438,000
Spring 2020-2021 Volume Change: 1,000
Fall 2020-2021 Volume Change: +5,000
Fall 2011 to 2021 Volume Change: -5,000

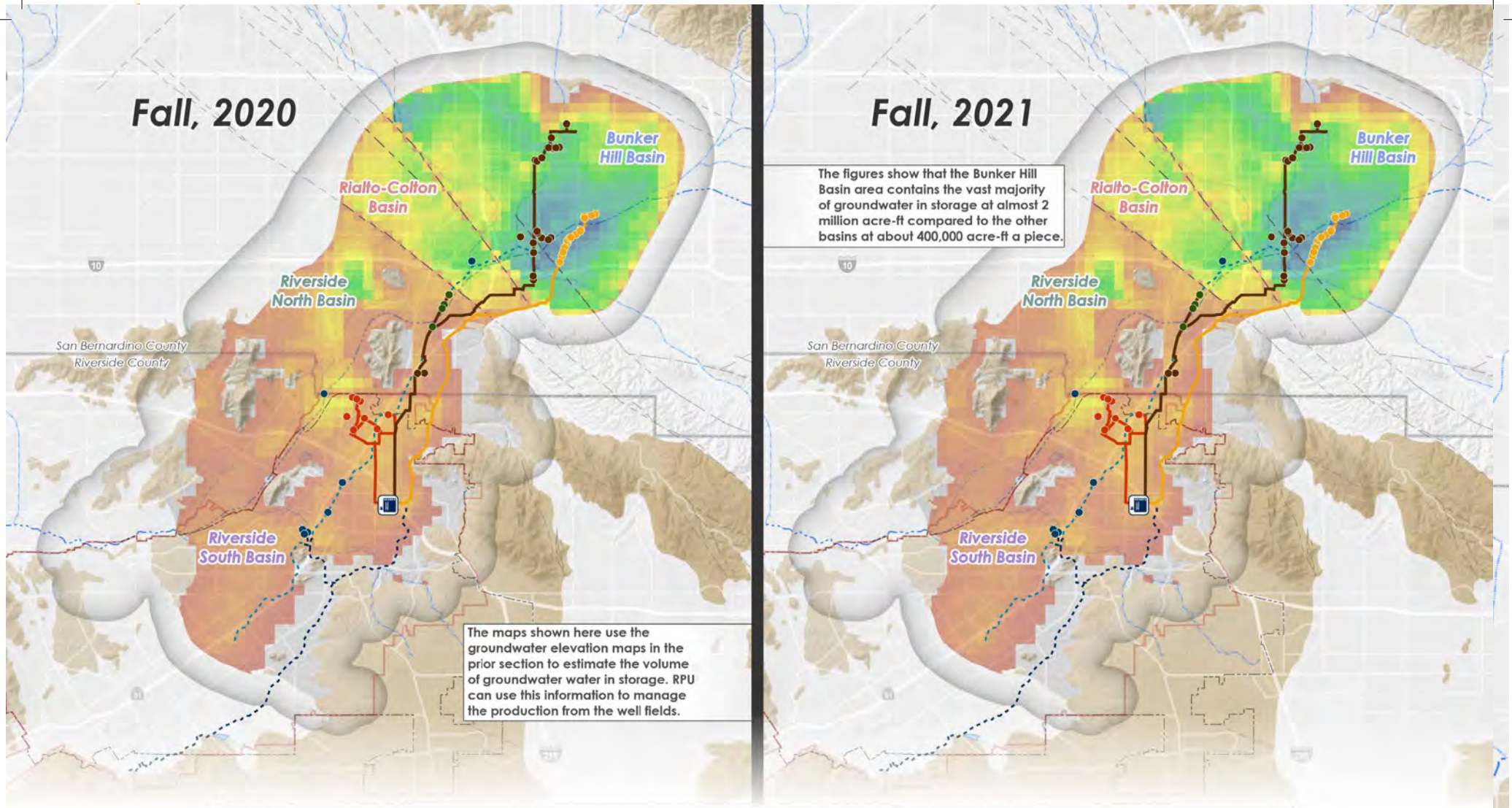
RIVERSIDE SOUTH

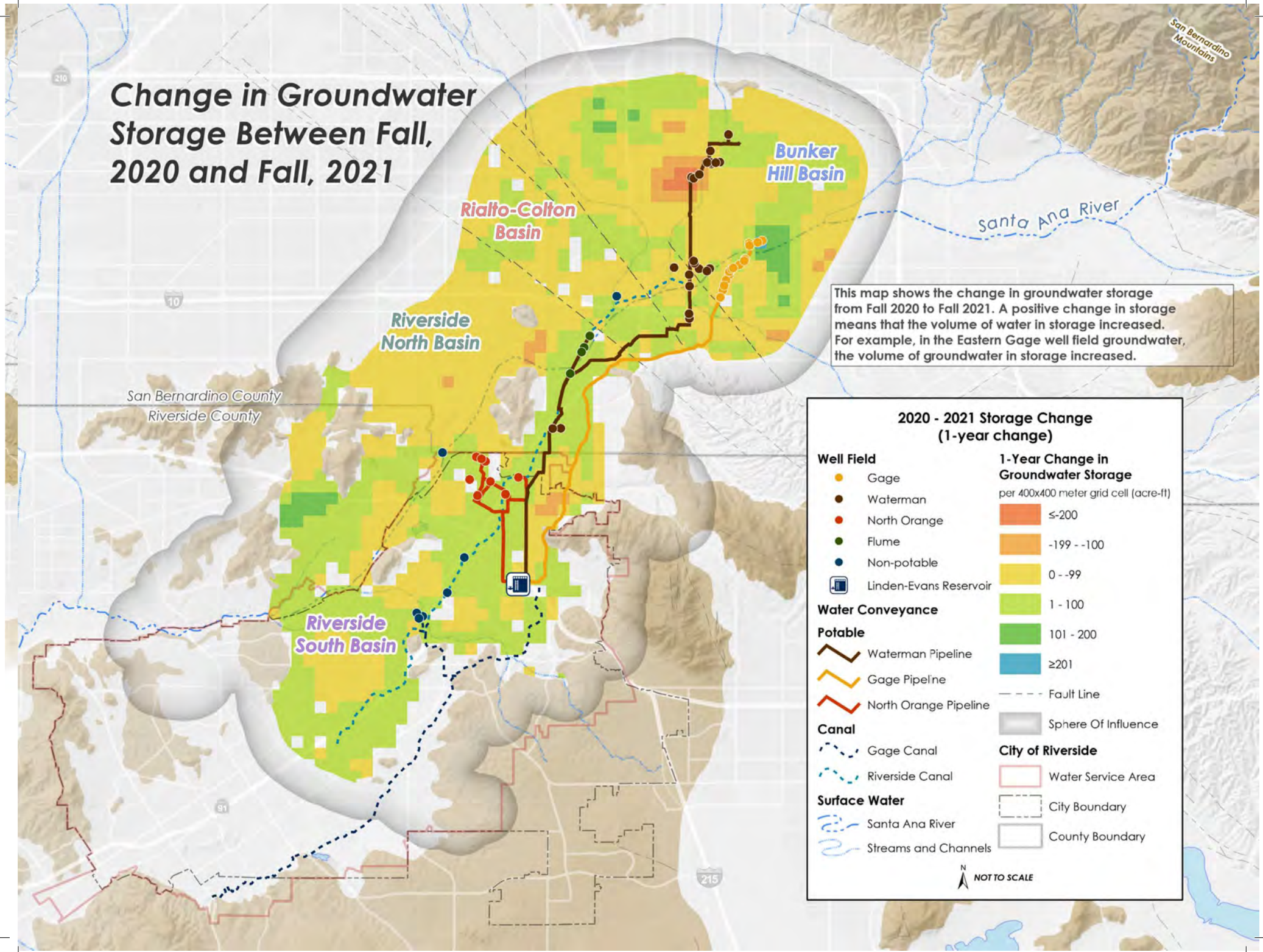
Fall 2011 Total Volume: 368,000
Spring 2020 Total Volume: 351,000
Fall 2020 Total Volume: 351,000
Spring 2021 Total Volume: 349,000
Fall 2021 Total Volume: 345,000
Spring 2020-2021 Volume Change: 2,000
Fall 2020-2021 Volume Change: -6,000
Fall 2011 to 2021 Volume Change: -23,000

