# CITY OF PORTALES

# REVIEW OF WATER SUPPLY OPTIONS

Prepared for

**City of Portales**

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## Executive Summary

This report presents an overview of optional sources of municipal water supply to supplement Portales' current supply from the Blackwater Wellfield. Consideration has been given to obtaining supplemental supplies from shallow groundwater, deep groundwater, and surface water from Ute Reservoir. In addition, the report reviews alternatives for reducing water demands including wastewater recycling as well as other water conservation measures.

*Shallow Groundwater.* Shallow groundwater from the Ogallala Aquifer in the vicinity of Portales does not provide a sustainable supply for municipal use. It has become limited in quantity and the City's Blackwater Wellfield may be unable to support the current rate of use within 10 to 15 years. In the longer term, shallow groundwater can only be considered as a low yield, emergency water source. However, the aquifer could be used to store excess water when available from other sources, such as Ute Reservoir.

*Deep Groundwater*. Deep groundwater from below the Ogallala Aquifer is not a promising water supply alternative for east-central New Mexico. Any water that could be available from this source would be expensive to access, of low quality, and likely also of low quantity. Further, deep groundwater would not be a renewable source of supply. nPursuit of deep groundwater in the Roosevelt – Curry County area would be costly, have a high probability of failure, and is not recommended at this time.

*Ute Reservoir.* A surface water supply from Ute Reservoir on the Canadian River is the only available alternative that would provide Portales with a demonstrated, renewable water supply in sufficient quantity for municipal use. Uncertainties in when this supply will become available and in the impact of drought years on Ute water deliveries make it important to accompany this water supply alternative with reductions in the City's water demands and identification of other, temporary sources of supply.

*Wastewater Recycling*. Wastewater recycling is an important conservation measure that reduces demands on the City's primary water sources. The reduction in demand from the planned use of recycled wastewater for irrigating City parks will be significant. The option to extend wastewater treatment to include directly supplementing Portales' drinking water supply could further reduce demand on the wellfield, would provide an alternative source of potable water, and should be investigated.

*Water Conservation*. Alternative water conservation measures that are designed to significantly reduce potable water demand are provided in this report for consideration by the City. Implementation of wastewater recycling and other additional conservation measures is important to help assure an adequate water supply for Portales in the interim until Ute water becomes available, and becomes especially important if the Ute Reservoir supply is not available on schedule. Many of these measures are already in place in Portales and should be continued. Others can be made more stringent depending on the City's judgment of:

- the likelihood that receipt of the Ute water supply will be delayed;
- the potential duration of a delay;
- the potential impact of drought conditions on the Ute water supply;
- the availability of interim water supplies; and
- the risk the City is willing to take in addressing possible water supply shortfalls.

It will still be desirable to maintain a demand well below the expected full Ute allocation of 1.12 billion gallons per year after Ute deliveries begin to create a prudent water reserve at Ute Reservoir for drought years, to have the option to store excess Ute water deliveries underground in the Blackwater Wellfield in wet years, and to conserve remaining groundwater in the wellfield for emergency use.

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## 1.0 Introduction

This report provides a summary of future water supply options for the City of Portales. The need to assess options for alternative sources of water supply were reviewed with the knowledge that the City's existing source of supply, shallow groundwater from the Ogallala Aquifer, is being pumped at a faster rate than it is being recharged. The aquifer therefore has a finite remaining life as a high-yield source of municipal water supply. Following this introduction, the second section in this report presents a review of the existing aquifer supply and the projections that have been made of its longevity. Section 3 discusses the alternative of pumping deep groundwater from geologic formations beneath the Ogallala Aquifer. Section 4 reviews obtaining surface water by means of a pipeline from the Canadian River at Ute Reservoir. Section 5 reviews the benefits to be obtained from treating and reusing municipal wastewater in Portales. Section 6 reviews alternative water conservation measures that are currently implemented and could be strengthened to extend the life of the City's groundwater supply. Section 7 presents an overview of the alternatives and provides recommendations on how to proceed.

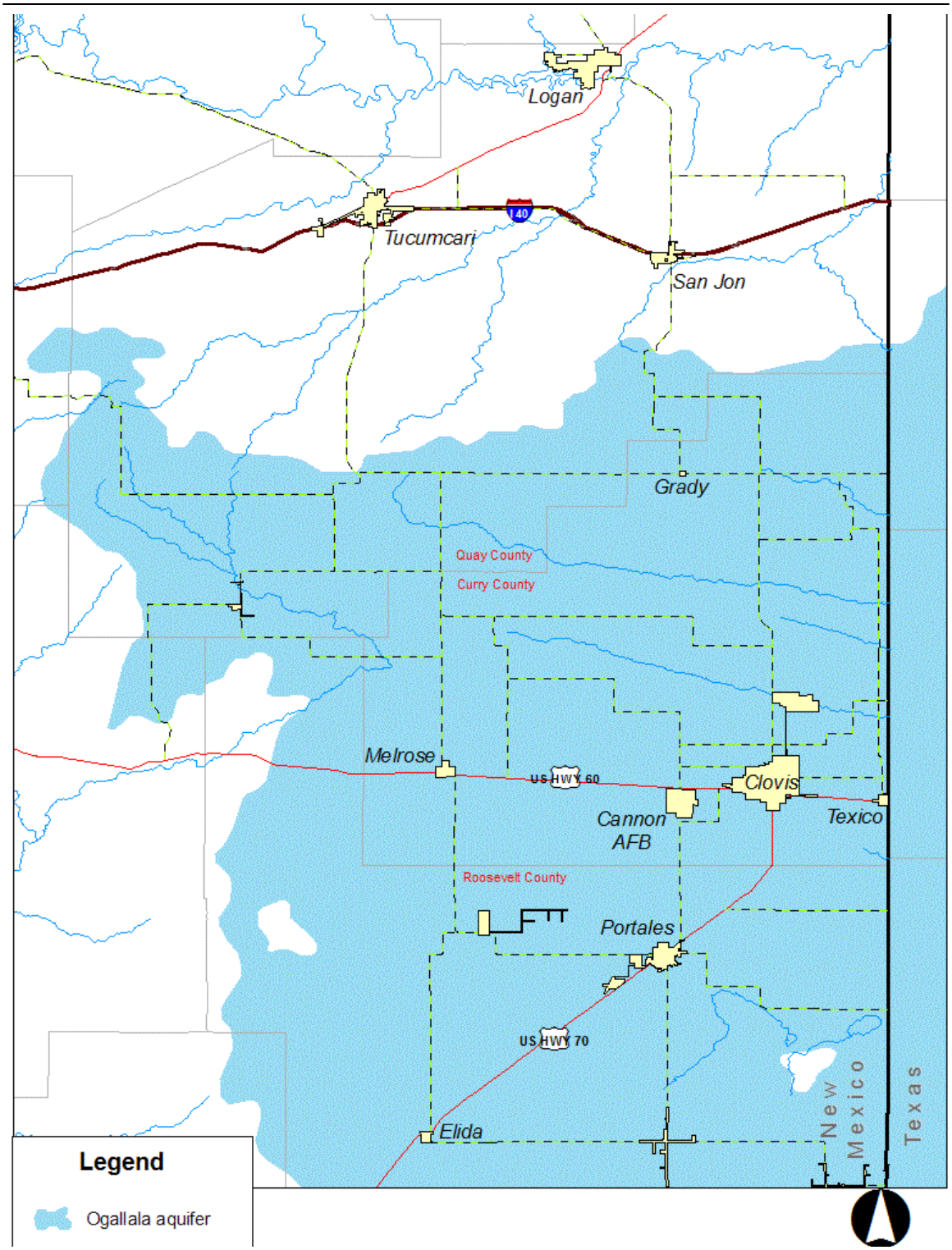
Elements of the 2013 Strategic Water Plan for the City of Lubbock, Texas, are cited in this report as examples of approaches, costs, and benefits of augmenting an existing water supply. Lubbock's water supply concerns are particularly relevant to the City of Portales because Lubbock, like Portales, is drawing water from the depleting Ogallala Aquifer and faces a similar deadline and similar alternatives for identifying and implementing supplemental water sources. In addition, the geologic formations underlying Lubbock are the same as those underlying Portales; Lubbock's climate is similar to that of Portales; Lubbock is also an inland city with no access to the sea or to extensive surface water resources; and Lubbock's Strategic Plan was completed in 2013 and is comprehensive and current in technology, costs, and benefits. Information for this report was also obtained from EPCOR Water for the City of Clovis, the City of Albuquerque, the New Mexico Office of the State Engineer, and from other sources.

## 2.0 Shallow Groundwater

The City of Portales currently gets its water supply exclusively from shallow groundwater in the Ogallala Aquifer. This regional water table aquifer underlies most of Roosevelt and Curry Counties and extends eastward into Texas, Oklahoma and Kansas, and northward into Colorado, Nebraska, and South Dakota. The Ogallala Aquifer is in the sedimentary Ogallala Formation consisting of gravels, sands, silts, and clays derived from the ancestral Rocky Mountains. A map showing the original extent of the Ogallala Aquifer in east central New Mexico is shown in Figure 2-1. Although the Ogallala Aquifer was originally present throughout most of the Ogallala Formation, the aquifer is shrinking and is no longer present along most of the northern and western edges of the formation.

The Ogallala Aquifer is being pumped at a faster rate than it is being recharged and the water is effectively being mined over much of its area, including Roosevelt and Curry Counties. Aquifer water levels have been declining since widespread irrigation began in the 1950s, leaving significantly reduced saturated thicknesses in many areas and dry wells in others. The long-term impact of a depleted Ogallala Aquifer is of growing popular concern throughout the region as noted, for example, in a September 1, 2013 article by Karen Dillon in the Kansas City Star. This article cites the results of a four-year study at Kansas State University and states "A vast underground lake beneath western Kansas and parts of seven other states could be mostly depleted by 2060, turning productive farmland back to semi-arid ground…" (Dillon 2013).

Portales obtains most of its water supply from its Blackwater Wellfield with supplemental supplies from the smaller and older Sandhill Wellfield. Both wellfields draw water from the Ogallala Aquifer. When the first Blackwater wells were drilled in the 1960s, the depth to water in those wells was about 20 ft and the aquifer was 170 ft thick. In 2012 the depth to water in these same wells was 130 ft and the remaining aquifer thickness was 60 ft. At the same time typical well yields have dropped from 800 gpm to 100 gpm (Wilson 2012, Figures 7 and 11). In response to this depletion, the City of Portales purchased the Blackwater Farm and adjacent Las Lomas properties in 2001 and retired agriculture in those areas to expand the Blackwater Wellfield and create a groundwater reserve. This reserve was projected to extend the City's water supply for approximately 19 years at a water demand of 1.5 billion gallons per year (Wilson 2000). A map showing the present extent of the Blackwater Wellfield is shown in Figure 2-2.




Source: CH2M HILL 2005, Figure 2

Figure 2-1. Original extent of the Ogallala Aquifer in east-central New Mexico.

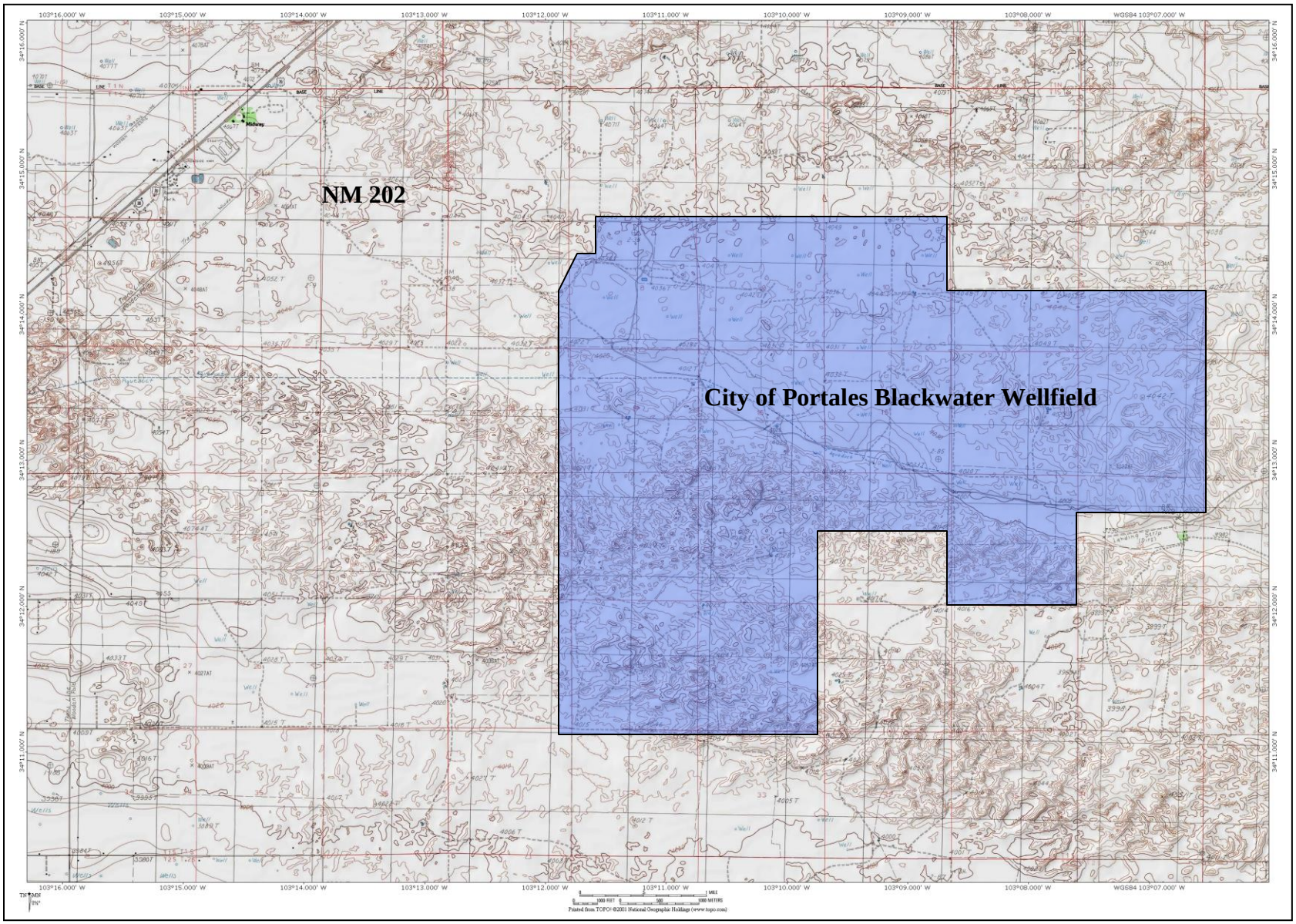



Figure 2-2. Location of Blackwater Wellfield

## 2.1 Ogallala Aquifer in Roosevelt County, New Mexico

Studies of groundwater resources in the Ogallala Aquifer in Roosevelt County in the vicinity of Portales were commissioned by the City in 2004 and 2007. The purpose of these studies was to identify areas that might be favorable for expanding the City's groundwater reserve (Wilson 2004 and 2007). The 2007 study provided an update of the 2004 study and estimated that at the City's then-current demand of 1.5 billion gallons per year, the water in storage in the Blackwater Wellfield and groundwater reserve in 2006 would be sufficient for a 25-year supply (to approximately 2031). This projection assumed recovery of water throughout the wellfield area, but to do so would require installing additional wells at an increasing frequency. The purchase of additional land and water rights identified in the 2007 study would extend that supply for an additional 28 to 44 years (to approximately 2059 or 2075), depending on the date the land was purchased and existing agricultural water use was retired. The cost of purchasing the land, drilling new wells to recover the water, and conveying the water to the City's distribution system was estimated to be approximately $86 million in 2006 dollars. The 2007 study assumed that the City could purchase every Section (square mile) of land within the study area that had an average saturated thicknesses greater than 15 ft. The study projected that at then-current depletion rates, by 2036 no Sections with a good municipal supply potential (at least 15 ft of average saturated thickness) would remain outside those identified for potential City acquisition. Once the average saturated thickness dropped below 15 ft in either the land identified for acquisition or in the existing Blackwater Wellfield, some of the remaining water could still be recovered for municipal use but at the cost of installing hundreds of low-capacity wells.

In updating the 2007 projection of 25 years remaining Blackwater Wellfield supply to 2012 conditions, it was found that the short term average rate of aquifer depletion at the City's Blackwater wells had increased from 2.3 ft/year in 2007 to 3.9 ft/year in 2011 and then dropped to 2.8 ft/year in 2012 as pumping began in 7 additional wells newly added to the system. Locating additional wells in areas outside the primary zones of influence of existing wells allows the water in storage away from existing wells to be utilized. The additional wells also allow pumping rates at existing wells to be reduced while maintaining the same wellfield pumping capacity, thereby reducing the rate of depletion at those wells. Although maintaining the average depletion rate in the range of 2 to 3 ft/year is a desirable target, the increasing rate at which additional wells would have to be installed to more completely recover the water stored in the wellfield area may prove to be financially infeasible, especially after all the existing agricultural wells in the wellfield have been converted to municipal use and any additional wells would have to be newly drilled. It may be prudent to lower expectations of practical remaining wellfield life as a high-yield municipal source to on the order of 10 years, while extending that life through wastewater reuse and stringent conservation practices. As an example, despite that 2012 was a dry year, the City's total pumping dropped from the original assumed demand basis of 1.5 billion gallons per year to 1.12 billion gallons. Maintaining this lower wellfield demand into the future would extend the life of the wellfield by about 3 years. As will be discussed in the following sections of this report, the timing of availability of alternative,

renewable water sources for Portales is somewhat uncertain and extending the life of the City's current water source by even a few years may be quite beneficial.

It is noted that the foregoing projections are based on generalized evaluations of water supply and demand conditions, and must be considered to provide only rough estimates of aquifer life due to data limitations and the inherent uncertainties in projecting future conditions. However, the studies do clearly illustrate the finite nature of the shallow groundwater supply in the vicinity of Portales and the importance of the need to conserve the existing supply and identify and obtain supplemental supplies, preferably from renewable sources. It must be reiterated that while the foregoing dates are only approximate, the Ogallala Aquifer is rapidly being reduced to a shadow of its former self and while some natural water will likely always be available from the Ogallala at some locations, the quantities will be small and unable to sustain Portales' current municipal demand.

