SPECIAL MEETING

AGENDA

Carlsbad City Council Special Meeting
Municipal Annex
114 S. Halagueno Street
Carlsbad, New Mexico

January 30, 2020 at 4:00 p.m.

Invocation – Pledge of Allegiance

1. Approval of Agenda

2. Consider Approval of Personnel Report

3. Consider Approval to Convene into a Closed Session Pursuant to N.M.S.A. 1978, Section 10-15-1 (H) (8) for the Discussion of the Purchase, Acquisition or Disposal of Water Rights

4. Reconvene into Open Session

5. Consider Approval of Statement regarding Closed Session Pursuant to N.M.S.A. 1978, Section 10-15-1 (H) (8) for the Purpose of the Purchase, Acquisition or Disposal of Water Rights

6. Consider Approval of City of Carlsbad Updated 40 Year Water Plan

7. Adjourn

FOR INFORMATION ONLY
Agendas and City Council minutes are available on the City web site:
cityofcarlsbadnm.com or may be viewed in the Office of the City Clerk during normal and regular business hours.

CARLSBAD CITY COUNCIL MEETING SCHEDULE

- Regular meeting - Tuesday, February 11, 2020 at 6:00 p.m.
- Regular meeting - Tuesday, March 10, 2020 at 6:00 p.m.

If you require hearing interpreter, language interpreters or auxiliary aids in order to attend and participate in the above meeting, please contact the City Administrator's office at (575) 887-1191 at least 48 hours prior to the scheduled meeting time.

This item was not available at the time the Agenda packets were compiled

NO DOCUMENT FOR THIS AGENDA ITEM

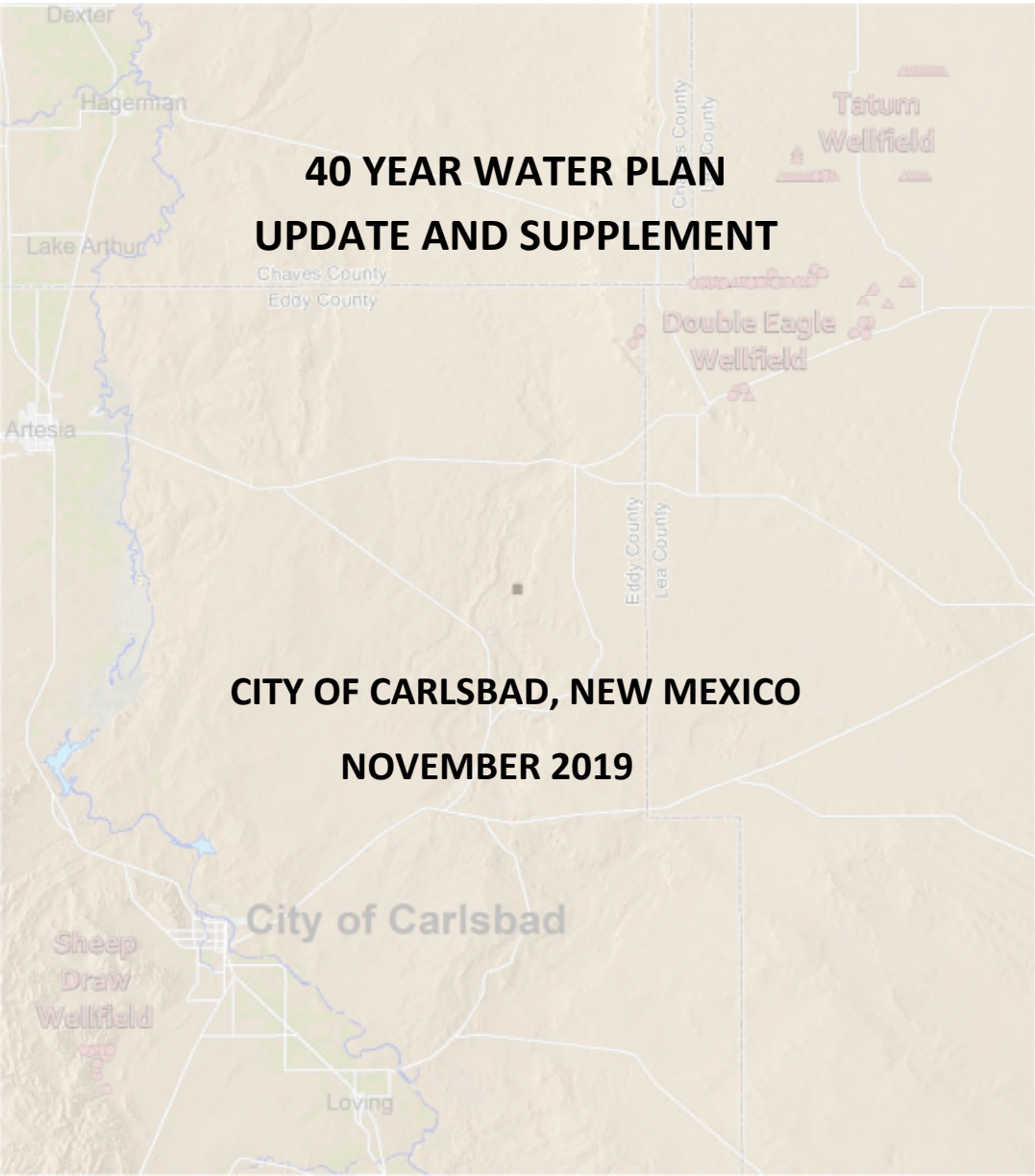
NO DOCUMENT FOR THIS AGENDA ITEM

STATEMENT REGARDING CLOSED SESSION

Pursuant to the requirements of the Open Meetings Act, the closed session, was to discuss matters pursuant to the provision of Section 10-15-1 H (8) NMSA 1978, to discuss the Purchase, Acquisition or Disposal of Water Rights. No other matters were discussed.

Prepared for:

CITY OF CARLSBAD
101 N Halagueno
Carlsbad, NM 88221



40 YEAR WATER PLAN UPDATE AND SUPPLEMENT

CITY OF CARLSBAD, NEW MEXICO

NOVEMBER 2019

BALLEAU GROUNDWATER, INC.
901 Rio Grande Blvd. NW, Suite F-242
Albuquerque, NM 87104
505-247-2000

MODRALL SPERLING
500 Fourth Street NW, Suite 1000
Albuquerque, NM 87102
505-848-1800

40 YEAR WATER PLAN
UPDATE AND SUPPLEMENT
CITY OF CARLSBAD, NEW MEXICO
November 2019

TABLE OF CONTENTS

TABLES

FIGURES

40-YEAR WATER PLAN
UPDATE AND SUPPLEMENT
CITY OF CARLSBAD, NEW MEXICO
November 2019

INTRODUCTION

In 1995, the City of Carlsbad ("City") developed and adopted a 40 Year Water Plan ("1995 Plan"), which was submitted to and accepted by the New Mexico Interstate Stream Commission. The City updated the 1995 Plan with a supplemental document in March 2009 ("2009 Plan Supplement") with the intent to periodically update parts of the 1995 Plan as changes occurred. This document provides an update and supplement ("Update") to the 1995 Plan and the 2009 Plan Supplement.

This Update is based on evolving water supply issues and information and plans developed by the City since 1995 regarding water supply management and the City's water needs. The Update is prepared pursuant to NMSA 1978, § 72-1-9 and in accordance with New Mexico Office of the State Engineer ("OSE") rules and regulations. The Update generally follows the *Proposed Elements of a Water Development Plan Template* (HM 42, 2008) ("Template"), which is used by OSE staff as a basis for review of water development plans. The Update provides information pursuant to the Template regarding City water use, conservation efforts, projected population, demand for water, water availability and the planning period.

CITY WATER USE

Water System Overview

The City's water supply is predominantly from the Sheep Draw and Double Eagle wellfields, located respectively in the Carlsbad Basin and the Lea County Underground Water Basin ("Lea County Basin"). The City also has begun to develop a second wellfield in Lea County, the Tatum wellfield (Figure 1).

In addition to groundwater rights, The City also holds water rights to Pecos River surface water. The Pecos River flows through the City providing source water for recreation at the City's Pecos River Park and source water for irrigation of the municipal golf course as needed. The wellfields supply the City's drinking water. The Sheep Draw wellfield is located about five miles southwest of the City in central Eddy County (Figure 2). The Double Eagle wellfield is located about 40 miles northeast of the City in Lea County (Figure 3). The Tatum wellfield also in Lea County, is located northeast of the Double Eagle wellfield (Figure 3). Water is routed from the Sheep Draw and Double Eagle wellfields into the City's municipal water system and delivered to approximately 12,700 customers (meters) (LWA and PCR, 2016, p. 3). The Tatum wellfield is under development and is not yet connected to the City's municipal water system. The City plans to connect the Tatum wellfield to the municipal system within the next decade as available funding allows.

The groundwater resource that supports the water supply from the Sheep Draw and Double Eagle wellfields is derived from two separate aquifer systems. The Sheep Draw wellfield is supported by the Capitan Reef aquifer whereas the Double Eagle and Tatum wellfields are supported by the High Plains (Ogallala) aquifer (Figure 1). Additional detail on the aquifer systems is described in the *Water Availability* section of this Update.

Permitted and Actual Use

The City owns water rights and holds OSE permits allowing use of surface water and groundwater. The OSE administers the City's water use in two declared basins: the Carlsbad Basin and the Lea County Underground Water Basin. The two administrative basins are shown on Figure 4. A general description of the City's permitted use and actual use is described below; a detailed listing of the City's water rights and OSE permits is on Table 1.

Surface Water

The City holds OSE permits for 611.46 acre-feet per year ("afy") of Pecos River surface water rights and 430 afy pursuant to a Declaration of Ownership of Water Rights on file with the OSE. Collectively these surface water rights support the City's Pecos River Park (Upper and Lower Tansill Lakes) and allow for a backup water supply for irrigation of the City golf course. The primary means of irrigating the municipal golf course is with treated effluent. Additionally, the City owns Carlsbad Irrigation District ("CID") water rights that allow irrigation on up to 63.5 acres within CID. Water used in the City's distribution system is subsequently treated at the City's wastewater treatment plant located at the east end of the City (Figure 2), and discharged to the Pecos River to the extent not used for municipal turf irrigation or other purposes. The City has had a cooperative agreement with the New Mexico Interstate Stream Commission ("ISC") (2005 through 2014) relating to the City's return flow, maintenance of Tansill Lake levels and coordination of releases and fills with ISC Pecos River Compact operations. That agreement recognized a continual annual overpayment of return flow credit to the river by the City (approximately 500 to 600 afy).

Out of the City's surface water rights, approximately 350 afy are permitted with an alternate point of diversion from Sheep Draw wellfield for municipal uses other than irrigation if needed (Table 1). The principal diversion for City water use is from groundwater supplied by the Sheep Draw and Double Eagle wellfields.

Groundwater

The City holds OSE permits for diversion of up to 10,283.11 afy of water from the Sheep Draw wellfield, up to 7,648 afy from the Double Eagle wellfield and up to 10,640 afy from the Tatum wellfield. Additionally, the City holds title to 2,300 afy of water rights under OSE File No. C-110 and C-111 which are permitted for diversion for municipal use from the Sheep Draw wellfield in addition to industrial use at the Mosaic potash mine.[1]

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[1] These water rights were acquired from IMC Kalium , Mosaic's predecessor in interest, subject to a 1999 agreement and will be available for full use or disposition by the City commencing in 2039 subject to the terms of the 1999 agreement.

Currently, active use occurs at the Sheep Draw and the Double Eagle wellfields.[2] Over the last five years (2014 through 2018), the City has diverted an average of 7,825 afy from the Sheep Draw wellfield and an average of 166 afy from the Double Eagle wellfield for public water supply within the City service area (Figure 2). The City's current water system is set up to allow use of Double Eagle wellfield water in only part of its water system, and is not sized to allow full diversion of Double Eagle water. However, a significant (approximately $50 million)[3] decade long capital infrastructure project ("Double Eagle Water System Improvement" or "Double Eagle Project") is underway and nearing completion that will allow the full use of Double Eagle water (and eventually Tatum water) throughout the entire municipal water system. The project has included drilling of new wells in Double Eagle, upsizing and re-routing of significant water pipeline, and addition of reservoirs and related infrastructure. At completion, the Double Eagle Project will allow the transport of up to approximately 7,000 afy of Double Eagle water into the City for municipal use. Importantly, the project was intended to and will provide a means for the City to conjunctively manage the water resource available from the two separate aquifers (Lea County and Carlsbad Basin) in which the City has significant water rights and wellfields. These two aquifers have different physical supply limitations and management challenges. The City must conjunctively manage these two different water supply sources to ensure a sustainable long term supply for the City. Significant aspects of the project are described in the "Double Eagle Water System Improvements Phase 3 – Preliminary Engineering Report" (Molzen Corbin May 2017).

In addition to municipal drinking water, the Double Eagle wellfield also serves industrial users (outside of the City water system) including oil and gas operations, the Waste Isolation Pilot Plant (WIPP), the Brantley Lake State Park and agricultural stock tanks. Depending on those levels of demand, historic Double Eagle well diversions have ranged from hundreds to about 1,500 afy. This will change significantly (increase) as the Double Eagle Project is completed and fully integrated into the City municipal system.

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[2] The City's Tatum wellfield has three wells and permits for 32 additional wells. The three drilled wells are not yet connected to the City's water system.

[3] The funding for the project has come from Water Trust Board loans and grants and use of the City's bonding capacity.

In addition to the Sheep Draw and Double Eagle wellfields, the City has two water supply wells located at the Carlsbad airport, a water supply well at the municipal shooting range, two wells at the sports complex (the former Wood Farm) and a well at the municipal cemetery, Sunset Gardens, for localized domestic and irrigation uses associated with these City facilities (Figure 2). Over the last five years, combined use at these wells is on the order of tens of acre-feet per year. Demand at these wells is not anticipated to change significantly in the future. Projected demand supplied by the Sheep Draw and Double Eagle wells is described below in the *Projected Population and Associated Demand* section of this Update.