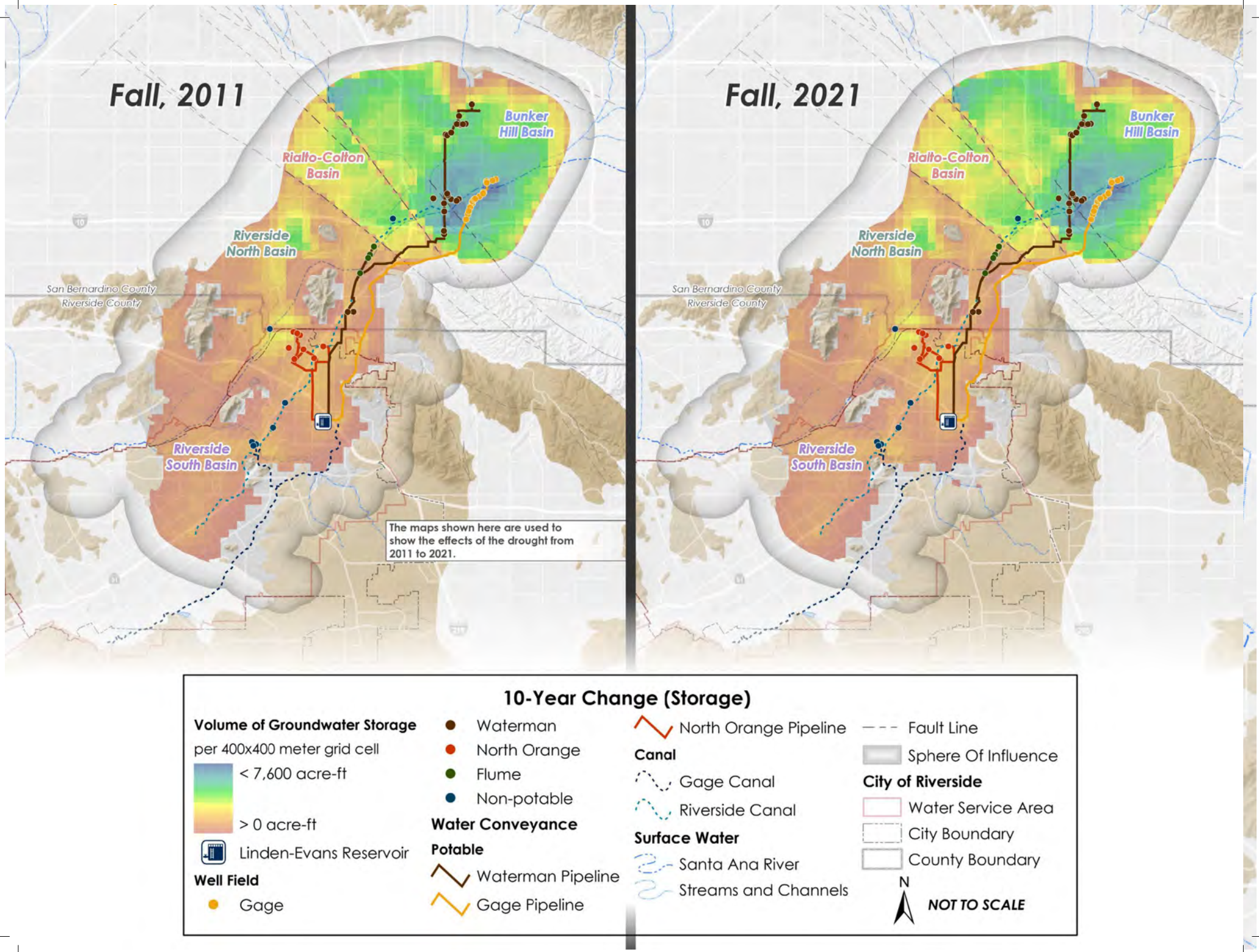
TOTAL VOLUME

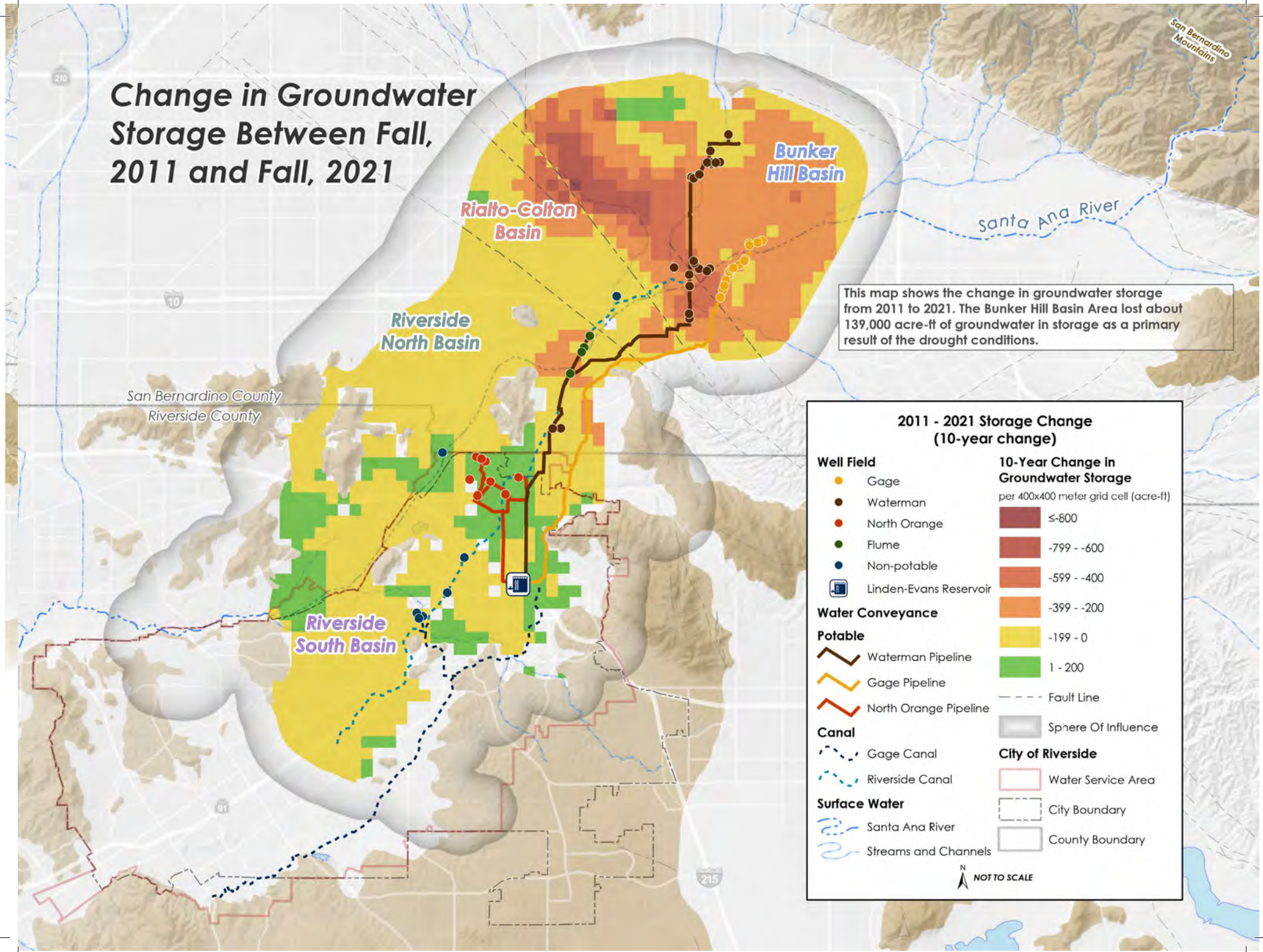
Fall 2011 Total Volume: 3,402,000
Spring 2020 Total Volume: 3,277,000
Fall 2020 Total Volume: 3,219,000
Spring 2021 Total Volume: 3,234,000
Fall 2021 Total Volume: 3,209,000
Spring 2020-2021 Total Volume Change: -43,000
Fall 2020-2021 Total Volume Change: -10,000
Fall 2011 to 2021 Total Volume Change: -193,000