## 2.2 Ogallala Aquifer in Bailey County, Texas

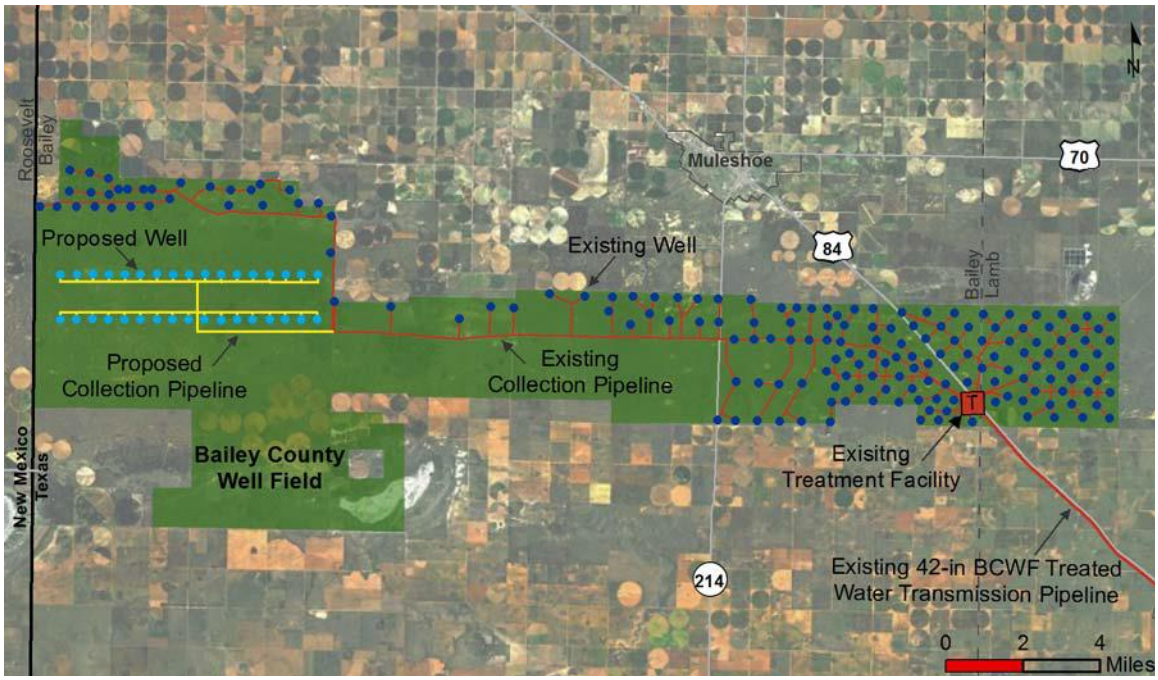
Bailey County, Texas, lies just across the New Mexico–Texas state line east of Roosevelt County, about 3.5 miles east of the eastern end of Portales' Blackwater Wellfield.. Groundwater is pumped from the Ogallala Aquifer near the state line for agricultural purposes and for the City of Lubbock in its Bailey County Wellfield. This pumping has been of concern because of the possible impacts of increasing groundwater flow rates from New Mexico into Texas. Lubbock's wellfield has been of particular concern because of the large groundwater withdrawals that have occurred and the location of the wellfield east of Portales' Blackwater Wellfield. The following information on Lubbock's wellfield was taken from Spear and Dunn (2013).

Lubbock's Bailey County Wellfield is shown in Figure 2-3. It occupies a 25-mile long strip of land extending east from the state line to the vicinity of Highway US 84. The width of this strip varies from 3 to 9 miles and is about 5 miles wide at the state line. The conveyance pipeline from the wellfield to Lubbock is 60 miles long. Pumping began in 1957, peaked at about 6.5 billion gallons per year in late 1960s, and is currently about 3 billion gallons per year. Although the wellfield provided 40% of Lubbock's water in 2012, its pumping capacity is decreasing and Lubbock's Water Department is proposing to limit future use of the wellfield to meeting peak summer demands. This would reduce pumping and prolong the lives of the wells and the aquifer. Spear and Dunn (2013, p. ES-3) state that by 2014, additional water supplies and/or aggressive water conservation will be needed in order to limit use of the wellfield to providing a peaking supply. They also state that without additional water supplies, by 2025 Lubbock will not be capable of supplying its projected water demand even with aggressive conservation unless alternative sources of supply are found.

The 175 active wells in the Bailey County Wellfield are shown as dark blue dots in Figure 2-3. Of these, 20 are located within 3 miles of the New Mexico border and 5 are located within 1 mile of the border. The biggest concentration of wells is around US 84, about 25 miles east of the border. Lubbock's goal is to reduce pumping in this wellfield

to less than 2.3 billion gallons (7,000 acre-ft) per year. Part of this goal is to increase the wellfield efficiency by initially adding 34 additional wells outside the primary zones of influence of existing wells, shown as light blue dots in Figure 2-3, and adding 10 more wells 10 years later. This would allow the City to rotate, rest, and repair wells as needed, while maintaining the target production capacity. As shown in Figure 2-3, the 34 initial wells would be located in the western part of the wellfield and 4 of these would be located within about 1 mile of the New Mexico border. The locations of the ten additional wells are unspecified.

The impacts of groundwater pumping in Texas on the flow of groundwater from New Mexico's Roosevelt and Curry Counties into Texas have been studied by the New Mexico Office of the State Engineer (Chudnoff and Logan 1995). Flow naturally occurs in the aquifer across the border into Texas due to higher water table elevations in New Mexico. The Chudnoff and Logan study found that water levels have been declining on both sides of the border since 1955 and that water level declines in New Mexico are primarily due to pumping in New Mexico. The study also determined that after 40 years of pumping a well located in this area, about 80% of the pumped water comes from within one mile of the well and only 6% of the water comes from beyond five miles. The Chudnoff and Logan study found that by 1991 the water level declines along the border have reduced the aquifer cross-sectional area and decreased the flow across the border to about 64% of the flow that occurred in 1956 under an essentially natural hydraulic gradient. In addition, the number of active and proposed wells in Lubbock's Bailey County Wellfield within 1 mile of the New Mexico border is relatively small, perhaps as many as 11 wells out of 219 or 5% of the total. If the aforementioned target production of 2.3 billion gallons per year for the wellfield is spread across 219 wells, the average continuous production rate for each well is only 20 gpm. This very low pumping rate indicates that while the past pumping in Lubbock's wellfield likely had a small effect on flow across the state line, the preponderance of Lubbock's pumping is far from the state line and the future impact of a few wells near the state line pumped at a very low rate would be small compared to the natural, predevelopment flow.




Source: Spear and Dunn 2013, Figure 7.14

Figure 2-3. Present extent of Lubbock's Bailey County Wellfield.

## 2.3 Sustainable Municipal Pumping

Sustainable municipal pumping would involve acquiring sufficient land such that the natural recharge from precipitation on that land would meet the City's long-term water supply needs. This would require acquiring the water rights and retiring all other pumping, primarily agricultural pumping, on that land. Such a scenario was studied by CH2M HILL (2005) by creating a hypothetical example of how it could be accomplished. An area of about 770 square miles (nearly 500,000 acres) in the vicinity of Clovis, shown in orange on Figure 2-4, was identified that had a recharge roughly equivalent to a hypothetical municipal demand of 4.6 billion gallons (14,000 acre-feet) per year. The agricultural pumping on approximately 62,000 irrigated acres within this area was assumed to be removed from production so that the municipal demand would roughly balance the natural recharge. To be a viable alternative for a near-future water supply, all the agricultural pumping in this area would have to be retired within the next decade while there is still an adequate saturated thickness in the aquifer for a high-capacity well to function.

The current cost of farmland in the Clovis–Portales area ranges from an estimated $350/acre for dry land to $2,200/acre for top quality irrigated agricultural land (personal communication with appraiser Jack Merrick, September 18, 2013). At an average cost of $1,500/acre for irrigated agricultural land, purchasing and retiring the aforementioned 62,000 irrigated acres within the orange area in Figure 2-4 would cost about $93 million, exclusive of incidental costs and the cost of recovering the stored water over such a large area. Although it is doubtful that such a project would be financially feasible and could

be accomplished over a short time period, a modified version of this scenario could be considered as a future supplemental source of water for Portales.

Portales' water demand of about 1.5 billion gallons per year is one-third of the 4.6 billion gallons per year assumed in the aforementioned hypothetical study, so the land area needed for sustainable municipal pumping would be less. Also, the sand hills in the area of the City's Blackwater Wellfield would have a better than average recharge capacity for natural rainfall. Additionally, the cost for acquiring the necessary land and water rights should decrease in the future as irrigated agriculture is voluntarily retired due to aquifer depletion. A large surface area would be needed for this option because the rate of groundwater accumulation would be small.

In calibrating the OSE's groundwater model of the Ogallala Aquifer in the Portales-Clovis area, Musharrafieh and Logan (1999, p. 27 and Figure 12) estimated the average annual recharge in an area that included the Blackwater Wellfield to range from 0.50 to 0.66 inches of water. Although this recharge rate is equivalent to an average water table rise of only about 2 inches/year, it is approximately twice the recharge rate estimated by Musharrafieh and Logan for the Clovis area. This higher recharge rate was applied in the OSE model to an area in New Mexico of some 72 square miles (or about 46,000 acres) northeast of Portales, shown in yellow on Figure 2-5. The upper half of this area may be in or near the EPCOR (formerly New Mexico-American) wellfield serving Clovis. As a very rough estimate, and considering only the lower half of this area, an average annual recharge of 0.55 inches/year over a 36 square mile catchment area would yield an average of about 344 million gallons/year (1,050 acre-feet). Recovery efficiencies would likely be low because of the size of the area, but could be improved by taking advantage of natural paleodrainage channels in the top of the redbeds that form the bottom of the Ogallala Aquifer. At a hypothetical recovery efficiency of 50%, with a 36 square mile catchment area, it would take about 9 years to accumulate the equivalent of Portales' annual demand of 1.5 billion gallons. By comparison, the current area of the Blackwater Wellfield, including the City's groundwater reserve, is about 9.6 square miles.

The foregoing scenario would clearly not meet Portales' total annual demand but could potentially be managed as an alternative, renewable supply that would allow natural recharge to accumulate until it was needed to supplement the City's primary supply. Acquiring the necessary land and/or water rights would be expensive and sustainable municipal pumping may never be practical in east-central New Mexico, but further evaluation of perhaps a scaled-down version of this alternative may become desirable as water becomes scarce and its value increases.

### 2.4 Aquifer Storage and Recovery

The option to store water in the Ogallala Aquifer when excess water is available and recover it when needed at a later date is particularly appealing to Portales because of the favorable geology for groundwater recharge in the City's Blackwater Wellfield. The sand hills in the wellfield are highly permeable not only for rainfall, as described above in Section 2.3, but also for artificial groundwater recharge basins. The recharge capacity is

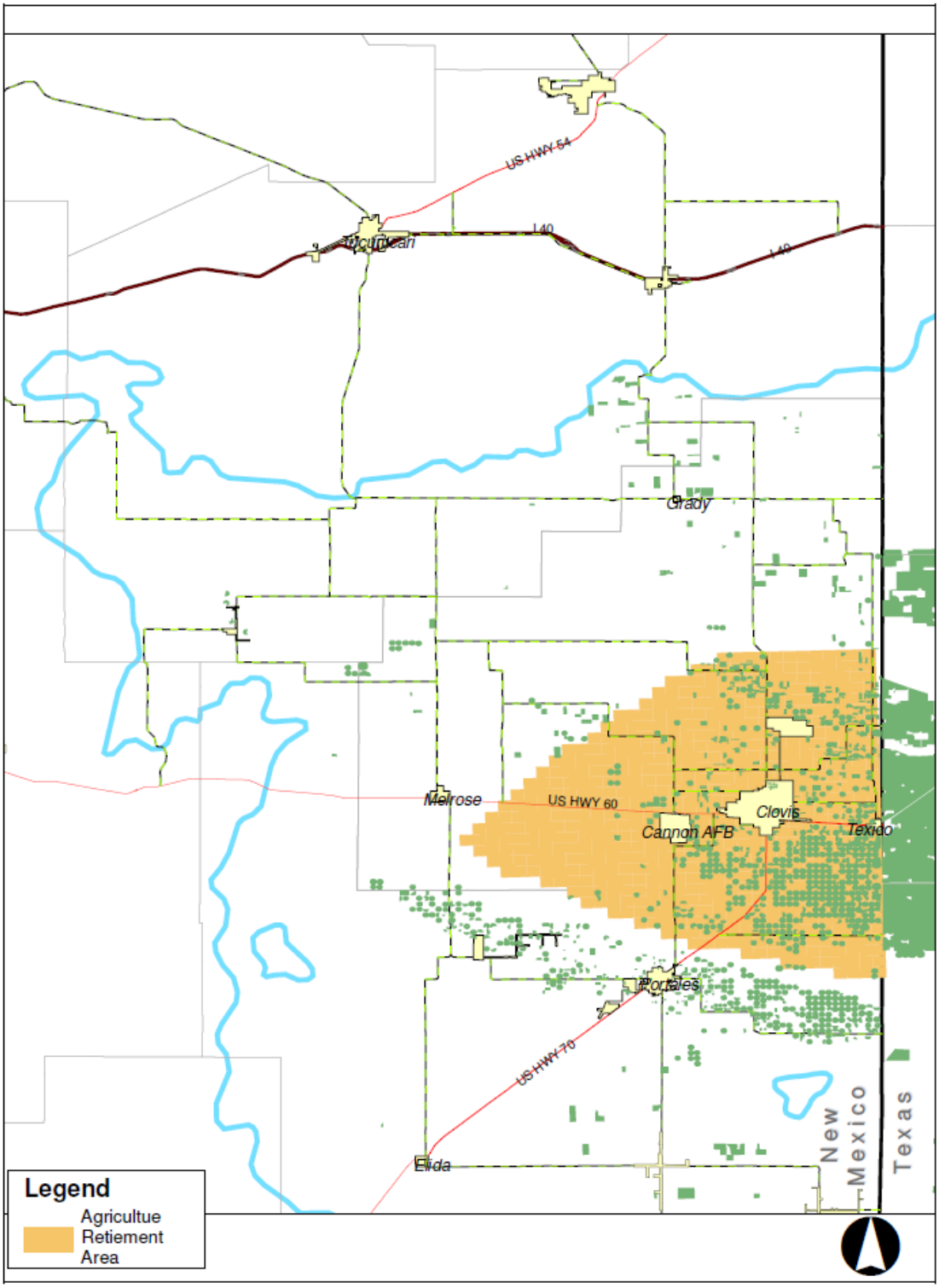
also enhanced by the lack of low permeability horizons at greater depth in some parts of the wellfield that would impede deep percolation to groundwater. Excess water for artificial recharge could come from the Ute Pipeline project described in Section 4 of this report, and from storm water diverted into the recharge area. In addition, aquifer storage could serve as an alternative to Ute Reservoir storage in the drought management planning also described in Section 4.

Losses would occur in aquifer storage because not all the water would be recoverable, and should be compared to losses for other storage options. The losses in artificial aquifer storage would likely be less than the 50% recovery efficiency assumed for the sustainable yield scenario because the water could be recharged where recovery well locations and aquifer topography are optimal. For comparison, a six-month aquifer storage and recovery alternative in the Ogallala was included among the City of Lubbock's water supply enhancement alternatives and the water losses for that alternative were estimated to be 20% (Spear and Dunn 2013, p. 7-29).

### 2.5 Long-Term Viability of the Shallow Groundwater Resource

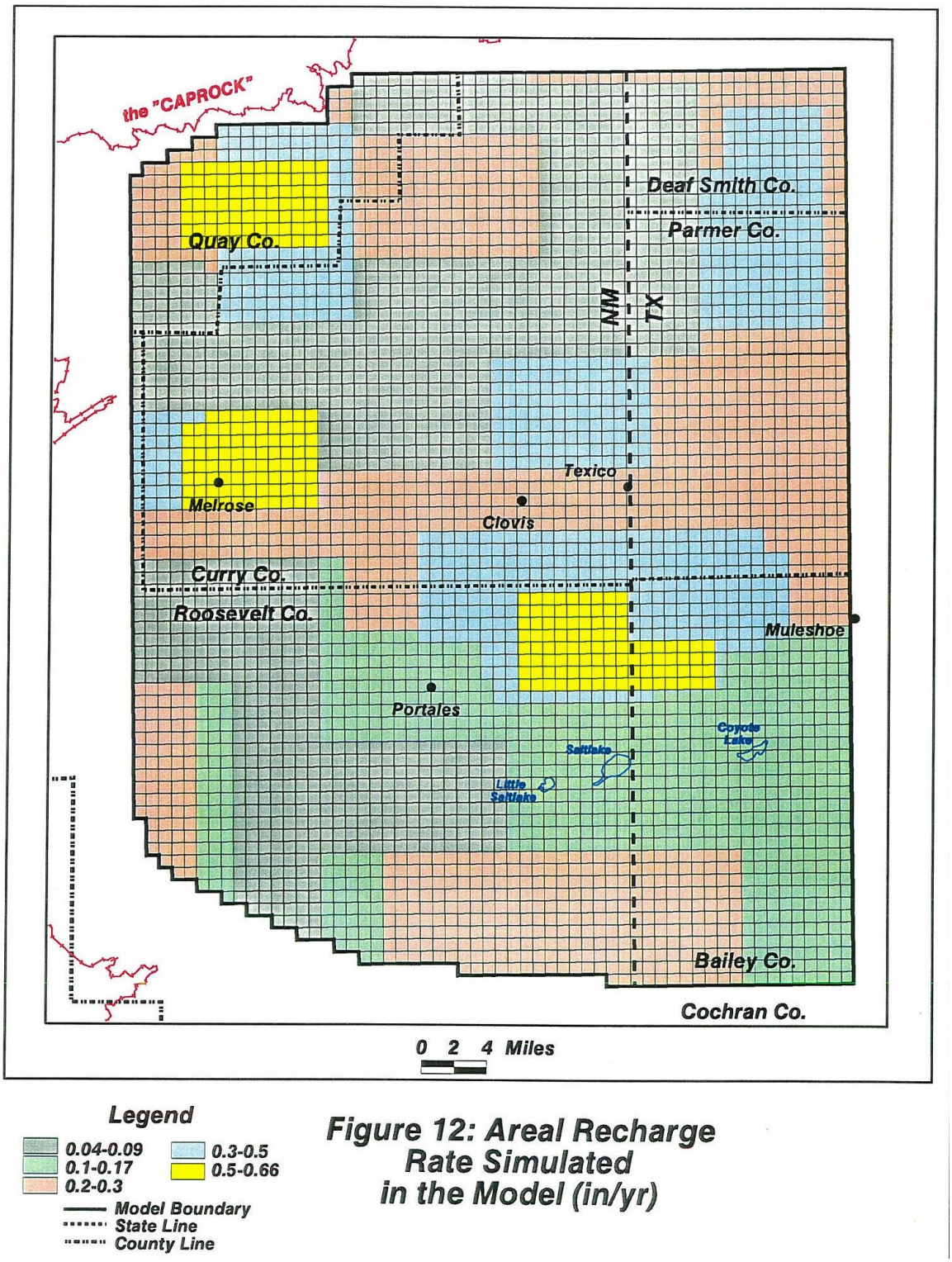
The long-term viability of the Ogallala Aquifer is being seriously questioned throughout much of its extent. At the present rates of depletion, the aquifer is expected to cease being a viable source of the quantities of water needed for large scale municipal, industrial, and agricultural use over most of its area within the next few decades. Although projections based on present rates of depletion are likely to underestimate the life of the aquifer because demands will almost certainly decrease as well yields drop and the cost of recovering the water increases, the ability of the aquifer to sustain current production levels will eventually vanish. Identifying and acquiring alternative sources of water will become mandatory and, as discussed below, uncertainties in the reliability of those sources make it important that steps be taken in the near future to further conserve Portales' existing groundwater supply to provide a buffer against severe future shortages.