CONSERVATION AND MANAGING FOR WATER QUALITY

Conservation Plan

The City developed a Water Conservation Plan ("Conservation Plan") in December 2016 (LWA and PCR, 2016), which is an update from the City's first conservation plan developed in 1993. The Conservation Plan includes a City system water audit in a form developed by the American Water Works Association (AWWA, 2014) and an estimate of gallons per capita per day (GPCD) use in a form developed by the OSE (OSE, 2015). The GPCD analysis in the Conservation Plan results in an estimate of 250 GPCD with a future goal in reducing per capita demand to 225 GPCD (LWA and PCR, 2016, p. 19).

The Conservation Plan describes an overall objective *"…for Carlsbad is to help sustain the community's water supply to meet water needs in the coming years."* (LWA and PCR, 2016, p. 7). To obtain that objective, two action-oriented goals are described:

1) Improve the operational efficiency of the water supply system to more accurately account for water use and water loss[4] (to support supply-side conservation),

[4] In the process of compiling data for the water audit and GPCD programs, discrepancies in some of the datasets were identified that could be fixed to improve the analysis of the water audit estimate of GPCD use (LWA and PCR, 2016, p. 5).

2) Increase the water use efficiency of the residential, commercial, industrial and institutional water users (demand-side conservation).

Supply-side conservation (Goal 1) involves water meter replacement, improved water use data management, water distribution line replacement and continued system leak detection. Out of those measures, the Conservation Plan reports meter replacement is anticipated to achieve the greatest water savings (2 percent) from information based on more accurate accounting of water use and water loss (LWA and PCR, 2016, p. 11). Overall, the total water savings from all supply-side conservation measures is estimated to be 4 percent of water use.

Demand-side conservation (Goal 2) measures involve expanded wastewater reuse, evaluation of water demand in the high-use sectors (industrial, commercial and institutional), water rate scheduling, water ordinance enforcement, incentive programs and public outreach/education on conservation. Out of those measures, expanding wastewater reuse is expected to achieve the greatest water savings (5 percent) (LWA and PCR, 2016, p. 15). The total water savings from all supply-side conservation measures is estimated to be 8 percent of water use.

Accordingly, if all the demand management measures described in the Conservation Plan are implemented, a projected water savings of up to 12 percent of water use could be achieved. The savings is scheduled over the five-year period from 2017 to 2021. This is an ambitious conservation goal and may not be fully achievable but the City remains committed to the efforts set forth in the 2016 Conservation Plan. Potential funding sources for the most effective measures are through the New Mexico Water Trust Board, the state Community Development Block Grant Program and the Bureau of Reclamation Water Conservation Program. Additional detail is available in the Conservation Plan.

Conservation Ordinance

The City has a Water Conservation, Emergency Response and Drought Management Ordinance[5] (No. 2011-12) ("Conservation Ordinance") establishing conservation measures and a plan to respond to drought or other emergency situations that may affect the quality or quantity of the City's water supply. The Conservation Ordinance defines three stages of water rationing measures that rely on monitor well data from the Capitan aquifer and on water quality data from the Sheep Draw production wells. The approach of tracking water levels and water quality stemmed from the City's observation that the chloride concentration in the water supplied by the Sheep Draw wells increases when pumping increases. An illustration of the variation in chloride concentration alongside pumping is shown on Figure 5.

Water Quality Changes

Figure 5 shows the average annual (composite[6]) concentration from chloride samples taken from all Sheep Draw wells during the year and the maximum average concentration taken from all wells during the year. The pattern of chloride concentration is greatest when well diversions are highest (generally greater than 8,000 afy) and lower when well diversions are in the 7,000 to 8,000 afy range.

A spatial pattern is also apparent with regard to increases in chloride observed from pumping. Figure 6 shows average monthly pumping (purple labels, AF/month) in summer (July) and in winter (January) along with chloride concentrations (while labels, mg/L) for three different years. City water demand is greater in the summer than in the winter. During summer months, chloride concentrations are greater than in the winter. Also,

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[5] The Conservation Ordinance is available at: https://library.municode.com/nm/carlsbad/codes/code_of_ordinances?nodeId=COOR_CH52UT_ARTVWACOEMREDRMA, accessed April 8, 2019.

[6] Composite concentration is based on constant volume sample from each well. It differs from the water system entry point concentration, which would be weighted by the volume of water diverted from each well.

during summer months, Figure 6 shows the greatest increase in chloride concentration is observed near the north end of the Sheep Draw wellfield (near wells 1, 2, 3 and 4).

The pattern of increased chloride with increased pumping can be explained by the presence of a fresh/saline water interface in the Capitan aquifer[7] that is affected by water-level changes. If the City reduces well withdrawals, aquifer water levels are maintained at an elevation that prevents significant intrusion of saline water. Pumping the Sheep Draw wellfield, however, can reverse the hydraulic gradient around the wellfield and induce saline water into the wells. Water levels in the Capitan aquifer are also affected by recharge events and drought conditions. Recharge causes water levels in the aquifer to rise and provides a source of freshwater that can dilute areas with degraded water quality, whereas extended drought results in lowered water levels and little source water for dilution. Accordingly, the greatest potential for inducing saline water into the wells is during drought conditions when water levels are lowered by two factors: reduced aquifer recharge and increased groundwater pumping.

Water Quality Zones

The explanation of a fresh/saline water interface is further supported by the study of Bjorklund and Motts (1959, p. 275 - 280), which describes three zones of water quality in the Capitan aquifer: 1) a freshwater zone (total dissolved solids (TDS) less than 700 mg/L, 2) a potable mixed-water zone (mixed fresh and moderately saline water - TDS ranging from 700 to 1,700 mg/L) and 3) a non-potable water zone (TDS greater than 1,700 mg/L). Bjorklund and Motts (1959, p. 275) describe the boundaries of the zones to be indefinite and subject to migration resulting from recharge events or pumping from wells. The understanding of water quality zones in the Capitan aquifer developed by Bjorklund and

[7] A fresh/saline water interface can also exist in other subsurface formations that are in hydraulic connection with the Capitan aquifer and/or poor-quality water can be induced from the Pecos River. The specific location of the fresh/saline water interface need not be specifically known to understand that lowered water levels induce migration of saline water. Interpretations of water quality zones in the Capitan aquifer by Bjorklund and Motts (1959) provide insight to how poor quality water can migrate into the City water supply from Sheep Draw wellfield pumping.

Motts (1959) is compatible with the current observations based on the City's monitoring of the City's Sheep Draw wellfield.

For context, the spatial layout of the water quality zones is of interest. The Sheep Draw wellfield is in the freshwater zone (Zone 1). This zone generally continues northeast within the Capitan aquifer until reaching an interface with the potable mixed-water zone (Zone 2) beneath the southern area of Happy Valley.[8] Moving farther northeast along the Capitan aquifer, water quality degrades further. The non-potable water zone (Zone 3) underlies the northern parts of Happy Valley, La Huerta and the intervening area to Lake Avalon (Richey and others, 1985, p. 11).

Conservation Ordinance Triggers

The City's Conservation Ordinance implements water rationing measures when water levels at two monitor wells (MW#4 and MW#6) lower below trigger levels and when the chloride concentration in the water supplied by Sheep Draw wellfield meets or exceeds 50 ppm. An objective of the monitor wells is to project against long-term reversals in the gradient around the wellfield that can induce poor quality water into the City's water supply. The observed increase in chloride production with increased pumping in the Sheep Draw wellfield is interpreted to represent initial trends of water quality degradation that could become problematic if significant quantities of water are induced from the non-potable zones of water described by Bjorklund and Motts (1959). Accordingly, it is prudent to consider the present capacity of the Sheep Draw wellfield to be close to optimum for safe and sustainable long-term performance (BGW, 2010). This "capacity" is below the water rights available to and held by the City. However, increased pumping to the full amount of the City's water rights for any extended period of time would jeopardize water quality and the sustainability of the Sheep Draw wellfield. Additionally, pumping the Sheep Draw wellfield to the full amount of the City's water rights would negatively impact Carlsbad Springs and affect the

[8] Bjorklund and Motts (1959, Figure 48) describe the occurrence of an interface between freshwater and potable mixed water in the Capitan aquifer in the area of Happy Valley where alluvium is present. This alluvium is classified as non-potable groundwater (Bjorklund and Motts, 1959, p. 288) and interpreted to provide a source of poor water quality that mixes with the freshwater of the Capitan aquifer to create the potable mixed-water zone.

City's important water and municipal resources in the Upper and Lower Tansill Lakes. It is imperative therefore, that the City maintain, but not divert or consumptively use, the entirety of its portfolio of Carlsbad Basin water rights to prevent additional groundwater pumping that would deleteriously affect the City's municipal water supply through water quality degradation and detrimental effects on Carlsbad Springs.

PROJECTED POPULATION AND DEMAND

Traditional projected water demand is based primarily on an examination of projected population growth and associated water use. However, in the instance of the City's physical water supply and its management of that supply, projected demand based solely on population growth is insufficient to ensure the City and its citizens will have a sustainable and adequate water supply for forty years and beyond. As discussed in the *Permitted and Actual Use* section of this Update, the City holds significant water rights in both the Lea County and Carlsbad Basins. Based on projected demand as related solely to population projections, the City may hold sufficient water rights to satisfy a narrow definition of population projected demand. However, the City's demand encompasses more than needs related solely to population; and the City must hold water rights above forecasts based solely on population projections. The City must maintain all of its water rights to ensure it can conjunctively manage water supplies in Lea County and the Carlsbad Basin to provide a sustainable, reliable and adequate water supply for the City's future and to address the management challenges described in the *Planning Factors for Wellfield Management* section of this Update. Demand for planning purposes must take limitations of physical supply and other management factors into account.

As discussed elsewhere in this Update, limitations on the City's physical water supply are present in both the Lea County and Carlsbad Basins. In the Lea County Basin, the aquifer holds a finite resource that is being mined. That limitation prevents the City from full exercise of its Lea County Basin water rights in order to manage the water resource to support the City's use and demand into the future.

The Carlsbad Basin also has physical limitations albeit of a different nature than Lea County. As described in the Conservation Ordinance section and elsewhere in this Update, in the Carlsbad Basin the City is limited by the concern of degraded water quality and salt intrusion as diversions increase from the Sheep Draw wellfield as well as the effects of drawdown on Carlsbad Springs. Diversion of the maximum rights held by the City in the Carlsbad Basin is not sustainable for extended periods.

Accordingly, in both the Lea County and Carlsbad basins the physical limitations of the respective aquifers require the City to hold more rights than are necessary to meet projected demand based solely on population growth. This is necessary to allow the conjunctive management of the aquifers – within the observed limitations; as well as the necessity to acquire and hold rights to guard against aquifer drawdown and/or water quality degradation occasioned by both the City's and third party groundwater diversions.

Due to the unique aspects of the physical water supply available to the City, the City's water planning has historically, and continues to include, an examination of not just population projections, but prudent management and balancing of its different water supplies. This section examines projected water demand based on population projection but also assumes within the City's demand, the need to hold water rights to address the physical limitations of the water supply available to it.

One aspect of projected water demand is based on a projection of population growth and gallons per capita per day (GPCD) water use (approximately 250 GPCD).[9] The projected population in this Update is derived from two sources: the Lower Pecos Valley Regional Water Plan (NMISC, 2016) ("LPVRWP") and a study commissioned by the City from the Arrowhead Center of New Mexico State University (NMSU) (Arrowhead Center, 2018). The LPVRWP population projection is considered a schedule of moderate growth whereas the Arrowhead Study is considered a high rate of growth. Each growth schedule is described below.

[9] In the City's Conservation Plan, GPCD water use is estimated to be 248.61 GPCD (LWA and PCR, 2016, p. 6).

Moderate Population Growth

The LPVRWP developed two population forecasts for Eddy County: one based on a moderately optimistic view of the economy over the long term (through 2060) and one that represents a more pessimistic picture (NMISC, 2016, p. 156 and Table 6.3). The City used the growth rate from the moderately optimistic projection to develop a population growth schedule for the Carlsbad water service area. That moderate growth schedule is projected through year 2060 and shown on Figure 7a.

In addition to population growth within the City specifically, the City is planning for water service area growth to unincorporated areas of Eddy County. The City's Conservation Plan describes efforts being made to diversify the sources of area income to dampen the boom and bust cycles of its dominant mining and oil and gas industries (LWA and PCR, 2016, p. 6), which is anticipated to support stable population growth. Expansion of the water service area considers growth from expansion of the area and population growth within that area. As an example, the City annexed 1,300 acres for residential development planned to include single-family homes and rentals to provide housing for workers who are in the area temporarily (NMISC, 2016, p. 154). For planning, expansion of the City's water service area is anticipated to serve an additional population of approximately 11,800 by year 2060. That is, by year 2060, the City population, within its current service area, is assumed to grow from 28,000 to 43,000; with expansion of the City's water service area, the population served grows to 54,800 (Figure 7a).

High Population Growth

The City commissioned the Arrowhead Center of NMSU ("Arrowhead Study") because of the significant impact oil and gas development in Eddy County can have on the population of the City (both temporary and permanent residents and associated commercial activity). In commissioning the study, the City recognized the need to account for population growth attributable to oil and gas development to allow planning for potential development and infrastructure. Unlike the LPVRWP population projection which focuses on Eddy County,

the Arrowhead Study focuses specifically on the City of Carlsbad and updated data related to new jobs associated with ongoing oil and gas development in the area. The City's concerns regarding unique and large population increases due to oil and gas development apply equally to the need to plan a sufficient water supply for temporary and permanent residents and associated commercial development. The City's Conservation Plan notes that the population of the City can almost double based on temporary residents related to time periods in which oil and gas production activities reach peak rates in the region (LWA and PCR, 2016, p. 3).