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.

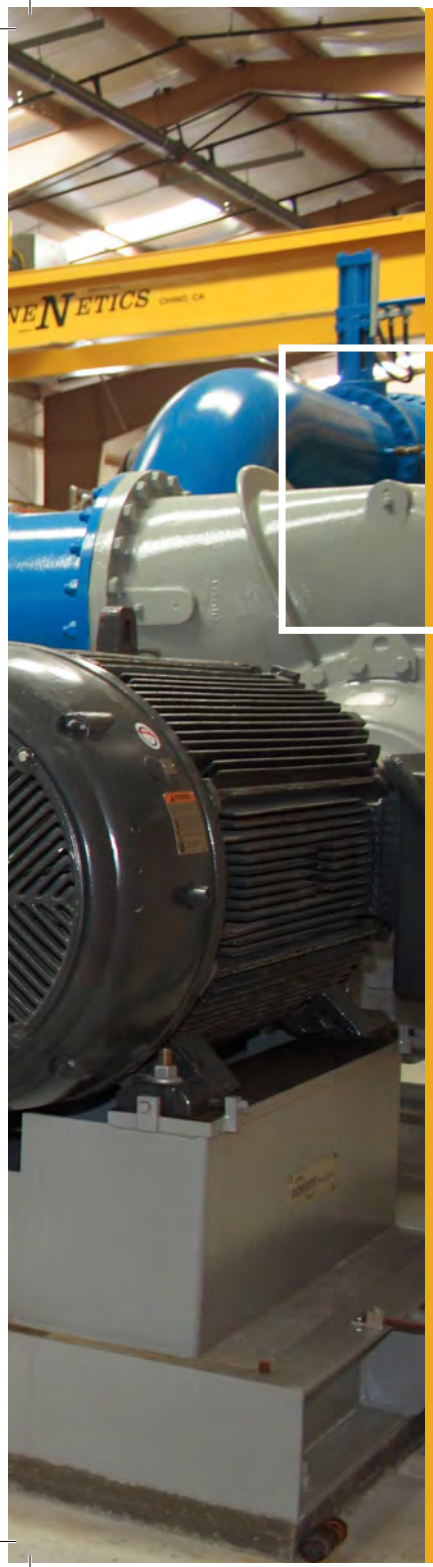

Fall, 2020
Fall, 2021
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
San Bernardino County
Riverside County
The figures show that the Bunker Hill Basin area contains the vast majority of groundwater in storage at almost 2 million acre-ft compared to the other basins 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)
Volume of Groundwater Storage
per 400x400 meter grid cell
< 7,300 acre-ft
> 0 acre-ft
Linden-Evans Reservoir
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Water Conveyance
Potable
Waterman Pipeline
Gage Pipeline
North Orange Pipeline
Canal
Gage Canal
Riverside Canal
Surface Water
Santa Ana River
Streams and Channels
Fault Line
Sphere Of Influence
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE


Change in Groundwater Storage Between Fall, 2020 and Fall, 2021
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
Santa Ana River
San Bernardino Mountains
San Bernardino County
Riverside County
This map shows the change in groundwater storage from Fall 2020 to Fall 2021. 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.
2020 - 2021 Storage Change (1-year change)
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Linden-Evans Reservoir
Water Conveyance
Potable
Waterman Pipeline
Gage Pipeline
North Orange Pipeline
Canal
Gage Canal
Riverside Canal
Surface Water
Santa Ana River
Streams and Channels
1-Year Change in Groundwater Storage
per 400x400 meter grid cell (acre-ft)
≤-200
-199 - -100
0 - -99
1 - 100
101 - 200
≥201
Fault Line
Sphere Of Influence
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE


Fall, 2011
Fall, 2021
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
San Bernardino County
Riverside County
The maps shown here are used to show the effects of the drought from 2011 to 2021.
10-Year Change (Storage)
Volume of Groundwater Storage
per 400x400 meter grid cell
< 7,600 acre-ft
> 0 acre-ft
Linden-Evans Reservoir
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Water Conveyance
Potable
Waterman Pipeline
Gage Pipeline
North Orange Pipeline
Canal
Gage Canal
Riverside Canal
Surface Water
Santa Ana River
Streams and Channels
Fault Line
Sphere Of Influence
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE


Change in Groundwater Storage Between Fall, 2011 and Fall, 2021
Bunker Hill Basin
Rialto-Colton Basin
Riverside North Basin
Riverside South Basin
Santa Ana River
San Bernardino Mountains
San Bernardino County
Riverside County
This map shows the change in groundwater storage from 2011 to 2021. The Bunker Hill Basin Area lost about 139,000 acre-ft of groundwater in storage as a primary result of the drought conditions.
2011 - 2021 Storage Change (10-year change)
Well Field
Gage
Waterman
North Orange
Flume
Non-potable
Linden-Evans Reservoir
Water Conveyance
Potable
Waterman Pipeline
Gage Pipeline
North Orange Pipeline
Canal
Gage Canal
Riverside Canal
Surface Water
Santa Ana River
Streams and Channels
10-Year Change in Groundwater Storage
per 400x400 meter grid cell (acre-ft)
≤-800
-799 - -600
-599 - -400
-399 - -200
-199 - 0
1 - 200
Fault Line
Sphere Of Influence
City of Riverside
Water Service Area
City Boundary
County Boundary
N
NOT TO SCALE

John W North Treatment Plant



7

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.