The City's alternatives for seeking additional shallow groundwater supplies were limited by water and land availability, location, and cost. To be a primary water source, a supplemental wellfield should have sufficient water to significantly augment the City's future water supply, it should be located within New Mexico, it should be of acceptable quality, and it should be available at an affordable cost. The cost would be optimal for land owned by a willing seller and located in the proximity of one of the City's existing wellfields to minimize conveyance costs. As described above, areas with remaining groundwater supplies do exist but are not optimal. Most are not near the City's existing wellfields, they do not have sufficient remaining quantities of water to extend the City's supply for more than a few decades, and they would therefore provide a non-renewable water supply at a significant cost. The option of vigorously seeking additional shallow groundwater supplies was therefore not pursued and instead the City determined to maintain the yield of the existing Blackwater Wellfield by periodically installing new wells, to promote increasingly effective water conservation and wastewater recycling measures to prolong the life of the shallow groundwater supply, to explore the viability of deep groundwater resources, and to vigorously pursue obtaining a supplemental,




Source: CH2M HILL 2005, Figure 13

Figure 2-4. Agricultural retirement area needed to meet a hypothetical municipal demand of 4.6 billion gallons (14,000 acre-ft) per year.




Source: Musharrafieh and Logan 1999, Figure 12

Figure 2-5. Estimated groundwater recharge rates used in OSE's groundwater model of the Portales-Clovis area.

renewable surface water supply from Ute Reservoir on the Canadian River. The current status of these efforts is described in the following sections of this report.

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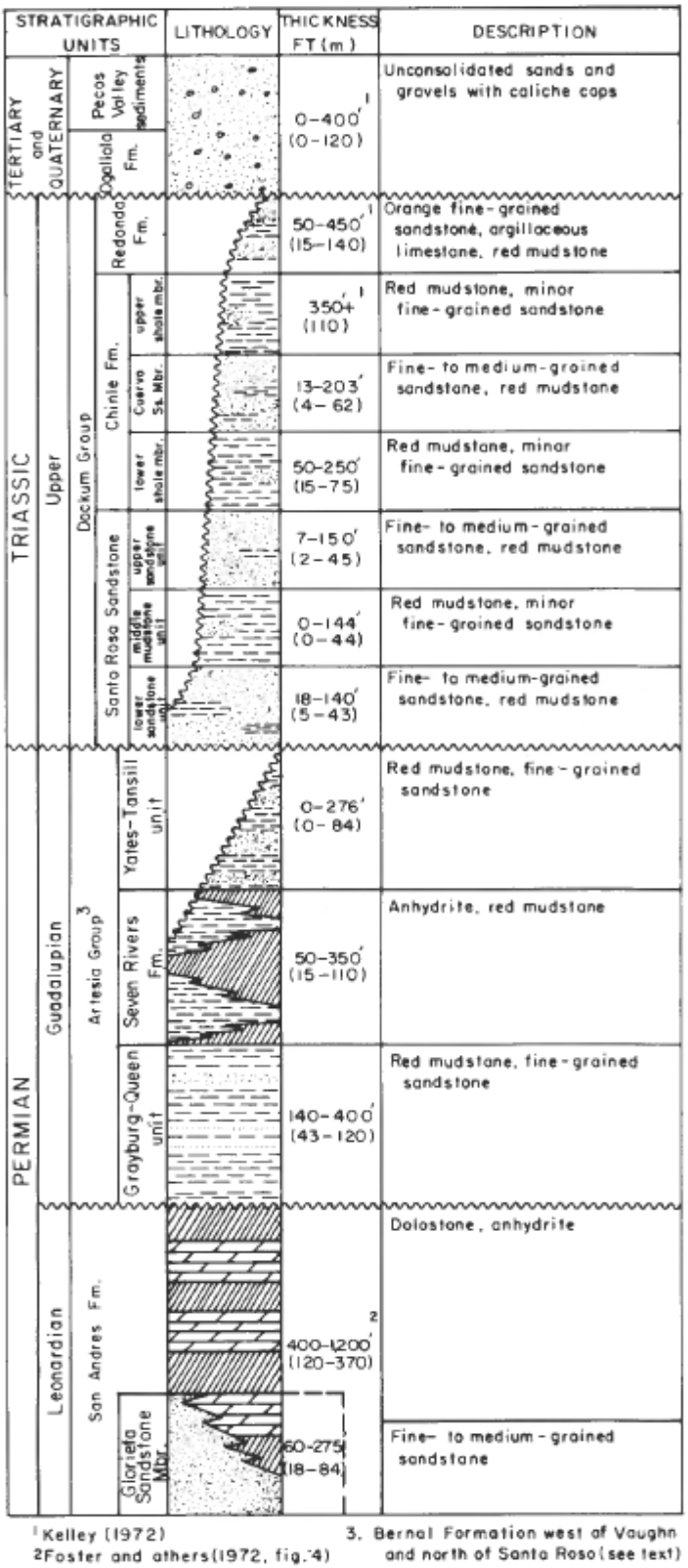
## 3.0 Deep Groundwater

Water supplies in the Portales area have historically been drawn almost exclusively from wells in the Tertiary age Ogallala Formation. The combined thickness of the Ogallala and the overlying, more recent Quaternary age sediments is about 200 feet in the area of the City's Blackwater Wellfield. The redbeds, a horizon of much lower permeability Triassic age clays and silts, form the bottom of the aquifer. The historic abundance of water in the Ogallala Aquifer has until recently not justified the cost and uncertainty of exploring deeper aquifers. As a result, little is known about the water supply potential of those aquifers in east-central New Mexico. However, the Ogallala Aquifer has been pumped since the 1950s at a rate exceeding its recharge and its declining saturated thickness has prompted an increasing interest in the possibility of deeper water sources. The two deeper sources in the Portales area that have held the greatest potential for a municipal water supply, the Dockum Group and the San Andres Formation, are discussed in the following paragraphs. A stratigraphic section showing the relationships among the Ogallala Formation, Dockum Group, Artesia Group, and San Andres Formation is shown in Figure 3-1.

### 3.1 Dockum Group

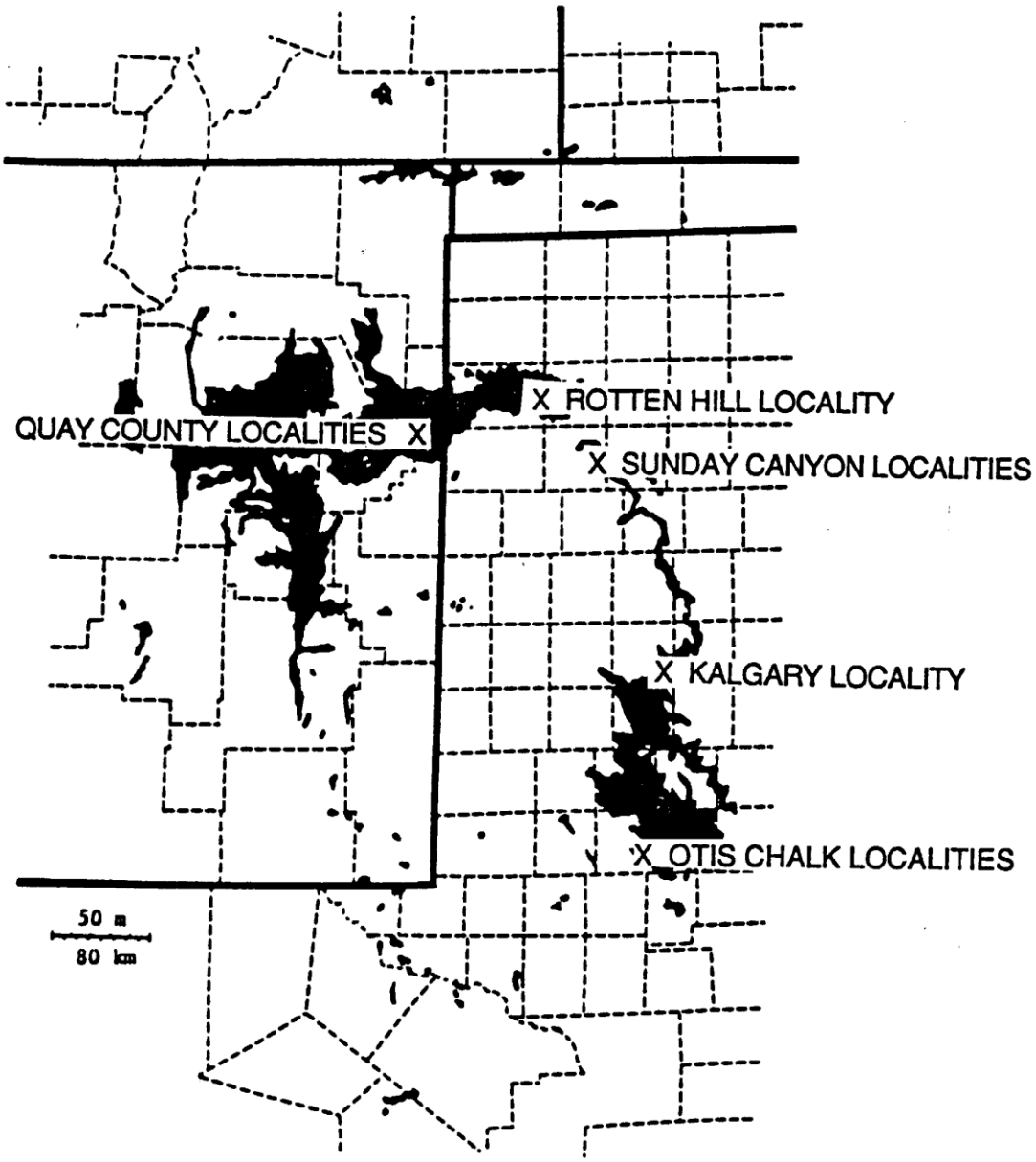
The Dockum Group of formations directly underlies the Ogallala Formation in the Portales area and consist of some 1,500 ft of Triassic age fluvial, deltaic, and lacustrine deposits in alternating horizons of generally fine to medium-grained sandstone and low permeability red mudstone. The low permeability horizons limit vertical groundwater movement making the more permeable sandstones act as confined or semi-confined hydrologic units. Although the stratigraphic nomenclature of the Dockum is variable in the literature, the stratigraphy adopted by Broadhead (1985, Figure 1), reproduced in Figure 3-1, serves the practical purpose of focusing on the occurrence of the Dockum in New Mexico and on the relative abundance of sandstone versus mudstone as an indicator of permeability. Broadhead divides the Dockum into the basal Santa Rosa Sandstone, the central Chinle Formation, and the uppermost Redonda Formation. The Redonda Formation includes the aforementioned low permeability redbeds that form the bottom of the Ogallala Aquifer. The most permeable units of interest to both oil and gas as well as water resource potential are the dominant sandstone of the Cuervo member of the Chinle Formation and the dominant sandstones of the upper and lower units of the Santa Rosa Sandstone. The upper and lower units of the Santa Rosa are separated by a generally low permeability red mudstone unit.

Major outcrops of the Dockum are shown in Figure 3-2. The Dockum outcrops 50 miles west of Portales in Chaves and De Baca counties, 75 miles north of Portales in Quay County, and some 200 miles to the east in Texas. Between these outcrop areas the Dockum is generally deeply buried beneath the Ogallala Formation. Massive sandstone and siltstone horizons within the Dockum are resistant to erosion and can be seen in the Llano Estacado escarpment of southern Quay County. The aeolian sandstones at the base of the Ogallala Formation form the caprock at the top of this escarpment.




Source: Broadhead 1985, Figure 1

Figure 3-1. Stratigraphy of Upper Permian and Triassic rocks in northeastern New Mexico




Source: Murry 1989, Figure 1

Figure 3-2. Dockum Group exposures and major vertebrate fossil localities in west Texas and eastern New Mexico.

### 3.1.1 The Dockum in New Mexico

Although Broadhead's study area did not extend south of the Curry – Roosevelt County line, it is reasonable to assume that his overall conclusions would also apply a reasonable distance southward into Roosevelt County. Broadhead describes the upper and lower sandstone units of the Santa Rosa as being fine to very coarse grained and moderately to well sorted, with a net thickness of sandstone in each unit of up to approximately 130 ft (Broadhead 1985, p. 308). The Cuervo member sandstone was described as being fine to very fine grained, moderately to well sorted, and with a net sandstone thickness of up to 200 ft (Broadhead 1985, p. 311).

Broadhead describes the reservoir quality of the Santa Rosa sandstones as being good.

> "The sandstones have well-developed primary pores that have not been destroyed by compaction or occluded to any significant extend by silica or calcite cements. However, porosity of some of the Santa Rosa sandstones has been completely occluded by calcite cement. Calcite cementation does not appear to follow any regional trends." (Broadhead 1985, p. 313).

With regard to the Cuervo member, Broadhead states

> "Sandstones of the Curevo Member are generally well cemented by calcite. They are generally less porous than sandstones of the Santa Rosa and are generally only poor to fair reservoirs." (Broadhead 1985, p. 313).

Although Broadhead's objective was to determine the petroleum resource potential of these units, his observations also apply to the water supply potential. Wildcat drilling of 14 deep wells in the Portales area turned up only dry holes (from an oil and gas perspective), and all were plugged and abandoned (Wilson 2005). Although the petroleum resource potential of these units appears to be poor because no oil or gas was found to be present, these wells were not drilled or evaluated for their potential water yield or quality. Based on Broadhead's findings, a reasonable water supply potential may exist at some locations in the Santa Rosa, however because of the lack of observed regional trends in calcite cementation, only regional trends in formation thickness are available to guide the expensive, deep drilling drilling required to investigate the water supply potential of the Dockum in the Portales area.

Bradley and Kalaswad (2001, 2003) evaluated the Dockum in Texas from a water supply perspective and noted that the quality of Dockum water improves in the vicinity of its outcrop areas where it is unconfined and receives recharge from precipitation. In New Mexico the Dockum is at or near the ground surface in Quay County and northern Curry County, and better quality water might be expected from the Dockum in those areas.

### 3.1.2 The Dockum in Texas

The Dockum Group extends into west Texas where it has been used more extensively than in New Mexico for water supply purposes and more information is available. The Dockum is treated as a single aquifer in Texas and its groundwater resources are extensively described by Bradley and Kalaswad (2003).The Texas Water Development Board considers the Dockum to be a minor aquifer that underlies much of the Ogallala Formation in the Texas panhandle and west Texas. Groundwater is recovered from the sandstone and conglomerate beds within the Dockum. The hydrogeologic properties of the Dockum Aquifer vary widely. Although well yields range from 0.5 to 2,500 gpm, yields are generally fairly low throughout much of the aquifer in Texas.

Groundwater from the Dockum in Texas is generally of poor quality. Water quality is relatively fresh in the outcrop areas, where total dissolved solids (TDS) are generally less than 1,000 milligrams per liter [mg/L], it is moderately saline (TDS between 3,000 and 10,000 mg/L) over most of the confined parts of the aquifer, and becomes brine with TDS concentrations exceeding 60,000 mg/L in the deepest parts of the confined aquifer. The groundwater is characterized by decreasing quality with depth, mixed types of water, constituent concentrations that exceed secondary drinking water standards over most of the area, and high sodium levels. Because the confined parts of the aquifer receive little recharge, any significant withdrawal of water from those areas will essentially mine and eventually deplete the aquifer (Bradley and Kalaswad 2001).

Regarding the Dockum in Texas, Bradley and Kalaswad conclude:

> "Although the Dockum aquifer can be an important source of groundwater for irrigation, public supply, oil-field activity, livestock and manufacturing purposes, deep pumping depths, poor water quality, low yields, and declining water levels have generally discouraged its use except locally." (Bradley and Kalaswad 2001, p. 167)

The reports of deep pumping depths, poor water quality, low yields, and declining water levels in the Dockum aquifer in Texas are discouraging not only for Texans but also for the potential transfer of Dockum water from Texas into New Mexico. The additional problems of interstate water transfers, increasing interest in alternative water sources in Texas, and the large conveyance distances involved make the Dockum in Texas of interest primarily as a source of information on what might be expected in the Dockum in New Mexico.

### 3.1.3 Exploratory Drilling into the Dockum in New Mexico

Three deep wells have been identified as penetrating the Dockum to the Santa Rosa Formation in the vicinity of Portales. These are the New Mexico-American well, the Schaap well, and the Oppliger well.