The Arrowhead Study projects population growth through 2025 with significant increases in southern Eddy County and the City of Carlsbad between 2018 and 2025. The Study predicts a City of Carlsbad population of 51,023 residents by 2025 (Arrowhead Center 2018, Table 4). This projection is much higher than the LPVRWP estimate but is properly considered as the City plans a secure water supply for its citizens. Since the Arrowhead Study estimates Carlsbad population growth only through 2025, this Update appends the LPVRWP rate of moderate growth from 2026 through 2060 to develop a population growth schedule. That resulting growth schedule is shown on Figure 7b and is considered a potential high growth schedule herein.

For planning purposes, the City assumes the high growth schedule accounts for an expanded service area. That is, Figure 7b does not include a separate curve for an expanded service area population.

Water Demand

The projection of water demand for both the moderate and high population growth cases is based on current estimated use (248.61 GPCD) in the City applied to the projected population over 40 years from 2020 to 2060 with an account of improved conservation measures totaling 12 percent of water use, which while ambitious, is compatible with the City's Conservation Plan. Improved conservation measures include both supply-side (4 percent) and demand-side (8 percent) water savings for an estimated total water savings in

the range of 12 percent (LWA and PCR, 2016, p. 19). In the moderate and high projections of water demand, the 12 percent water savings is assumed to occur by year 2040.

Projected water demand for the City, after accounting for current per capita use (248.61 GPCD), moderate and high rates of population growth, and improved conservation measures is shown on Figures 7a and 7b. Under the assumptions described above, water demand under conditions of moderate growth is planned to grow from 7,800 afy in 2020 to 13,500 afy by 2060. Under conditions of high growth, water demand grows from 11,600 afy in 2020 to 14,200 afy in 2025 and to 17,800 afy by year 2060. As included in the 1995 Plan a 20% reserve is also accounted for.

As noted at the outset of this section, projected water demand based solely on population projections do not, and cannot, explain the entirety of the basis for the City's demand for water. As set out above and in more detail in the following sections, the physical limitations imposed by the City's water supply require it to hold and maintain the full amount of its Lea County and Carlsbad Basin water rights to ensure it can meet the demand of balancing physical supply limitations with consumptive use needs.

OTHER PLANNING FACTORS

Other factors which impact the City's water planning include ensuring a sufficient available water supply during a call of priority on the Pecos River; and management of the City's return flow obligation to the Pecos from diversions related to its Sheep Draw-Carlsbad Basin water rights. When the full interconnection of the Double Eagle wellfield with the Sheep Draw wellfield is completed, the City will be able to manage its water supply to address both shortages on the Pecos River as well as return flow obligations. Prudent management and planning related to both requires the City to hold, but at times not fully utilize, the full amount of its water rights in Lea County and the Carlsbad Basins.

Water Supply Shortage

As a result of a year-2000 OSE permit approving a swap of priority dates with rights the City sold to the Interstate Stream Commission associated with Harroun Farms, all of the City's water rights in Sheep Draw hold priority dates prior to the Pecos River Compact and represent senior water rights in the Carlsbad Basin (Table 1). Accordingly, the City's Sheep Draw rights are relatively protected from any shortages related to a priority call. However, in the event drought or Compact related concerns potentially impact the City's ability to utilize some or all of its Sheep Draw rights on an interim basis, the City planning includes the ability to utilize water from its Double Eagle and Tatum wellfield to back-up or supplement the Sheep Draw water supply. The City's Lea County Underground Basin rights are not connected to the Pecos River and would accordingly be unaffected by any Pecos River drought or issues relating to any Compact concerns.

Return Flow Obligation

Management for return flow obligations also requires the City hold additional water rights than what might be specifically utilized to meet consumptive demand as measured solely by customer usage. The City's Sheep Draw-Carlsbad Basin water rights have a return flow obligation of 1,414.95 associated with 3,839 acre-feet (12 of the water rights comprising the City's Sheep Draw wellfield rights). As noted elsewhere in this Update, the City utilizes some effluent for turf irrigation and currently returns more than its return flow obligation to the Pecos River. The City continues to evaluate whether transitioning to zero discharge of return flow is in the best interest of the City and its overall water planning and water management efforts. It would be feasible for the City to go to zero discharge in light of the fact that it could refrain from pumping those water rights with a return flow obligation and supplementing customer demand with water rights from the Double Eagle and Tatum wellfield.

Managing and planning to address both drought and return flow issues require the City to hold water rights above and beyond water rights necessary to meet demand based on population projections alone.

WATER AVAILABILITY

Water Supply

Surface Water

As described previously in this report, the City is permitted to use 611.46 afy of Pecos River surface water rights with a purpose of use involving the Pecos River Park and irrigation of the golf course if needed along with CID water rights allowing irrigation on 63.5 acres. The City also holds 430 afy of surface water rights pursuant to a Declaration of Ownership of Water Rights on file with the OSE in connection with offsetting evaporation for Upper Tansill Lake. The City's surface water rights are not part of the City's drinking water supply. The City's potable water supply is derived from its Sheep Draw and Double Eagle wellfields as described below.

Groundwater

The principal groundwater supply available to the City of Carlsbad is derived from the Sheep Draw wellfield west of the City and from the Double Eagle wellfield and the Tatum wellfield northeast of the City.

Sheep Draw Wellfield

The City is permitted to annually divert up to 10,283.11 acre feet from the Sheep Draw wellfield under OSE File No. C-76 et al.. As described above in the *Permitted and Actual Use*, section of this Update, the City also holds rights to an additional 2,300 afy of Carlsbad Basin water rights (C-110/C-111) with the Sheep Draw wellfield an alternative permitted

point of diversion which will be available to the City sometime after 2039. The wellfield is completed in the Permian Capitan Reef aquifer located in the Carlsbad Underground Water Basin as administered by the OSE. Bjorklund and Motts (1959, p. 138 to 140) provide a description of the reef aquifer and of its hydrologic interaction with the shelf aquifer system east of the Guadalupe mountains. The reef aquifer consists principally of the Capitan limestone and it is characterized by cavernous channels resulting from solution of the limestone and adjoining formations after the rock was deposited. Figure 8 shows groundwater level contours in the area of the City. The groundwater gradient is the driving force for groundwater flow. The direction of the gradient is perpendicular to the contours from higher to lower elevation, representing generalized groundwater flow directions. The contours on Figure 8 show that the reef aquifer exhibits a much flatter water-level surface than seen in other areas.[10] The flatter surface indicates a higher degree of permeability in the reef aquifer than the permeability in other aquifer formations such as the alluvium. That higher degree of permeability stems from the interconnection of solution channels in the limestone.

Recharge is the addition of water to the water table (Wilson and Moore, 1998, p. 163). Groundwater in the area of Sheep Draw wellfield and the City of Carlsbad area is recharged from precipitation in the Guadalupe Mountains that percolates to the water table and that causes runoff to soak in the intermittent draws that generally flow eastward toward the Pecos River. Under natural conditions in the area of the wellfield, groundwater generally moves eastward from the Guadalupe Mountains through the aquifer system until it discharges at Carlsbad springs or in the Pecos River. Carlsbad Springs is supported by groundwater discharge from the reef aquifer (Bjorklund and Motts, 1959, p. 258).

Groundwater development affects the natural system and intercepts groundwater that otherwise would naturally flow into the Pecos River. The solution channels and caverns of the reef aquifer provides a high degree of hydrologic connection between groundwater in the reef aquifer and Carlsbad springs. The Sheep Draw wellfield causes a cone of depression in

[10] The Capitan Reef Aquifer water-level gradient is generally on the order of one foot per mile compared with 11 feet per mile in other areas.

the Capitan aquifer that expands until it reaches Carlsbad Springs and the Pecos River. Upon reaching those surface-water features, the cone ceases to expand because flow is captured from the Pecos River to "fill-in" the edge of the cone. The Pecos River is, therefore, expected to provide a source of water that can sustain Sheep Draw wellfield production indefinitely as long as Pecos River water is available. The converse of the Pecos surface flows serving as a source of recharge induced by the Sheep Draw wellfield is that pumping the wellfield depletes Carlsbad Springs and therefore the City's Upper and Lower Tansill Lakes will be negatively impacted. (Figure 10)

Nine wells in Sheep Draw are currently in operation. Individual well yield and performance information is summarized on Table 2. Layne Western Company, Inc. inspected Sheep Draw wellfield for pump setting and depth and tested each well for instantaneous yield and specific capacity on June 11, 1996 (Table 2). Sheep Draw wellfield has large capacity wells with individual yields ranging from over 1300 gallons per minute (gpm) to over 2000 gpm per well. Individual well specific capacities vary from tens of gallons per minute per foot of drawdown (gpm/ft) to over 150 gpm/ft (Table 2, Column 9), reflecting the high capacity of the cavernous limestone.

The high-yield characteristic of the Sheep Draw wells is apparent in historical operations. Monthly well use records (January 1996 to May 2002) of Sheep Draw wellfield show no trends of decreasing yield to individual wells; Table 2 (Column 10) shows that during that time, individual wells were operated from less than 10 percent of the time (Wells 2 and 6) to 50 percent of the time (Well 7). During that time frame, annual wellfield production averaged about 9,w160 afy (Table 2, Column 11). Sheep Draw wellfield as a whole operated, on the average, 26 percent of the time, yet it produced nearly its full permitted amount of 10,283.11 afy. However, as discussed elsewhere in this Update, maximizing pumping in the Sheep Draw wellfield is not prudent water management due to the danger of salt intrusion and the effects on Pecos River surface supplies. Accordingly, the City must manage pumping in the Sheep Draw wellfield at rates below 10,000 afy.

Double Eagle Wellfield

The Double Eagle wellfield is located about 40 miles northeast of the City of Carlsbad in the Lea County Underground Water Basin administered by the OSE (Figure 4). The City has an OSE permit to divert up to 7,648 acre feet annually from multiple file numbers (Table 1). The wellfield is completed in the Late Tertiary (Neogene) Ogallala Formation aquifer northeast of the City of Carlsbad in Lea County. The Ogallala Formation in Lea County is part of the southern High Plains Aquifer System (Lucky and others, 1886). The Mescalero Ridge escarpment forms the western and southern boundary of the Ogallala Formation in the Southern High Plains.

Throughout the Southern High Plains, the sub-surface is composed of Ogallala Formation. It unconformably overlies less permeable rocks of Cretaceous and Late Triassic age (McGuire and others, 2003). The Ogallala Formation consists of clay, silt, fine to coarse-grained sand, gravel and caliche (Cronin, 1969, p. 4). The water resource feasible for use is the volume of drainable water in storage in the Ogallala Formation and reversal of groundwater that otherwise would flow to downgradient areas. Figure 9 shows water-level contours in the Ogallala aquifer in the area of the Double Eagle wellfield. Groundwater generally flows in a southeasterly direction.

Recharge and discharge are active processes in the Ogallala, but are not much altered by, and do not appreciably influence, the Double Eagle wells which are supported by the stored resource. In the wellfield area, the Ogallala Formation aquifer saturated thickness varies from 0 to over 150 feet (Ash, 1963, Sheet 1).

Table 3 shows specific capacity information available for some of the wells at the time they were drilled in the 1960's and 1970's and as measured in 2003. Specific capacity data indicates a reduction over the last 30 to 40 years, which is expected as the saturated thickness of the Ogallala Formation aquifer has been reduced from groundwater development. In 2015 and 2016, the City increased capacity by drilling five new Double

Eagle wells.[11] Overall however, the Ogallala is a declining resource and not capable of producing the City's full water right in a sustainable manner. As discussed elsewhere in this Update, prudent management of the Double Eagle wellfield will require strategies to manage well interference, periods of non-use to allow at least some aquifer recovery, and maintaining the City's full water right but not planning to divert that full amount to manage the lifetime of the resource. Ogallala aquifer resource management will also include development of the Tatum wellfield.

Tatum Wellfield

The Tatum wellfield is located five to ten miles northeast of the Double Eagle wells as shown on Figure 9. In year 2013, the City of Carlsbad drilled and completed three wells in the Tatum wellfield. The wells are not yet connected to the City water system but are a first step toward development of the Tatum wellfield. The City holds an OSE approved permit to divert up to 10,640 afy under multiple file numbers at the Tatum wellfield from various permitted sites (Table 1). The Tatum permit sites provide access to water from the Ogallala Formation aquifer. The saturated thickness of the Ogallala Formation aquifer in the area of the Tatum permits ranges from 100 to 200 feet, which represents some of the greatest aquifer thickness in Lea County (BGW, 2005, Figure 2). That thickness is greater than the aquifer thickness at the Double Eagle wells and supports the prospect of more productive wells, at least until the saturated thickness declines from well use. Managing that well use is a key aspect of planning the lifetime of the water resource at the City's Lea County Basin wells.

Producible Water to City Wells

The City of Carlsbad has investigated water availability from the aquifer systems that supply its wells. The OSE developed a groundwater flow model of the Capitan Reef and alluvial aquifer systems in the administrated Carlsbad Underground Water Basin (Barroll and

[11] The wells are listed on Table 3 as City Well 7, City Well 8, City Well 9, City Well 10 and City Well 11.

others, 2004). The City developed a separate groundwater flow model of the Ogallala Formation aquifer to better understand the geohydrologic system affected by groundwater development in the Double Eagle wellfield and Tatum permit areas (BGW, 2005, Appendix A). Both models provide a tool to analyze producible water to City of Carlsbad wells.

Sheep Draw Wellfield

Producible water to Sheep Draw wellfield over a 40-year period is shown on Figure 10 as a stacked area chart. The model simulates pumping the City's permitted quantity of 10,283.11 afy. When wells are pumped, the immediate source of water is from aquifer storage. As pumping continues, there is a transition in the hydrologic budget from aquifer storage to other sources if they are available within the radius of influence. At Sheep Draw wellfield, the Pecos River provides a source of water in addition to aquifer storage. The high degree of connection between the reef aquifer and the Pecos River is apparent as the transition occurs almost entirely over the first few years of groundwater withdrawal (Figure 10). The model indicates that over 95 percent of the Pecos River flow affected by Sheep Draw wellfield is depleted from Carlsbad Springs. The findings agree with the expectation that the Pecos River will supply a sustainable source of water captured by Sheep Draw wellfield indefinitely as long as Pecos River source water is available. However, as previously described, the present production of the Sheep Draw wellfield is close to optimum for safe long-term performance with regard to water quality. And, it is not an acceptable strategy to allow significant depletion of Carlsbad Springs which feed the City's important resources in Upper and Lower Tansill Lakes.

