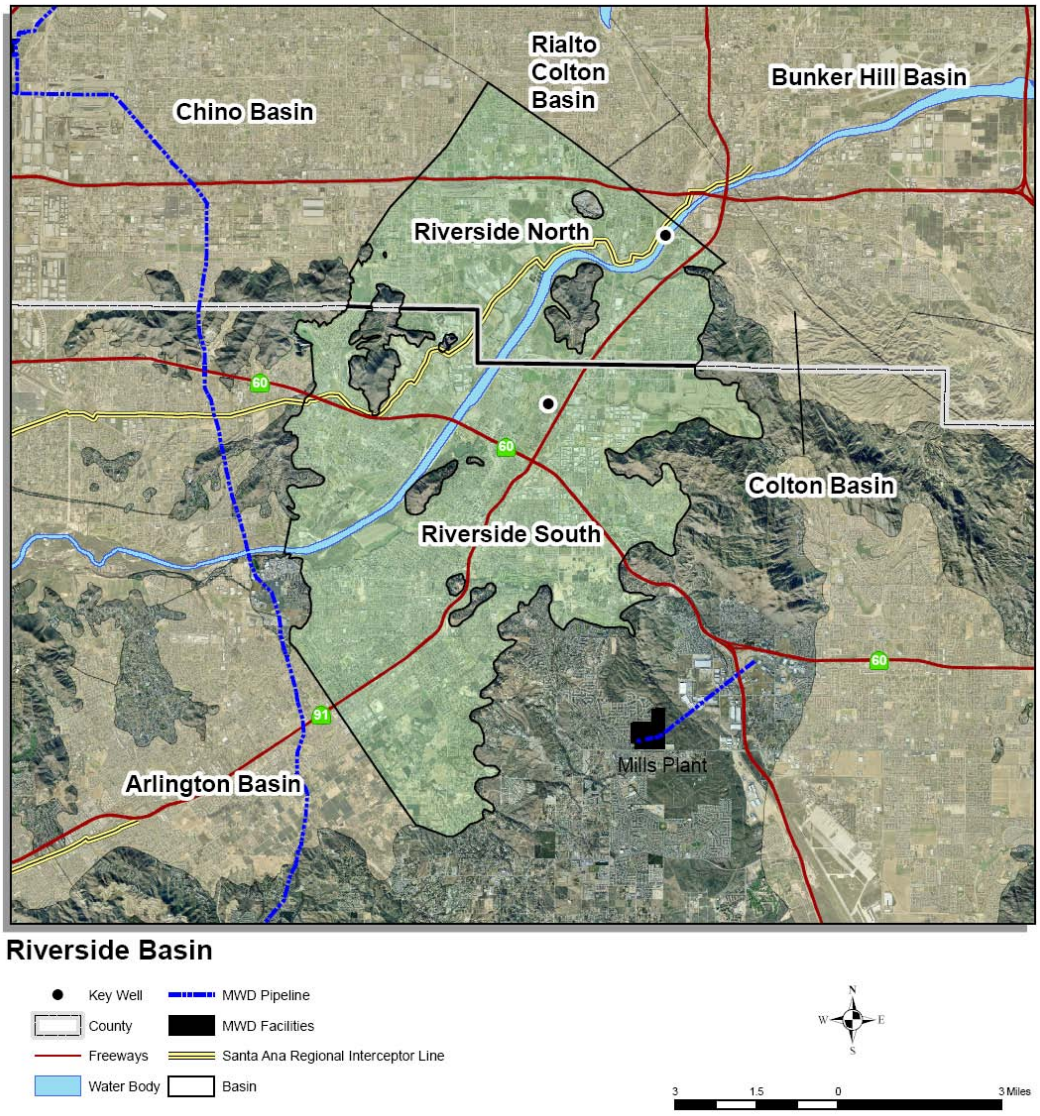
The Riverside Basin, located in northwestern Riverside County and southwestern San Bernardino County, includes the Riverside North and Riverside South subasins. The Riverside North Basin includes the portion of the Riverside Basin located in San Bernardino County, which is within the service area of the San Bernardino Valley Municipal Water District (SBVMWD), and the Riverside South Basin, which is located within the service area of Western Municipal Water District (Western MWD), includes the portion in Riverside County. This division is strictly administrative and does not reflect a physical barrier to groundwater flow between the subasins. The Riverside Basin includes the community of Riverside and unincorporated areas of Riverside County. The location and key facilities of the Riverside Basin are shown in **Figure 13-1**.