New Mexico-American Deep Well

In summer 2010, a 1,790 ft deep exploratory well was drilled into the Dockum by New Mexico-American Water (NMAW), now operating as EPCOR Water. EPCOR is a private company that provides municipal water for the City of Clovis. The well was located southeast of Clovis in NE ¼ of Section 22, T1N R36E, in Roosevelt County just south of the Roosevelt – Curry County line. As described in a letter from NMAW's General Manager to New Mexico-American customers dated March 1, 2011,

> "The deep well project is part of New Mexico American Water's strategy to explore all options for a sustainable water supply for our customers in Clovis. The well was drilled through the Ogallala Aquifer – which is currently the sole source of water for Clovis – into the Lower Dockum formation to test the quantity and quality of water. The final depth of the well is over 1700 feet. Unfortunately, testing concluded that the Lower Dockum formation contains highly brackish water, in very low quantities, that is not suitable for domestic use and would be too expensive to treat." (Bailet 2011).

Little was known about the hydrogeology of the Dockum Group in the area southeast of Clovis prior to NMAW's deep drilling project. Predicted aquifer properties were described in a NMAW's Clovis District Comprehensive Planning Study (2004). Yields of 200 to 250 gpm were estimated for wells screened over the entire thickness of the Dockum. NMAW expected the TDS of the Dockum Group in the Clovis area to be near 5,000 mg/L.

The well was permitted as an exploration well by the New Mexico Office of the State Engineer (OSE) and was assigned permit number P4539. Locating the well would be difficult because little was known about the hydrogeology of the Dockum except what could be inferred from experience in Texas and from the geophysical logs of scattered oil and gas exploration wells. The well was located within the NMAW wellfield area southeast of Clovis where the lower sandstone unit of the Santa Rosa was predicted by Broadhead to be over 120 ft thick, the upper sandstone unit was predicted to be less than 40 ft thick, and the Cuervo Sandstone was predicted to be over 100 ft thick (Broadhead 1985, Figures 4, 5, and 6). Although all three predictions were made by Broadhead on the basis of very little local data and the uncertainty was high, the total predicted sandstone thickness was one of the most promising within NMAW's wellfield area.

The well was drilled through the lower sandstone unit of the Santa Rosa Sandstone at the base of the Dockum Group. The top of the Triassic redbeds of the Dockum Group was encountered at a depth of 340 ft and the Dockum Group was found to be about 1,360 ft thick. The well was drilled under artesian specifications, indicating that confined aquifers were expected to be penetrated. The three most promising water-bearing zones of the Dockum were individually tested. Based on the driller's log, it appears that Broadhead's Cuervo Sandstone and Upper Santa Rosa Sandstone were included in 480 foot-thick Zone 1, his Middle Santa Rosa Mudstone was included in 128 foot-thick Zone 2, and his Lower Santa Rosa Sandstone was included in 200 foot-thick Zone 3.

Estimated production capacity and water quality information for the well are given in Table 3-1. The estimated combined yield of all three test zones was 165 gpm; however, the water quality was poor, ranging from saline to brine and would have to be treated. The authors of the well report concluded that because of the high TDS content of the water, waste concentrate from the treatment process could reduce the quantity of water available for municipal use to as little as 50% of the production capacity. The authors concluded that the capital costs for equipment, operation and maintenance costs associated with treating water produced from the well, and disposal of the waste concentrate would likely be prohibitively high for a municipal supply (Peery and Kelsch 2010, p. iii).

OSE records show that the well was subsequently plugged and abandoned. The total cost of NMAW's deep well project, including drilling, equipping, testing, and abandoning the well, was $977,359.00 or $546/ft (Bailet 2011).

**Table 3-1. Production Capacity and Water Quality Data for NMAW Deep Well**

| Test Zone | Estimated Production Capacity (gpm) | Total Dissolved Solids (mg/L) |
|---|---|---|
| 1 | 10 | 33,542 |
| 2 | 55 | 97,846 |
| 3 | 100 | 39,578 |
| Combined Capacity | 165 | |

Source: Peery and Kelsch 2010, Tables 12 and 13.

Schaap Deep Well

In the summer of 2008, a 963 ft deep exploratory water well was drilled into the Dockum by the Schaap family. The well is located at North Point Dairy in the SW ¼ of Section 15, T4N R36E, in east central Curry County. The well was assigned permit number CC462 POD10. The well was drilled under artesian specifications, indicating that confined aquifers were expected to be penetrated. The driller's log indicates that the Ogallala Formation and the Dockum Group were fully penetrated. The top of the Triassic redbeds of the Dockum Group was encountered at a depth of 285 ft and the Dockum Group was found to be 675 ft thick. Broadhead's Cuervo Sandstone was encountered between 660 and 675 ft depth and was considered by the driller to be water-bearing. The Upper Sandstone member of the Santa Rosa was encountered between 917 and 940 ft depth and was not water-bearing. The Lower Sandstone member of the Santa Rosa was encountered between 945 and 960 ft depth and was water-bearing. These three horizons were identified by the driller as consisting of sandstone, gravel, and conglomerate. The final 3 ft of the well were drilled into the red clay of the underlying, low permeability Artesia Group (see stratigraphic section in Figure 3-1; the driller's log is available on the OSE website at www.ose.state.nm.us under permit CC462 POD10).

According to well owner Eddie Schaap, the well has continuously produced about 40 gpm of slightly brackish water since it was drilled. The TDS concentration is about 1,000 mg/L and the Dockum water is blended with Ogallala water to feed dairy cattle. The well cost about $250,000.00 or $260/ft (personal communication with Eddie Schaap, June 21, 2013).

Oppliger Deep Well

The Oppliger well was drilled for Oppliger Land & Cattle Co. by BP Pump Co. The well was located on the Texas side of the state line about 2 miles north of Kakawate Road (NM 202). According to the driller, Tom Beekman, the well was about 650 ft deep and was drilled into the Santa Rosa Formation. The sandstones of the Santa Rosa were found to be tight, of low yield (less than 50 gpm), and brackish. The well was subsequently plugged and abandoned, and is not identified in the Texas Water Development Board records. Mr. Beekman stated that yields from the Santa Rosa improve to the east and cited a second well, about 850 ft deep, located on the Christian Farm about 8 miles northeast of Farwell, Texas, that was also brackish but yielded sufficient quantities of water to warrant completing in the Dockum (personal communication with Tom Beekman, BP Pump Co., October 3, 2013).

## 3.2 San Andres Formation

Again using the stratigraphy adopted by Broadhead in Figure 3-1, the Permian age Artesia Group immediately underlies the Dockum Group and separates the Dockum Group from the Permian age San Andres Formation. The Artesia Group of formations consists of low permeability red mudstone, fine-grained sandstone and anhydrite, and has little water supply potential. The San Andres Formation immediately underlies the Artesia Group. It is up to 1,200 feet thick and consists of Permian age limestone with beds of dolomite, fine to medium grained sandstone, mudstone, gypsum, anhydrite, and salt. The limestone, dolomite, and sandstone strata of the San Andres have the potential to be more permeable than the strata of the Artesia Group.

In the vicinity of Santa Rosa, New Mexico, the San Andres is near the ground surface where dissolution from circulating groundwater has created water-filled caverns. However in the vicinity of Portales, the San Andres is buried at a depth of about 2,500 feet beneath a relatively flat landscape. At such depths and without the driving forces of significant surface topography, groundwater movement is likely to be very slow resulting in only minor dissolution and high TDS. The most permeable parts of the formation are likely to be fracture zones possibly enhanced by minor dissolution. The fracture zones may also be clay-filled, limiting their permeability. The San Andres' location below the low permeability units of the Artesia Group further restrict groundwater movement. These and other low-permeability formations have trapped hydrocarbons in the San Andres at some locations in eastern New Mexico, supporting commercial oil and gas production. Beneath the San Andres is a series of sedimentary shales, limestones, conglomerates, and sandstones. The granitic basement rocks are encountered at a depth of about 7,000 feet.

Little is known about the water supply potential of the San Andres Formation in the vicinity of Portales. Gratton and LeMay (1969) indicate that porosity in the San Andres decreases going north from Lea County into southern Roosevelt County, as dolomite is replaced by anhydrite. This suggests an increasing salinity and decreasing permeability in the Portales area. The water is slightly saline near Santa Rosa northwest of Portales and is likely to be highly saline near Portales due to the presence of gypsum, anhydrite and salt evaporates, and low groundwater circulation rates. In Lea County south of Portales, the San Andres Formation was estimated to have a TDS greater than 9,600 mg/L (Shomaker, 2004).

No direct information on the water supply potential of the San Andres in the Portales area has been identified; however, indirect information is available from geophysical logs of deep oil and gas exploration wells. A detailed review of data from these wells was prepared for the City of Portales in 2005 (Wilson 2005). The study area extended east-west from Range 37E at the Texas border to Range 32E near Floyd, and north-south from Township 1N in Curry County to Township 2S south of Portales. Records from the Oil Conservation Division of the New Mexico Energy, Minerals, and Natural Resources Department were reviewed for 14 wells in a 600 square mile area around Portales. Sufficient information was available from geophysical logs for 10 of those wells to provide qualitative information on formation porosity; however, a different parameter, formation permeability, is needed to estimate well yields. Correlations between porosity and permeability are generally unreliable because although a formation may have a high porosity and therefore a high water content (which can be measured by geophysical logs), flow through the formation to the well depends on water movement through open, interconnected flow paths (which cannot be measured by geophysical logs).

Of the ten oil exploration wells with logs that were evaluated in the 2005 study, the most promising well had porous zones that constituted about 33 percent of the total thickness of the San Andres. Five of the wells were more typical, with total porous zone thicknesses constituting from 10 to 20 percent of the San Andres. The remaining four wells were poorer prospects, with total porous zone thicknesses constituting less than 10 percent of the San Andres. This small sample indicated that perhaps one well in ten might be a good producer. The most promising well was located about 8 miles north-northeast of Portales. There were too few wells to indicate clear trends of the more promising locations.

Even though correlations between porosity and permeability are generally unreliable, the more promising high porosity zones identified in the 2005 study may have sufficiently high permeability and yield to provide a municipal supply for a period of time. However, additional factors such as the uncertain extent of the porous zone, the unknown volume of water within the zone, and the costs of drilling to depths of several thousand feet, pumping from those depths, acquiring the water rights, treating the likely highly saline water, disposing of the waste concentrates, and conveying the water to Portales must also be considered. None of the exploration wells were found to yield commercial quantities of oil or gas and all were plugged and abandoned. The 2005 study concluded that

additional information was needed to justify pursuing this water source. Records from the Oil Conservation Division of the New Mexico Energy, Minerals, and Natural Resources Department were again reviewed for this report and no additional deep oil and gas exploration wells were found to have been drilled within the study area since the 2005 study was completed.

### 3.3 Brackish Water Treatment Options

Available information indicates that any deep groundwater would be brackish and would have to be treated before it could be used for municipal purposes. Water may be categorized as fresh, brackish, saline, or brine according to its TDS content.

- Fresh water <500 mg/L
- Brackish water 500 to 10,000 mg/L
- Saline water 10,000 to 50,000 mg/L
- Brine >50,000 mg/L

The Santa Rosa water from the aforementioned Schaap well, with a reported TDS of about 1,000 mg/L, would be slightly brackish. The Santa Rosa water from the NMAW deep well, with a TDS ranging from 30,000 to nearly 100,000 mg/L, would be saline or brine. Deep Santa Rosa water in Texas, with a reported TDS of greater than 60,000 mg/L, would be brine. By comparison, the TDS of sea water is typically about 35,000 mg/L, or about 3.5% dissolved solids. Although many processes are available for removing dissolved salts and other minerals from water and thereby lowering the TDS, the most commonly used options are flash (or vacuum) distillation and reverse osmosis.

Until recently, multistage flash distillation was the most commonly used desalination process for large scale treatment facilities. The process involves heating water at less than atmospheric pressure to reduce the boiling temperature and therefore reduce the energy requirement. Most such plants process sea water and many are located in the Middle East where fresh water is scarce and abundant petroleum resources reduce energy costs.

Improvements in technology have made reverse osmosis (abbreviated RO) the process of choice for most new desalination plants. Reverse osmosis involves forcing saline water under pressure through a membrane that is more permeable to water molecules than to dissolved salts. The chief advantages of reverse osmosis are that it can be readily scaled from individual household applications to large municipal treatment plants, and that it requires one half to one fifth the energy input of distillation methods. Reverse osmosis has been used in most desalination plants constructed in the past few years, including El Paso’s newly constructed Kay Bailey Hutchison (KBH) brackish water treatment plant. Reverse osmosis and is likely to be the process of choice should brackish water be treated for the City of Portales. Desalination remains energy intensive, however, and future costs will continue to depend on the price of both energy and improvements in desalination technology.

A downside of most desalination technologies is that they do not efficiently remove all dissolved solids from the feed water, with the result that potentially large quantities of highly saline wastewater concentrate remain that must be disposed of. For inland treatment plants not located on the sea, brine disposal is generally by injection to deep aquifers that already have elevated dissolved solids, or by solar evaporation in surface ponds. For household reverse osmosis systems the wastewater concentrate flow may be 60% of the feed water flow (a 40% efficiency) but for large-scale industrial/municipal systems production efficiencies of 75% to 80% may typically be achieved. This is because the large-scale plants can generate the high pressure needed to drive water with increasingly concentrated dissolved solids through a membrane (UTEP 2013). The water pressure used to drive reverse osmosis ranges from about 30 psi for slightly brackish water to as high as 1,200 psi for sea water (Lachish 2002). However, it is noted that as the pressure increases the capability of the membrane to remove dissolved solids tends to drop.

In addition to the concentrated dissolved solids from the groundwater source, the concentrate may also contain residues of pretreatment and cleaning chemicals, their reaction byproducts, and heavy metals due to corrosion. Chemical pretreatment and cleaning are necessary in most desalination plants, which for reverse osmosis plants typically includes treatment against biofouling, suspended solids, and scale deposits.

Research in improving desalination technology is being pursued world-wide as well as locally at the Bureau of Reclamation's new Brackish Groundwater National Desalination Research Facility in Alamogordo, New Mexico. The island nation of Singapore, for example, is a leader in desalination research, with projects to reduce current energy requirements for membrane desalination as well as development of biomimetic membranes (Freyberg 2013). Reclamation's Research Facility in Alamogordo opened in 2007 with a focus on developing technologies for the desalination of brackish groundwater found in inland states. The Facility's goal is to lower costs, improve performance, and improve management of the concentrates removed from the water. New treatment technologies include a combination of nanofiltration and electrodialysis developed at the University of Texas at El Paso (UTEP) with the goal of achieving low concentrate discharge. A 40 gpm capacity demonstration unit in Alamogordo is treating brackish water to drinking water standards for TDS and getting good recovery. The process looks promising but needs to be tested at a commercial scale.

Costs increase as the TDS of the feed water increases due to reduced plant efficiency. The most easily treatable brackish groundwater has from 2,000 to 5,000 mg/L TDS (Hightower 2008). A detailed review of the cost of treating brackish groundwater for a sample of six operational reverse osmosis treatment plants in Texas was prepared by Arroyo and Shirazi (2009). The plants were completed between 2004 and 2008 and ranged in design capacity from 1.2 to 27.5 MGD. The largest plant is El Paso's Kay Bailey Hutchison (KBH) Desalination Plant described in more detail below. The costs were adjusted to 2009 dollars and include power, O&M, and debt service expenses. For brackish water, the treated water costs at the plant (excluding subsequent conveyance costs) ranged from $1.26 to $2.60 per 1,000 gallons (Arroyo and Shirazi 2009, Table 1).

Arroyo and Shirazi (2009, Table 2) also provided planning-level production costs for six proposed coastal seawater desalination plants with design capacities between 2.5 and 100 MGD. The costs for treating seawater were higher than for treating less saline brackish water and ranged from $3.59 to $5.77 per 1,000 gallons in 2009 dollars. Hightower (2008) summarized the cost of treating brackish and saline water as $2 to $3 per thousand gallons for water being treated at the ocean and $4 to $6 per thousand gallons for inland treatment. The higher costs for inland treatment reflect the increased cost of concentrate disposal.

### 3.4 Brackish Water Treatment in the Southwest

El Paso's Kay Bailey Hutchison (KBH) Desalination Plant

The potable water supply for El Paso and Ft. Bliss is being supplemented by brackish groundwater from beneath Ft. Bliss. The feed water, with a quality of 2,000 to 4,000 mg/L TDS, is treated by reverse osmosis to drinking water standards at El Paso's new KBH Desalination Plant. The plant's output of 27.5 million gallons of fresh water per day makes it the world's largest inland desalination plant. The project includes a state-of-the-art desalination plant, a learning center, groundwater wells, transmission pipelines, storage and pumping facilities, and deep well disposal of 3 MGD of concentrate, with a reported brackish water treatment efficiency of 83% (El Paso Water Utilities 2013). Safe concentrate disposal was considered the most complex part of the project. The available underground concentrate storage volume is estimated to be sufficient for 50 years of operation. The plant is a joint project of El Paso and Ft. Bliss. It was completed in 2007 at a cost of $87 million. Treated water costs in 2009 dollars were $2.56 per thousand gallons, including power, O&M, and debt service (Arroyo and Shirazi 2009)..

Sandoval County's Brackish Water Initiative

Sandoval County (New Mexico) Wholesale Water Supply Utility is proposing to extract brackish groundwater from deep wells drilled into the Rio Puerco Aquifer in the San Andreas (called the San Andres in eastern New Mexico) and Glorieta Formations in the Rio Puerco Valley west of Albuquerque, New Mexico. The water would be treated to drinking water standards at an initial plant capacity of 5 MGD using a reverse osmosis process preceded by multi-stage pretreatment. The County's motivation in initiating this project is to foster economic growth in the West Mesa area between the City of Rio Rancho and the Rio Puerco. The following information was taken from Sandoval County Wholesale Water Supply Utility (2011, Section 1, Figure 1-1, and Table 1-2).

The raw water would be supplied by 5 deep wells with a capacity of 1,100 gpm each, drilled within the service area into the Rio Puerco Aquifer. The Rio Puerco Aquifer is a confined aquifer located at a depth of 3,500 feet. Aquifer testing and analysis revealed that from 576,000 to 2,600,000 acre feet of water could be recovered from the aquifer. Chemical analysis of water from test well EXP-6 indicated a TDS of 12,000 mg/L and high levels of chloride, gross alpha, radium, and sulfate. At this TDS, the water is nominally considered slightly saline rather than brackish, with an accompanying increase

in treatment cost. The cost of treated water for the proposed 5 MGD plant was projected to be $6.01 per 1,000 gallons. Cost estimates were also prepared for plant capacities ranging from 1 MGD ($10.55 per 1,000 gallons) to 16 MGD ($5.02 per 1,000 gallons).