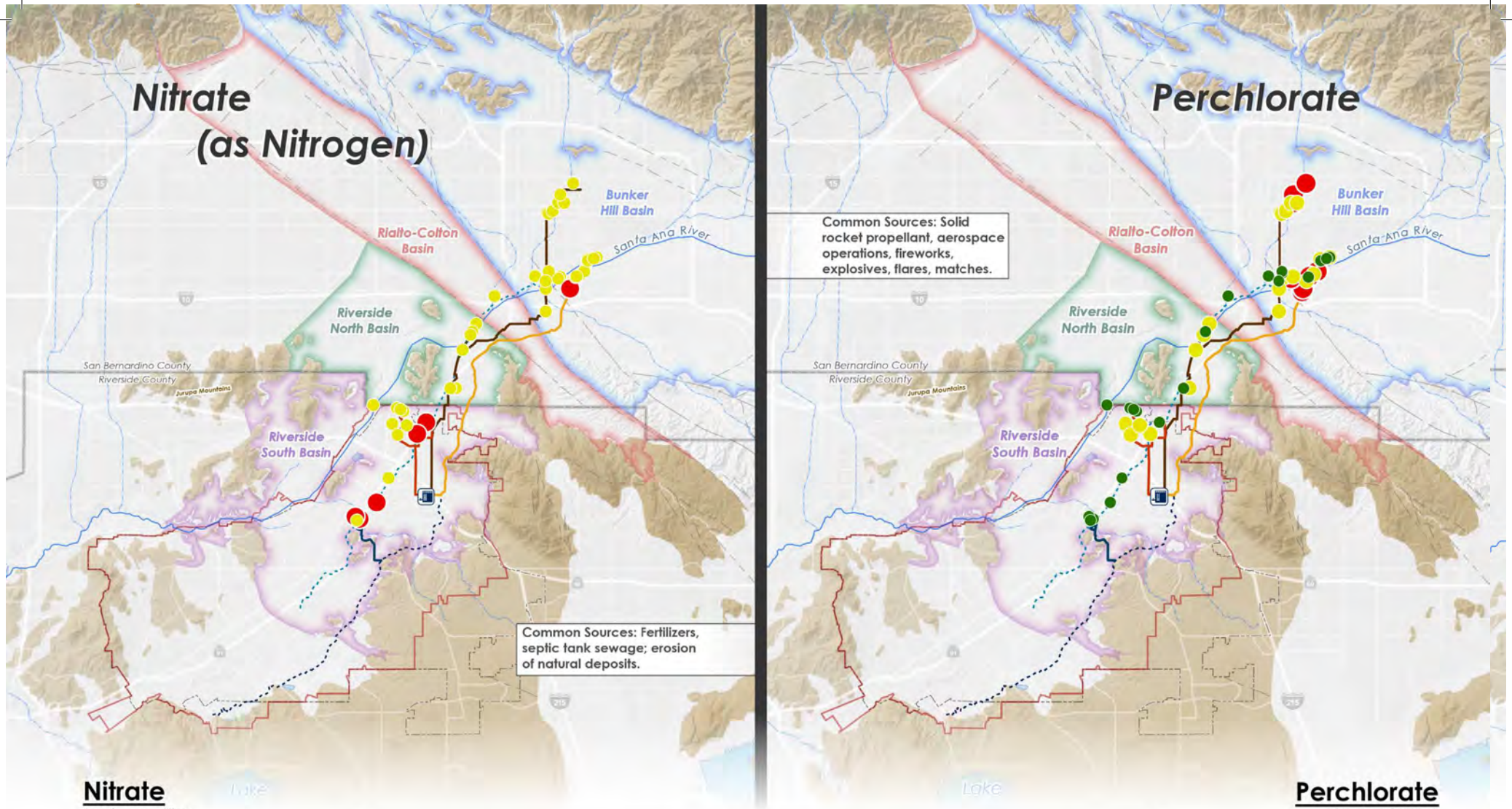
2021 RPU Groundwater Sampling

50 **wells sampled**
46 potable
4 non-potable

150+ **constituents**

29,100 **water quality samples**

Mission Inn Booster Station



Nitrate
(parts per million)

California DLR = 0.4 ppm
(Detection Level Report)

California MCL = 10 ppm
(Maximum Contaminant Level)

RPU Wells Above MCL = 6

Highest Detection = 17 ppm

Legend

Well Contaminate Level
- < Detection Level Reporting
- > Detection Level Reporting & <= Maximum Contaminant Level
- > Maximum Contaminant Level
- Linden-Evans Reservoir

N
NOT TO SCALE

Water Conveyance
- Waterman Pipeline
- Gage Pipeline
- North Orange Pipeline
- Flume Pipeline
- Non-potable

Data shown in the figures above shows raw groundwater prior to treatment and delivery to RPU customers.

Canal
- Gage Canal
- Riverside Canal

Surface Water
- Santa Ana River
- Streams and Channels
- Fault Line

Groundwater Basins
- Bunker Hill Basin
- Rialto-Colton Basin
- Riverside North Basin
- Riverside South Basin

City of Riverside
- Water Service Area
- City Boundary

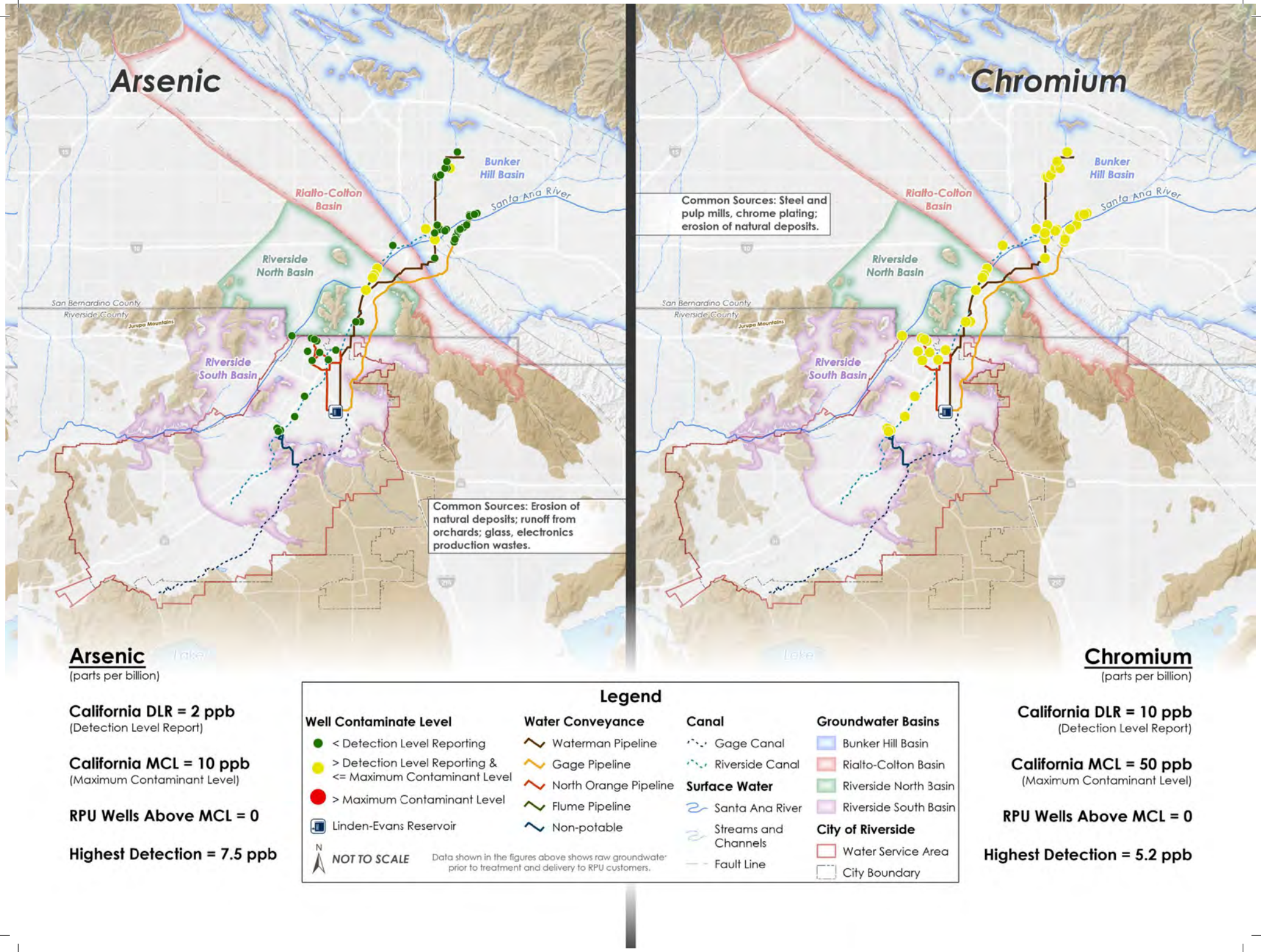
Perchlorate
(parts per billion)