Figure 13-1
Map of the Riverside Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Riverside Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Riverside Basin, which follows the course of the Santa Ana River, is a large alluvial fill basin that is bounded by major faults and topographic barriers. The northeast boundary is formed by the Rialto-Colton fault, and a portion of the northern boundary is a groundwater divide. The Santa Ana River flows over the northern portion of the basin (DWR, 2004). Alluvial deposits in the basin consist of sand, gravel, silt, and clay deposited by the Santa Ana River and its tributaries. Near the city of Riverside, the upper 50 feet of deposits are principally clay. At the northern end of the basin, coarser gravels with cobbles 4 to 6 inches in diameter are common (DWR, 2004). As discussed above, the Riverside Basin is divided into the Riverside North and Riverside South for administrative purposes; there are no groundwater barriers or physical divides between these subbasins within the Riverside Basin. The hydrogeologic parameters for the Riverside Basin are summarized in **Table 13-1**.

Groundwater occurrence is generally unconfined in the Riverside Basin. Maximum aquifer depth in the Riverside North Basin ranges from about 600 to 700 feet and more than 400 feet in the Riverside South Basin, with water bearing units comprised of sand and gravel deposits (Riverside, 2005a). The total estimated groundwater storage capacity in the Riverside Basin is approximately 1.15 million AF (Wildermuth, 2006). In the fall of 2003, it is estimated that approximately 427,000 AF was unused (Wildermuth, 2006). However, because the upper 50 to 100 feet of unsaturated thickness cannot generally be used because of issues such as increased liquefaction potential, not all of the storage space identified can be used for storage. The usable storage in the Riverside Basin is unknown.

Safe Yield/Long-Term Balance of Recharge and Discharge

Recharge to the basin occurs via infiltration of flow from the Santa Ana River and unlined channels, underflow from saturated alluvium and fractures within the surrounding bedrock hills, underflow as seepage across the Rialto-Colton fault and percolation of precipitation and returns from use. About 1/3 of the inflows to the basin (about 20,000 AFY) come from underflow across the Rialto-Colton fault (Riverside, 2005a). Safe yield of the combined Riverside Basin is approximately 63,362 AFY (Riverside, 2005a).

Precipitation recharge is a relatively small component of the water budget for the Riverside Basin. Average precipitation is 9.6 inches per year. **Figure 13-2** provides the historical precipitation data from the CIMIS Riverside #44 Station located near UC Riverside (CIMIS 2006). These data suggest below average precipitation between 1986 and 1990 and 1999 and 2003, above average precipitation between 1991 and 1998 and since 2004.

Table 13-1
Summary of Hydrogeologic Parameters of Riverside Basin

Parameter	Description
Structure	
Aquifer(s)	Unconfined alluvium
Depth of groundwater basin	0 to 700 feet
Thickness of water-bearing units	Riverside North: 600 to 700 feet Riverside South: at least 400 feet
Yield and storage	
Natural safe yield	Riverside North: 33,729 AFY [1] Riverside South: 29,633 AFY [1] Total: 63,362 AFY [1]
Total Storage	1,149,000 AF
Unused Storage Space (Fall 2003)	427,000 AF
Portion of Unused Storage Space Available for Storage	Unknown

Source: Riverside, 2005a ;DWR, 2004; and Wildermuth, 2006
[1]1959-63 base period average extraction as verified by the Watermaster