Total project cost was estimated at approximately $105 million. Processing and handling of waste concentrates was found to represent the most significant part of the cost of constructing and operating the treatment plant. Waste concentrates with no commercial value would be injected into the uppermost units of the Madera Group Formation about 1,500 feet below the San Andreas and Glorieta source formations. Energy represented the second most significant expense. Because the wells were planned to be located within the service area, conveyance costs were not a significant part of the total.

Lubbock's Brackish Wellfield Alternative

One of the alternative sources of water being considered by the City of Lubbock is to install wells in the sandstone units of the Santa Rosa Formation of the Dockum Aquifer. The following information was taken from Lubbock's 2013 Strategic Water Supply Plan (Spear and Dunn 2013, p. 7-41 and Table 7.7). The alternative involves drilling four 1,900 ft deep production wells on existing city property with an estimated combined capacity of 1.17 MGD, treatment of 25,000 mg/L TDS raw water to drinking water standards using pretreatment and a reverse osmosis finish, two 5,000 ft deep concentrate injection wells, and a potable water recovery of 85%. This alternative is intended to provide a dependable treated supply of 1.0 MGD. The required raw water supply of 1.17 MGD would allow for the 85% treatment efficiency and would generate approximately 0.17 MGD of concentrate. The capital cost would be $33 million and the projected unit cost is $10.96 per 1,000 gallons in 2012 dollars.

The expected well yields and water quality were primarily based on modeling studies of the Dockum Aquifer. Because of the uncertainty in the supply and concentrate disposal aspects of this project, this alternative was ranked last out of 16 alternatives being evaluated for supplementing Lubbock's water supply (Spear and Dunn 2013, Figure 10.1).

### 3.5 Deep Drilling Option Overview

The deep drilling option deserved consideration because the formations underlying the Ogallala Aquifer in Roosevelt County, and particularly the Santa Rosa and San Andres, are good producers at other locations. However, in the vicinity of Roosevelt County the deep drilling option does not appear promising. Exploratory drilling into the Santa Rosa Formation in New Mexico has yielded only limited production capacity and, in the Portales – Clovis area, has encountered saline water and brine that would be expensive to treat. Although little is known about the production capacity of the San Andres Formation in this area, the quality of any water found would likely be very poor. Because of the depths and paucity of information about these formations, exploratory drilling would be expensive with no guarantee of success.

In summary, the deep drilling option is problematic: the target formations are found at considerable depth and are expensive to access; well yields are likely to be far below what would be required for an adequate municipal supply; groundwater recharge is minimal and any water recovered would be mined without replacement; and what water is available is likely to be highly saline and require expensive treatment to bring it to drinking water standards. Because of the uncertainties and costs involved, it is unlikely that deep drilling would be a feasible option for providing the quantity and quality of water required for an active municipality. Although a water production potential sufficient for municipal purposes may exist at some locations, the cost of finding those locations and then recovering and treating the water are likely to be prohibitive.

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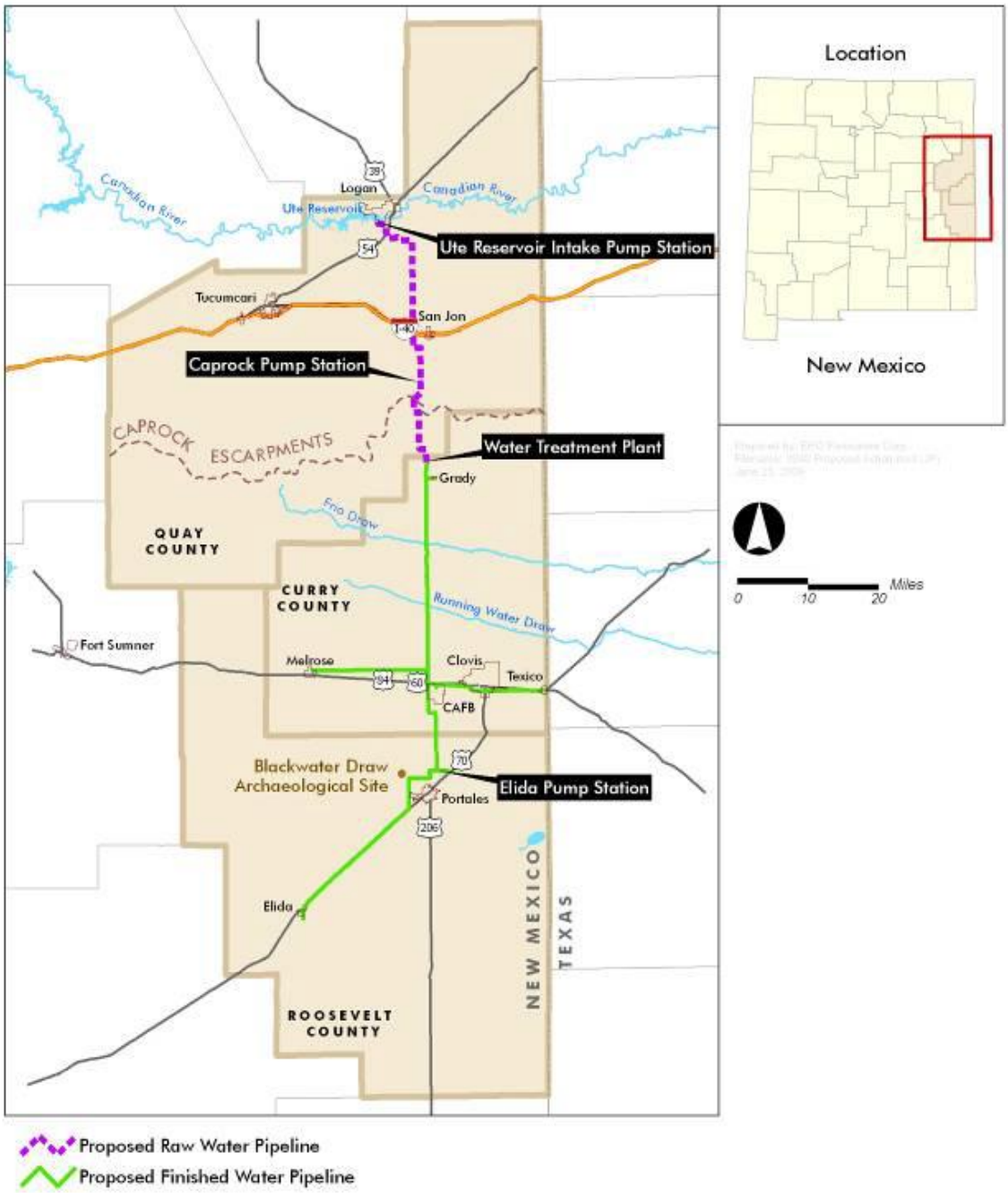
## 4.0 Ute Reservoir

A pipeline currently under construction between Ute Reservoir on the Canadian River and seven communities in east-central New Mexico provides the most viable renewable water supply alternative for Portales. No other stream of sufficient size to provide a meaningful municipal water supply crosses the plains of eastern New Mexico. Ute Dam is located near Logan, New Mexico, about 25 miles upstream of the Texas border and 50 miles downstream from Conchas Reservoir. The locations of the reservoir and the pipeline are shown in Figure 4-1. Ute Dam was constructed in 1962 by the New Mexico Interstate Stream Commission and expanded in 1984 to increase the height of the dam and spillway crest. The primary purpose of the dam was to provide a renewable surface water supply for eastern New Mexico municipalities. Unlike groundwater, which is being pumped at most locations in eastern New Mexico much faster than it is being recharged and is therefore being mined, the Canadian River water supply is renewed each year by precipitation in its watershed.

### 4.1 Conservation Water Storage

The reservoir created by Ute Dam is operated by the New Mexico Interstate Stream Commission in conformance with the 1950 Canadian River Compact between Texas, New Mexico and Oklahoma. The Compact limits the amount of water stored in the reservoir, not the amount of water used. New Mexico has no minimum delivery obligations to downstream states under the Compact. Article IV(b) of the Compact and the 1993 U.S. Supreme Court decree in *Oklahoma and Texas v. New Mexico* restrict New Mexico's long-term conservation storage in the Canadian River drainage in New Mexico below Conchas Dam to a total of 200,000 acre-feet. Conservation storage is that portion of the capacity of a reservoir available for storing water for subsequent release for domestic, municipal, irrigation, or industrial uses, and excludes any portion of the capacity of reservoirs allocated solely to flood control, power production, or sediment control. Conservation storage capacities in other reservoirs within this drainage area reduce the total conservation storage permitted in Ute Reservoir to 193,240 acre-feet (Whipple 1994, p. 12). Water in excess of this conservation storage limit must be released to the Canadian River below the dam.

Because the reservoir’s capacity is progressively reduced by sediment accumulation, the water surface elevation corresponding to a conservation storage of 193,240 acre-feet is updated at approximately 10-year intervals. The most recent survey was completed in 2012 and is described by Tetra Tech, Inc. (2012). The results indicated that 49,763 acre-feet of sediment had accumulated in the reservoir between 2012 and 1963 when water storage in the reservoir began. The total reservoir water holding capacity in 2012 was 218,932 acre-feet as compared with its initial 1963 capacity of 268,695 acre-feet. The 49,763 acre-feet of sedimentation is about 18.5% of the 1963 capacity and represents an average sedimentation rate of 1,016 acre-feet per year. At this sedimentation rate and assuming most of the sediment is deposited in the active conservation storage volume of the reservoir (described below), the water holding capacity of the reservoir would drop below the 193,240 acre-foot maximum conservation storage volume in about 2037. As




Source: Reclamation 2011, Figure 6.

Figure 4-1. ENMRWS pipeline location map.

discussed below, the active conservation storage volume is one of the parameters used to calculate reservoir yield, and decreases in this volume will decrease the yield.

A schematic drawing of Ute Reservoir showing key water surface elevations related to conservation storage is presented in Figure 4-2. In 2012 the conservation water storage volume of 193,240 acre-feet corresponded to a water surface elevation of about 3,786 feet (Tetra Tech, Inc. 2012, Figure 4). This is about 3 feet below the spillway crest elevation of 3788.86 feet. As of June 1, 2013, the water surface elevation was reported by the U.S. Geological Survey to be 3,771.25 ft and the volume in storage was about 111,000 acre-feet (taken from website http://waterdata.usgs.gov/usa/nwis/uv?07226800). This water level is about 15 feet and 82,000 acre-feet below the reservoir's maximum allowable conservation storage capacity.

The conservation storage capacity includes inactive water storage between the outlet works sill elevation of 3725 feet and an elevation of 3741.6 feet. The storage volume within this elevation range is called the inactive conservation storage and will be maintained indefinitely for such purposes as fish and wildlife and recreation, and is not available to project participants (Whipple 1994, p. 12). Water below the outlet sill elevation of 3725 feet is considered dead storage. In 2012 the volume of water in dead storage was approximately 7,000 acre-feet and the volume of water in inactive conservation storage was approximately 19,000 acre-feet (Tetra Tech, Inc. 2012, Figure 4).

### 4.2 Reservoir Losses

The principal reservoir losses are to seepage beneath the dam and to evaporation. Both types of losses vary depending on the amount of water in the reservoir. Seepage losses vary with water depth and are estimated to typically be on the order of 2,500 acre-feet per year (Whipple 1994, p. 14). Most of the seepage water resurfaces in the Canadian River below the dam  The base flow that this seepage maintains provides habitat for the endangered Arkansas River Shiner. Evaporation losses vary with water surface area and temperature, and are estimated to average 32 cubic feet per second, or about 23,000 acre-feet per year (GeoSystems Analysis, Inc. et al. 2012, Appendix A, p. 34).

### 4.3 Reservoir Yield

The annual yield of Ute Reservoir for supplementing water supplies in eastern New Mexico communities was estimated in a 1994 study conducted by the New Mexico Interstate Stream Commission (Whipple 1994). This yield was based on available meteorological data and Canadian River flows for the 50-year period from 1943 to 1993. The results were projected forward based on different rates of sediment accumulation for an additional approximately 50 years to 2045. The analysis included consideration of upstream water rights, Canadian River Compact requirements for downstream flows, reservoir seepage, reservoir evaporation losses, and a total conservation storage limited to 193,240 acre-feet. Uncertainties in the yield estimates arise from incomplete historic records, the use of data developed using correlations with information from other

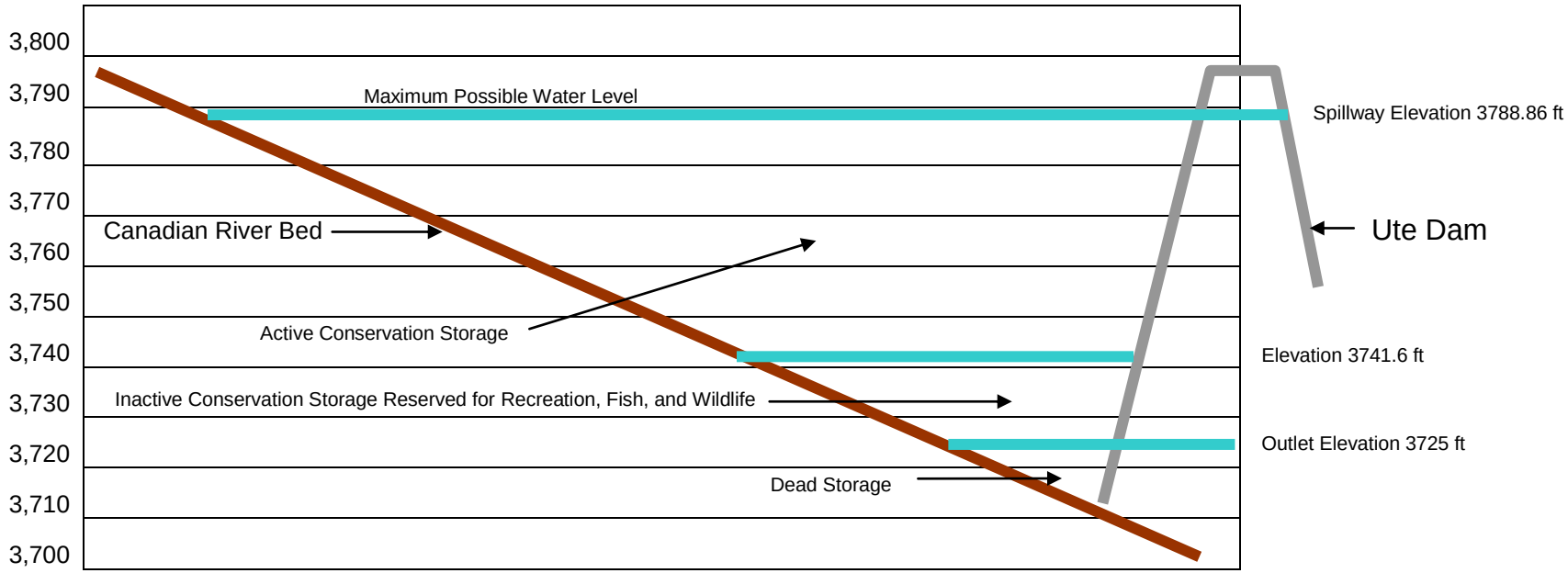



Figure 4-2. Schematic of key Ute Reservoir water surface elevations.

locations such as Tucumcari and Conchas Dam, and the need to estimate future climatic conditions and sedimentation rates.

The ISC study estimated that if climatic conditions for the 50-year period from 1943 to 1993 were representative of conditions for the following 50-year period from 1995 to 2045, a reservoir yield ranging from 18,000 to 22,500 acre-feet per year could be achieved through the year 2045 with no shortages (Whipple 1994, p. 1). These yields were estimated assuming a somewhat conservative future average reservoir sedimentation rate of 1,190 acre-feet per year and the range reflects uncertainty in the extent to which evaporation would occur from reservoir beach areas not covered by water (Whipple 1994, Figure 3). The study also estimated that the yield could be increased by 3,000 acre-feet per year if the project participants were willing to accept small occasional shortages in the water supply (Whipple 1994, p. 16). Increasing the yield by 3,000 acre-feet per year would result in an acceptable yield in the range of 21,000 to 25,500 acre-feet per year. The OSE subsequently adopted an intermediate value of 24,000 acre-feet per year for what the OSE calls the annual yield of Ute Reservoir (see, for example, http://www.ose.state.nm.us/isc_canadian_ute.html). Given that reservoir yields for water supply planning purposes generally include occasional shortfalls and that the yield estimates are associated with considerable uncertainty, as are any projections of future conditions, the working yield of 24,000 acre-feet per year adopted by the OSE is reasonable under the assumptions of the study. The important conclusion is to be aware of the uncertainty and to take steps to address the possibility of a shortfall.

Insights into the magnitude of a possible shortfall were provided in the Whipple study. Withdrawals of the 24,000 acre-foot annual yield from the reservoir were assumed in the study to begin in 2006 and continue beyond 2045. Under the aforementioned sedimentation rate, these withdrawals progressively increased the reservoir yield by drawing down the conservation storage pool, thereby decreasing water surface evaporation and increasing the ability of the pool to store greater volumes of incoming water. If evaporation was assumed to occur only from the water surface area and not from the beaches, the reservoir yield was estimated to progressively increase, reaching an increase of about 1,000 acre-feet per year by the end of the study period. This increase in yield resulted in a progressive decrease in the impact of drought over time.

Assuming an annual yield of 24,000 acre-feet and evaporation from only the water surface area, Whipple found that a repeat of the 1943 to 1993 climatic record with all its floods and droughts would result in only one year when that annual yield could not be met (Whipple 1994, p. 16). Because of the aforementioned increase in annual yield due in part to project activities, the amount of shortfall decreased over time. If the shortfall occurred in 2005, just before the start of project withdrawals, the project would have received 48% of the annual yield (a shortage of 52%) in that year. If the shortfall occurred in 2045, the project would have received 74% of the annual yield (a shortage of 26%) in that year (Whipple 1994, Figure 4). Under the assumptions of Whipple's analysis, a shortfall would occur in only one year out of 50, and Ute Reservoir's annual yield would be available 98% of the time. Whipple concludes that the use of water from

Ute Reservoir can be maximized if the project participants "…are willing to accept small occasional shortages in the reservoir water supply." (1994, p. 16).

