**DESIGN ANALYSYS REPORT**

**FOR**

**VILLAGE OF TULAROSA**

**SUPPLEMENTAL WATER SUPPLY**

**FEBRUARY 2025**

Prepared for:

**VILLAGE OF TULAROSA**

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# 1 BACKGROUND

## 1.1 PURPOSE

The Design Analysis Report (DAR) for the Supplemental Water Supply Project in Tularosa, NM, aims to address the current state of the village's water system and the need for a reliable, alternative water source. This report is built on the findings of the village's water usage and a hydrogeologic study by John Shoemaker and Associates, Inc.

The surface water treatment plant in Tularosa is designed to treat 2 million gallons per day (MGD), current records show that it is producing around 1.6 MGD during the peak months. This indicates that the plant is operating below its full capacity.

The hydrogeologic study raises concerns about the long-term sustainability of the water supply from the Tularosa creek. The study suggests that the water flow in the creek is decreasing over time, and this trend could lead to a situation where the creek no longer provides sufficient water to meet the needs of the entire village. As the creek's water supply potentially diminishes, the village may face challenges in ensuring a steady, reliable water source.

Given the potential risks associated with relying solely on the Tularosa creek, an alternative water production method is recommended to ensure that the village has enough water in case of an emergency. A recommendation is to drill a new well that will replace the existing Montezuma well. This groundwater will serve as a supplementary source of water, ensuring that the village has a reliable supply even if the surface water supply becomes insufficient.

The hydrogeologic study also indicates that the groundwater in the region, including the new well, contains high levels of Total Dissolved Solids (TDS). High TDS levels can affect water quality and may make it unsuitable for direct consumption or use without treatment. To address the high TDS levels and make the water from the Montezuma well usable, the DAR recommends the installation of a Reverse Osmosis (RO) facility.

The RO system will treat the water from the well, reducing the TDS and ensuring that it meets the required quality standards for beneficial use. This solution will allow the newly sourced groundwater to be put into the village's water system and used immediately if needed, especially during times of reduced surface water availability. The recommended location for the RO facility is next to the storage tank site .Land already owned by the village. Locating the RO plant and the new Montezuma Well near the fire station, the village can take advantage of pre-existing land ownership, enhance operational efficiency, and minimize costs related to land acquisition and infrastructure development. This strategic positioning of both the water source and treatment facility will enable the village to respond effectively to water supply challenges and ensure a reliable, high-quality water source for the future.

## 1.2 LOCATION

The Village of Tularosa is situated within Otero County, New Mexico, at the intersection of US highway 54 and 70. It lies approximately 13 miles north of Alamogordo and 80 miles northeast of Las Cruces. Recognized for its historical significance, Tularosa attained the designation of a historic district in 1979. The village is hydrologically located in the Tularosa Basin west of the Sacramento Mountains. The village relies on surface water sourced from the Tularosa Creek for its water supply. The village is at an elevation of 4250 feet above sea level. The area has a semi-arid, continental climate characterized by light and variable total precipitation, large diurnal and moderate annual temperature ranges, low relative humidity, and plentiful sunshine.

## 1.3 COMMUNITY INFORMATION

Founded in 1860 The Village of Tularosa was settled in 1863 by Hispanic farmers and 49 blocks were mapped and the village was formally established with water rights. The main source of water for the public water supply system in the village of Tularosa is Tularosa Creek, also known as Rio Tularosa. It is a perennial stream which originates at the higher elevations of the Sacramento Mountains. Presently, the village provides water and wastewater services to its residents, supporting amenities such as public schools, grocery stores, service stations, restaurants, and various offices.

The village is currently facing significant challenges with its water supply. Concerns have been raised about the creek's ability to meet the increasing demand, and groundwater usage is not feasible due to elevated levels of total dissolved solids (TDS). The village has two wells, the Stodgen Well and the Montezuma Well; however, both are currently inactive. The Stodgen well was drilled in 2007 searching for better quality water which was not obtained. The Montezuma Well has exceeded its operational lifespan and is recommended for replacement.

## 1.4 SUPPLEMENTAL HYDROGEOLOGIC STUDY

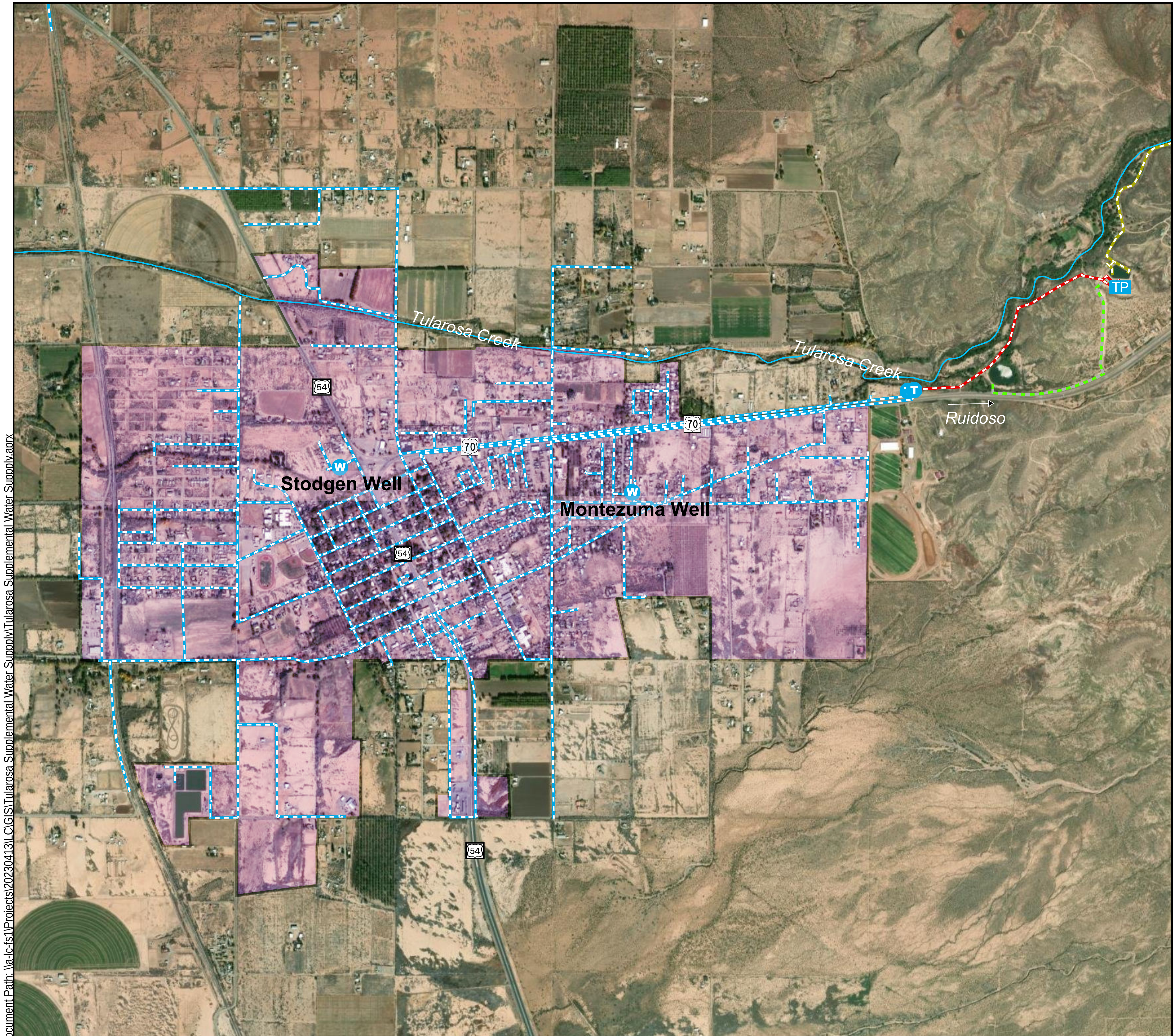
John Shoemaker & Associates (JSAI) completed a hydrogeologic study for the Village of Tularosa to evaluate supplemental water supply options, specifically in relation to the village's surface water resources. This study was conducted in conjunction with the Design Analysis Report (DAR) and provides a comprehensive hydrogeologic subsurface evaluation of the village's service area. The study includes a review of historical well production data, an assessment of existing groundwater contamination sources, an analysis of long-term regional water-level declines, and the identification of potential well sites along with estimated yields at these locations. The full study can be found in **Appendix A**.