Double Eagle and Tatum Wellfields

Unlike the Sheep Draw wellfield, the Double Eagle and the Tatum wellfields are not situated near a perennial stream that can provide water to sustain well diversions over the long term. Groundwater is stored in the pore spaces of the sediments that define the Ogallala aquifer. The principal source of water to the Ogallala Formation wells is aquifer storage, which is a finite quantity. Depletion of aquifer storage is depicted in the cone of

depression (water-level drawdown) caused by Ogallala well pumping. In the setting of the City's wells, eventually drawdown from pumping will approach the base of the aquifer and well yield will be limited by the reduced thickness of the aquifer. Over the long term of pumping, the rate of well yield will decrease to a sustainable quantity of flow that can be produced from the Ogallala aquifer under a condition where groundwater levels generally cease to decline. It is the groundwater that, but for pumping, would otherwise flow through the aquifer down gradient to aquifer discharge areas. That sustainable quantity of water is not examined herein, but the dynamics of producible water from the Ogallala aquifer are described for context in water planning. The pertinent question relates to how well yield is affected by groundwater development as the saturated thickness of the Ogallala aquifer is reduced, or as aquifer storage is depleted.

The City has analyzed well yield from the Double Eagle wells and the Tatum permit sites under a condition of maximum permitted use. The analysis includes an example of pumping from neighboring wells, which is adapted from BGW (2005). The findings are shown on Figure 11. The analysis illustrates that the permitted quantities of water at the Double Eagle (7,648 afy) and Tatum (10,640 afy) wells are produced for 35 to 40 years until well water levels lower enough that well yield begins to decline. After 100 years, yield declines at the wellfields to 5,100 afy at Double Eagle and to 9,400 afy at Tatum. If example pumping from neighboring wells is accounted for, there is an additional decrease in yield (down to 4,200 afy at Double Eagle and 9,100 afy at Tatum).

An observation on Figure 11 is apparent. After 100 years of pumping, the yield at the wells is steadily declining. That is, well yield has not yet stabilized indicating that it has not equilibrated with groundwater flow that otherwise would flow downgradient to eventual aquifer discharge areas. The implication is that, in the long term, aquifer storage provides a source of water for decades; however, well yield declines and will eventually stabilize at a rate that is less than the permitted water rights. In that setting, a prudent planning approach is to make use of the stored aquifer resource over the long term if the full water right is not immediately needed. In other words, the City must maintain its Lea County groundwater

rights primarily as stored water to offset against the projected aquifer declines which limit the City's ability to optimize its water rights in the Lea County Basin.

PLANNING FACTORS FOR WELLFIELD MANAGEMENT

In consideration of how the aquifer systems (Capitan and Ogallala) that supply the City wells respond to groundwater pumping, factors that influence general water planning are apparent.

Sheep Draw Wellfield Factors

1. The wellfield is completed in the Capitan aquifer, which is highly permeable and cavernous. The high permeability translates to a high degree of hydraulic connection to the Pecos River.
2. In as much as Pecos River source water is available, groundwater pumping is sustained indefinitely by capturing flow from the Pecos River, but capture of Pecos River water will negatively impact the surface water assets of the City.
3. The wells produce fresh water, but pumping the wellfield results in lowering water levels enough to affect the fresh/saline water interface in the Capitan aquifer such that saline water is induced into the City water system. Management of pumping at current rates, ranging from 7,000 to somewhere under 10,000 afy, appears to be close to optimum for safe long-term performance without inducing poor quality water into the City's potable water supply.

Double Eagle/Tatum Wellfield Factors

A. The wellfield is completed in the Ogallala aquifer. The principal source of water is aquifer storage. A river is not present nearby to provide an additional source of water.

B. Groundwater diversions deplete a finite quantity of water stored in the aquifer; however, a supply is available for decades. Thereafter, a sustainable quantity of water can be diverted, but at rates less than the water rights at each wellfield.

The wellfield factors provide a framework for planning management of the City's water supply. Sheep Draw well production is sustainable; however, maintaining water quality and balancing river depletion impose a constraint on use. Double Eagle/Tatum well production is derived from a finite source of stored water, but it can provide a managed supply for decades. The Sheep Draw wellfield currently provides the principal source of water to meet City demand. City water demand is projected to exceed the water rights and safe capacity of Sheep Draw wellfield within the next 20 years. This setting dictates that management of Sheep Draw well operations to prevent water quality degradation in conjunction with development of groundwater from the Double Eagle/Tatum wells is needed to provide a reliable, long-term water supply for the City. As part of that management strategy it is critical for the City to maintain its full portfolio of water rights in both the Lea County Basin and the Carlsbad Basin to allow it to balance consumptive use demand with the physical limitations of these two very different aquifers.

Since year 2012, the City has invested in five replacement wells[12] and five new wells[13] at the Double Eagle wellfield, drilling of three new wells[14] in the Tatum wellfield and installation of approximately 40 miles of new pipeline to route water from the Double Eagle wellfield to the City. Currently, Double Eagle water is used in a portion of the City water system; however, a project is underway and almost complete to allow routing of Double Eagle water into the entire City water system. These developments are part of the City's plans to conjunctively manage the Sheep Draw and Double Eagle/Tatum wellfields to provide a sufficient, reliable water supply for the long term.

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[12] Year 2013 well completions included drilling five replacement production wells in the Double Eagle wellfield: Ambasador 4 (L-3852), Frontier 2 (L-5494), Caprock 1 (L-3853), Caprock 4 (L-4918) and Caprock 21 (L-4566-S2).

[13] Year 2015 well completions included drilling five new wells in the Double Eagle wellfield: City Well 7, City Well 8, City Well 9, City Well 10 and City Well 11. In 2015, the City also installed five new monitor wells in the Double Eagle wellfield for the purpose of observing long-term aquifer conditions as groundwater is developed in the future.

[14] Year 2012 well completions included three new wells in the Tatum wellfield: Tatum 1 (L-7321-S2), Tatum 2 (L-7321-S5) and Tatum 3 (L-7321-S7).

PLANNING PERIOD

The City's planning with regard to its water resources has generally surpassed the 40 year planning period traditionally followed. The City believes it is imperative as a municipality to plan for the long term needs of its citizens beyond 40 years in a sustainable manner. The City has repeatedly demonstrated its proactive and long term planning commencing with the purchase of the Harroun Farm in the 1960s for purposes of water supply; acquisition of the Double Eagle system in the 1970s to balance out the limitations of the Carlsbad Basin, and acquisition of the IMC Kalium (Mosaic) water rights in 1999 for access after 2039 to allow use or potential resting of these water rights to avoid negative impacts on surface resources and water quality in the Carlsbad Basin. Accordingly, while the City uses the more traditional 40 year planning period in this Update, the City believes it is critical to look beyond 40 years. Additionally, given the City's unique location in the heart of southern Eddy County where significant oil and gas development is ongoing and projected to continue, the City must plan conservatively for potential large population increases requiring both water infrastructure and water supply.

The City holds and will continue to hold water rights which it is not using for direct consumptive purposes as those rights are needed to balance the unique challenges of the City's physical supply as well as the potential significant population increases associated with oil and gas development. All of the City's water rights it currently holds are necessary now and into the future to allow the City to maintain its two aquifer sources and its surface water assets in a sustainable manner. Without holding the right to the water in those aquifers the City cannot manage its physical supplies in a way that ensures a safe, reliable water supply to its citizens now and throughout a 40 year planning period and beyond. The City's holding and maintenance of its water rights in both Lea County and the Carlsbad Basins to allow conjunctive management of those aquifers, to allow the aquifers to be balanced and periodically "rest", promotes both the public welfare and the conservation of water. There are no additional sources of water available to the City. New appropriations are not allowed in either the Carlsbad or the Lea County Basin, nor should they be.

Acquisition of additional existing water rights is feasible but not necessary within the 40 year planning period. An exception to this may be acquisition of water rights as necessary to protect the City's physical resources from water quality degradation and aquifer decline and or to prevent impairment to the City's existing water rights.

RECOMMENDATIONS

1. Continue to monitor chloride levels at Sheep Draw wellfield. Plan to monitor hydrologic conditions at Carlsbad Springs. Direct management efforts to maintain optimum water quality in the wellfield and to maintain the springs.
2. Continue with plans to develop groundwater from the Double Eagle and Tatum wellfields. Such plans will include completion and implementation of Phases 1, 2 and 3 of the Double Eagle Water System Improvements as set forth in the Molzen Corbin Preliminary Engineering Reports for Phases 1, 2 and 3. The Lea County Basin water source available from the Double Eagle and Tatum wellfields will provide a key component for conjunctive management with the Sheep Draw wellfield to provide a reliable water supply as demand grows in the future.
3. Install a pipeline from the Double Eagle wellfield to the Tatum wells and begin development of groundwater in the area of the Tatum wells. The aquifer in that area represents some of the thickest portions (greatest resource) available in Lea County.
4. Track water use in the area of the Double Eagle and Tatum wells, particularly water transfers into that area. Groundwater developed by others in the area has potential to deplete water stored in the aquifer that otherwise would be available for use by the City.

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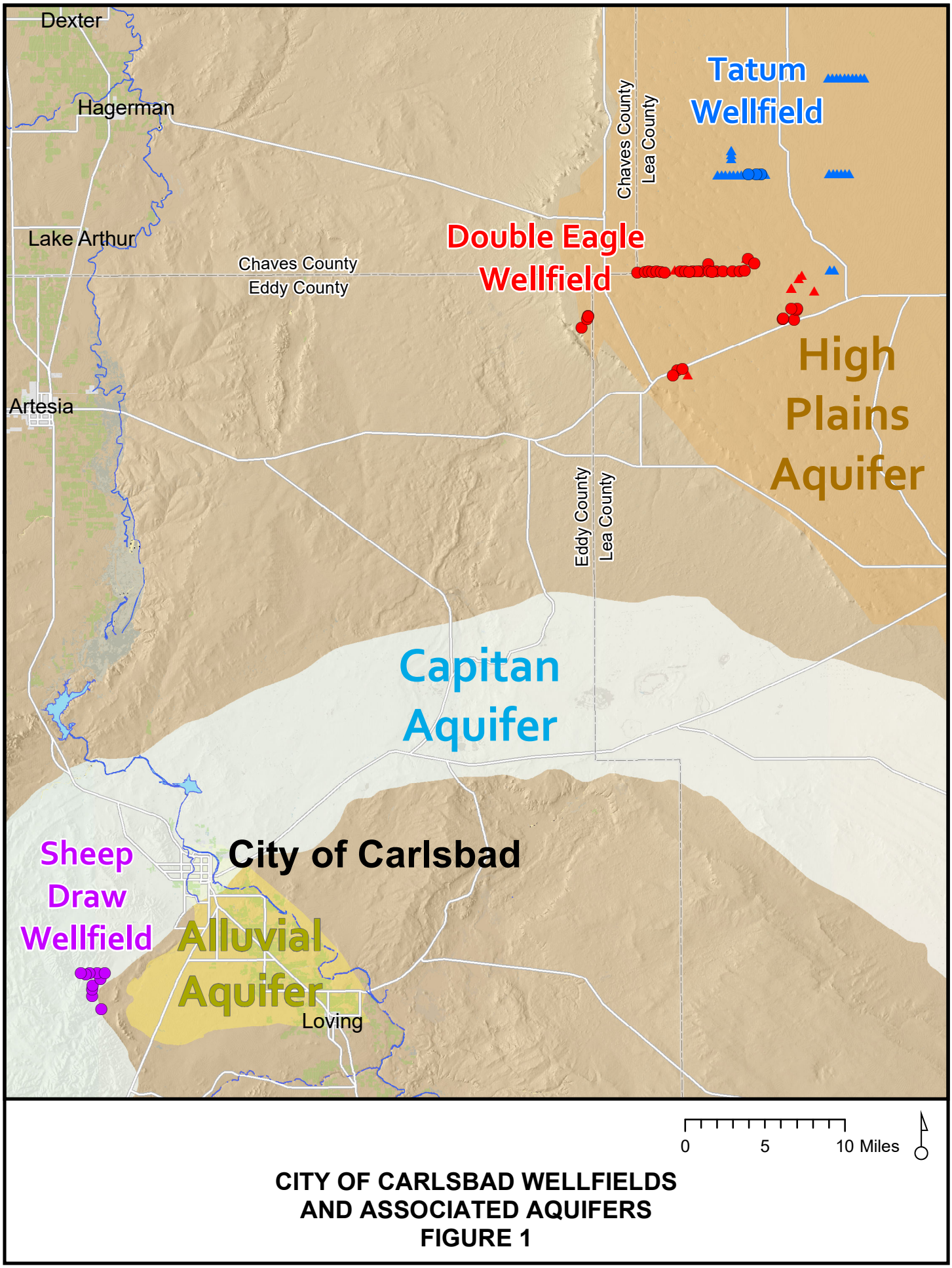
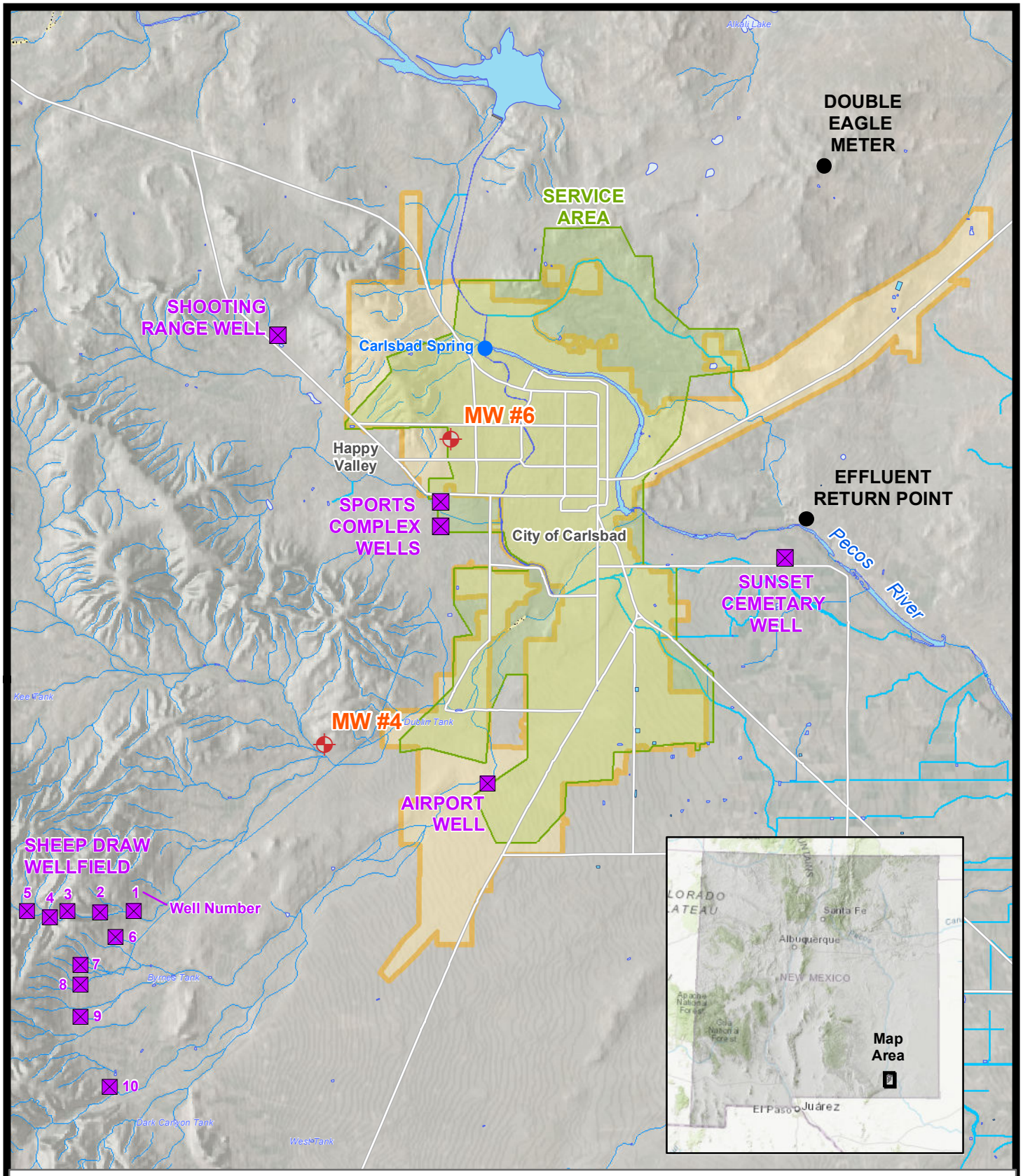