California DLR = 2 ppb
(Detection Level Report)

California MCL = 6 ppb
(Maximum Contaminant Level)

RPU Wells Above MCL = 11

Highest Detection = 44 ppb



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 = 7.5 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 = 5.2 ppb

Legend

Well Contaminate Level
- < Detection Level Reporting
- > Detection Level Reporting & <= Maximum Contaminant Level
- > Maximum Contaminant Level
- Linden-Evans Reservoir

Water Conveyance
- Waterman Pipeline
- Gage Pipeline
- North Orange Pipeline
- Flume Pipeline
- Non-potable

Canal
- Gage Canal
- Riverside Canal

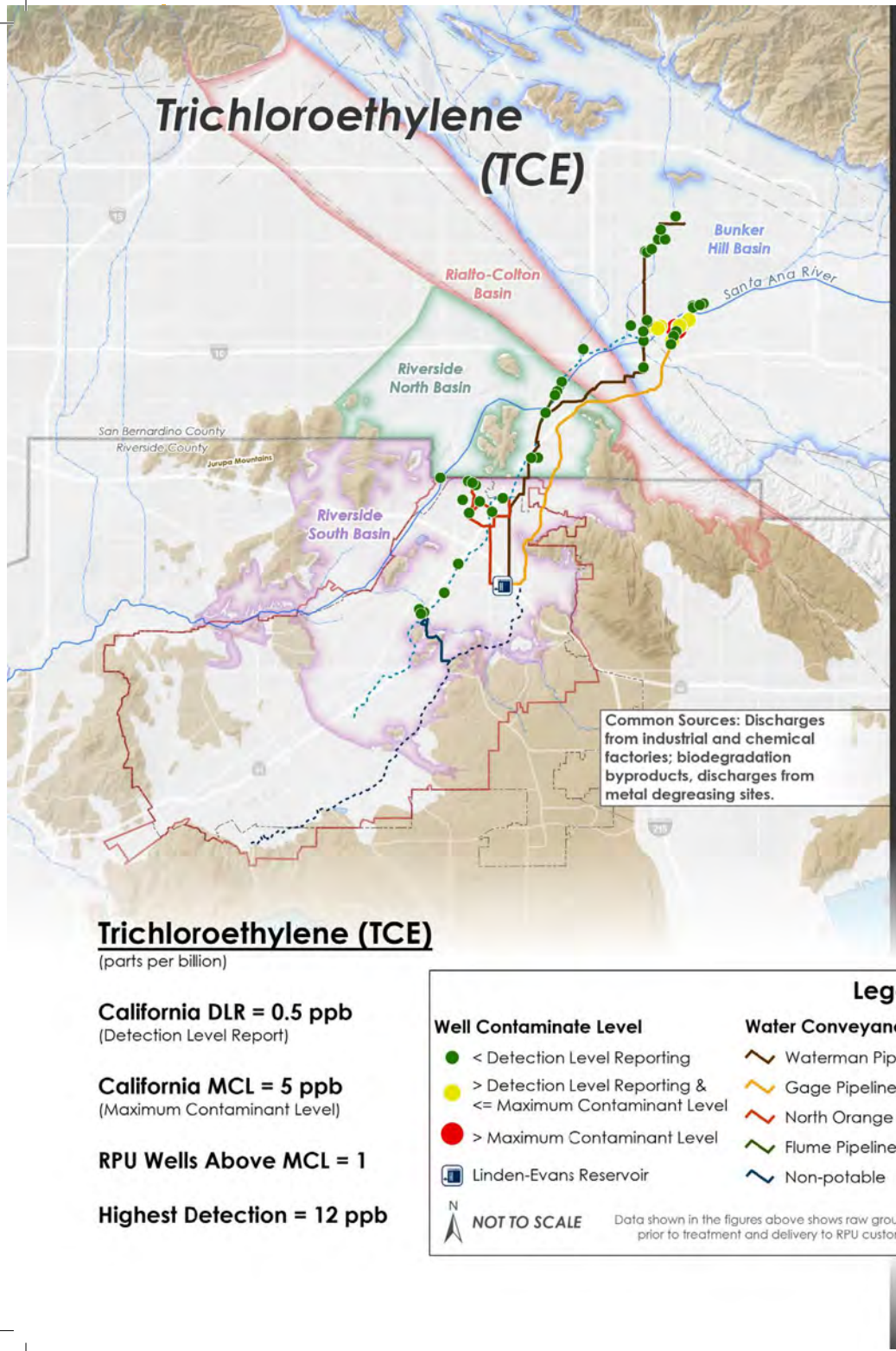
Surface Water
- Santa Ana River
- Streams and Channels
- Fault Line

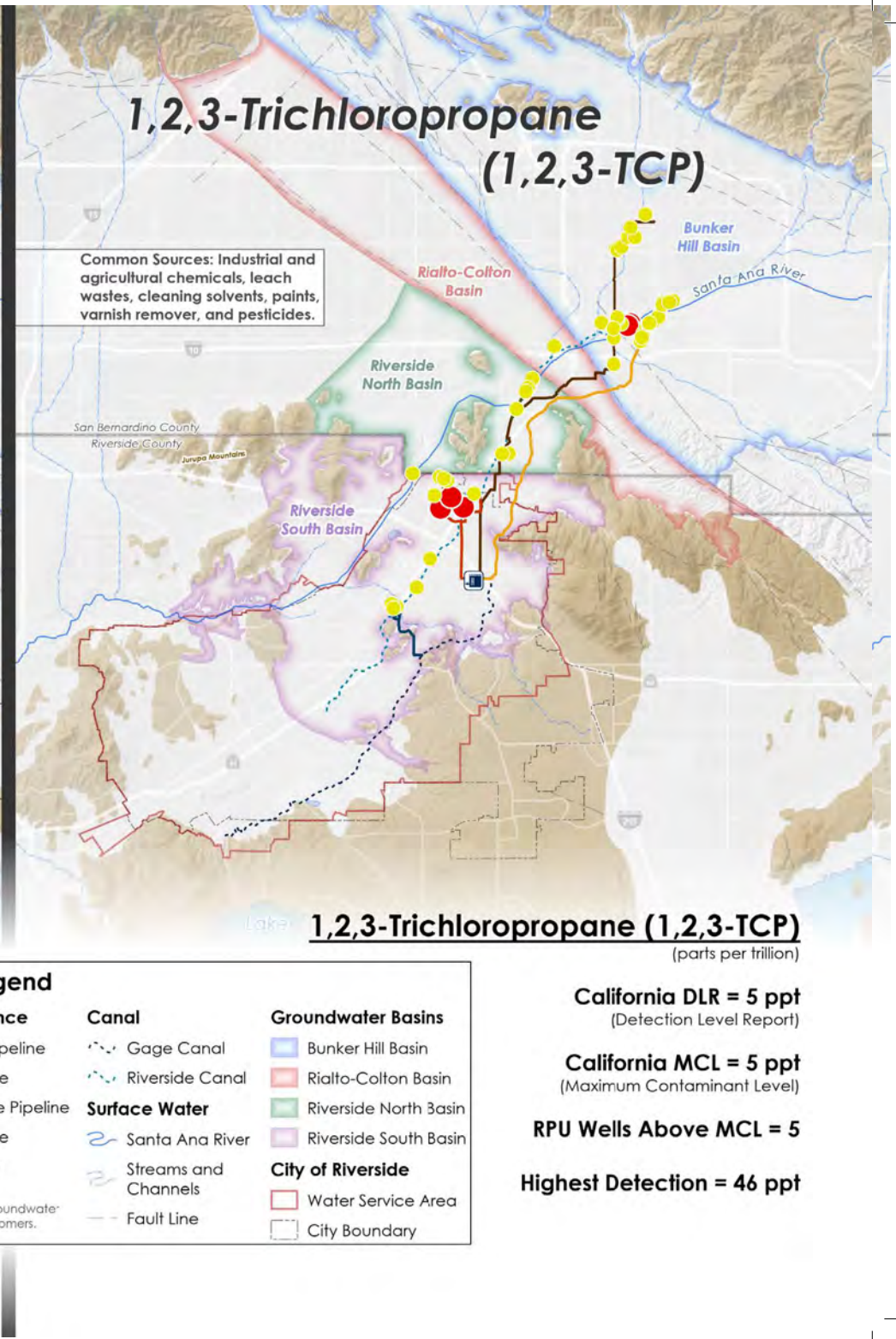
Groundwater Basins
- Bunker Hill Basin
- Rialto-Colton Basin
- Riverside North Basin
- Riverside South Basin