GROUNDWATER MANAGEMENT

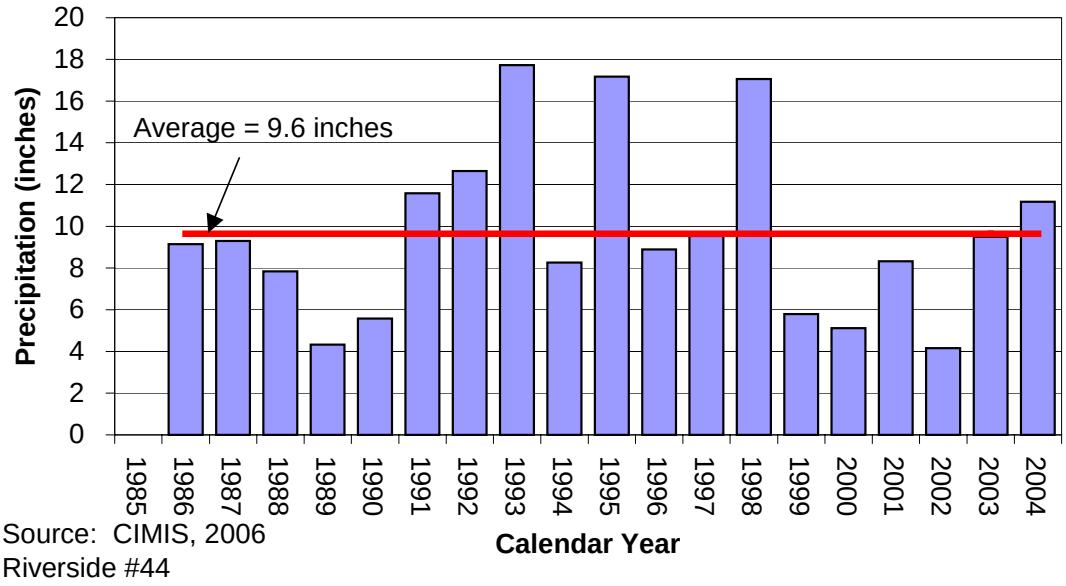
The following section describes how the Riverside Basin is currently managed. This description includes a description of the governing structure and agreements pertaining to adjoining basins.

Basin Governance

The Riverside Basin is adjudicated. The Riverside Basin is included in the 1969 Stipulated Judgment No. 78426, Western Municipal Water District of Riverside County et al. versus East

San Bernardino County Water District, et al, Superior Court of the State of California for Riverside County (1969 Judgment). The 1969 Judgment distinguishes the portions of Riverside

Figure 13-2
Historical Precipitation in the Riverside Basin



Source: CIMIS, 2006
Riverside #44

Basin in San Bernardino and Riverside counties sets out the average annual extraction for each portion of the Riverside Basin and establishes a watermaster to administer and enforce the judgment provisions. Extraction from the San Bernardino County portion for use *outside* San Bernardino Valley and from the Riverside County portion of the basin, without replenishment obligation, are limited within any 5 consecutive year period to 5 times the annual average extraction during the 1958-63 base period. Replenishment is required if the extraction in any year is 20 percent more than the annual average in a basin portion. Extractions from the Riverside Basin within San Bernardino County for use *within* San Bernardino Valley are not limited except that static water levels in the area shall not fall below a specified water elevation. The 1969 Judgment specifies that it does not limit rights to spread, store and recapture imported water.

Table 13-2 provides a list of managing agencies in the Riverside Basin.

Interactions with Adjoining Basins

As discussed above, the Rialto-Colton fault to the northeast separates the Riverside Basin from Rialto-Colton Basin. The fault is a barrier to groundwater flow along of its length, especially in its northern reaches (Wildermuth 2000). A groundwater divide in the alluvium separates the Riverside Basin from the Arlington Basin to the south (DWR, 2004). In addition, groundwater beneath the Santa Ana River in the western portion of the Riverside Basin rises to become

surface water within the Santa Ana River upstream of Riverside Narrows and flows into the Chino Basin. There are no agreements that govern the flow into Chino Basin.

The Riverside Basin is tributary to the Santa Ana River upstream of Prado Dam. On April 17, 1969, the Orange County Superior Court entered a Stipulated Judgment in Case No. 117628 involving the Orange County Water District vs.City of City of Chino et al (Santa Ana River Judgment). The Santa Ana River Judgment, which became effective October 1, 1970, contained a declaration of rights of the entities in the lower Santa Ana River area (i.e. OCWD) versus those in the upper Santa Ana River area (i.e. San Bernardino Valley Municipal Water District, or SBVMWD, Chino Basin MWD, now called IEUA, and Western MWD).

Table 13-2
Summary of Management Agencies in the Riverside Basin

Agency	Role
San Bernardino Valley Municipal Water District	Co-Watermaster for 1969 Judgment Part of Watermaster Committee responsible for administration of 1969 Santa Ana River Judgment.
Western Municipal Water District (Western MWD)	Co-Watermaster for 1969 Judgment Part of Watermaster Committee responsible for administration of 1969 Santa Ana River Judgment.
San Ana River Watermaster	Watermaster for 1969 Stipulated Judgment that defined water allocations in the Santa Ana River among lower Santa Ana River and upper Santa Ana River producers.
Santa Ana Water Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.
California Regional Water Quality Control Board – Santa Ana Region (Regional Board)	Issuance of permits for discharges to Santa Ana River
Cities of Colton and San Bernardino	Operation of Rapid Infiltration and Extraction (RIX) facility