CITY OF CARLSBAD WELLFIELDS
AND ASSOCIATED AQUIFERS
FIGURE 1



CITY OF CARLSBAD PRODUCTION WELLS

WATER SERVICE AREA

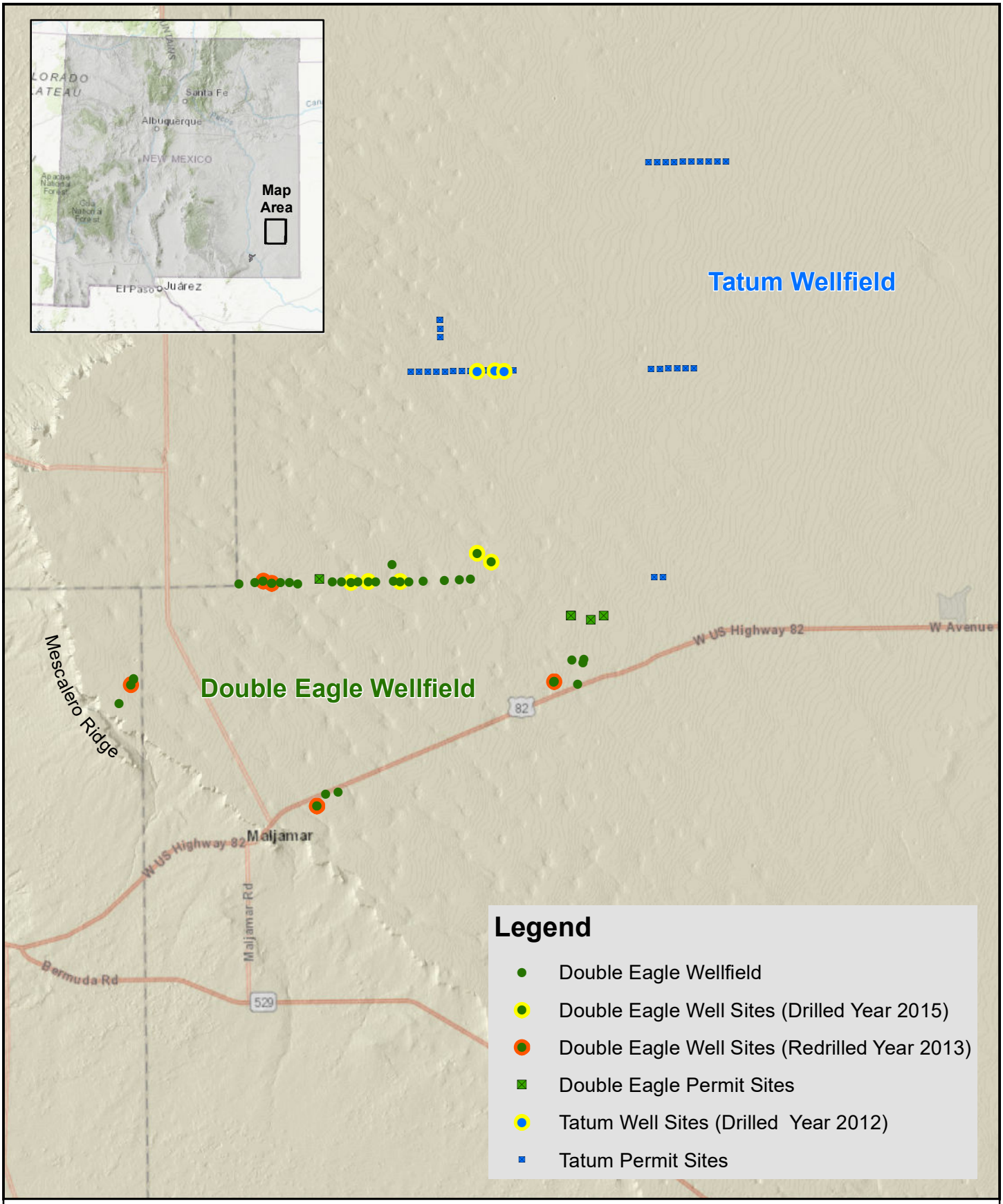
CARLSBAD CITY LIMIT

0 2 Miles

CITY OF CARLSBAD SHEEP DRAW WELLS, OTHER WELLS AND SERVICE AREA

FIGURE 2

BALLEAU GROUNDWATER, INC.



Data Sources
City of Carlsbad well locations and status are from NMOSE WATERS data, City of Carlsbad and State Land Office records and BGW field inspection data. Applicant wellsites adapted from applicant model files. USGS Topo Base VIA ESRI online.

CITY OF CARLSBAD DOUBLE EAGLE AND TATUM WELLS AND PERMITS
FIGURE 3

0 5 Miles
Coordinate System: NAD 1983 UTM Zone 13N

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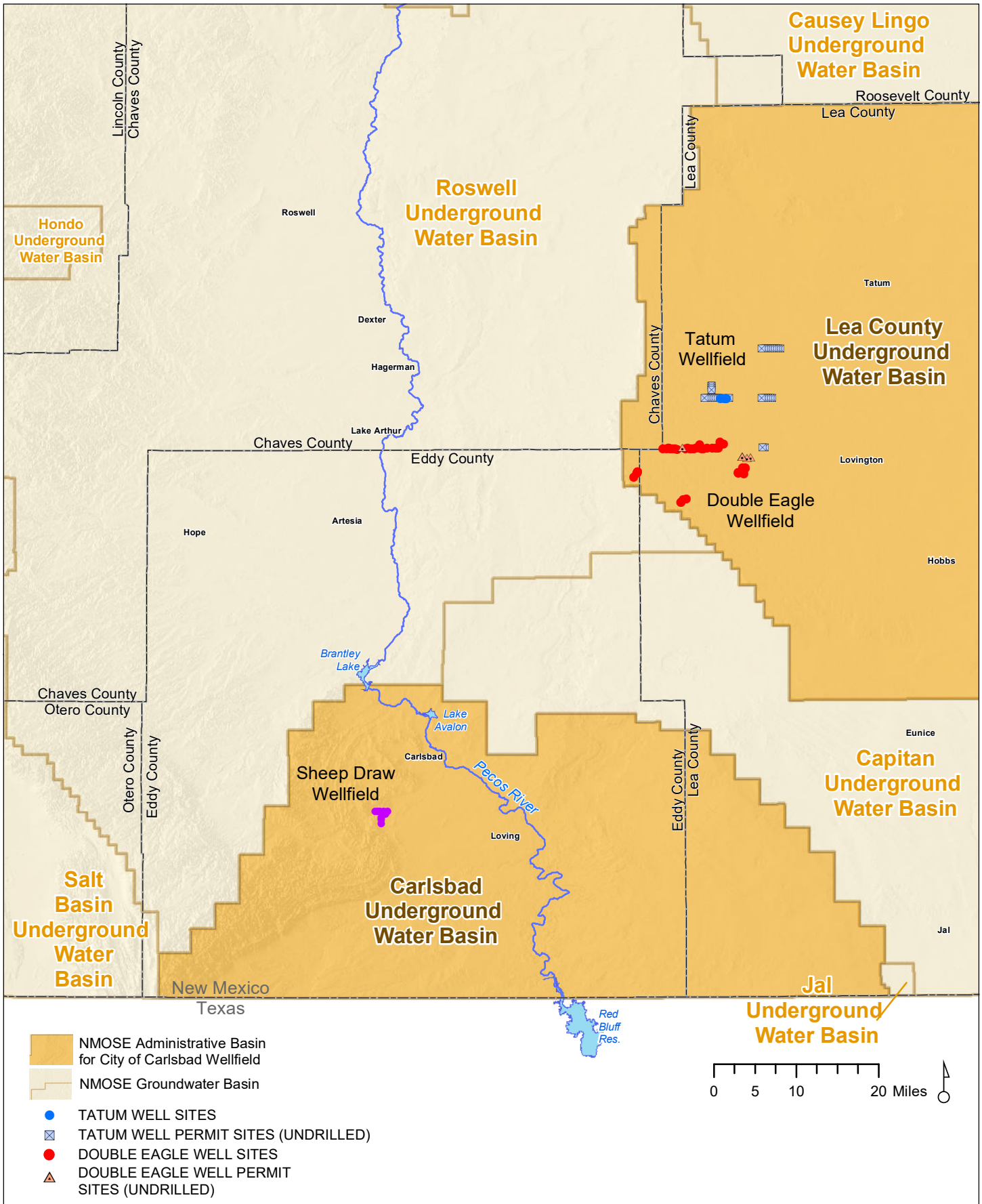
BALLEAU GROUNDWATER. INC.



CARLSBAD AREA UNDERGROUND WATER BASINS
FIGURE 4

NMOSE Groundwater Basin Boundaries were adapted from NMOSE Digital Data

BALLEAU GROUNDWATER, INC.