City of Riverside
- Water Service Area
- City Boundary

N
NOT TO SCALE

Data shown in the figures above shows raw groundwater prior to treatment and delivery to RPU customers.





Trichloroethylene (TCE)

(parts per billion)

California DLR = 0.5 ppb
(Detection Level Report)

California MCL = 5 ppb
(Maximum Contaminant Level)

RPU Wells Above MCL = 1

Highest Detection = 12 ppb

Legend

Well Contaminate Level
- < Detection Level Reporting
- > Detection Level Reporting & <= Maximum Contaminant Level
- > Maximum Contaminant Level
- Linden-Evans Reservoir

Water Conveyance
- Waterman Pipeline
- Gage Pipeline
- North Orange Pipeline
- Flume Pipeline
- Non-potable

Canal
- Gage Canal
- Riverside Canal

Surface Water
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- Fault Line

Groundwater Basins
- Bunker Hill Basin
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City of Riverside
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- City Boundary

N
NOT TO SCALE

Data shown in the figures above shows raw groundwater prior to treatment and delivery to RPU customers.

1,2,3-Trichloropropane (1,2,3-TCP)

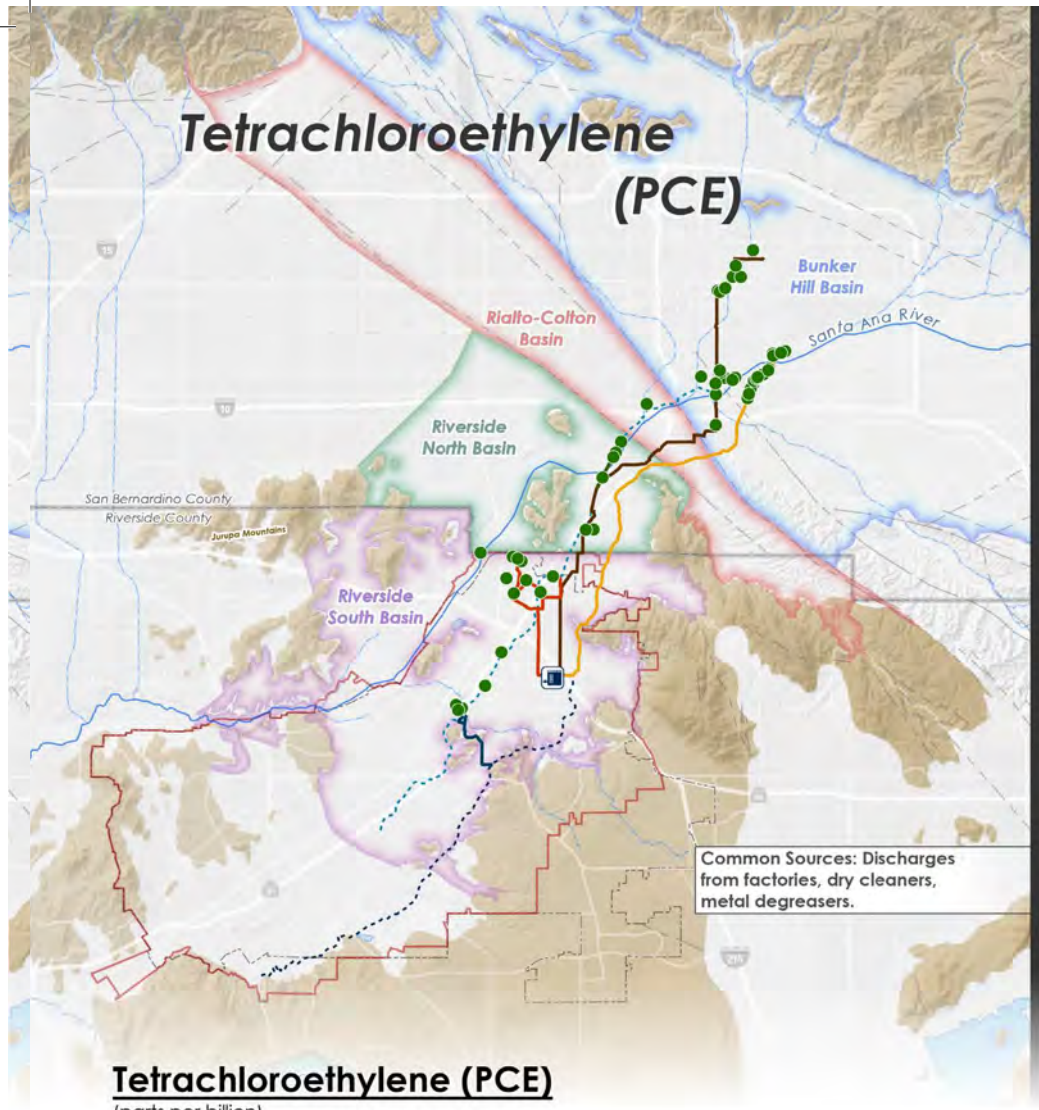
(parts per trillion)