The Judgment is administered by the Santa Ana River Watermaster, a committee of five members (one each from SBVMWD, IEUA and Western MWD and two from OCWD). Under this Judgment, purveyors upstream of Prado Dam, have the right to use all surface and groundwater supplies originating above Prado Dam without interference from water purveyors downstream of Prado Dam, provided that the average adjusted base flow at Prado Dam is at least 42,000 AFY. Baseflows have ranged from approximately 38,000 AFY in 1970 to approximately 170,000 AFY in 2002. (Santa Ana River Watermaster, 2003). SBVMWD has an obligation to ensure an average annual adjusted base flow of 15,250 AFY at Riverside Narrows. IEUA and Western MWD have a joint obligation to ensure average annual adjusted base flow of

42,000 AFY at Prado Dam. In addition, SBVMWD, IEUA and Western MWD are prohibited from exporting water from the lower area to the upper area while OCWD is prohibited from exporting water or causing water to from the upper area to the lower area (Santa Ana River Watermaster, 2003).

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Riverside Basin. Facilities include about 100 active production wells and the RIX facility in Colton.

Active Production Wells

There are currently about 100 active production wells (both agricultural and municipal) in the Riverside Basin. A summary of the production from these wells is provided in **Table 13-3**. Average production between 1985 and 2004 was approximately 49,661 AFY and presented in **Figure 13-3**. Based upon the past 5 years of production, the estimated production capacity is about 84,000 AFY.

Table 13-3
Summary of Production Wells in the Riverside Basin

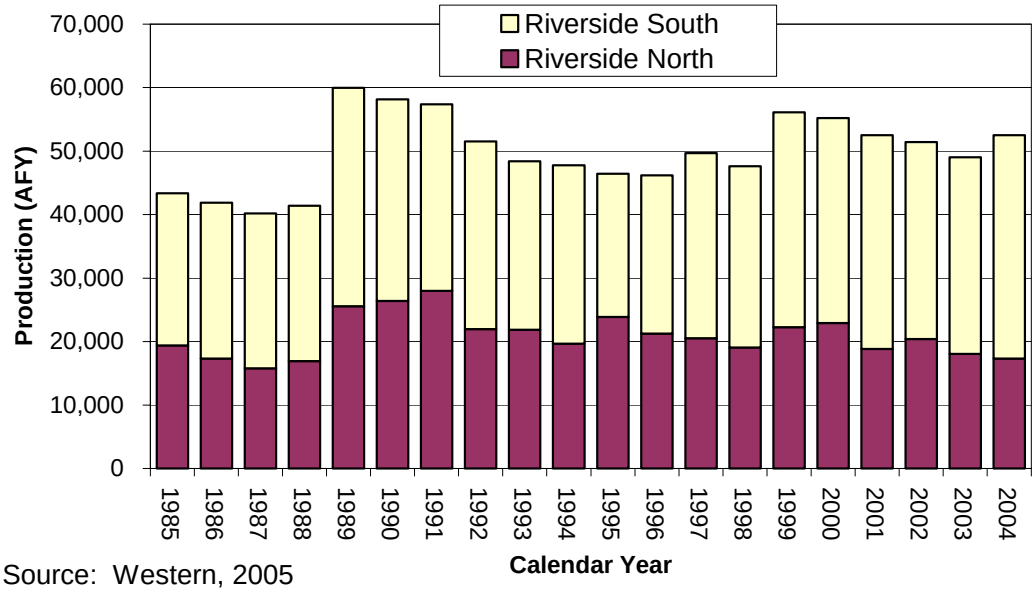
Category	Number of Active Wells [1]	Estimated Production Capacity [2] (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Riverside North	43	30,000	20,690	Not available
Riverside South	57	54,000	28,971	
Total	**100**	**84,000**	**49,661**	

Source: Western, 2005

1. Active wells have production within past 5 years
2. Estimated production capacity is based upon maximum annual production rate for each well in past 5 years.

Like many water systems in Southern California, Riverside's water system is aging. Many critical elements have exceeded their service life span and are in need of repair and/or replacement. A consultant hired by the City of Riverside recommended about $139 million (2004 dollars) of capital improvement facilities to address water system distribution needs over the next 20 years (MWH, 2005).