The findings from JSAI's evaluation offer a detailed overview of the current condition of the surface water available to the village and recommend specific improvements to the village’s groundwater system. This is particularly relevant for addressing the challenges associated with surface water availability in the future and the need for alternative water sources.

Key findings from the study include:

- High levels of Total Dissolved Solids (TDS) in the village's groundwater, which exceed acceptable limits for potable water use without treatment.
- Highlights significant concerns about the Tularosa Creek and its ability to provide a reliable water supply for the Village of Tularosa in the future.
- The capacity of existing wells to produce the required water volume to complement surface water production during periods of high demand, particularly in the summer months.
- A recommendation to explore injection wells as a method for storing excess winter surface water from Tularosa Creek. This stored water could then be reused during peak demand periods in the summer, helping to manage seasonal water shortages and increase the village’s water supply reliability.

The hydrogeologic study provides critical insights and actionable recommendations to help the village ensure a sustainable and reliable water supply. These findings will be essential as the village moves forward with the implementation of the proposed water supply improvements.




## Legend

- TP Surface Water Treatment Plant
- W Existing Groundwater Well (Inactive)
- T Existing Water Storage Tank Site
- Existing Distribution Line
- Existing Transmission Raw Water
- Existing Transmission Finished Water
- Existing Transmission Backwash Water
- Tularosa Village Limits

NORTH

2,000 1,000 0 2,000

Feet

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**Figure 1**
**Village of Tularosa**

Supplemental Water Supply
**Existing Water System**

# 2 EXISTING FACILITIES

## 2.1 LOCATION MAP

**Figure 1** illustrates the boundaries of the village and identifies locations of existing components contributing to the surface water supply and distribution system. **Figure 2** provides a detailed overview of the primary components within the surface treatment plant.

## 2.2 SUPPLY SYSTEM DESCRIPTION

The surface water supply system consists of an intake structure that is located near the Tularosa creek. The raw water is screened through a sandbox bar screen and sent to the surface water treatment plant. The backwash water is sent to a reservoir that is located south of the surface water treatment plant and treated water is discharged into the storage two tanks that are located southwest of the surface treatment plant. **Figure 2** illustrates these components and their precise locations within the water supply system.

The Hydrogeologic Study for the Village of Tularosa by John Shomaker and Associates, Inc. summarizes the village's water rights, totaling 1,529.90 acre-feet per year, of which 701.25 ac-ft are allocated to surface water rights. There are 755.35 ac-ft allocated to groundwater municipal use. The remaining 73.3 ac-ft of water rights are allocated to irrigation use. The village has two wells, the Stodgen Well (T-03861) and the Montezuma Well (T-0020 B).

Additionally, the village has two existing storage tanks on its eastern side, with capacities of one million gallons and two million gallons, respectively. The distribution lines, originally installed in the 1960s, are currently a focus for replacement due to significant water losses. According to the 2018 Conservation Plan by Bohannan Huston, approximately 10% of total water production is lost through leaks.

Unlike larger towns, the village utilizes an acequia irrigation system, which continues to serve tree-lined streets, gardens, and landscaping. While the village now has a modern water distribution system, the acequia remains an active component of irrigation. The surface water treatment plant is located approximately one mile east of the village limits.