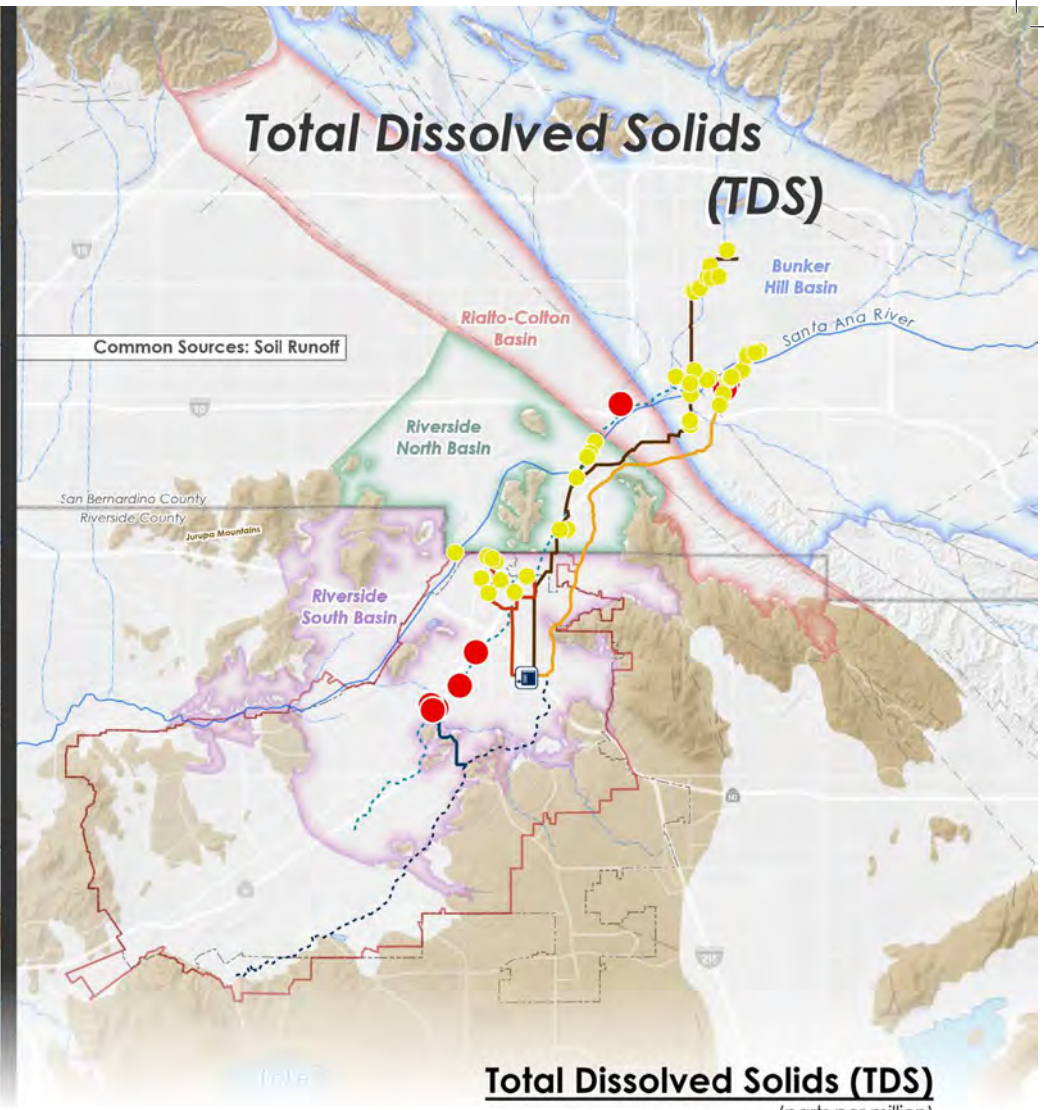
California DLR = 5 ppt
(Detection Level Report)

California MCL = 5 ppt
(Maximum Contaminant Level)

RPU Wells Above MCL = 5

Highest Detection = 46 ppt





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

Legend

Well Contaminate Level
- < Detection Level Reporting
- > Detection Level Reporting & <= Maximum Contaminant Level
- > Maximum Contaminant Level
- Linden-Evans Reservoir

Water Conveyance
- Waterman Pipeline
- Gage Pipeline
- North Orange Pipeline
- Flume Pipeline
- Non-potable

Canal
- Gage Canal
- Riverside Canal

Surface Water
- Santa Ana River
- Streams and Channels
- Fault Line

Groundwater Basins
- Bunker Hill Basin
- Rialto-Colton Basin
- Riverside North Basin
- Riverside South Basin

City of Riverside
- Water Service Area
- City Boundary

N
NOT TO SCALE

Data shown in the figures above shows raw groundwater prior to treatment and delivery to RPU customers.