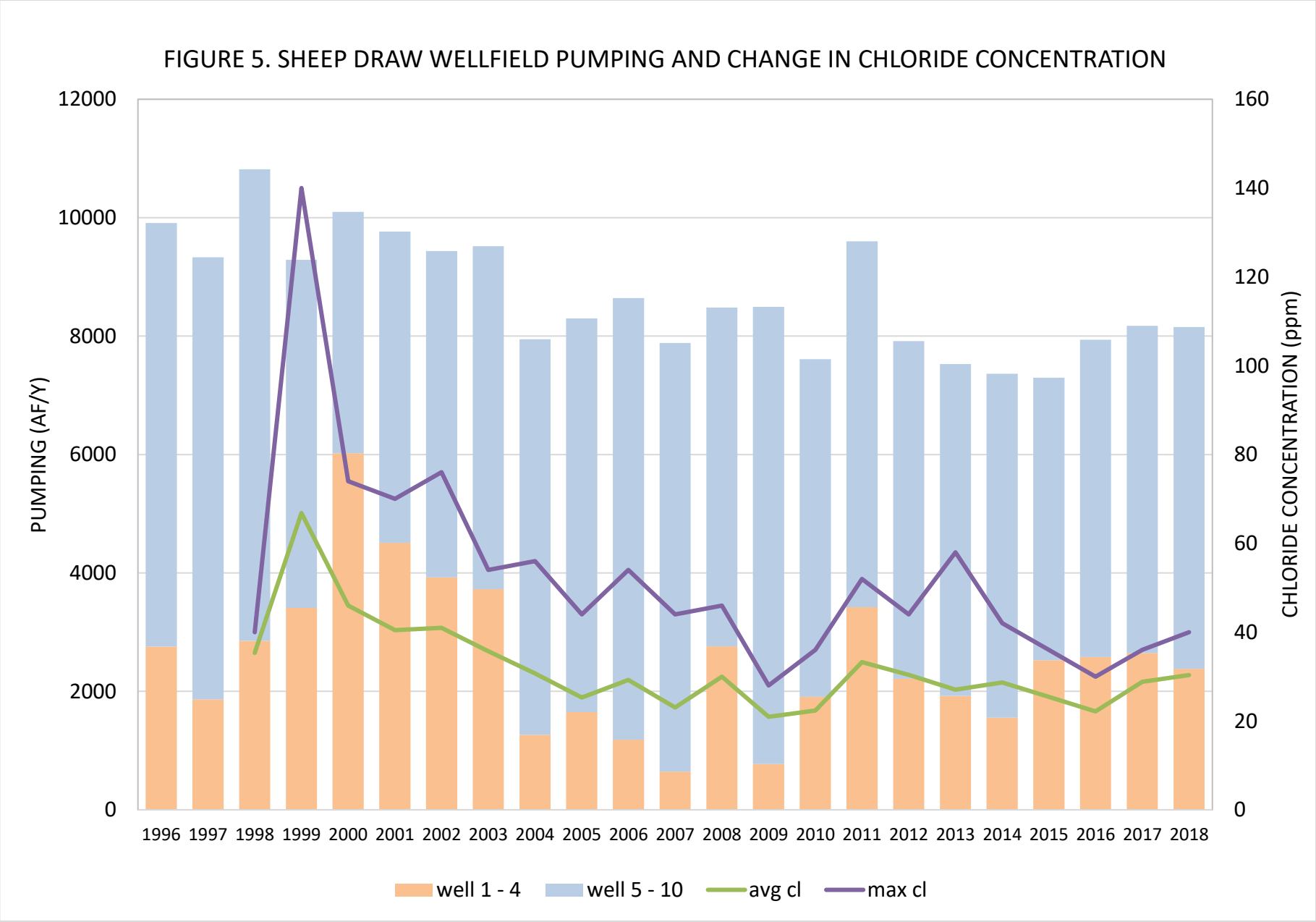
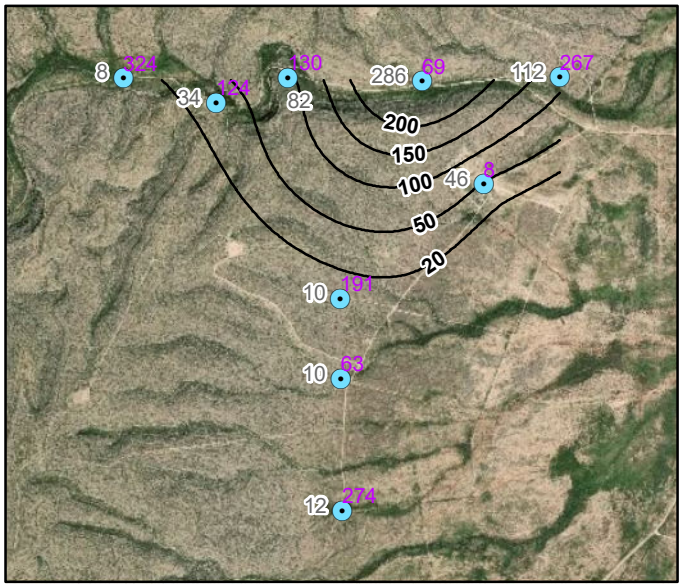
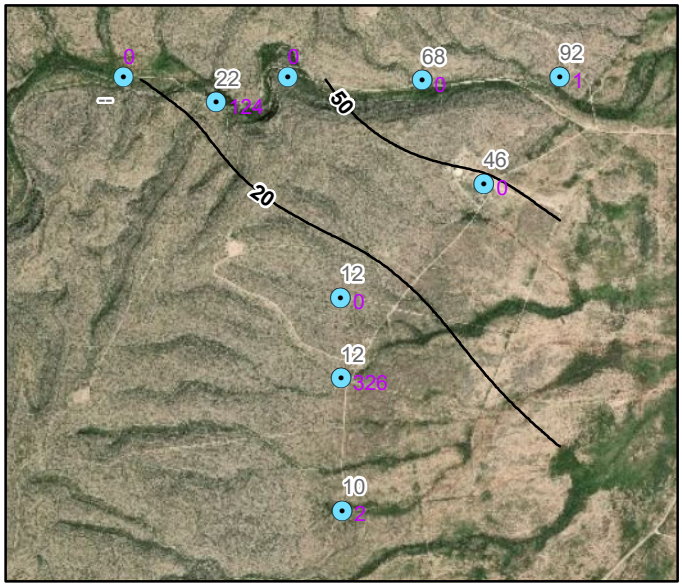


FIGURE 5. SHEEP DRAW WELLFIELD PUMPING AND CHANGE IN CHLORIDE CONCENTRATION
PUMPING (AF/Y)
CHLORIDE CONCENTRATION (ppm)
12000
10000
8000
6000
4000
2000
0
160
140
120
100
80
60
40
20
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
well 1 - 4
well 5 - 10
avg cl
max cl

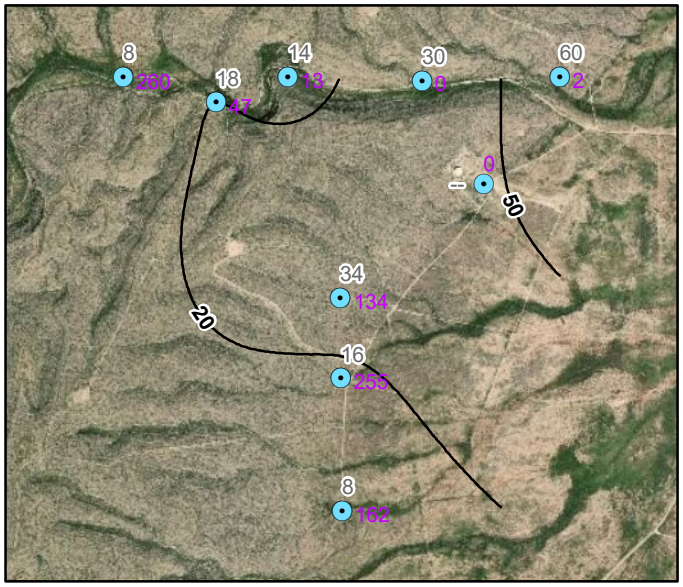
Purple Label: Well Diversion (AF/month) White Label: Chloride (mg/L) Contours are of Chloride



July 2002



January 2003



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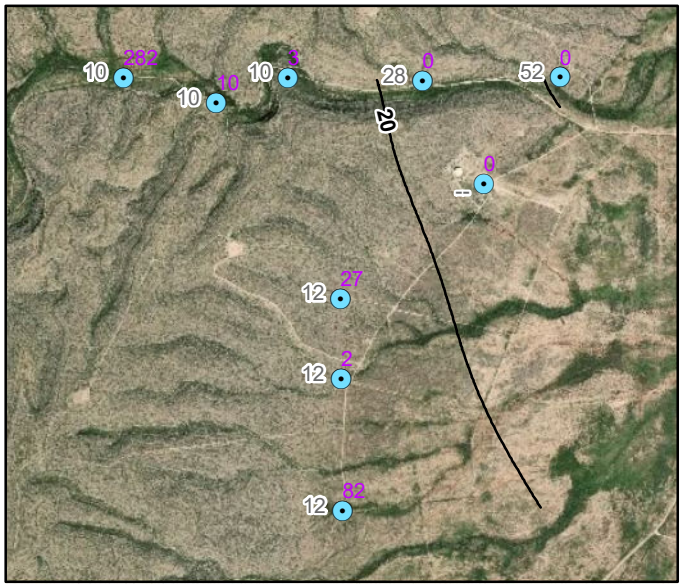

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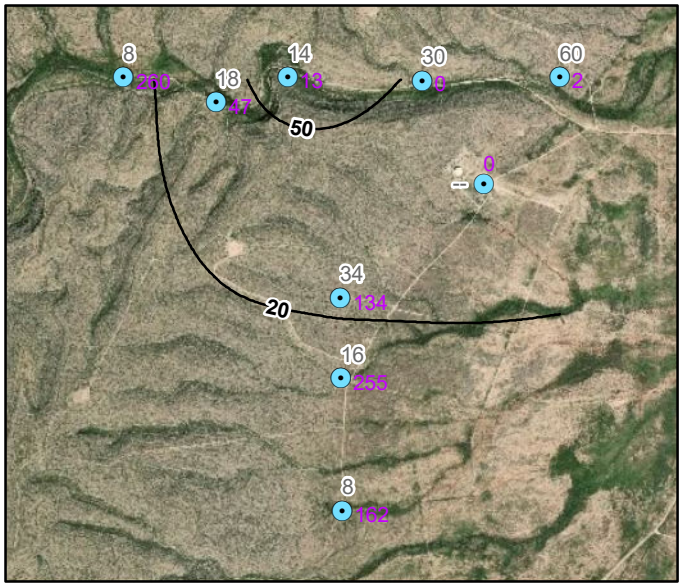

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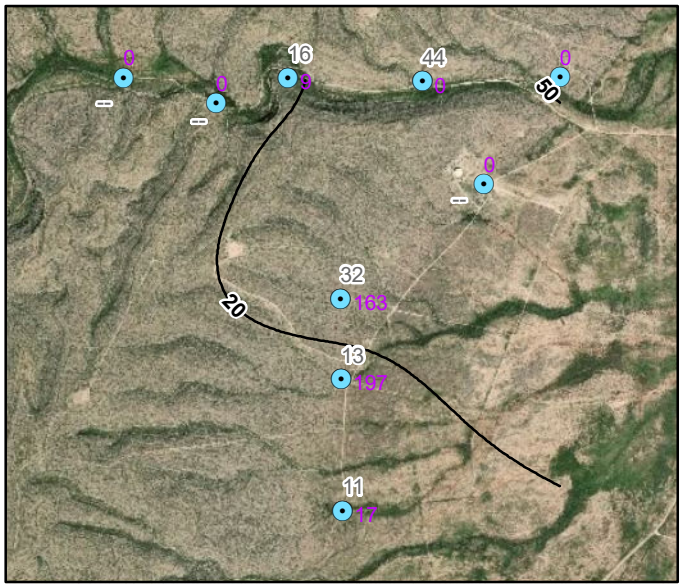


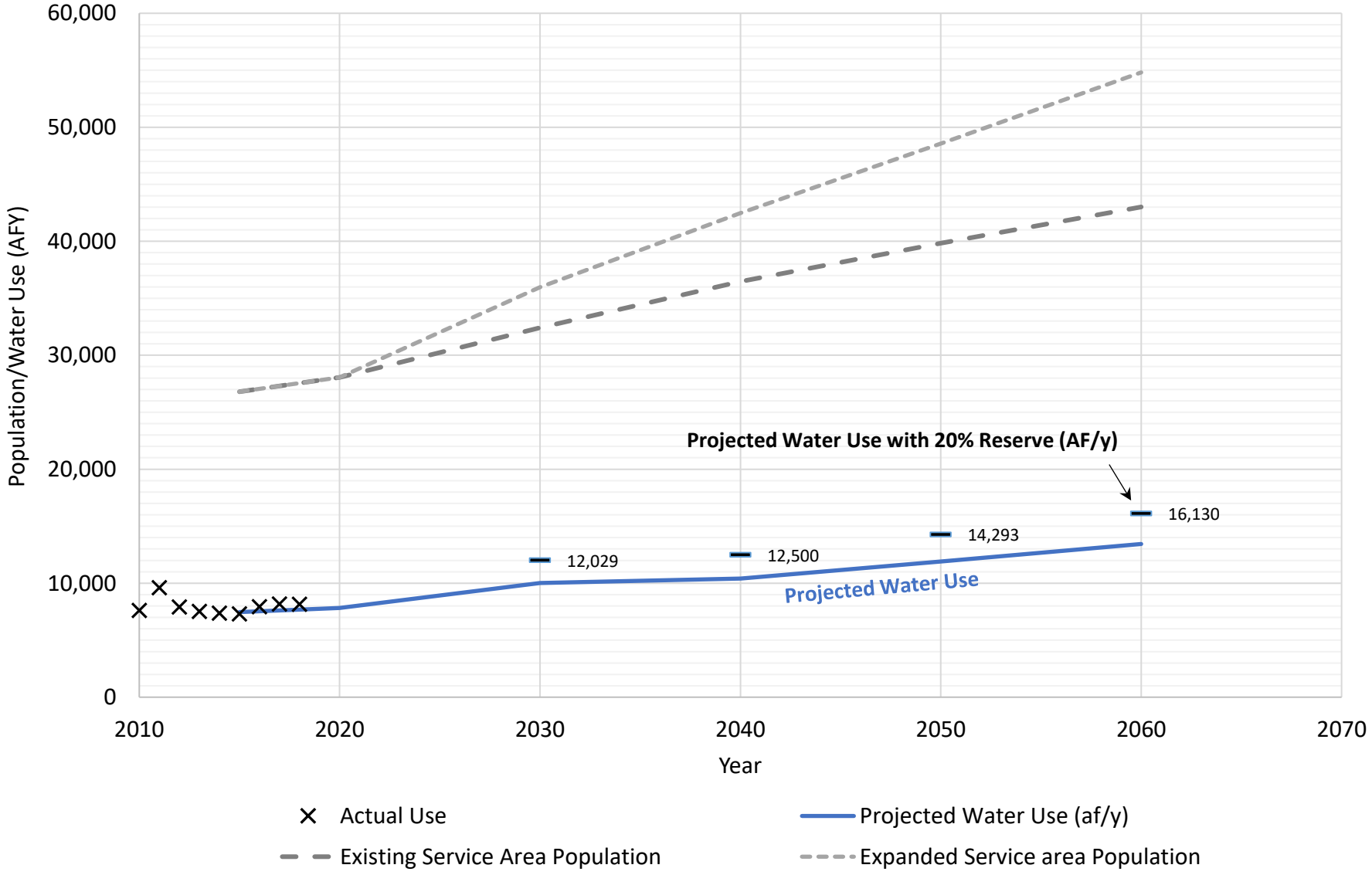
January 2014

0 0.25 0.5 1 Miles

FIGURE 6. SPATIAL PATTERNS OF CHLORIDE CHANGES FROM SUMMER TO WINTER

FIGURE 7a

PROJECTED CITY OF CARLSBAD POPULATION GROWTH AND WATER USE (**Moderate Growth**)