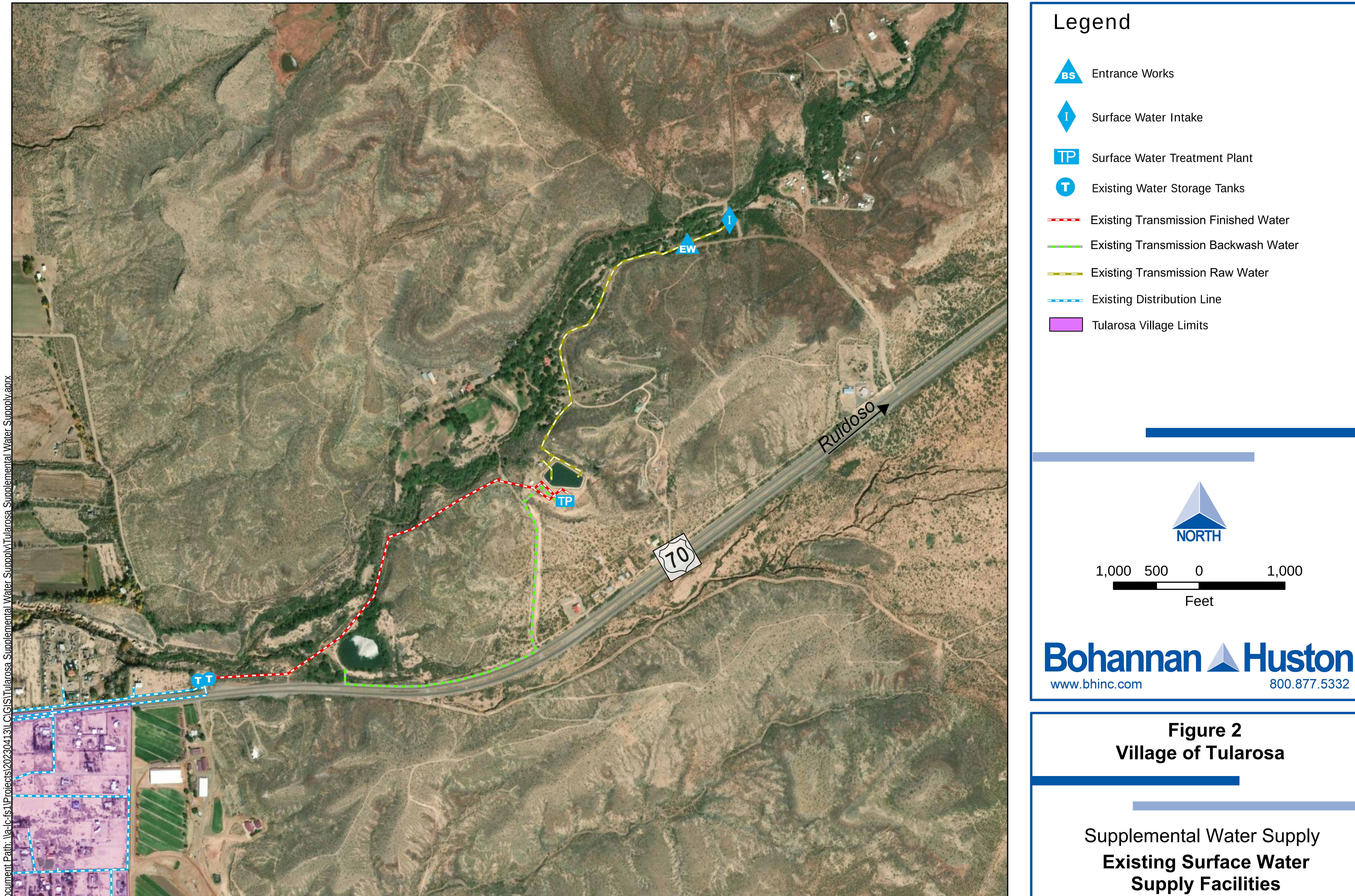


**Figure 2**
**Village of Tularosa**

Supplemental Water Supply
**Existing Surface Water Supply Facilities**

## 2.3 CONDITION OF EXISTING FACILITIES

### 2.3.1 GROUNDWATER PRODUCTION WELLS

The existing wells owned by the Village of Tularosa, the Stodgen Well and the Montezuma Well, produce brackish water that is not safe for consumption without treatment. Both wells have elevated levels of total dissolved solids (TDS). According to the 2023 *Hydrogeologic Study for Supplemental Water Supply* conducted by John Shomaker & Associates, Inc., the TDS content of the Stodgen Well and Montezuma Well are 2,500 mg/L and 1,900 mg/L, respectively.

The Stodgen Well, located near the intersection of NM-54 and NM-70, was drilled in 2007 and has a capacity of 280 gallons per minute (gpm). However, the well has not been in operation in recent years.

The Montezuma Well is located on Montezuma Avenue, on the eastern side of the village. This well, which has a capacity of 550 gpm, is estimated to be at least 69 years old, surpassing the typical lifespan of 40-60 years for groundwater wells. Despite its age, the well is estimated to still produce approximately 350 gpm in its current condition.

### 2.3.2 SURFACE WATER TREATMENT PLANT

The surface water filter plant in Tularosa plays a vital role in ensuring the community has access to potable water. With a processing capacity of 2,000,000 gallons per day (gpd), the plant can effectively meet the daily water demands for the village. Additionally, the plant has 5 million gallons (MG) of storage capacity in the sedimentation pond, which helps in maintaining a buffer supply in case of fluctuations in water demand or any temporary disruptions in the treatment process.

Recent upgrades in 2019 were completed at the surface treatment plant. These improvements include the replacement of the UV module, installation of an additional filter, headworks modification, and replacement of several feet of piping. These improvements are crucial for maintaining water quality and ensuring the system meets modern standards for safe water treatment. Overall, the surface water treatment plant's continued operation and its recent system improvements are central to providing reliable and safe drinking water for Tularosa's residents.

#### 2.3.3 STORAGE FACILITIES

The two finished water storage tanks on the eastern side of the Village are critical components in the overall water supply system for Tularosa. With capacities of 1 million gallons and 2 million gallons, these tanks provide a combined storage capacity of 3 million gallons. This storage is essential for meeting the water demands of the village, especially during times of high consumption or when the surface water filter plant is temporarily offline for maintenance or repairs.

These tanks serve as the primary water storage for the entire village, ensuring a steady supply of water for residential, commercial, and public needs. Having such significant storage capacity helps stabilize the water supply system by providing a reserve that can be drawn upon during peak usage hours or emergencies, ensuring that the village's water needs are consistently met.

#### 2.3.4 TRANSMISSION AND DISTRIBUTION SYSTEMS

The village has over 33 miles of transmission and distribution pipeline throughout the system. The distribution system consists of a main trunk 12” C-900 PVC distribution line, with a second main 8” distribution line from the tank site. All other distribution pipelines typically are 6” PVC or AC material. The AC waterlines were installed in the 1960’s and are continuously being replaced as funding allows.

### 2.4 POPULATION

According to Census data, Tularosa's population was 2,828 residents in 2000, slightly increased to 2,842 in 2010, and then decreased to 2,553 in 2020. The most recent estimate for 2024 puts the population at 2,590, showing a relatively stable trend with minimal fluctuation over the years. The 2022 Census recorded 1,085 households in the village. However, water distribution records indicate there are 1,259 active connections receiving water services, suggesting that some properties may have multiple connections, or that non-residential or agricultural accounts contribute to the total number of connections.

**Figure 3** illustrates the population trend from 2000 to 2022 and shows a slight decline over the years. However, the chart also shows a recent increase in population since 2020, indicating a rebound in the communities’ growth.

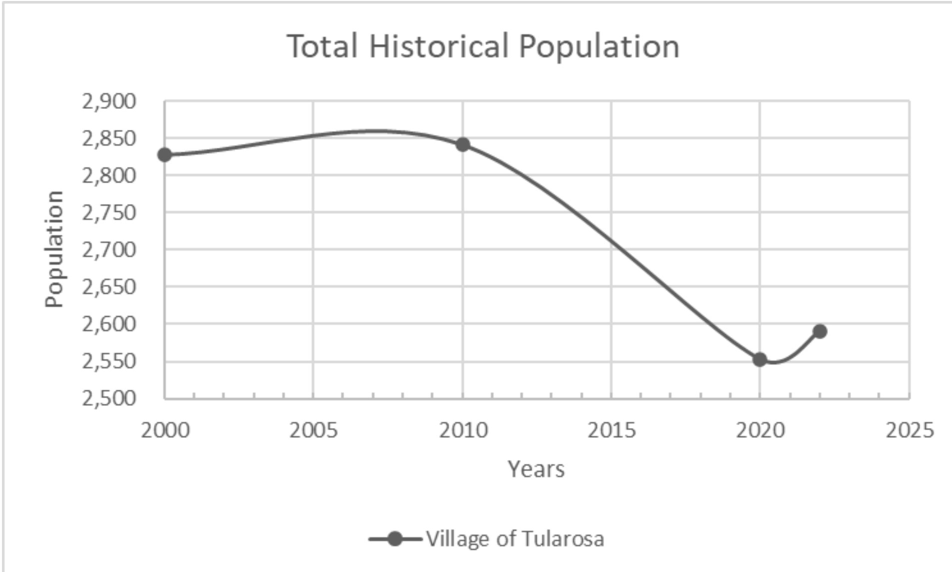


**Figure 3. Historical Population in Tularosa**

Otero County has experienced a population growth of 0.4% over the past 20 years, while Tularosa has seen a decline in population until recent years, when it began to experience an increase. The village's population trend reflects this recent growth. According to the Water Conservation Plan implemented in 2018, Tularosa has been using an average annual growth rate of 0.2%. For this design analysis report, we will also apply an average annual growth rate of 0.2% to project the village's population over the next 20 years. **Table 1** outlines the planning period for the village of Tularosa, incorporating the projected population growth of 0.2% annually over the next two decades.