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 = 8

Highest Detection = 870 ppm

Riverside Water Quality Control Plant Fuel Cell

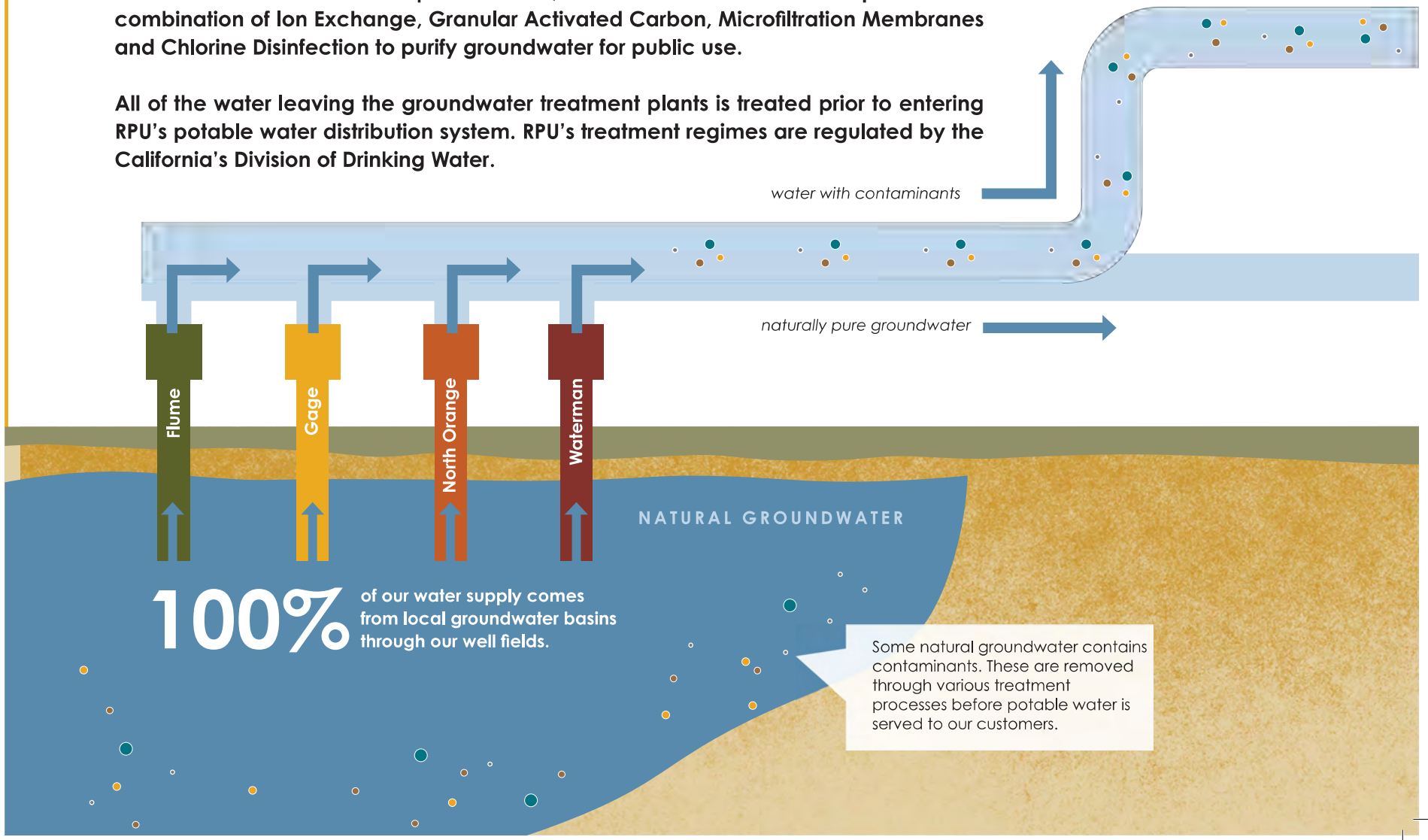
8

GROUNDWATER TREATMENT

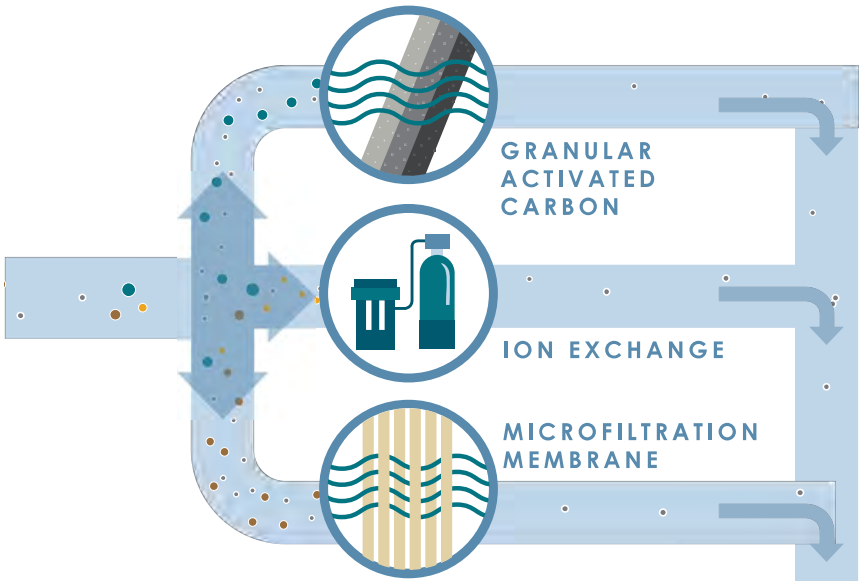
8 GROUNDWATER TREATMENT

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.



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



Some wells don't need to be treated. Water from these wells is blended with the treated water and disinfected.

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.*

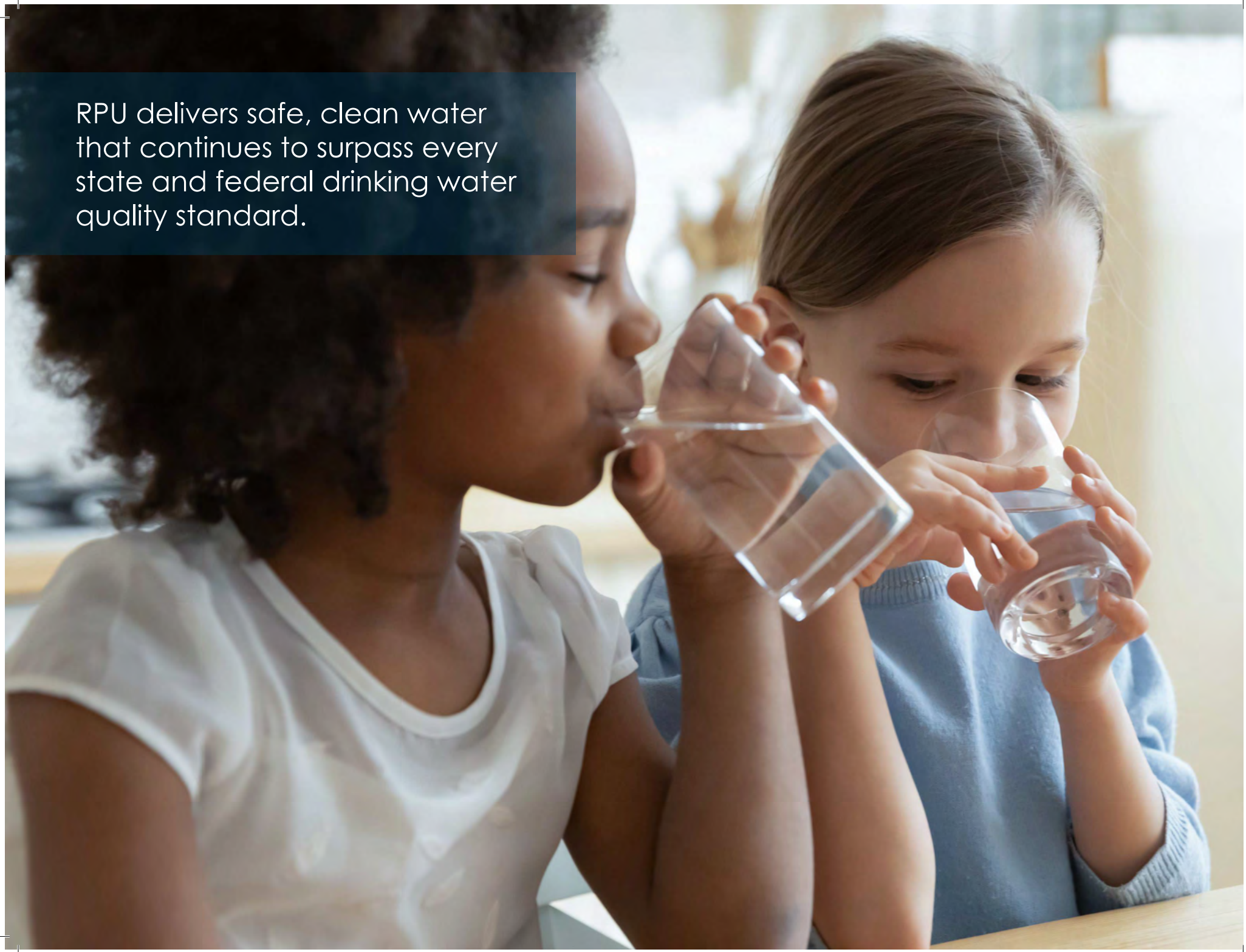
Ion Exchange reactors are filled with tiny resin beads that remove charged compounds. RPU's ion exchange reactors are designed for removal of perchlorate through an ionic exchange. *This treatment is effective in removing ClO_4^-, and can be effective in removing PFAS.*

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.*

All treated water is stored at the Linden/Evans Reservoirs where it receives final testing. Then, it is sent to 14 other reservoirs for distribution to the community. Linden/Evans and the other reservoirs help maintain pressure and are tested daily to ensure reliable water service.

All of the potable water served to RPU's customers meets stringent state and federal water quality regulations. Water is tested at all of the stages of extraction, treatment, and distribution.


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

ACKNOWLEDGMENTS

Riverside Public Utilities Board of Directors:

David M. Crohn (Board Chair), Ward 1

Rebeccah A. Goldware (Board Vice-Chair), Ward 2

Nipunjeet Gujral, Ward 3

Gary Montgomery, Ward 4

Nancy E. Melendez Ward 5

Rosemary Heru, Ward 6

Gil Oceguera, Ward 7

Peter Wohlgemuth, Citywide/Ward 1

Riverside Public Utilities Executives:

Todd M. Corbin, General Manager

Daniel E. Garcia, Deputy General Manager

Carlie Myers, Assistant General Manager I
Business Systems and Customer Service

Daniel Honeyfield, Assisstant General Manager I
Energy Delivery

David A. Garcia, Assisstant General Manager I
Water Delivery

The 2021 City of Riverside Public Utilities Groundwater Atlas was prepared by the RPU team

Michael Plinski, P.E.

Leo Ferrando, P.E., PMP

Farid Boushaki, P.E., PhD.

Jolie Matta, E.I.T.

Lindsay Spencer

Greg Herzog

Kristina Clabaugh

Reginald Agunwah

Jovie Camarce

Noemi Ochoa

With the assistance of the Water Systems Consulting, Inc.

Michael Cruikshank, P.G., C.H.G, M.S.

Casey Springer, GIT

WATER | ENERGY | LIFE

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RiversidePublicUtilities.com

WSC

ExpectWSC.com