The benefit of an analysis such as Whipple's is not to provide precise numbers but to provide a general indication of the water supply limitations that could occur. As is warned for stock market enthusiasts, while past performance can provide insights, it is no guarantee of future behavior. This is especially pertinent in light of current indications of climate change, the potential impacts of which are discussed in Section 4.7 below.

### 4.4 Eastern New Mexico Rural Water System Project

The aforementioned pipeline that would supply Portales and other eastern New Mexico communities from Ute Reservoir is a project of the Eastern New Mexico Water Utility Authority (ENMWUA). The transmission pipeline and associated lateral pipelines, pumping plants, water treatment plant, and other facilities, are components of the Eastern New Mexico Rural Water System (ENMRWS or the Project). The system is being designed with a total capacity of 30 MGD and an annual reservoir yield of 24,000 acre-feet per year (http://www.ose.state.nm.us/isc_canadian_ute.html). When completed, the Project would convey 16,450 acre-feet of water per year from Ute Reservoir to Curry County and to the eastern New Mexico municipalities of Clovis/Cannon Air Force Base, Elida, Grady, Melrose, Portales/Roosevelt County, and Texico. These are the Project Participants and their individual allocations are listed in Table 4-1. The remaining 7,550 acre-feet per year of the annual yield (to make up the total of 24,000 acre-feet per year) would be used by Tucumcari, San Jon, and Quay County, which will acquire that water under a separate project.

**Table 4-1. Eastern New Mexico Rural Water System Project Participants**

| Project Participant | Apportionment (acre-feet per year) | Percent of Total |
|---|---|---|
| Clovis / Cannon AFB | 12,292 | 74.7 |
| Portales / Roosevelt County | 3,433 | 20.9 |
| Melrose | 250 | 1.5 |
| Texico | 250 | 1.5 |
| Curry County | 100 | 0.6 |
| Grady | 75 | 0.5 |
| Elida | 50 | 0.3 |
| **Total** | **16,450** | **100.0** |

Notes:

- Roosevelt County's share of 100 afy will be delivered to the City of Portales.
- The City of Clovis will supply 2,150 afy of project water to Cannon AFB.

Portales' share of 3,433 acre-feet per year, or approximately 1.12 billion gallons per year, is the same as the City's 2012 demand and about 90% of the City's typical demand of 1.25 billion gallons in previous recent years.

## 4.5 Project Status

The ENMRWS was authorized by Congress under PL 111-11 in March 2009 and the seven member Eastern New Mexico Water Utility Authority (ENMWUA) became official in July 2010. Federal funding for the Project is passed through the U.S. Bureau of Reclamation (Reclamation). The ENMRWS Finance Plan was submitted to Reclamation for review and comment on June 30, 2010 and has been accepted. A 10 to 12-year construction period is anticipated but is subject to funding constraints. The Environmental Assessment (EA) and Biological Assessment (BA) are complete and a Finding of No Significant Impact (FONSI) was approved.

Construction of the Project's Phase 1, the intake structure at Ute Reservoir, began in March 2013. This phase consists of construction of the intake screens, tunnel, and pump forebay shaft, and the awarded construction bid for the project was about $14 million. Final design is currently in progress for Phase 2, constructing what is called the interim groundwater pipeline. This pipeline system will be designed to final specifications for the ENMRWS but as a first stage would only interconnect the member municipalities and would not extend below the caprock to Ute Reservoir. This interim pipeline would permit transfer of groundwater purchased from farmers and ranchers in areas with good water production to Project Participants.

Total Project cost was estimated in 2009 to be $500 million. Project funding is expected from federal, state, and local sources. Original planning was based on capital cost sharing of 75% federal, 15% state, and 10% local funding. Operation and maintenance costs would be borne by the Project Participants. Federal funding is currently being allocated on a year-by-year basis. Federal funding is received as construction grants from Reclamation and has amounted to $3.5 million through 2013. Supplemental Department of Defense funding through Cannon AFB and more stable federal funding through Reclamation are being sought. State and local financial support for the Project through 2013 have amounted to $30 million. (ENMRWS Project Update Information Sheet, May 2013, and telephone conversations with Paul van Gulick, ENMRWS Project Manager, May 30, June 5, and November 12, 2013).

## 4.6 Drought Management

Ute Reservoir's watershed is essentially limited to the Canadian River and its tributaries below Conchas Dam. Nothing upstream of Conchas contributes to Ute Reservoir except when Conchas Dam spills, which is rare. Ute's watershed includes no high peaks, is relatively small, and is susceptible to drought. In recognition of this, a Drought Management Plan (the Plan) has been prepared as part of the reservoir operations plan for the Project (GeoSystems Analysis, Inc. et al. 2013). The Drought Management Plan identifies declining water levels in Ute Reservoir which, when reached, would trigger a series of water diversion reductions of increasing severity. The objective of the Plan is to maintain a 'prudent reserve' that will remain available in Ute Reservoir during a drought to help avoid more drastically curtailing or completely shutting off the Project Participants' water supplies. The impacts on Project Participants and reservoir operations

of five alternative sets of water level trigger points were analyzed. Among the impacts were reductions in reservoir yield as a result of maintaining a greater volume of water in the reservoir.

The preferred alternative recommended in the Drought Management Plan was the 90% Probability Inflow-based scenario. This scenario was based on the 90% probable low annual Ute Reservoir inflow determined over the entire 83-year period of record. Using this approach, annual flows would be lower than the flow used in the analysis in 10 years out of 100, or 1 year in 10. The 90% Inflow scenario resulted in a slightly higher yield and lower reservoir spillage than the other drought management scenarios. A comparison between model results for the 90% Inflow scenario and the Status Quo scenario is presented in Table 4-2.

The Status Quo scenario essentially repeats the assumptions used in the Whipple analysis described above: no drought management and any water above the inactive conservation storage pool can be pumped from the reservoir when needed. This scenario was based on the updated 83-year period of record and resulted in a lower average reservoir yield of 21,068 acre-feet/year as compared with the original Whipple estimate of 24,000 acre-feet/year. As with Whipple's analysis, the estimated reservoir yields assume that Project Participants can accommodate occasional shortfalls. The average annual shortfall is shown in Table 4-2 as the ENMWUA Project Deficit.

**Table 4-2. Comparison of Drought Management Scenarios**

| Averages (acre-feet/year) | Status Quo Scenario | 90% Inflow Scenario |
|---|---|---|
| Reservoir Storage | 139,665 | 146,618 |
| Reservoir Yield | 21,068 | 19,228 |
| ENMWUA Project Deficit | 2,010 | 3,271 |

From GeoSystems Analysis, Inc. et al. 2013, Table 4.1.

As compared with the Status Quo scenario, the 90% Inflow scenario resulted in a larger average reservoir storage, a smaller average reservoir yield, and a larger average project deficit. However, the tradeoff for having less water on the average is having more water in drought years. Under the 90% Inflow scenario, Stage 1 restrictions are invoked when the reservoir water level drops to 3771 feet and water deliveries are reduced by 10%. Stage 2 restrictions commence when the water level drops to 3769 feet and deliveries are reduced by 20%. Stage 3 restrictions commence when the water level drops to 3765 feet and deliveries are reduced by 30%. Under both scenarios water deliveries cease when the water level drops to 3,741.6 feet, the top of the inactive conservation storage pool. As noted above, on June 1, 2013, the water surface elevation was 3,771.25 feet, and would almost trigger Stage 1 delivery restrictions if the project were operational. The Drought Management Plan notes that these elevation triggers should be changed over time to account for storage loss due to reservoir sedimentation.

The preferred alternative was selected because it had a smaller negative impact on reservoir yield and project deficit than the other alternatives, but the Drought

Management Report (GeoSystems Analysis, Inc. et al. 2013) did not provide quantitative illustrations of how the Project would benefit from maintaining a prudent reserve in specific sequences of drought years. Presumably the Project Participants would get more water in drier years when the reserve is being used and less water in wetter years when the reserve is being replenished, as compared with the Status Quo alternative, but no information was presented on how much extra water would be available in specific sequences of dry years and unavailable in specific sequences of wet years. Such information, including worst case situations based on the historic record, will be needed to help Project Participants to determine the benefit of the proposed Drought Management Plan, the probable severity of the cutbacks, and the alternatives the individual Participants must face in dealing with the droughts.

Alternatives for shortage sharing among Project Participants was understandably not addressed in the Plan because that is an issue the Participants themselves must resolve. Supplemental water to reduce Project shortfalls would have to come from other sources, possibly including local surface or aquifer storage of Project water, however some of those alternatives could face legal, financial, and possibly other challenges.

### 4.7 Climate Change

Climate change is an element of drought management that may lead to further long-term reductions in the reservoir's yield. The reality of climate change is no longer rejected by most people in light of progressively increasing worldwide average temperatures, the persistent, severe drought in the Southwest and severe weather conditions in other parts of the country. The increasing temperatures associated with climate change will increase the energy in the atmosphere, leading to more severe storms, increased variability in precipitation, decreased snowpacks, increased evaporation, reduced streamflow, and drier landscapes. Although the long-term average precipitation is generally expected to remain the same, precipitation is expected to come at infrequent intervals and be more torrential. The ability to store rainfall when it occurs, such as in Ute Reservoir, will become increasingly important as natural storage in the form of snowpack diminishes.

Although no formal projections of the impacts of climate change specific to the Canadian River and Ute Reservoir have been made, such estimates are being prepared by the Bureau of Reclamation and others for other areas and can give a general idea of the impacts that may occur. The problem is that all such estimates are very uncertain because they depend on climatic processes that are poorly understood and future human activity that is difficult to predict.

David Gutzler, professor of Earth and Planetary Sciences at UNM speaking at New Mexico Water Dialogue's 18$^{th}$ Annual Statewide Meeting in January 2012, stated that long term warming trends already evident in the data are going to amplify the hydrologic impacts and what we now consider drought could become the new normal. Warmer temperatures, diminished snow pack, earlier snow melt, and escalating evaporation rates all imply that even if the average precipitation remains the same, as some models predict, future droughts are going to be more severe than in the past. According to Gutzler, "…the

worst case scenario is something close to a 30% average reduction in annual streamflow by the late 21st century." (as summarized by Lisa Roberts 2012). In a subsequent climate change workshop held in Santa Fe in March 2012 and attended by the author, Gutzler stated that the expected average decrease in annual streamflow was on the order of 10 to 20%, depending on the strength of the summer monsoons.

The impacts of climate change were also studied for Reclamation's San Juan – Chama (SJC) Diversion Project as part of Reclamation's West Wide Climate Risk Assessment (WWCRA). The SJC project provides supplemental surface water to several entities in northern and central New Mexico including the City of Albuquerque, the Middle Rio Grande Conservancy District, the Jicarilla Apache Nation, and the City and County of Santa Fe. The annual yield of the project was originally calculated to be 96,200 acre-feet per year, fully available in 9 out of 10 years. This water is part of New Mexico's 11 percent share of water from the Upper Colorado River Basin allocated under the Upper Colorado River Basin Compact. The SJC Project headwaters are less susceptible to drought than most New Mexico rivers because of their high elevation in the Colorado Rockies.

Reclamation's analysis projects that the SJC Project will experience increasing water supply shortfalls during the 21st century. Model results indicate that SJC contractors would have received a full allocation in 99% of simulated years between 1951 and 1999. Full allocations are projected to drop to 85% of simulated years during the 2020s, to 72% during the 2050s, and to 61% of simulated years in the 2090s. The average volume of water received decreases from nearly 100% of full allocation in simulated years between 1951 and 1999, to 94% of full allocation in the 2020s, 88% in the 2050s, and 81% in the 2090s. In the 2090s the volume of water received is projected to be 100% of full allocation in 6 years out of 10, between 50% and 100% of full allocation in 2 years out of 10, and less than 50% of full allocation in 2 years out of 10 (Roach and Llewellyn 2012). Again, there is considerable uncertainty in these results but, as noted above, the impact of climate change on the Canadian River Basin could be worse. Recommendations for addressing Ute Project shortfalls and climate change impacts are presented in Section 7.

### 4.8 References

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## 5.0 Wastewater Reuse

Wastewater is currently collected by the City of Portales in a sewer system and conveyed to a treatment plant. The treated water is released to a discharge area southeast of town where it is used to irrigate up to 300 acres of agricultural land. The City is upgrading its treatment plant to improve the quality of the discharged water so it can be used to irrigate the City's public parks. Although not currently planned, the technology is also available to treat wastewater to drinking water standards such that it can be used to augment a potable water supply. Reclaimed water used for irrigation or for augmenting a potable water supply will reduce demand on the City's primary water supply and can therefore be considered a water conservation measure.

### 5.1 Levels of Wastewater Treatment and Use

Guidance on wastewater treatment and reuse in New Mexico is provided by the New Mexico Environment Department (NMED 2007). An overview of NMED's guidance and classification system is provided below.

- Class 1A reclaimed wastewater has no access or setback limitations and may be used for any purpose except direct consumption, food handling and processing, and spray irrigation of food crops.
- Class 1B reclaimed wastewater has no access limitations but should be used for irrigation at times when public exposure is unlikely and where the 100-foot spray irrigation setback requirement from occupied dwellings is met.
- Class 2 reclaimed wastewater is suitable for uses in which public access and exposure is restricted by fencing and locking gate or other approved means, and where the 100-foot spray irrigation setback requirement from occupied dwellings is met.
- Class 3 reclaimed wastewater is suitable for uses in which public access and exposure is prohibited and where the 500-foot spray irrigation setback requirement from occupied dwellings is met.

NMED's reuse classifications are based on meeting treatment performance standards rather than meeting design standards. The performance standards include meeting wastewater quality requirements for biological oxygen demand (BOD), turbidity or total suspended solids (TSS), fecal coliform, and UV transmissivity (NMED 2007, Table 2). NMED's specified quality levels for Class 1B, Class 2, and Class 3 assume a minimum of meeting design standards for conventional secondary wastewater treatment plus disinfection. A summary of conventional primary, secondary, and tertiary treatment design standards is provided by EPA (2013). NMED's Class 1A is the highest quality reclaimed wastewater described in NMED's guidance document. Class 1A assumes treatment to remove colloidal organic matter, color, and other substances that interfere with disinfection, thereby allowing for the use of the reclaimed wastewater for urban landscaping adjacent to dwelling units or occupied establishments.

The focus of NMED's wastewater classification system is on treating and using reclaimed wastewater in a manner that protects human health. The benefits of Portales' current plan to treat and reuse wastewater for irrigating public parks are described in Section 5.2. The option of treating wastewater to the levels required for potable water use is described in Section 5.3.

## 5.2 Landscape Irrigation Reuse in Portales

The City's wastewater treatment plant is being upgraded to produce reclaimed wastewater that meets NMED's Class 1A quality standards. The reclaimed wastewater will be suitable for its intended use in irrigating public parks and the sludge residues from the treatment process will be suitable for reuse as compost by local farmers.

Information on the planned treatment plant upgrade was taken from the project's Preliminary Engineering Report (Bolinger 2012b). The upgraded treatment train will include a biological nutrient removal system with advanced extended aeration. This is a continuous flow process and is a modified form of activated sludge treatment that relies on sludge recycling and retention times longer than a typical activated sludge process. The treatment train includes an anoxic tank for nitrate removal, first and second stage aeration tanks, a clarifier tank, two digester tanks, and two air lift pumps. The aeration tanks remove organics and nutrients using microbes to biologically convert them to bio-solids called sludge. The sludge is separated from the effluent in the clarifier tank. The removed sludge would still contain active microbes and is recycled back to the second stage aeration tank to enhance the biological treatment process. The recycled sludge is periodically removed from the second stage aeration tanks and stabilized in the sludge digester tanks. The waste sludge is later pumped from the digesters to a solids handling facility for further dewatering and is ultimately converted to organic compost. The clarified, treated effluent is pumped out of the clarifier tank and into a 15 million gallon lined storage pond. The reclaimed wastewater in the storage pond will meet NMED's Class 1B quality standards. Effluent from the storage pond will be filtered and disinfected in a tertiary process to Class 1A quality prior to use in irrigating City parks.

Information on treatment plant capacity and the demand for reclaimed wastewater was provided by the City of Portales and by a report describing the planned wastewater reuse system (Bolinger 2012a). The upgraded treatment plant is designed to meet a future average daily flow of 1.6 MGD and a peak flow of 3.2 MGD. The current average flow of the City's treatment plant is about 0.8 MGD (292 million gallons/year) and is expected to reach an average of 1.6 MGD (584 million gallons/year) within about 20 years due to population growth. The Abengoa Bioenergy Plant adds about 0.2 MGD to the treatment plant flow when it is operating, for a periodic current total of about 1 MGD (365 million gallons/year). Water losses will be minimized by recycling waste process water, such as filter backwash, to the upstream plant headworks. Construction is expected to begin in March 2014 and the upgraded treatment plant is expected to be operational in the summer of 2015 (personal communication with Allen Bolinger, Smith Engineering, Albuquerque NM, October 10, 2013).

The reclaimed wastewater distribution system is planned to be completed at the same time as the treatment plant. The irrigation demands of City parks, the golf course/Country Club, and ENMU are greater than the future average treatment plant flow of 1.6 MGD and are therefore also greater than the current average flow of 0.8 to 1.0 MGD. The aforementioned study therefore does not consider reclaimed wastewater use for industrial, commercial, agricultural, or drinking water purposes.

To achieve the goal of reducing demand on the City's Blackwater Wellfield, the reclaimed wastewater must be used at locations where irrigation water is currently supplied from that wellfield and not from local, onsite wells. Onsite irrigation wells exist, for example, at ENMU and at the golf course/Country Club. For purposes of this report, it is assumed that all of the current reclaimed wastewater flow will be used to irrigate parks that are currently being irrigated with water from the City's wellfield. The additional 0.8 to 1.0 MGD (292 to 365 million gallons/year) that reclaimed wastewater will currently provide the City amounts to a reduction in wellfield demand of about 25 to 30 percent, which is significant. Reclaimed wastewater has the distinct advantage of providing a relatively stable supply that is expected to grow as the City's population increases.