**Table 1: Planning Period Population Projection**

| Year | Population | Annual Growth |
|---|---|---|
| 2024 | 2590 | - |
| 2025 | 2595 | 0.2% |
| 2029 | 2616 | 0.2% |
| 2034 | 2642 | 0.2% |
| 2039 | 2669 | 0.2% |
| 2044 | 2696 | 0.2% |

The village's water distribution data indicates that water demands fluctuate throughout the year, with higher usage during the summer months compared to the winter. In the winter, the village's average water usage is approximately 500,000 gallons per day. However, during the summer, the demand increases significantly, with peak usage reaching up to 1,600,000 gallons per day. The surface water treatment plant is capable of treating up to 2,000,000 gallons per day, which allows it to handle these seasonal peaks, even at the highest demand levels. **Table 2** reflects the amount of processed water provided by the surface treatment plant for the Village of Tularosa during the year 2023 helping to evaluate the plant's performance in relation to the village's water consumption.

**Table 2: Surface Water Treatment Plan Summary in 2023**

| Month | Average Gallons/Day | Minimum production Day | Maximum Production Day |
|---|---|---|---|
| January | 395,194 | 119,000 | 804,000 |
| February | 405,464 | 106,000 | 844,000 |
| March | 516,000 | 151,000 | 884,000 |
| April | 698,862 | 200,000 | 999,000 |
| May | 758,613 | 175,000 | 1,037,000 |
| June | 825,129 | 477,000 | 1,018,000 |
| July | 972,000 | 721,000 | 1,453,000 |
| August | 896,065 | 416,000 | 1,552,000 |
| September | 663,613 | 383,000 | 1,224,000 |
| October | 556,806 | 160,000 | 1,071,000 |
| November | 421,467 | 111,000 | 1,043,000 |
| December | 369,774 | 147,000 | 969,000 |
| Annual Average | 623,249 | | |
| **Annual Water Produced** | | **228,813,000** | Gallons |

The village's water distribution data reveals a discrepancy between the amount of water produced by the surface treatment plant and the amount actually distributed to consumers. In 2023, the plant produced approximately 228 million gallons of water, while only 213 million gallons were distributed. This difference suggests potential issues such as leaks in the distribution system or metering inaccuracies, which may be preventing an accurate measurement of the water being distributed.

**Table 3** provides a summary of the distribution data for the village during the 2022-2023 period. This table helps to highlight the gap between the water produced and the water delivered, serving as a basis for further investigation into system losses or technical issues that could be affecting the accuracy of water distribution records.

**Table 3: Water Distribution Summary 2022-2023**

| Month | Residential customers | Commercial Customers | Residential Billed Gallons | Commercial Billed Gallons | Total Billed Gallons | Gallons/Day |
|---|---|---|---|---|---|---|
| August | 1,254 | 59 | 26,441,000 | 11,485,000 | 37,926,000 | 1,223,419 |
| September | 1,255 | 59 | 17,584,000 | 261,000 | 17,845,000 | 594,833 |
| October | 1,255 | 59 | 7,790,000 | 540,000 | 8,330,000 | 268,710 |
| November | 1,259 | 59 | 5,572,000 | 1,422,000 | 6,994,000 | 233,133 |
| December | 1,262 | 59 | 5,884,000 | 400,000 | 6,284,000 | 202,710 |
| January | 1,261 | 59 | 6,601,000 | 2,181,000 | 8,782,000 | 292,733 |
| February | 1,258 | 59 | 10,163,000 | 461,000 | 10,624,000 | 379,429 |
| March | 1,262 | 58 | 9,414,000 | 637,000 | 10,051,000 | 324,226 |
| April | - | - | - | - | - | - |
| May | 1,264 | 67 | 7,696,000 | 1,383,000 | 9,079,000 | 292,871 |
| June | 1,262 | 58 | 40,751,000 | 7,740,000 | 48,491,000 | 1,616,367 |
| July | 1,262 | 58 | 40,751,000 | 7,740,000 | 48,491,000 | 1,564,226 |
| | | **Annual Usage** | **178,647,000** | **34,250,000** | **212,897,000** | **6,992,657** |

Based on the available distribution data, it was determined that the village distributed 212,897,000 gallons of water in the year. To ensure consistency with the 2018 Water Conservation Plan prepared by Bohannan Huston, Inc., an average household size of 2.37 was used for this report. Using this figure, the gallons per capita per day (gpcd) was calculated to be 190 gallons.

In comparison, the 2018 conservation plan indicated a gpcd value of 187. This represents a slight increase in water consumption, which may reflect various factors such as changes in household behavior, increased water use during peak periods, or issues with the distribution system. This rise in consumption may warrant further analysis to understand the underlying causes and consider appropriate strategies for water conservation moving forward.

# 3 NEED FOR PROJECT

## 3.1 HEALTH, SANITATION, AND SECURITY

The village's ability to meet its required water demands is in a critical condition due to a concerning trend observed at the creek, where water levels have been running lower. This trend has raised significant concerns for the village, as the current surface water source may no longer be sufficient to meet future water needs. As a result, the village is actively seeking alternative sources to supply water to its residents. This may involve exploring new water supply options or implementing additional infrastructure to ensure a reliable and sustainable water source for the community in the coming years.

Annual data from the USGS National Water Information System for the period from 2000 to 2024 for the Tularosa Creek near Bent, NM, shows a clear negative trend in the discharge of water (measured in cubic feet per second) into the meter. This data supports the concerns raised by the village, which were also highlighted in the hydrogeologic study, indicating that the creek's water flow has been progressively decreasing each year. Detailed historical data from the United States Geological Survey (USGS) regarding Tularosa Creek can be found in **Appendix C**

This decline in water discharge is a serious concern for the village, as it threatens the sustainability of the current water supply. Given this trend, it is evident that alternative water production methods need to be considered and planned for in order to ensure a reliable water source for the community in the future. The village must begin exploring other options to secure a consistent and sustainable water supply, such as new groundwater sources, additional surface water options, or water conservation strategies. **Figure 4** illustrates the historical trend of the discharge into the meter located at the Tularosa Creek near Bent, NM.