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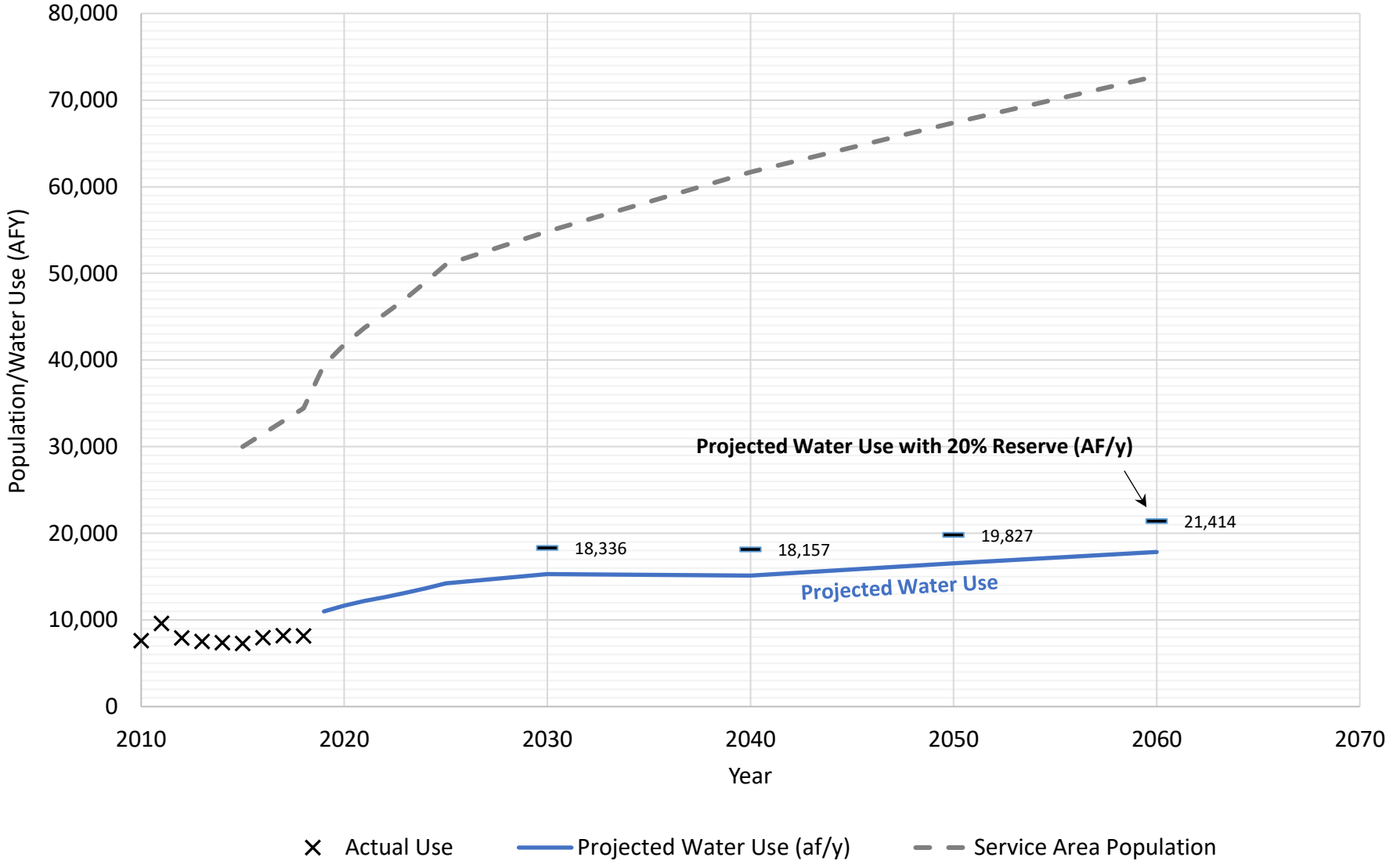
9/11/2019

FIGURE 7b

PROJECTED CITY OF CARLSBAD POPULATION GROWTH AND WATER USE (**High Growth**)



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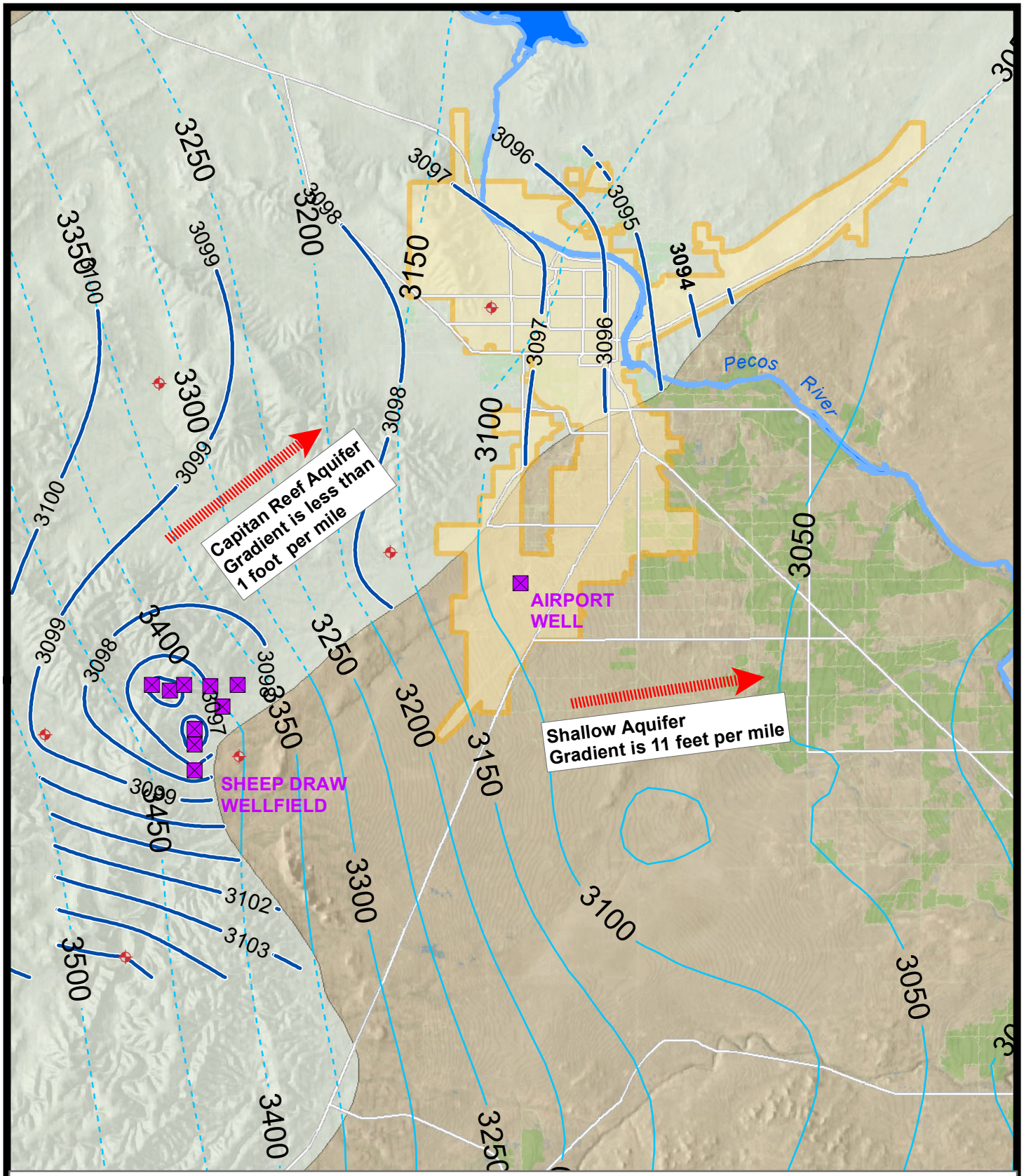
9/11/2019



YEAR 2003 SHALLOW AQUIFER WATER LEVELS, DASHED WHERE SHALLOW AQUIFER IS OVER REEF AQUIFER (FT, NGVD29)

YEAR 2003 CAPITAN REEF AQUIFER WATER LEVELS (FT, NGVD29)

CITY OF CARLSBAD PRODUCTION WELLS

REEF AQUIFER MONITORING WELL

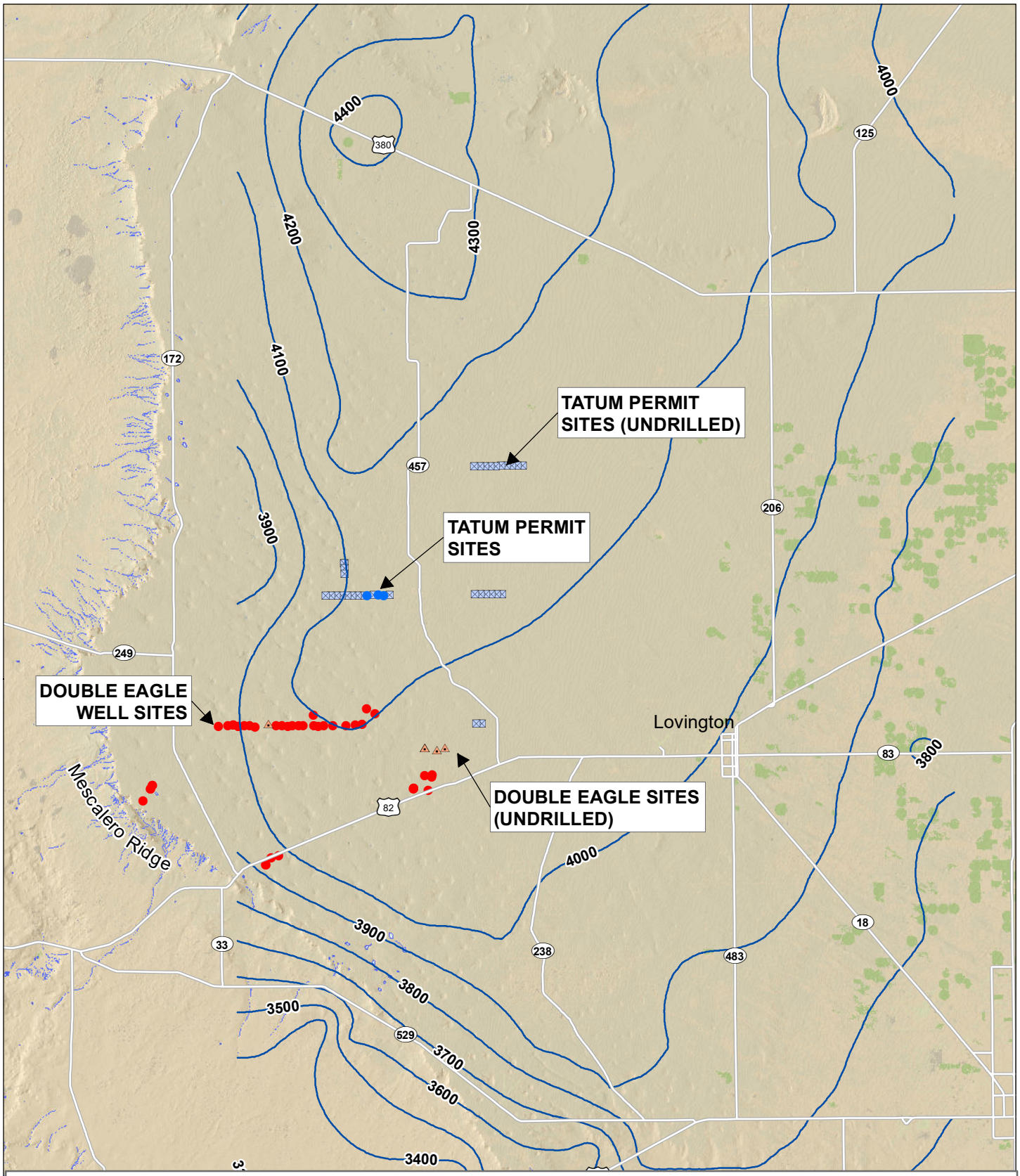
REEF AQUIFER

CARLSBAD CITY LIMIT

CITY OF CARLSBAD AREA
GROUNDWATER CONTOURS
FIGURE 8

0 2 Miles

BALLEAU GROUNDWATER. INC.