Irrigation water demands vary seasonally and it is possible that excess reclaimed wastewater may be available in winter when irrigation demands are low. One option for use of excess water is to further treat it to drinking water standards and supplement the City's potable water supply, as discussed below. The most important consideration is to use as much of the City's reclaimed wastewater as reasonably possible to offset wellfield demands. This will extend the life of the City's wellfield and will also reduce the future demand on alternative sources of potable water.

### 5.3 Potable Water Reuse in Portales

Potable reuse requires the most extensive treatment. Potable reuse can be indirect or direct. Indirect reuse involves discharging treated wastewater into a river bed or into the ground and subsequently withdrawing it at a point downstream or down gradient and combining it with the raw water supply for final treatment to potable standards. Water managed in this manner is naturally oxidized, filtered, and blended to improve its quality. Direct potable reuse involves injecting more highly treated wastewater directly into the raw water supply for blending and final treatment to potable standards. The primary concerns associated with potable reuse include addressing regulatory standards and public perception. Particular challenges to public acceptance of potable reuse projects include perceptions of health risks, the issues of choice and options, trust and knowledge, and the cost of reclaimed wastewater. A successful potable reuse project will need to address these public acceptance issues.

In addition to the treatment described above to achieve NMED's Class 1A standard, direct potable water reuse would require additional filtration to lower turbidity to drinking water standards and likely also redundant disinfection. Upon meeting those standards, the reclaimed wastewater could be directly blended with the drinking water supplies from the City's wellfields (personal communication with Allen Bolinger, Smith

Engineering, Albuquerque NM, October 14, 2013). There are two principal advantages of acquiring the ability to treat reclaimed wastewater to drinking water standards. Such an ability would provide an immediate use for any excess reclaimed water not needed for landscape irrigation regardless of the season of the year and would therefore maximize the benefit to the City's wellfields. In addition, such an ability would allow the City to divert reclaimed wastewater from irrigation to potable reuse in emergency situations where sufficient water for potable use is not available from the City's primary sources. Obtaining the flexibility to treat for potable reuse could be of significant benefit in future years.

### 5.4 Review and Conclusions

Reclaiming wastewater for irrigation use will substantially reduce demands on the City's wellfield. The ability to further treat some of the wastewater for potable reuse would further reduce wellfield demands at times when the availability of treated wastewater exceeds the irrigation demands at City parks. This ability would become most significant in emergencies when the demand for drinking water increases to exceed the supply. In such a case, reclaimed wastewater could be immediately diverted by the City from irrigation use and further treated for drinking water use.

The City's plans for irrigating public parks can supplement a conservation strategy for reducing landscape irrigation at individual residences and businesses. The City may, for example, adopt a strategy of encouraging residents and businesses to convert to drought-resistant plants and hardscapes while retaining City parks as oasis-like greenscapes. Reclaimed wastewater has the distinct advantage of a fairly stable supply and any application that reduces demand on the City's wellfield will be beneficial.

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## 6.0 Water Conservation

Water conservation is one of the least expensive ways to augment a water supply. Conservation does not create additional supplies but through reducing demand it does extend the useful life of a limited supply. The importance of water conservation for the City of Portales is increasing because of the ever decreasing, finite life of the Ogallala Aquifer as a high yield source of water and uncertainties in the quantity of water available from alternative sources.

The City of Portales has been actively promoting water conservation for decades. Summaries of the City's historic and ongoing conservation measures are presented in the City's Water Conservation Plan (Wilson 2001) and in the City's annual Water Conservation and Use Reports (see, for example, Wilson 2012). The following discussion of water conservation measures focuses on those that are likely to be the most effective and are amenable to increased emphasis, given the increasing importance of conserving existing supplies.

### 6.1 Optional Water Conservation Strategies

Commonly used conservation strategies include public education and awareness, seasonal watering restrictions, inverted block water rates, indoor water fixture replacement incentive programs, landscape rebate programs, and reducing unaccounted for water losses. Wastewater reuse can also be considered a conservation measure because it results in a beneficial reduction in water use and is discussed separately in Section 5. Descriptions of these and other conservation measures are presented below. Although the City has already implemented many water conservation measures, consideration should be given to implementing increasingly stringent measures as part of an overall strategy for meeting future water demands. Much of the following information is adopted from the City of Portales Water Conservation Plan (Wilson 2001) and the 2013 Strategic Water Supply Plan for the City of Lubbock (Spear and Dunn 2013).

**Indoor Water Conservation**

The American Water Works Association (AWWA) completed a study in 1999 that examined residential indoor water usage (Mayer et al. 1999). The study determined the following average uses: toilets (26.7%); washing machines (21.7%); showerheads (16.8%); faucets (15.7%); leaks (13.7%); other (dishwasher, bath, etc.; 5.4%). Replacing old fixtures with new, water-efficient models reduces overall water use. New toilets use 1.6 gallons per flush, whereas toilets pre-dating 1992 use between 3.0 and 5.0 gallons per flush. New commercial washing machines are estimated to save 37,800 gallons of water per machine per year, and new residential washing machines are estimated to save 8,500 gallons of water per machine per year. New showerheads meet 2.5 gpm flow rate standards, whereas older showerheads use more than 3.0 gpm (Spear and Dunn 2013, Appendix C).

*Water-Conserving Fixture Rebates.* Residential water use is the largest single water demand category in Portales. Indoor water conservation can be stimulated by providing

rebate incentives for residential, commercial, and institutional facilities for the replacement of fixtures such as toilets, washing machines, dishwashers, and showerheads. As examples, the City of Albuquerque is offering rebates of $150 to replace old toilets with new high-efficiency toilets, $100 to replace old residential washing machines, $25 to install swamp cooler thermostats, and $10 to replace showerheads.

*Indoor Water Use Surveys.* Free, voluntary indoor water use surveys have been offered by Portales for all water utility customers since 2002. Implementation of survey findings is also voluntary. The surveys identify faucet and toilet leaks, water use patterns, and older and less water-efficient fixtures. The customer is provided with survey results, including estimates of average indoor and outdoor use, and the water savings that could be attained using water saving fixtures and leak repair. Experience to date has shown that few customers have requested these surveys, probably because the cost of water is currently low relative to the cost of replacement fixtures. However, generally declining municipal water use, particularly in the residential sector, indicates that water conserving use patterns are being increasingly practiced in Portales, probably due to independently identified and voluntarily implemented conservation measures. Indoor water use surveys should continue to be offered by the City and may become increasingly requested as the cost of water increases and personal water-wise conservation practices grow.

*Sewer Rate Schedules.* Sewer rate schedules are tied to water use and are therefore also structured to encourage water conservation. Sewer rates outside the city limits are 50% higher than inside the city limits. These conservation practices should continue to be implemented.

*Low Water Pressure.* Low water pressures (40 to 60 psi) are maintained in the distribution system to reduce waste from leaks and from running faucets. This conservation practice should also continue to be implemented.

Although there are numerous opportunities for reducing indoor water use, most such use is captured by the City's sewer system and will be reclaimed for beneficial use in irrigating City parks. It is therefore recommended that emphasis be placed by the City on conservation measures that reduce total water use including outdoor uses.

**Conservation Water Rates**

Conservation water rates are rates that increase as water use increases. This is called an inverted block rate structure. Increasing block rates have been a part of Portales' water billing structure since 1995. The City of Portales currently has five water rate blocks. Portales' Block 1 usage represents the minimum service charge and includes the first 2,000 gallons of water use. The Block 1 volume was set at less than the expected minimum usage to encourage water use awareness. The remaining blocks represent increasing water use and include a household's seasonal or non-essential water use. Five-year schedules of increasing water rates were renewed by the Portales City Council in 2001 and again in 2007 and 2012. The current schedule extends to 2017 and raises most rates by 10% in the first year and 5% per year thereafter.

Raising water rates has been found to be one of the most effective methods for increasing conservation awareness and reducing water demands. Higher water rates also provide funding for rising water costs and help cushion "rate shock" when more expensive water must eventually be used. Increasing water rates with increasing water use more rapidly encourages customers to reduce their seasonal or non-essential water usage. A water rate study by the National Bureau of Economic Research revealed that a 10% increase in water rates can result in a 3% to 6% reduction in water demand (Olmstead and Stavins 2008).

A comparison of current residential water rates for Portales, Clovis, and Albuquerque is presented in Figure 6-1. As can be seen from the figure, the rates for Portales and Albuquerque are essentially identical while the rates for Clovis are higher.

**Reducing Unaccounted-For System Losses**

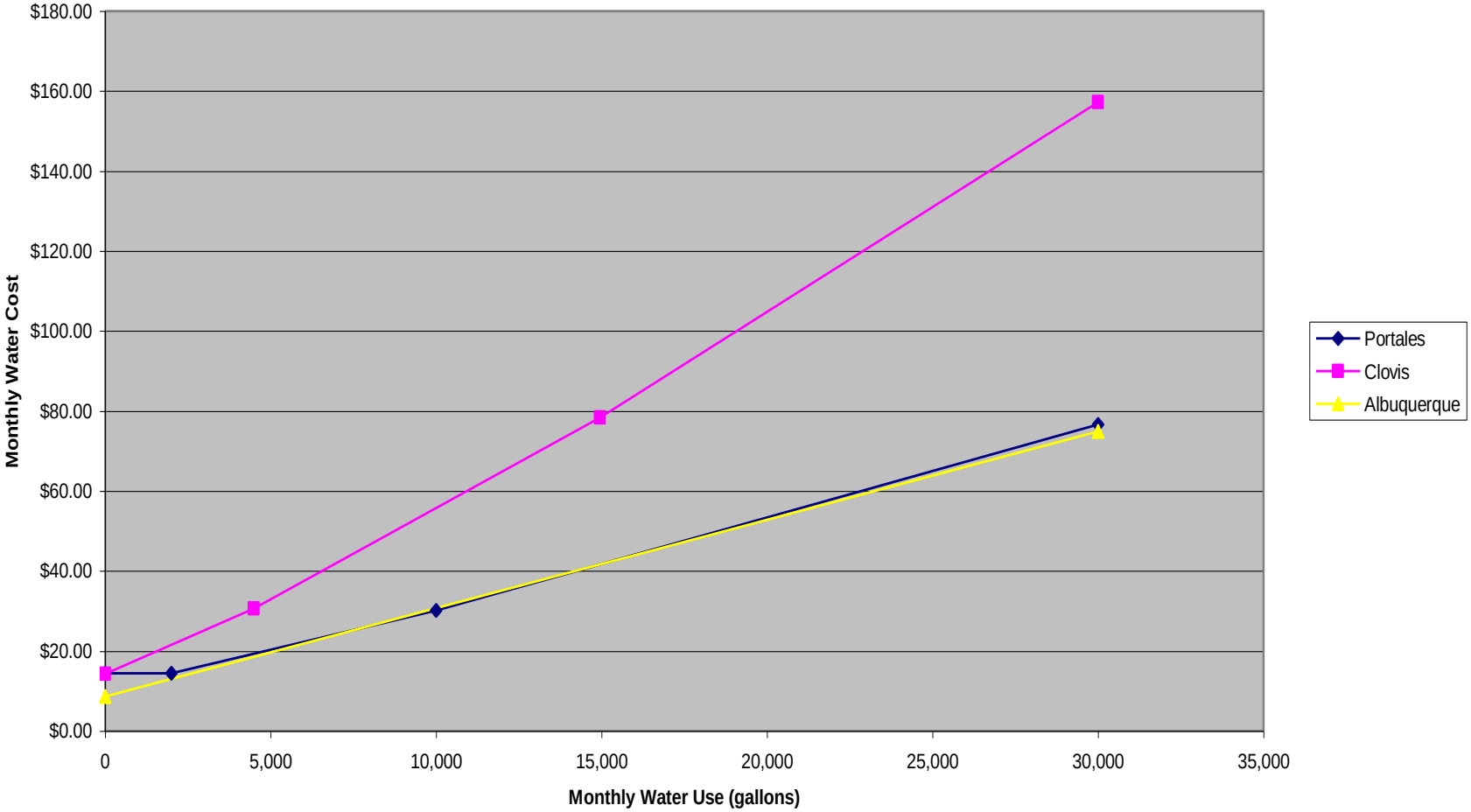
Unaccounted for (UAF) system losses are water distribution system losses from unknown causes. The most common example is an unknown water main leak, but other unmeasured or unknown losses such as fire hydrant use and construction use also contribute. One important method of conserving water is to reduce the amount of unaccounted-for water lost from the system.

Over the 5 years from 2007 to 2011, Portales' historic unaccounted-for water system losses averaged 9.5% of total water use. By comparison, AWWA's 2007 Distribution System Water Loss benchmark survey for water purveyors in the South region of the United States found that the top 25% achieves UAF system losses of 3.8% or lower and the bottom 25% achieves 14.1% or higher (AWWA 2007). The median UAF system loss was 8.9% of total water use, which is considered a benchmark for comparison in this region. Portales' loss of 9.5% was slightly higher than this benchmark and amounted to an average system water loss of about 120 million gallons per year. Reductions in UAF losses can be achieved by replacing older water mains; replacing older water meters with newer, more accurate meters; metering fire hydrant, street department, and construction water uses; and metering currently unmetered uses such as public park irrigation. Small improvements in reducing UAF losses could yield significant results.

*Replacement Water Meters.* Replacement water meters were installed at 386 locations in Portales in 2011 as part of an ongoing replacement program. The old meters often measured less than the actual flow and the improved accuracy and reliability of the replacement meters is expected to result in additional water savings. Most of these replacement meters support the City's new Automatic Meter Reading (AMR) system. This replacement program should continue to be implemented.

*Expanded Water Metering.* Portales reduced its unmetered water use in 2011 by installing meters at the City's swimming pool and in City parks. In addition, portable meters have been provided for fire hydrant and street department use. The City's goal of 100% metering should continue to be actively pursued. Accurate measurement of water use is key to identifying and correcting major UAF system losses as well as other forms of wasteful use.

**Figure 6-1. Comparative Water Rates**



*Automatic Water Metering.* Portales is installing a fixed base Automatic Meter Reading (AMR) system that allows water meters to be read at City Hall through a wireless network. The City is progressively replacing existing water meters with automatic meters that are more accurate and the increased accessibility to consumption data is expected to reduce water losses. The AMR system became operational in 2010 and should continue to be expanded.

*Water Use Monitoring.* Water meter readings are monitored for excessively high and low values and checked for accuracy. High readings trigger onsite leak checks and informal water use surveys. This conservation measure should continue to be implemented.

*Water Utility Internal Audits.* Portales' Water Utility Department conducts annual internal water use audits that provide much of the information used in the City's annual Water Conservation and Use reports. This program should continue to be implemented because it is essential to identifying areas of excessive water use and to evaluating the effectiveness of the conservation programs.

**Public Education**

Public education is an important component of Portales' water conservation efforts. An awareness of the factors affecting the City's water supply will help customers to make wise water use decisions in their personal and business lives and will help achieve greater understanding and acceptance of increasingly stringent water conservation measures that may be needed. Information about water conservation issues and practices is available from the New Mexico Office of the State Engineer. Free water-wise guides for indoor and outdoor water use are also available from the New Mexico Office of the State Engineer. Many of these guides are available to the public in Portales' City Hall and can be disseminated to community groups and public schools.

Several of the following conservation awareness programs described below feature conversion to drought-resistant residential landscaping. Landscape irrigation naturally increases in summer months and accounts for much of the peak summer water demands that are increasingly difficult to meet. In 2012, residential water use in Portales doubled from about 200 million gallons in the six winter months (January to March and October to December) to about 400 million gallons in the six summer months (April to September). Widespread conversion to drought-resistant residential landscaping could reduce demand on the City's wellfields by over 100 million gallons per year.

*Public School Programs.* Outreach to the City's public schools has included coordination and implementation of educational programs that allow students to explore the science of water and become familiar with water stewardship concepts. An example program from Lubbock, Texas, consists of nineteen interactive presentations described in Table 6-1. Teachers can request Lubbock's municipal personnel to give the presentations or can use free lesson plans available on-line (http://water.ci.lubbock.tx.us/education/allEdu.aspx). Similar materials are available through the New Mexico Office of the State Engineer. Public school water awareness programs have been introduced in Portales and should continue to be pursued.

## Table 6-1. Example Public School Program Lessons

| Lesson Title | Grade(s) | Description |
|---|---|---|
| Blue Stuff | K-2 | Students will learn the difference between salt and fresh water. Discusstion will focus on how much water exists on the planet vs. how much we can actually use for drinking,farming, etc. |
| Cloudy Days | K-2 | The presenter will discuss the water cycle and provide an illustration of the whole process step by step. The students will learn by participating in the discussion. |
| Tale of Two Droplets | K-2 | A video tells the adventures of Drippy and Dropper, a couple of water drops that travel through a day with Jeremy. As the day progresses, we learn more ways to save water. |
| Make-a-Tree | K-2 | Students will learn the basic process creation, as well as the many ways that paper can be reused and then recycled. |
| Sources of Resources | K-2 | Students will be able to identify the natural resource that many common items are created from. |
| Mask of Trash | K-2 | Students will become aware of their role in practicing the Four Rs, thereby becoming good stewards of our natural resources. |
| Bird Feeder | K-2 | Students will create a decorated bird feeder to use at home and to teach parents about recycling. |
| Recycle Relay | K-2 | Following a brief introduction into recycling, students will get hands on experience sorting recyclables in a fast past relay race. |
| Water Bracelet | K-5 | Students will learn the terms and definitions associated with the water cycle and how the water cycle is impacted by actions on earth. |
| Fred the Fish | 3-12 | The water we use has to come from somewhere. The process of the water traveling from the source to the end point can be quite an adventure. |
| Edible Aquifer | 3-12 | Students will learn what an aquifer is and how the Ogallala benefits the City of Lubbock. |
| Water Treatment Video | 3-12 | Students will be able to identify the different steps involved with the process of providing clean drinking water. |
| Examining Effluent | 3-12 | Students will learn what effluent is and how Lubbock uses it to benefit local and area residents. |
| What's in your Water? | 3-12 | Students will understand the concepts fo solubility, dissolving, solutions, and mixtures. |
| The Best Fisherman | 3-12 | Students will learn about conservation, natural resources, and renewable resources while developing and understanding of resource manangement. |
| Water Shortages | 3-12 | Students will be able to define water shortage, discuss solutions to water shortages, be able to explain water solutions explore locally. |
| Edible Landfill | 3-12 | Students will learn appropriate vocabulary as well as the design of the landfill |
| Garbage Pizza | 3-12 | Students will construct a garbage pizza to represent all the trash thrown away. Students will learn the composition and the proportion of the types of trash that enter the landfill and will classify recyclable materials and analyze how personal choices make a difference. |
| Blow Wind Blow | 3-12 | Students will learn the vocabulary of wind energy, the concept behind the technology and the story of wind usage, past to future endeavors. |

Source: Spears and Dunn 2013, Appendix C-3

*Demonstration Gardens and Homes.* The City of Portales has developed a xeric demonstration garden at the City Hall and roadside demonstration gardens along NM 206 to Lovington and at the north and south entrances to town along US 70. In addition, a mile-long xeric garden was established in 2009 in the median along US 70 north of town. Another demonstration of xeric landscaping is provided by Eastern New Mexico University. These gardens provide ongoing models of water-wise landscaping. These programs can be expanded by encouraging local residents and businesses to convert their gardens to xeric hardscaping by replacing grass and shrubs with decorative gravel and highly drought-resistant plants. Although many residents are voluntarily converting their gardens, direct financial encouragement could help speed the process. For example, the City of Lubbock is proposing to offer an incentive rebate of 25 cents per square foot of traditional grass lawn that is removed and converted to hardscape or drought resistant plants. If xeric landscaping is associated with homes featuring water conserving fixtures and materials, such homes could be included in an annual Parade of Homes, to be on display for citizens to tour.