Figure 13-3
Historical Groundwater Production in the Riverside Basin



Source: Western, 2005

Other Production

In the 1990s, the cities of San Bernardino and Colton were required by the Regional Board to upgrade the quality of their wastewater discharges to the Santa Ana River to meet certain established discharge standards. In cooperation with SAWPA, and with the approval of the Regional Board, a wastewater treatment plan using the tertiary treatment process known as Rapid Infiltration and Extraction (RIX) was constructed in the city of Colton in the Riverside North Basin and placed into service in 1995. In this process, secondary treated wastewater from the two cities' treatment plants is applied to a series of percolation basins. As wastewater percolates through the soil, physical and biological treatment occurs removing many harmful pollutants from the wastewater. After the water infiltrates approximately 15 feet deep, the treated wastewater is extracted through shallow wells surrounding the basins, treated by ultraviolet radiation for disinfection purposes and discharged to the Santa Ana River. Currently, about 37,000 AFY of secondary effluent is percolated at RIX (Wildermuth, 2006). The current permit for RIX requires a certain amount of overextraction to contain percolated effluent. This overextraction is native groundwater from the Riverside Basin and currently (December 2006) equals about 20 percent of the volume of percolated effluent, or about 7,800 AFY. A portion of the treated water that is discharged from RIX percolates back into the Riverside Basin from the Santa Ana River. Between 1995 and 2004, an average of about 9,000 AFY of groundwater was over-extracted from the Riverside North Basin by the RIX project and discharged into the Santa Ana River (Western MWD, 2005).

ASR Wells

There are no ASR wells in the Riverside Basin.

Spreading Basins

There are no intentional spreading basins in the Riverside Basin to enhance groundwater recharge. Incidental recharge may occur at the RIX facility and stormwater detention basins throughout the basin

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Riverside Basin.

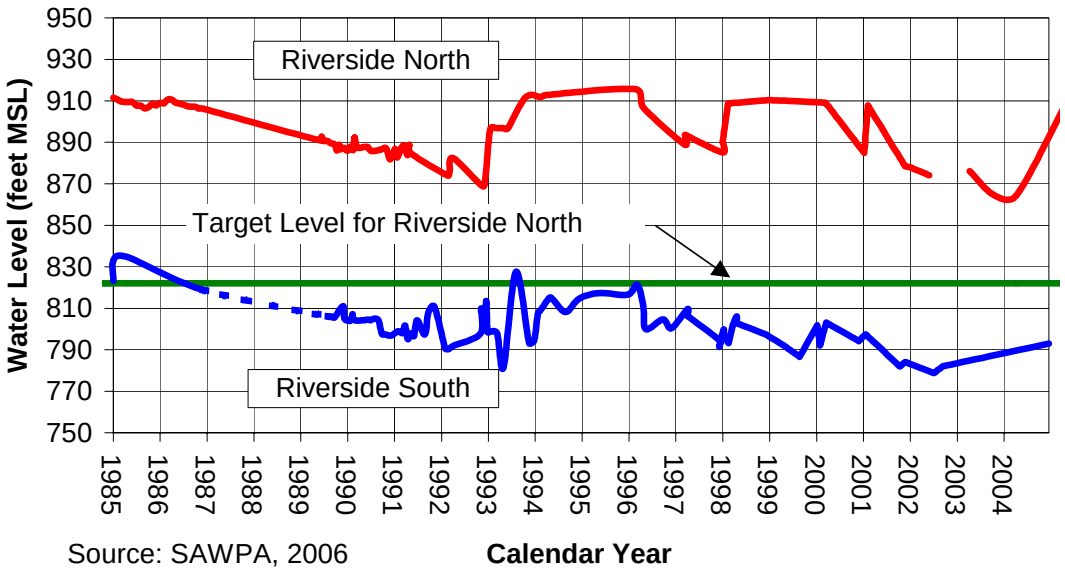
Desalters

There are no desalters in the Riverside Basin.

GROUNDWATER LEVELS

Groundwater levels in the Riverside North and Riverside South basins are summarized in **Figure 13-4**.

Figure 13-4
Historical Water Levels in the Riverside Basin



Source: SAWPA, 2006

As discussed above, per the 1969 Judgment, the target level based upon the water level in three specific wells (two in the Riverside North Basin and one in the Colton Basin) is 822.04 feet

MSL. Water levels below the target level trigger replenishment obligations. Between 1985 and 2004, water levels were above this level and remained relatively stable with fluctuations not exceeding 50 feet. Water levels in the Riverside South Basin decreased about 40 feet between 1985 and 2004.