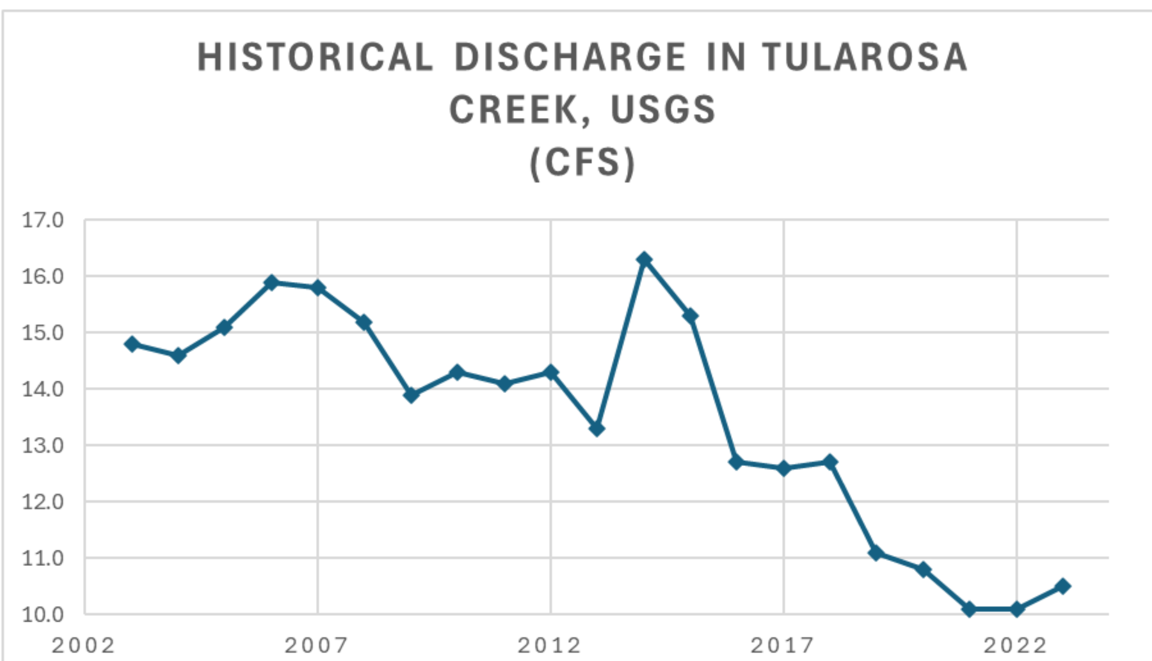


**Figure 4. Historical Discharge in Tularosa Creek**

It has been determined that the Village of Tularosa is in urgent need of a supplemental water source, and this need is categorized as an emergency crisis due to the potential consequences of a failure in their primary water supply. Currently, surface water accounts for the majority of the village's water distribution, but an alternative, reliable source of safe drinking water is essential for the sustainability of the community.

One of the major concerns is that the village lacks redundancy in its water supply system. If the surface water treatment plant were to fail, there would be no immediate alternative means of obtaining potable water. This situation underscores the critical need for a backup water source.

A viable solution would be for the village to utilize its groundwater wells, provided they are treated properly before being distributed. The existing wells are capable of supplying sufficient groundwater to meet the village's excess water demands during the summer, as well as storing unused water during the winter months when demand is lower.

To enhance system redundancy, it is recommended to install a reverse osmosis (RO) system to treat the produced groundwater. This would ensure the production of high-quality potable water, even when the surface water system is under strain. Additionally, incorporating a reverse osmosis system would not only safeguard against potential water shortages, but also provide an alternative, reliable water source for the future, ensuring uninterrupted access to treated water and greater resilience in the village’s water supply system.

The groundwater in the Village of Tularosa has been found to contain high levels of Total Dissolved Solids (TDS), which exceed the standards set by the New Mexico Environment Department/Drinking Water Bureau (NMED/DWB) of 500 mg/L. Specifically, the Stodgen well has a TDS level of 2,500 mg/L, and the Montezuma well has a TDS level of 1,900 mg/L. These elevated TDS levels make the groundwater unsuitable for direct consumption without treatment.

In addition to high TDS, water quality studies have also identified high sulfate concentrations in the area. Furthermore, some irrigation water used in the village has shown elevated levels of nitrate and chloride, which could pose further challenges to water quality and health standards.

Given these water quality concerns, it is essential for the village to find a method to treat this groundwater in order to bring it up to the standards required for safe drinking water distribution. Since the current groundwater supply is not suitable for beneficial use without treatment, the village must implement a water treatment solution that meets the standards imposed by NMED.

One effective treatment method would be the installation of a reverse osmosis (RO) system, which is capable of removing excess TDS, sulfate, nitrate, and chloride concentrations from the groundwater. Reverse osmosis is a filtration process in which water is forced through a specialized membrane to remove impurities. This membrane is designed to permit the passage of small water molecules while retaining larger particles, such as salts, minerals, and contaminants. The result is purified water, free from most impurities, which can be safely utilized for various beneficial purposes, including drinking. The RO system would allow the village to utilize its groundwater resources while ensuring that the treated water meets the required quality standards for safe distribution to customers.

By implementing this treatment method, the village would be able to secure a reliable and safe water source to meet both current and future demands, especially during periods of high consumption, such as the summer months. This approach would also provide redundancy to the village's water supply system, ensuring access to potable water even if surface water resources become insufficient.

## 3.2 AGING INFRASTRUCTURE

The water distribution system in the Village of Tularosa was originally installed in the 1960s, and over time, it has experienced some challenges related to aging infrastructure. A 2018 water audit, included in the Water Conservation Plan, identified a 10% water loss, which is attributed to leaking AC and galvanized pipes. These older pipes are planned for replacement as funding becomes available. The audit also noted that the village has a higher water usage (gallons per capita per day) compared to similar water systems. Contributing factors include the leaks in aging pipes, the lack of enforced watering ordinances, and the presence of older homes with outdated fixtures and appliances, all of which increase overall water consumption.

In 2019, several improvements were made to the surface water treatment plant, including the replacement of waterline pipes throughout the village, as well as enhancements to the desilting basin and raw water intake. While these improvements were significant, additional upgrades to the water system are still needed.

The Montezuma well, which has been in service for 69 years, has reached the end of its useful lifespan. It is recommended that a replacement well be installed to ensure continued water production and to help the village retain its water rights. This replacement is recommended as part of Phase 2 of the project, ensuring a reliable and sustainable groundwater source for the future.

While the village has made strides with its water system improvements, there remains a need for further enhancements to ensure the reliability, efficiency, and sustainability of its water supply and distribution system. Addressing these issues will be critical to meeting future water demands and maintaining a reliable supply for the community.

## 4 PROJECT DESCRIPTION

The following figures are intended to provide a visual representation of the overall site and the proposed components for the water supply improvements in the Village of Tularosa. These figures will help to illustrate the location and layout of the proposed infrastructure, such as the reverse osmosis (RO) treatment facility, the new groundwater well, the evaporation ponds, and the solar array. They are designed to give a clear understanding of how these elements will be integrated into the village's existing water system, as well as the areas where critical improvements will take place.