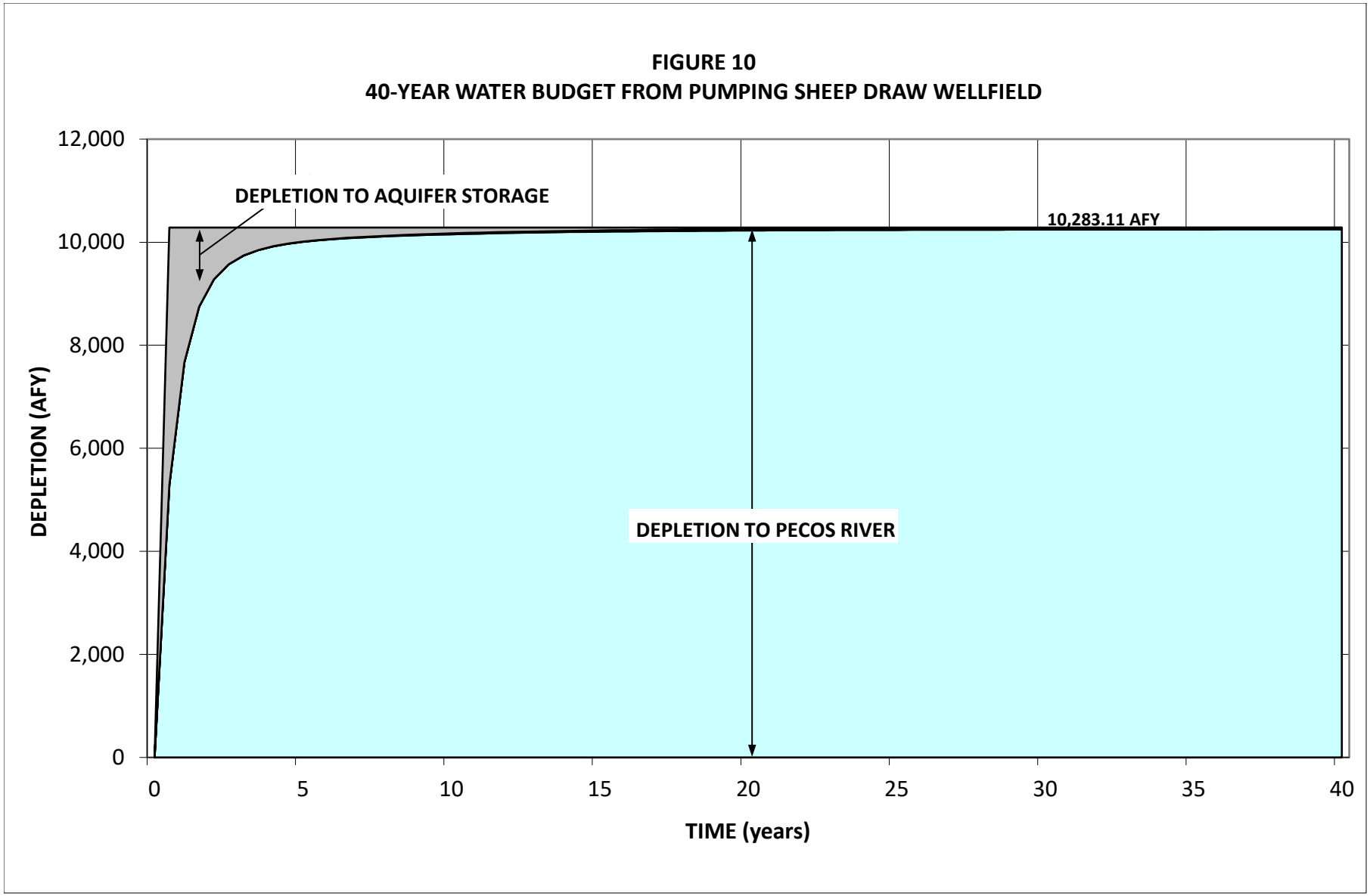


YEAR 2000 OGALLALA AQUIFER WATER LEVELS (FT, NGVD29)

0 5 Miles

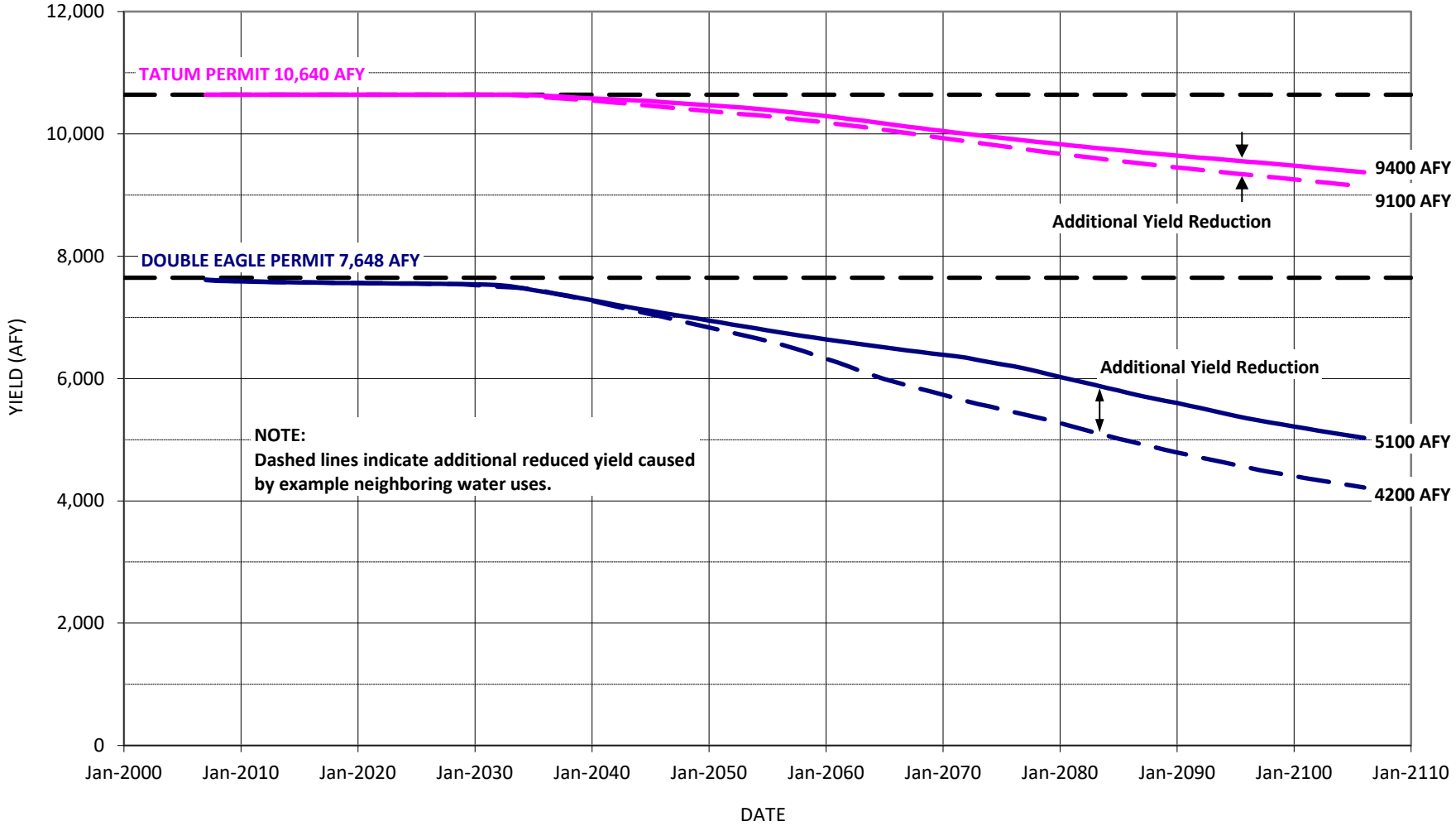
OGALLALA FORMATION AQUIFER GROUNDWATER CONTOURS
FIGURE 9

BALLEAU GROUNDWATER. INC.



BudgetSheep.xls
DMR
8/14/2019

FIGURE 11
DECLINING WELL YIELD AT SHEEP DRAW AND TATUM WELLFIELDS FROM PROJECTED WATER USE



DEtatumWellYield0sk_Upd.xls
DMR
8/14/2019

TABLE 1

CITY OF CARLSBAD
Water Rights

FILE NUMBER[1]	ACRE-FEET PER ANNUM (DIVERSION)	PRIORITY DATE[2]	USE
C-76 et al.	3599	1883	Municipal
Decl. 386 & 387	866	1883	Municipal
302 & 484 comb.	3500	1883	Municipal
C-227, 227-A, 227 AB&C and 990	26.68	1883	Municipal
C-798	15	1883	Municipal
C-494-A	24	1883	Municipal
C-113	51.9	1883	Municipal
C-149	258	1883	Municipal
C-446	294.9	(59.45 Acre-feet=1883; 235.45 = 1931	Municipal
C-652-D	15	1883	Municipal
C-47, C-47 Enlgd B & C-612	441	1883	Municipal
C-126-C	27	1883	Municipal
C-632	15	1883	Municipal
C-47-C7 Enlgd A	60	1883	Municipal
C-157-C	7.8	1918–1923	Municipal
C-126-A	18	1883	Municipal
C-446-A	9.6	1883	Municipal
C-139-A	30	1883	Municipal
C-1045	9	1883	Municipal
C-494	249.27	1883	Municipal
C-180-181	416.1	1932	Municipal, Recreation, Irrigation
1934-A	349.86	1909-1930	Municipal; Irrigation
Total as of 2007	**10,283.11**		
Transfer effective after 2039			
C-110 and 111	2,300	1883-1919	Municipal & Industrial
Total after 2039	**12,583.11**		

[1] All water rights are held under City's permit C-76 et al.; the File Number denotes the originating
[2] Priority dates reflect approved transfer (2000) of Harroun and Western Farm priority dates to City wellfield.

TABLE 1
CITY OF CARLSBAD
Water Rights

FILE NUMBER	Acre-feet Per Annum (DIVERSION)	PRIORITY DATE	USE
Decl. for Upper Tansil Lake	430	1895	Municipal; Recreation (Evap)
1934-A	349.86	1905-1929	Irrigation
303 & 1848 Lower Transil Lake Evap	261.60	1909-1929	Recreation (Evap)
TOTAL	**1,041.46**		
CARLSBAD IRRIGATION DISTRICT RIGHTS			
Subfile Nos. 22.27.07 - C and 21.27.32 K1	63.5 (Acres)	1888-1919	Irrigation
LEA COUNTY BASIN – (DOUBLE EAGLE SYSTEM)			
L-3853 et al	331	Shallow	SRO
L-4639	84	Shallow	Commercial
L-4918 et al	1,708	Shallow	Commercial
L-3967 et al	700	Shallow	SRO
L-4565	580	Shallow	Commercial
L-3852 et al	375	Shallow	SRO
L-4737 et al	70	Shallow	Commercial
L-5247 et al	140	Shallow	SRO
L-5667	25	Shallow	SRO
L-4566 et al	263	Shallow	Comm./Irr.
L-5061 et al	1,200	Shallow	SRO
L-5534 et al	1,372	Shallow	SRO
L-5713	800	Shallow	SRO
TOTAL	**7,648**		
Note: SRO = Secondary Recovery Operations (oilfield)			
TATUM RIGHTS – LEA COUNTY BASIN			
L-7219 et al	3,040	Shallow	Municipal
L-7320 et al	2,432	Shallow	Municipal
L-7321 et al	2,736	Shallow	Municipal
L-7322 et al	1,824	Shallow	Municipal
L-7324 et al	608	Shallow	Municipal
TOTAL	**10,640**		

TABLE 2. SHEEP DRAW WELL DEPTHS, SPECIFIC CAPACITY AND USE

1	2	3	4	5	6	7	8	9	10	11
Well	Pump Size[1] (HP)	Pump Setting[1] (ft)	Well Depth[1] (ft)	Static Depth to Water[1] (ft)	Pumping Depth to Water[1] (ft)	Drawdown (ft)	Flow Rate[1] (gpm)	Specific Capacity (gpm/ft)	Percent of Operation January 1996 to May 2002[2]	Average Annual Well Production January 1996 to May 2002[2] (AFY)
1	300	470	727	385	396	11	1,760	160.0	25%	943
2	300	470	930	380	430	50	1,360	27.2	7%	177
3	300	470	590	401	423	22	1,530	69.5	30%	1,115
4	350	470	678	407	416	9	1,550	172.2	31%	1,178
5	350	470	730	421	446	25	1,980	79.2	40%	1,576
6	300	470	878	390	419	29	1,920	66.2	8%	215
7	350	470	878	423	--	--	2,185	--	50%	2,055
8	400	440	790	403	424	21	1,860	88.6	19%	774
9	400	470	1,000	414	500	86	1,960	22.8	26%	1,124
							Average Jan '96 to May '02 ->		26%	9,158 AFY

[1] All information regarding pump size and setting, well depth, static and pumping depth to water were collected and reported by Layne-Western Company, Inc. during pump tests conducted on June 11, 1996.

[2] Percent of total wellfield yield and time of operation derived from *Monthly Survey of Carlsbad Water System* sheets provided by the City of Carlsbad to Balleau Groundwater, Inc. on July 3, 2002.

TABLE 3. DOUBLE EAGLE AND TATUM WELL DEPTHS AND SPECIFIC CAPACITY

Well	Depth (ft)	Original			2003		
		Yield (gpm)	Pumping Drawdown (ft)	Specific Capacity (gpm/ft)	Yield (gpm)	Pumping Drawdown (ft)	Specific Capacity (gpm/ft)
Original Double Eagle Wellfield Wells							
Ambassador 1	330	180	10	18.0	100	7	14.3
Ambassador 3	331	186	25	7.4	50	10	5.0
Ambassador 4	330	90	--	--	65	313	0.2
Caprock 2	312	140	31	4.6	85	--	--
Caprock 3	--	120	34	3.5	--	--	--
Caprock 4	330	170	50	3.4	--	--	--
Caprock 5	325	184	44	4.2	--	--	--
Caprock 19	--	305	145	2.1	--	--	--
Caprock 1	--	90	--	--	--	--	--
Caprock 6	303	148	84	1.8	150	--	--
Caprock 10	272	137	63	2.2	--	--	--
Caprock 13	243	265	66	4.0	150	--	--
Caprock 14	--	220	60	3.7	--	--	--
Caprock 15-A	220	245	66	3.7	--	--	--
Caprock 16	272	170	88	1.9	160	--	--
Caprock 17	235	300	45	6.7	125	45	2.8
Caprock 18	--	220	69	3.2	65	--	--
Caprock 20	265	283	41	6.9	120	--	--
Caprock 21	237	442	21	21.0	--	--	--
City Well 1	234	--	--	--	160	--	--
City Well 2	223	--	--	--	150	--	--
City Well 3	300	--	--	--	50	--	--
City Well 4	325	--	--	--	150	--	--
City Well 5	287	--	--	--	75	22	3.4
City Well 6	286	--	--	--	120	--	--
Frontier Well 1	280	--	--	--	75	--	--
Frontier Well 3	303	274	60	4.6	120	--	--
Hudson Well 1	--	470	59	8.0	--	0	--
Recent Double Eagle and Tatum Wellfield Wells							
City Well 7	320	48	83	0.6	Drilled 2016		
City Well 8	315	60	58	1.0	Drilled 2016		
City Well 9	300	88	42	2.1	Drilled 2015		
City Well 10	270	48	79	0.6	Drilled 2015		
City Well 11	234	118	80	1.5	Drilled 2015		
Tatum 1	320	254	105	2.4	Drilled 2013		
Tatum 2	330	310	116	2.7	Drilled 2013		
Tatum 3	300	295	87	3.4	Drilled 2013		

Note: The original wells are as reported at the time of construction in the 1960s and 1970s.

Several original wells were remeasured in 2003.

The recent wells are as tested at the time of construction (year noted).

ADJOURN