GROUNDWATER QUALITY

The following provides a brief description of the current water quality of the Riverside Basin. It includes a discussion of current groundwater monitoring activities, contaminants of concern and treatment processes for the region.

Groundwater Quality Monitoring

Groundwater quality samples are collected from active production wells in accordance with California DHS requirements as specified in Title 22 of the California Code of Regulations.

The Santa Ana Watershed Basin Monitoring Task Force is a collaborative effort of public and private sector agencies and interests. As part of this effort, SAWPA compiles water quality data in the Santa Ana River Watershed, including total dissolved solids (TDS) and nitrate (as N) data. SAWPA also prepares a triennial update of the ambient groundwater quality throughout all the groundwater basins in the Santa Ana River Watershed.

In 2004, the Basin Plan for the Santa Ana Region was amended to incorporate an updated TDS and nitrogen management plan (Regional Board, 2004). For water quality purposes, the Regional Board divided the Riverside Basin into six management zones, defined as Riverside A through Riverside F. These management zone boundaries are shown in **Figure 13-5**.

Groundwater Contaminants

Constituents of concern for the Riverside Basin include: TDS, nitrate, volatile organic compounds (VOCs) namely trichloroethylene (TCE) and tetrachloroethylene (PCE), perchlorate and dibromochloropropane (DBCP). Descriptions of the range and extent of concentrations in the basin are summarized in **Table 13-4.**

As discussed above, inorganic constituents of concern for the Riverside Basin are TDS and nitrate. As shown in **Figure 13-5**, TDS is generally lower in the northern portion of the basin and increases toward the south. Current ambient TDS concentrations range from 310 mg/L in the Riverside B management zone in the Riverside North Basin to 750 mg/L in the Riverside C management zone of the Riverside South Basin.

Like TDS, as shown in **Figure 13-6**, nitrate (as N) concentrations generally increase from north to south. Average ambient nitrate concentrations range from about 4.6 mg/L in the Riverside A management zone to 15.4 mg/L in the Riverside E management zone. Nitrate (as N) concentrations currently exceed the current MCL of 10 mg/L in management zones C, D, E and F.

Figure 13-5
Ambient TDS Concentrations (1984 to 2003)