**Figure 5** illustrates the overall scheme of the proposed water supply project for the Village of Tularosa. The selected land for the project is already owned by the village and includes the existing finished water storage tanks, which will remain in place. This area will also host several key components of the proposed improvements, including:

- Transmission line from the Montezuma well that will supply the RO facility while the new groundwater well is drilled.
- New Groundwater Well: A new well will be drilled in this area to supplement the village's groundwater supply. Also, this new groundwater well is intended to be a replacement for the existing Montezuma well.
- New Raw Water Tank: A new tank will be constructed to store raw water extracted from the groundwater well before it is treated at the Reverse Osmosis (RO) facility.
- New Solar Array: To support the energy requirements of the groundwater extraction, treatment, and storage systems, a solar array will be installed, providing a renewable energy source to reduce electricity costs.

Additionally, the RO treatment facility requires a designated area to handle the rejected concentrated brine water that is a byproduct of the reverse osmosis process. To efficiently manage this brine, evaporation ponds will be constructed. These ponds will serve to separate solids from the rejected water and allow for safe disposal. The design includes 4 evaporation ponds, requiring a total area of 15 acres to effectively discharge and manage the brine water.

In addition to the site layout, a process diagram is included in this report to describe the overall water system, including the integration of the reverse osmosis facility. This diagram provides a detailed visualization of how the various components of the water supply system, including the new groundwater well, RO treatment facility, raw water tank, and evaporation ponds, interact to ensure a continuous and reliable water supply for the village. The process diagram is depicted in **Figure 7.** Evaporation Pond Site Layout

to provide a comprehensive overview of the system design.

It is crucial for the Village of Tularosa to be able to meet the expected water demand throughout the year, ensuring a reliable and consistent supply of safe drinking water to its residents. The addition of a RO treatment plant along with all the supporting components will provide the necessary infrastructure to achieve this goal.

By incorporating the RO treatment plant, the village will have the capability to treat groundwater to meet potable water standards, addressing the challenges posed by the declining surface water supply from Tularosa Creek. The redundancy built into the system will ensure that the village is not solely reliant on one water source but has multiple sources of treated water that can be drawn upon during times of high demand, particularly during the summer months when water use peaks.

The integration of these components will not only provide safe drinking water for distribution but will also create a more sustainable and resilient water supply system. This approach will ensure that the village can meet both current and future water demands while adapting to changing environmental conditions, ensuring the long-term security of the water supply.


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## Legend

- Existing Distribution Line
- Raw Water - Montezuma Well
- RO Rejected to Evaporation Ponds
- Backwash Water
- Finished Water

NORTH

100 50 0 100

Feet

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**Figure 5**
**Village of Tularosa**

Supplemental Water Supply
**Proposed Reverse Osmosis Facilities**

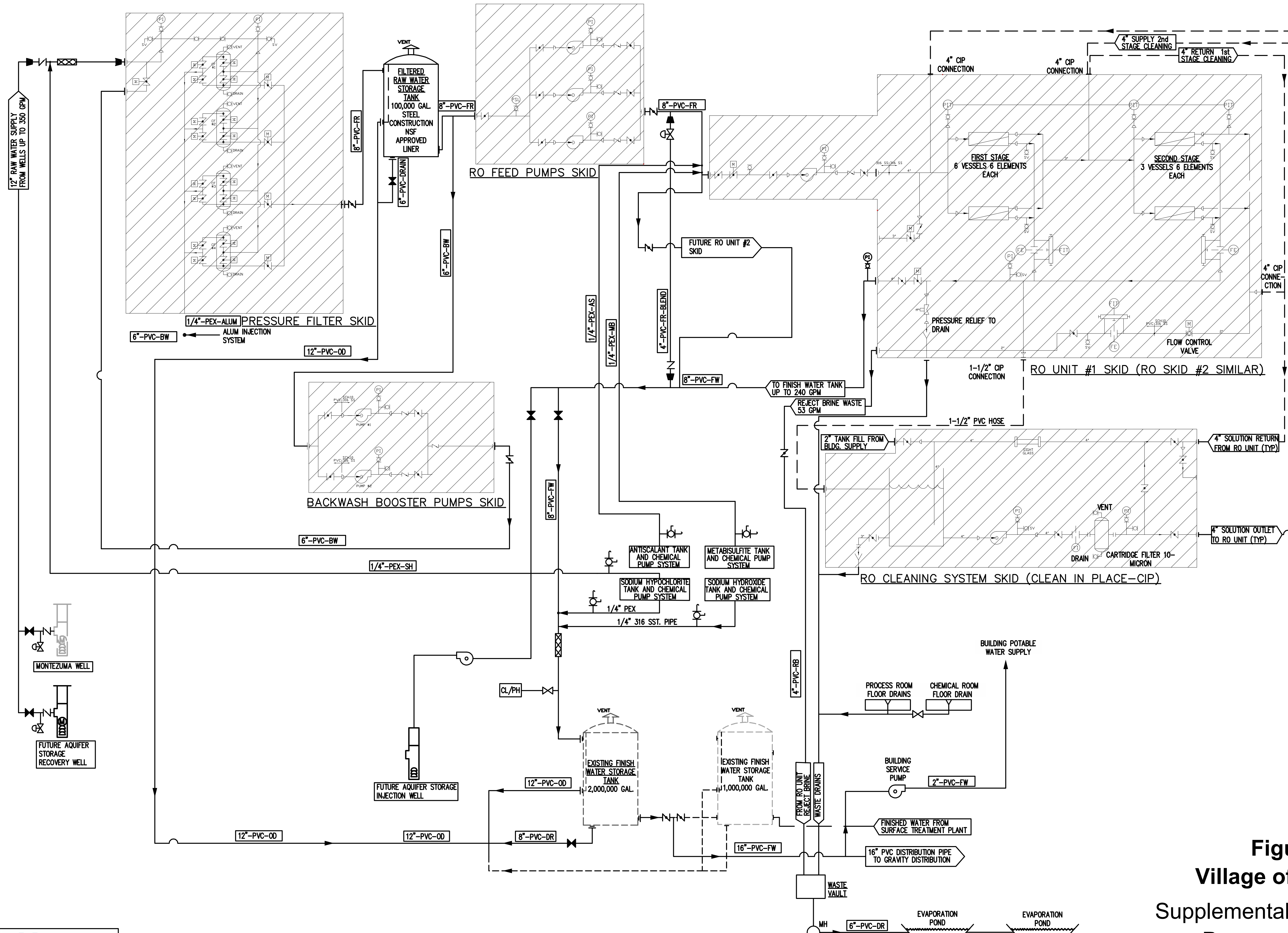



**Figure 6**
**Village of Tularosa**
Supplemental Water Supply
**Process Diagram**

Bohannan Huston

## 4.1 BASIS FOR DESIGN CRITERIA

The project is designed with a 20-year planning horizon, taking into account the number of active connections and projected population growth. This approach is used to estimate future water demand and serves as the foundation for the system's design and capacity planning. In section 2.1, The existing water demands for the village were analyzed, revealing that the average daily production is approximately 600,000 gallons, while the average daily distribution demand is around 500,000 gallons. **Table 4** outlines the projected water production requirement for the village over the next 20 years, reflecting anticipated growth and usage trends.