*Home & Garden Shows.* The City is working with *Pride in Portales* and *New Mexico Clean and Beautiful* organizations to promote water-conserving landscaping on road medians and adjacent areas. As part of this effort, the City could promote and/or participate in annual Home and Garden Shows where Water Utility Department representatives can be present to provide information, answer questions, make presentations, and support a community-wide water conservation effort through home and landscape design. The City can work with Master Gardeners and garden clubs to develop Water Wise Garden Tours of selected gardens that demonstrate the use of native, water-efficient landscaping and conservation water use. Information on water-efficient plants and landscape design are available through the New Mexico Office of the State Engineer and should continue to be routinely available at Portales' City Hall.

*Landscape Irrigation and Xeric Garden Consultation.* Offering free one-on-one consultation to residents and businesses on landscape irrigation and xeric garden conversions would help identify unnecessarily wasteful irrigation practices and encourage water-wise landscaping. The irrigation consultants would assist in optimizing sprinkler system by determining proper "cycle and soak" run times, and provide advice on measuring soil moisture content to determine the need to irrigate. When requested, they can reset sprinkler controllers to optimal settings. The consultants would assist in xeric landscaping by providing illustrations of drought resistant plants suitable for east-central New Mexico, samples of decorative gravels that would enhance homes or businesses, estimated costs of conversion, and photos of completed conversion projects. If the City adopts a monetary landscape conversion incentive, the consultant could help the customer calculate what the amount of that incentive would be. Free brochures on xeric landscaping and irrigation are available from the New Mexico Office of the State Engineer.

*Rainwater Harvesting and Cisterns.* Rainwater runoff from roofs, from other hard surfaces, and even from soils can be collected and redirected for beneficial use. The simplest approach that can be implemented by a homeowner involves redirecting runoff

for landscape irrigation. In commercial districts runoff from streets and parking lots can be redirected to catch basins for groundwater recharge. Check dams can be constructed in arroyos outside of town to retain runoff and promote groundwater recharge. More elaborate harvesting involves the use of rain barrels or cisterns to save rainwater for future use. A free guide to rainwater harvesting and system design has been prepared by the City of Albuquerque and is available from the New Mexico Office of the State Engineer.

The City of Portales has installed a rainwater catchment and cistern system to accompany the xeric landscaping demonstration project at City Hall. Rainwater from the City Hall roof is collected in two 1,500-gallon tanks and pumped to a xeric demonstration garden in front of the Portales City Hall. The irrigation demand is expected to be about 5,000 gallons per year. The system became operational in September 2005 and is designed to harvest an average of 7,500 gallons per year. The City of Portales has prepared a brochure describing the system and providing information on xeric landscaping.

*Irrigating with Gray Water.* Gray water is defined by the New Mexico Office of the State Engineer as untreated household wastewater that has not come in contact with toilet waste. Gray water includes wastewater from bathtubs, showers, washbasins, clothes washing machines and laundry tubs. It does not include wastewater from kitchen sinks or dishwashers or laundry water from the washing of material soiled with human waste, such as diapers. Gray water is distinguished from “black water,” which is wastewater from toilets, kitchen sinks and dishwashers. Black water should not be reused in the home without proper treatment because of the high risk of contamination by bacteria, viruses, and other pathogens.

Gray water can be captured and successfully used to irrigate household landscaping and fruit trees, and reduces the amount of potable water that would otherwise have been used. Gray water should not be used where it may come in contact with the edible part of food crops. Biodegradable and environmentally friendly soap products should be used. Soaps that contain borax and are high in salts and sulfates, including many powdered soaps, should be avoided. Gray water containing chlorine bleach should also be avoided.

A state permit is not required to apply less than 250 gallons per day of private residential gray water for a resident’s household gardening, composting or landscape irrigation if certain conditions of use are met. Gray water systems designed to discharge more than 250 gallons per day require a permit from the New Mexico Environment Department. Additional information on gray water and the limitations in its use are available from the New Mexico Office of the State Engineer.

**Water Conservation Ordinances**

Portales’ City Council has adopted ordinances that encourage customers to reduce water use. Ordinances could also be developed to avoid wasting water. Such ordinances include:

*Water Rate Ordinance.* This ordinance defines the City's conservation block rate structure where higher rates apply to higher volumes of water consumed. As previously described, such an ordinance is in place in Portales and is renewed every five years.

*Xeriscaping Ordinance*. This ordinance requires landscaping with drought-tolerant plants over most yard areas for new developments and for substantial improvements to existing developments. The ordinance provides for runoff controls and encourages rainwater harvesting. Landscape design reviews by the City are required prior to issuing landscape permits.

*Emergency Drought Management Ordinance.* The City Council has given the City Manager emergency water management authority including water conservation and drought management.

*Waste of Water Ordinance.* This ordinance would outline water use standards for outdoor irrigation. These standards would identify the times of day that landscapes can be watered (such as between 6 p.m. and 10 a.m. from April to September) and prohibit uncontrolled runoff to streets. Such an ordinance could also recognize that the City may, at times, enact more restrictive watering schedules, limiting the number of times customers can irrigate their landscapes during a given day or week. Portales has currently initiated a voluntary program of watering every other day with no watering on Mondays or between 10 am and 6 pm daily. More stringent mandatory, rather than voluntary, water use restrictions could be promulgated if needed to further reduce water use. However, mandatory measures can be expensive to track and enforce, and should be considered only when voluntary measures are insufficient.

### 6.2 Selection and Implementation of Water Conservation Strategies

The most important reason why Portales should consider increasing water conservation is to maintain a strategic reserve in the Ogallala Aquifer for future emergency drought conditions. The conservation measures presented above are alternatives that can be considered by the City and implemented with varying degrees of stringency depending on the level of confidence City planners have in the reliability and availability of future water sources.

The key factors needed to successfully implement a water conservation program have been described by Keyes et al. (2004):

- Stakeholder involvement
- Detailed policy with goals and specific conservation measures, including conservation based water rates and user incentives
- Broad-based education and outreach
- Detailed water use data, demand forecasting, and monitoring
- Stable funding sources for water conservation initiatives

- Sufficient staff and technical assistance to implement the program

A summary of water conservation measures for consideration by the City of Portales is presented in Table 6-2. New conservation measures and existing measures that could be strengthened are separately presented from existing measures that should be continued. Selecting and implementing stringent water conservation measures can rapidly become a contentious issue because of the restrictions they place on the landscaping of a home or business and on a person's lifestyle and pocketbook. It involves accepting that we are living in a water-scarce environment and broadening our concepts of beauty. As such, water conservation measures should be implemented progressively and with careful planning. The primary means of preparing for increasing conservation is through increasing public awareness of the need to conserve, and demonstrations of the beauty that can be attained from water-wise landscaping and living in a water-efficient home. The conservation plan itself should be developed with the input of citizens and the business community, staged over time, and key plan provisions adopted by City ordinances.

## 6.3 References

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**Table 6-2 Summary of Water Conservation Measures**

| Measure | Effectiveness | Cost | Notes |
|---|---|---|---|
| **Conservation Measures that could be Strengthened** | | | |
| Increase public education | M | L | Increases public awareness and acceptance of increasing costs and the need to conserve water |
| More stringent seasonal landscape irrigation restrictions | H | M | Replace voluntary with mandatory landscape irrigation use for existing developments |
| Increase water volume block rates | H | L | Have greater annual rate increases for Blocks 2 and 3 than for Block 1 |
| Offer landscape conversion rebates | H | M | Reducing landscape watering would reduce summer peaking demands |
| Offer water-using fixture rebates | M | M | Newer, low water use fixtures would reduce indoor use |
| Increase sewer rates | M | L | Encourages conservation by tying sewer rates to water use |
| **Existing Conservation Measures that should be Continued** | | | |
| Continue enforcement of xeriscaping ordinance | H | L | Provides reduction of peak summer water demands for new developments |
| Continue internal system audits | M | L | Provides data for monitoring health of water system |
| Continue water meter replacement program | M | M | Improves measurement accuracy and leak detection |
| Continue expanded metering program | M | M | Improves audit accuracy and reduces unaccounted-for losses to a goal of 100% metering |
| Continue installation of Automatic Meter Reading (AMR) system | M | M | Increased ability to screen distribution system for leaks and excessive use |
| Continue water use monitoring | L | L | Has the potential to save large water volumes through early detection |
| Continue use of low water pressures | L | L | Reduces water use through reducing water flow rates |
| Continue offering indoor water use surveys | L | L | Value of program may increase as water rates increase |

Note: Expected effectiveness and cost are presented in relative terms as high (H), medium (M), and low (L)

## 7.0 Summary and Conclusions

This report presents an overview of optional sources of municipal water supply to supplement Portales' current supply from the rapidly depleting Ogallala Aquifer. Consideration has been given to obtaining supplemental supplies from shallow groundwater, deep groundwater, and surface water from Ute Reservoir. In addition, the report reviews alternatives for reducing water demands including wastewater recycling and an array of other water conservation measures. In reviewing these alternatives, it is recognized that the City of Portales requires alternative supplies that meet the City's needs from the standpoints of quantity, quality, and cost. Sources of supply that yield only small amounts of water may be sufficient for individual household or stock use but are not sufficient for a municipality. Quantity, quality, and cost are not mutually exclusive. A supply of sufficient quantity may be available at a distance and must be conveyed to the City. Water of inferior quality may be available but must be treated. Also, the supplemental supply should be renewable so that Portales' water needs can be sustained into the future. The possibility of obtaining supplemental groundwater from Texas was not considered in this report because of expected difficulties in effecting interstate transfers.

*Shallow Groundwater.* The City's current water source, the Ogallala Aquifer, is being depleted by extensive groundwater pumping throughout the region and cannot serve as a high-yield source of municipal supply indefinitely. The yields of Portales' existing wells are expected to progressively decrease and at the current rate of use, many more wells will be required within the next decade to recover what water remains in the wellfields. Interim measures to supplement and conserve the City's groundwater supply and prolong the useful life of the City's Blackwater Wellfield are needed to help avert water supply emergencies until an alternative, long-term source of sufficient supply is available. Interim sources of supplemental supply include purchasing local Ogallala groundwater from willing sellers or purchasing local land and water rights in areas where sufficient aquifer thickness remains. An interim conveyance system for such water is planned as part of the Ute Pipeline Project discussed in Section 4 but the availability of funding and construction scheduling for this system are uncertain.

Wastewater reuse and more stringent conservation measures can be directly implemented by the City and can have the most immediate effect. More stringent conservation measures that can be considered by the City and the associated potential reduction in wellfield demand are identified in Table 7-1. Of these, the most important is informing the community of the need for such measures through education, but the most significant direct effect is from wastewater recycling. The ability to recycle wastewater is currently being developed and has the greatest potential to reduce demand on the wellfield. To have a meaningful effect on the wellfield, the conservation measures should be in place within the next 5 years and the interim supplemental supplies should be in place within the next 10 years.

The aforementioned supplemental supplies are considered interim because they rely on mining remaining pockets of shallow groundwater that are not renewable. Although the

conservation measures extend the useful life of a limited supply, they do not create the additional supplies that will still be needed. Nevertheless, identifying interim supplemental supplies and implementing stringent conservation measures now are good practices because they will help to maintain a groundwater reserve for use in drought years when the most promising source of a renewable supply, the Canadian River at Ute Reservoir, cannot provide the City's full allocation.

**Table 7-1. Potential Reduction in Wellfield Demand for Alternative Conservation Measures**

| Measure | Potential Reduction in Wellfield Demand |
|---|---|
| Water-wise education | No direct reduction but essential for acceptance of other measures |
| Wastewater recycling | 25 to 30 % |
| Residential drought resistant landscaping and watering restrictions | 10 to 15% |
| Reduce unaccounted-for system losses | 3 to 6% |
| Stringent conservation water rates | 3 to 6% |

Natural recharge of the Ogallala does occur but at a rate that is so slow that a huge area would be required to collect sufficient water to even approximate Portales' current municipal demand. However, natural recharge is renewable and could possibly be considered over a smaller area as a low-yield, supplemental water source. In the long term, the Ogallala Aquifer could also be used to store excess water when available from other sources, such as Ute Reservoir.

*Deep Groundwater*. Deep groundwater from below the Ogallala Aquifer has not been found to be a promising water supply alternative for east-central New Mexico. Any water that could be available from this source is deep and therefore expensive to access, of low quality, and likely also of low quantity. The sandstones of the Dockum Group are the shallowest of the deep, potentially water-bearing strata. Of the three deep wells that have been drilled into these sandstones in Roosevelt – Curry Counties and adjacent Texas, the highest yielding well produced only an estimated 165 gpm and all have encountered waters that are brackish, saline, or brine. Although little is known about the water-bearing properties of the San Andres Formation beneath the Dockum, it is even deeper and would very likely have even poorer quality water than the Dockum. Although most any quality water could be treated to drinking water standards at a cost, the difficulty is in finding deep water-bearing zones that could yield enough water to justify the cost of locating and treating it. Exploratory drilling would essentially be random because so little is known about the water-bearing properties of the deep strata, exploratory drilling would be expensive because of the depth of the target formations, and even if a high yielding water-bearing zone was found, it would likely be of finite extent and have little long term sustainability. Additional pursuit of deep groundwater in the Roosevelt – Curry County area would be costly, have a high probability of failure, and is not recommended at this time.

*Ute Reservoir.* A surface water supply from Ute Reservoir on the Canadian River is the only available alternative that would provide Portales with a demonstrated, renewable water supply in sufficient quantity for municipal use. Although a Ute water supply would be expensive, it has been demonstrated to be technically and financially feasible and would be a better investment than investing large amounts of money into alternatives that provide, at best, a few decades of supply, and at worst, are failures. Integration of a Ute water supply into long-term water management planning requires consideration of two concerns: uncertainty in the timing of project completion and strategies for addressing drought.

- Construction of the Ute conveyance system began in 2013 and is currently scheduled to be completed in 10 to 12 years, or by 2023 to 2025. Shortages of water from the City's Blackwater Wellfield are projected to become increasingly problematic over the next decade unless the demand on the wellfield is reduced. Because delays in water deliveries from Ute Reservoir could occur, it would be prudent for the City to reduce demands on the wellfield and increase its useful life.

- Shortages in the Ute water supply are expected during times of drought, and these shortages may be increasingly severe due to climate change. The Drought Management Plan prepared for the Ute water supply can be used to quantify the expected shortages and contingencies for addressing shortages should be prepared by Project Participants. Again, it would be prudent for the City to reduce demands on the Blackwater Wellfield so that a reserve water supply would be available in times of drought.

Both uncertainty in the timing of Ute Project completion and strategies for addressing drought call for reducing demands on the Blackwater Wellfield such that a reserve water supply can be maintained. Water demands on the wellfield can be reduced by recycling wastewater, adopting more stringent water conservation measures, and accessing interim sources of supply.

*Wastewater Recycling*. Wastewater recycling for uses that reduce existing demands on the Blackwater Wellfield is inherently a conservation measure that prolongs the life of the wellfield. The planned use of recycled wastewater for irrigating City parks will replace or reduce the use of wellfield water for that purpose and will therefore reduce the demand on the wellfield. The option to extend wastewater treatment to include directly supplementing Portales' drinking water supply could further reduce demand on the wellfield, would provide an emergency source of potable water, and should be investigated.

*Water Conservation*. Alternative water conservation measures that are designed to reduce potable water demand are provided in this report for consideration by the City. Many of these measures are already in place in Portales and should be continued. Others can be made more stringent depending on the City's judgment of:

- the likelihood that receipt of the Ute water supply will be delayed;
- the potential duration of a delay;
- the potential impact of drought conditions on the Ute water supply;
- the availability of interim water supplies; and
- the risk the City is willing to take in addressing possible water supply shortfalls.

To provide context to a delay in Ute water delivery, if Ute Project completion is delayed by 5 years to 2030, it would be prudent for Portales to reduce its wellfield demand by 40% to abut 700 million gallons/year by 2016 to help bridge the gap caused by such a delay. Although such a reduction is significant, it can reasonably be accomplished because much of it will be achieved by the wastewater recycling project already in progress. The increasing difficulty in making additional reductions based on conservation alone emphasizes the need for a multifaceted strategy of reducing demand through increasingly stringent water conservation efforts, increased accuracy in accounting for water use so that the success of the conservation efforts can be measured, and identification of interim sources of water supply.

If Ute water is delivered on or near schedule, it will still be desirable to reduce demand to well below the expected full Ute allocation of 1.12 billion gallons per year to create a prudent Ute water reserve for drought years, to have the option to store excess Ute water deliveries underground in the Blackwater Wellfield in wet years, and to conserve remaining groundwater in the wellfield for emergency use.