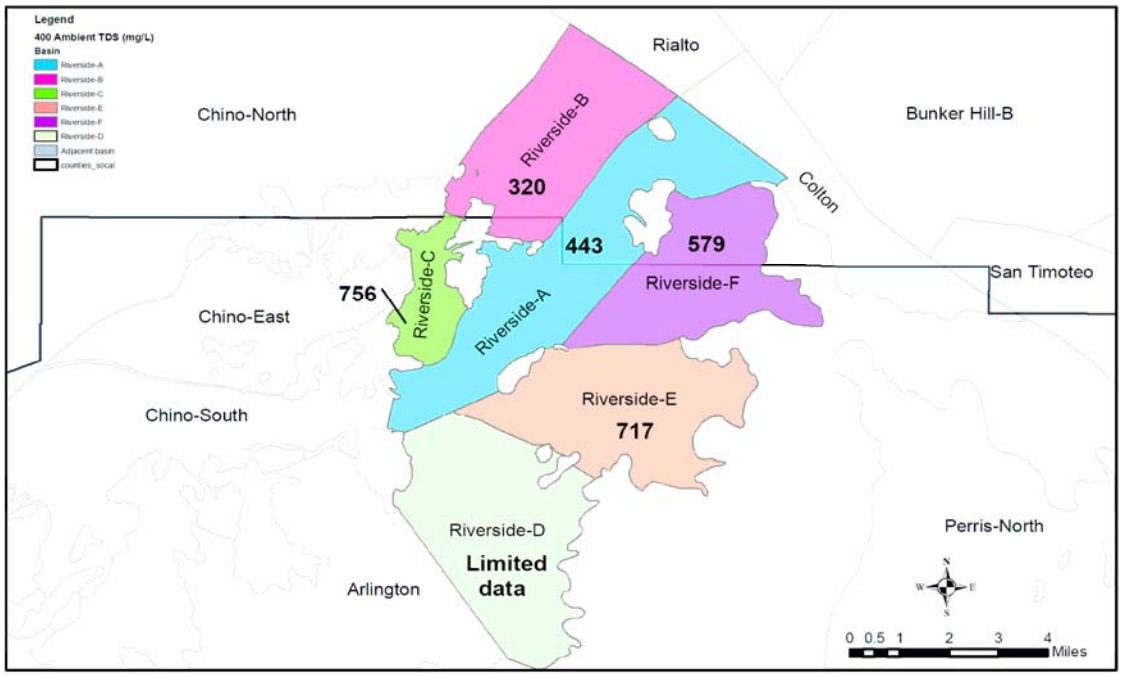
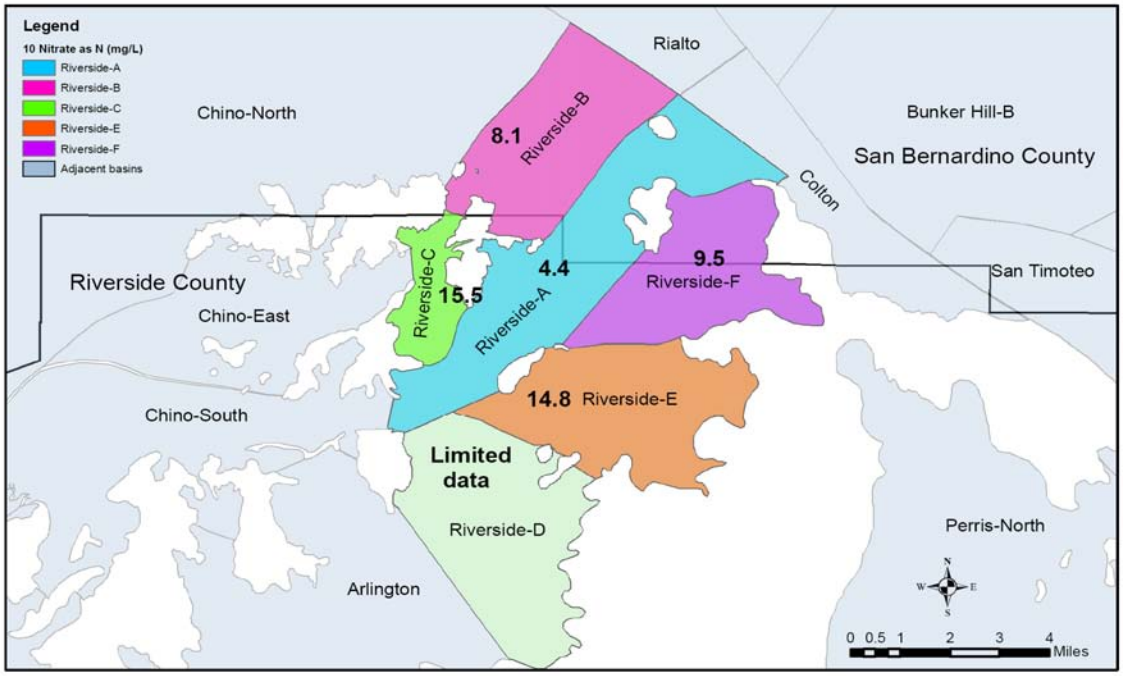


Figure 13-6
Ambient Nitrate Concentrations (1984 to 2003)



Source: Wildermuth, 2005

Table 13-4
Summary of Constituents of Concern in Riverside Basin

Constituent	Units	Range	Description
TDS Secondary MCL=500	mg/L	Average Ambient 310 to 750	TDS is generally lower in the northern portion of the basin and increases toward the south.
Nitrate (as N) Primary MCL =10	mg/L	Average Ambient 4.6 to 15.4	Like TDS, nitrate concentrations generally increase from north to south. Nitrate concentrations currently exceed the current MCL of 10 mg/L in management zones C, D, E and F.
VOCs (TCE and PCE) Primary MCL: TCE = 5 PCE =5	µg/L	ND to 52 for TCE ND to 7 for PCE	Seven wells have been impacted by TCE and 15 wells have been impacted by PCE
Perchlorate Notification level =6	µg/L	Riverside North ND to 5.2 Riverside South ND to 23	Sixteen wells within the Riverside Basin are known to have been impacted by perchlorate, 5 in the Riverside North Basin and 11 in the Riverside South Basin.
DBCP Primary MCL =0.2	µg/L	Not available	Nature and extent not available at this time

Source: Wildermuth, 2005, SAWPA, 2006 and Regional Board, 2006

In addition, perchlorate, DBCP, TCE and PCE have also been detected in produced groundwater from the Riverside Basin. Sixteen wells within the Riverside Basin are known to have been impacted by perchlorate, 5 in the Riverside North Basin and 11 in the Riverside South Basin. The perchlorate concentrations range from 4 to 5.2 µg/L in the Riverside North Basin and from 4 to 23 µg/L in the Riverside South basin (Regional Board, 2006).