**Table 4: Projected Water Production Required**

| | | ADD, gpd | PDD, gpd | |
|---|---|---|---|---|
| Year | Active Connections | Average Daily Production | Peak Daily Production | Annual Consumption ac-ft |
| 2023 | 1,320 | 623,249 | 1,074,833 | |
| 2025 | 1,325 | 653,660 | 1,127,279 | 732.6 |
| 2030 | 1,339 | 660,229 | 1,138,608 | 740.0 |
| 2035 | 1,352 | 666,865 | 1,150,051 | 747.4 |
| 2040 | 1,366 | 673,567 | 1,161,610 | 755.0 |
| 2044 | 1,377 | 678,977 | 1,170,940 | 761.0 |

The production data from the surface treatment plant served as the basis for the projections presented in **Table 4.** This approach was adopted because distribution data could be influenced by system leaks or metering inaccuracies. By the year 2044, the village is estimated to produce 761 acre-feet of water annually. Since the village holds 701.25 ac-ft of surface water rights, additional surface water rights will be required to provide an adequate upper limit to ensure an exceedance is not experienced. This highlights the rationale of supplementing the surface water rights with groundwater rights for the potential community growth in the future.

However, as the village utilizes their groundwater right resources, it will require a merging of the water right points of diversion as a new groundwater well extraction point. **Table 5** provides a summary of the water rights associated with the village obtained from the NMOSE NMWRRS.

**Table 5: Water Rights Summary**

| NMOSE File | Water Right | (ac-ft)/yr |
|---|---|---|
| Cause No. 293 | Surface Water | 701.25 |
| T-0020 B, Stodgen Well | Groundwater | 86.3 |
| T-3861, Montezuma Well | Groundwater | 669.05 |
| T-006G | Irrigation | 5.54 |
| T-0013 BBA | Irrigation | 2.25 |
| T-3417A | Irrigation | 65.51 |
| | **Total** | **1529.90** |

The hydrogeologic study conducted by John Shomaker and Associates, Inc. offers a detailed analysis of the groundwater quality in the village. A comprehensive summary of their findings is included in **Appendix A**. Additionally, **Table 6** provides a summary of key information regarding the groundwater wells owned by the village.

**Table 6: Summary of Village of Tularosa Wells**

| Name | Year Drilled | Total depth, ft | Reported Yield gpm | Total Dissolved Solids Mg/L |
|---|---|---|---|---|
| Stodgen Well | 2007 | 350 | 283 | 2,500 |
| Montezuma Well | 1954 | 364 | 550 | 1,900 |

### 4.1.1 REVERSE OSMOSIS TREATMENT FACILITY

Wigen Water Technologies presented a detailed conceptual proposal for brackish water treatment using reverse osmosis (RO) membrane technology. The proposed system is designed to treat 0.5 million gallons per day (MGD) of groundwater, with the capability to expand to 1 MGD as needed. The design parameters for this treatment facility are based on the projected water demand and the groundwater quality data from the hydrogeologic study, which indicates total dissolved solids (TDS) levels of up to 2,500 mg/L. **Appendix B** contains the proposal of the recommended RO system from Wigen Water Technologies. **Table 7** provides a detailed summary of the performance metrics for the proposed RO membrane system.

**Table 7: RO Facility Performance Details**

| | |
|---|---|
| Feed Flow | 315-350 gpm max |
| Permeate (finished) Flow | 220-250 gpm max |
| System Array | 8:4, 5L |
| Membrane Element Diameter | 8-Inch |
| Membrane Element Area | 400 Square Feet |
| Membrane Flux Rate | 12 - 15 gfd |
| System Design Recovery | 71% |
| Cartridge Size | 5 micron |
| Membrane Quantity | 60 per skid |
| Dimensions | 240"x84"x96" |

Based on the criteria provided for the RO facility, the expected permeate (finished) water flow will range from 220 GPM to 250 GPM. This corresponds to a finished water output of approximately 0.3 MGD to 0.36 MGD. Therefore, the recommended facility design includes two skids, which will be capable of meeting the future distribution demand of 0.5 MGD.

### 4.1.2 Solar Array

The proposed solar array design is based on similar projects in southern New Mexico with comparable applications. The system will be sized to maximize the onsite energy production and minimize new energy consumption.

### 4.1.3 Evaporation Ponds

The evaporation pond layout depicted in **Figure 7** was designed based on calculations of the water evaporation rate and the sediment volume generated by the RO system. The RO treatment facility is planned to operate initially during the summer months, producing an output rate of approximately 100 gallons per minute (gpm), based on its 71% recovery rate.