Seven wells have been impacted by TCE with maximum concentrations of 52 µg/L (MCL of 5 µg/L) and 15 wells have been impacted by PCE with maximum concentrations of 7 µg/L (MCL of 5 µg/L).

Blending Needs

Groundwater produced from some wells within the Riverside Basin are treated at the wellhead. In addition, groundwater produced at some wells are blended within transmission mains before

reaching the distribution system. Based upon wells within the City of Riverside's system, about 8 percent of the groundwater produced is blended.

Groundwater Treatment

The North Riverside Water Project, which includes two treatment plants and pipeline system, treats groundwater for TCE and DBCP. It was completed in June 2003 (Riverside, 2006). About 30 percent of the groundwater produced in Riverside Basin was treated in 2004/05 (Riverside, 2006; Western MWD, 2005).

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no current groundwater storage programs in the Riverside Basin.

The City of Riverside currently produces about 18,000 AFY of water from the southern portion of the Riverside Basin and is planning to increase production up to a total of 45,000 AFY in the future. To address the issues associated with increasing groundwater production in the southern portion of the Riverside Basin, Western MWD and the City of Riverside are cooperatively conducting several hydrogeologic studies of the basin.

BASIN MANAGEMENT CONSIDERATIONS

As discussed above, primary management considerations in the Riverside Basin involve water quality concerns, specifically:

- TDS and nitrate could limit ability to store and extract water
- Perchlorate, TCE, PCE and DBCP contaminants could limit ability to store and extract water

In addition to water quality issues, water levels must be maintained by SBVMWD in the Riverside North Basin per the 1969 Judgment.

References:

California Department of Water Resources (DWR). 2004. California's Groundwater Bulletin 118 - Upper Santa Ana Valley Groundwater Basin Riverside-Arlington Subbasin. Updated 2/27/04. Website: http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/8-2.03.pdf Accessed 7/10/07.

California Irrigation Management Information System (CIMIS), 2006. UC Riverside Station 44. Accessed at: http://wwwcimis.water.ca.gov/cimis/data.jsp

California Regional Water Quality Control Board (Regional Board). 1995. Water Quality Control Plan for the Santa Ana River (8).
California Regional Water Quality Control Board. 2004. Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate an Updated Total Dissolved Solids (TDS) and Nitrogen Management. Accessed at: http://www.waterboards.ca.gov/santaana/pdf/04-01.pdf

California Regional Water Quality Control Board (Regional Board). 2006. Geotracker database, accessed at: http://www.geotracker.swrcb.ca.gov/reports/

City of Riverside Public Utilities Department. 2002. City of Riverside Water Utility Report.. July 2, 2002.

City of Riverside Public Utilities Department (Riverside). 2005a. Urban Water Management Plan, December 2005.

City of Riverside Public Utilities Department (Riverside). 2005b. 2005 Annual Water Report.

City of Riverside Public Utilities Department (Riverside). 2006. http://ww.riversideca.gov/utilties/water-nriversidewaterproject.asp

MWH, 2005. Water System Master Plan. Prepared for the City of Riverside Public Utilities Department.
Santa Ana River Watermaster, 2003. Thirty-Second Annual Report of the Santa Ana River Watermaster.
Santa Ana Watershed Project Authority (SAWPA), 2006a. Accessed at: http://www.sawpa.org/rivbasin/

Santa Ana Watershed Project Authority (SAWPA). 2006b. Groundwater Level and Water Quality Data. Accessed at: www.sawpa.net

Superior Court of the State of California for Riverside County, 1969. Stipulated Judgment No. 78427, Western Municipal Water District of Riverside County et al. v. East San Bernardino County Water District, et al.

Western Municipal Water District (Western MWD), 2005. Water Extractions for calendar year 2004.

Wildermuth Environmental, Inc (Wildermuth). 2005. Basin Plan Amendment Required Monitoring and Analyses – Recomputation of Ambient Water Quality for the Period 1984 to 2003. Prepared for SAWPA Technical Advisory Committee, August 2005.

Wildermuth Environmental, Inc. (Wildermuth), 2006. Review Comments on MWD's Report on Groundwater Basins. Prepared for Western Municipal Water District. December 22, 2006.