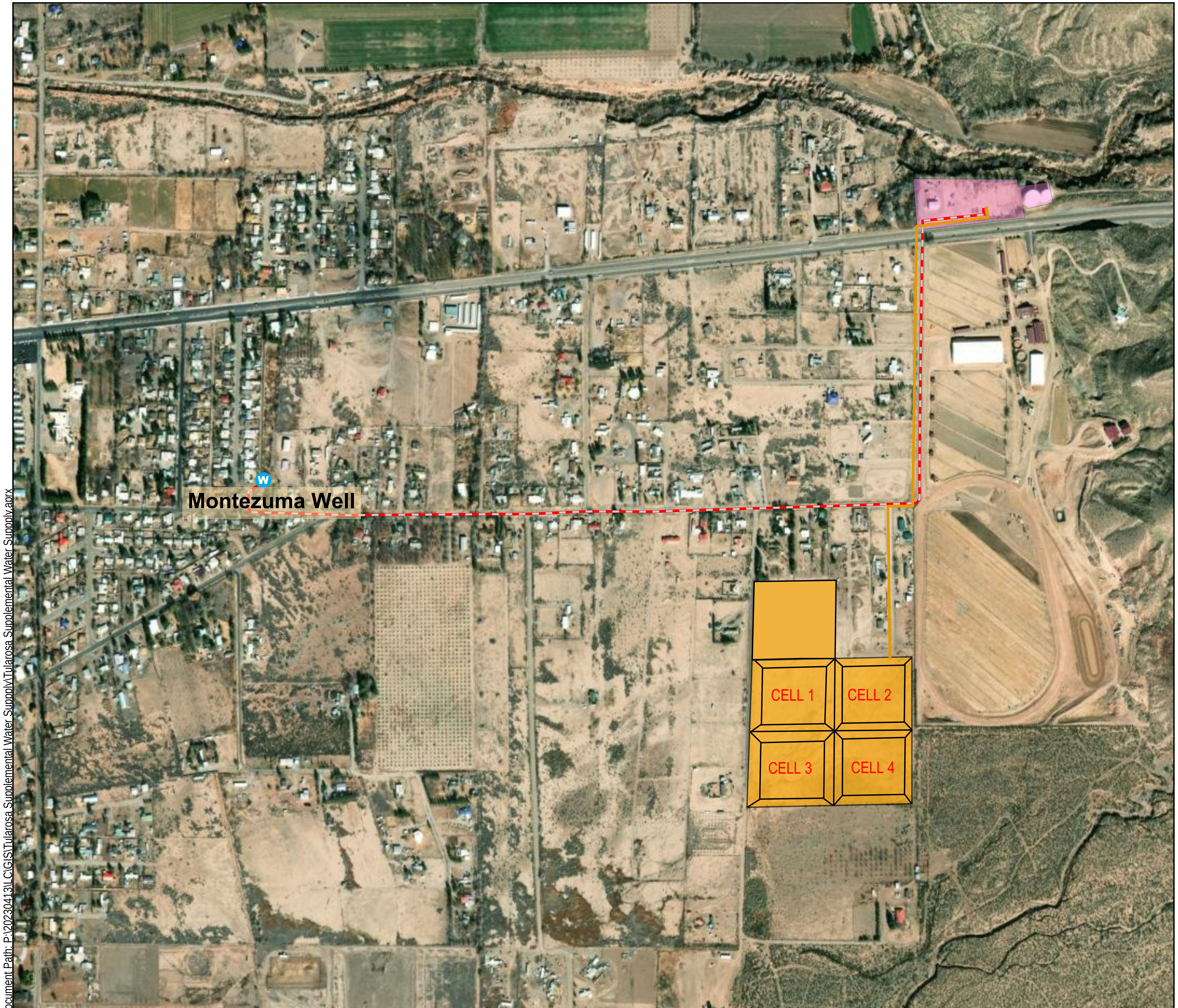
Under these conditions, it was estimated that the village will require approximately 16 acres of land to manage the 653,400 square feet of water produced as reject from the RO facility Annually. Additionally, sediment generation is estimated at 40,000 cubic feet per year, or approximately 4 cubic yards per day. It is recommended a nearby location of 26 acres, which includes the 16 acres required for current operations and additional space to accommodate future expansion. Considering the land geometry, the most efficient utilization of space involves the construction of four evaporation ponds. The calculation spreadsheet use for the evaporation ponds can be found in **Appendix D.**

The village will need to negotiate the acquisition of this 26-acre land. If securing this location is not possible, alternative locations will need to be explored for the construction of the evaporation ponds. It will be important to find a suitable alternative site that can accommodate the required space and meet environmental and logistical considerations.

**Table 8** provides the design parameters selected for the required evaporation ponds.

**Table 8: Pond Evaporation Criteria**

| | |
|---|---|
| Area needed (Acres) | 16 |
| Expected Water Surface Area ($ft^{2)}$ | 653,400 |
| Annual Sediment Volume ($ft^3$) | 39,612 |
| No. of Ponds | 4 |
| Pond Length (ft) | 410 |
| Pond Width (ft) | 410 |
| Pond Depth (ft) | 3.5 |

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## Legend

- W Wells
- RO Rejected to Evaporation Ponds
- Raw Water from Montezuma Well
- Proposed Area for Evaporation Ponds
- RO Treatment Facility

NORTH

700 350 0 700

Feet

Bohannan Huston
www.bhinc.com 800.877.5332

**Figure 7**
**Village of Tularosa**

Supplemental Water Supply
**Proposed Evaporation Pond Layout**

## 4.2 PROJECT LAND REQUIREMENTS

The village owns the necessary land for the proposed reverse osmosis (RO) treatment plant. This site currently houses Fire Station VFD #2, and the two storage tanks used for treated surface water storage. The site offers adequate space to accommodate most of the components recommended in this report.

However, the project also requires the addition of evaporation ponds to manage the rejected water from the RO system. The minimum area needed to effectively evaporate the rejected water is 16 acres, divided among four evaporation ponds. As the current site does not provide sufficient space for the ponds, the village will need to negotiate for or acquire additional land to meet this requirement. **Figure 7** illustrates the recommended layout, including the proposed evaporation ponds and their configuration. Challenges in obtaining private easements may require the exploration of alternative land options for the evaporation ponds. It is imperative for the village to initiate planning and actively search for suitable land to accommodate the ponds. Adequate time should be allocated for securing permits, negotiating easements, and completing land acquisition processes.

Additionally, the potential for waterline alignments to conflict with existing utilities must be considered. Careful coordination with utility providers and thorough site assessments will be essential to mitigate these conflicts and ensure the successful implementation of the project.

## 4.3 POTENTIAL CONSTRUCTION PROBLEMS

All recommended improvements can be executed using conventional construction methods. However, potential challenges may arise, including conflicts between pipe alignments and existing utilities. Additionally, boring under US 70 may pose difficulties depending on the site's soil conditions. Proper planning, soil analysis, and coordination with utility providers will be essential to address these challenges and ensure the project progresses smoothly.

## 4.4 PERMIT REQUIREMENTS

In addition to the Contractor’s Construction General Permit, the recommended project will require several other permits and approvals such as Right-of-Way Permit, Drilling, Construction Industries Division (CID) Permit. Proper coordination with relevant agencies and sufficient lead time will be essential to secure these permits and facilitate project execution.

## 4.5 TOTAL COST ESTIMATE (ENGINEER'S OPINION OF PROBABLE COST))

| Village of Tularosa DAR ( Engineers Estimate) | | | | | |
|---|---|---|---|---|---|
| **Item** | **Description** | **Unit** | **Quantity** | **Unit Price** | **Extension** |
| 1 | Mobilization/Demobilization | LS | 1 | $ 786,000 | $ 786,000 |
| 2 | Utility Relocation Allowance | ALW | 1 | $ 50,000 | $ 50,000 |
| 3 | Material Testing Allowance | ALW | 1 | $ 15,000 | $ 15,000 |
| **Reverse Osmosis Facility** | | | | | |
| 4 | Treatment Facility Building | SF | 2,500 | $ 250 | $ 625,000 |
| 5 | Pre-Engineered Water Treatment System | LS | 1 | $ 1,260,000 | $ 1,260,000 |
| 6 | Interior Process Piping Installation | LS | 1 | $ 150,000 | $ 150,000 |
| 7 | Exterior Process Drain Structures | LS | 1 | $ 25,000 | $ 25,000 |
| 8 | Treatment Facility SCADA Electrical System | LS | 1 | $ 150,000 | $ 150,000 |
| 9 | Raw Water Storage Tank 100,000 gallons | LS | 1 | $ 250,000 | $ 250,000 |
| 10 | Brine waterline to evaporation ponds | LF | 300 | $ 30 | $ 9,000 |
| 11 | 6-inch PVC C-900 Transmission line | LF | 2,500 | $ 30 | $ 75,000 |
| 12 | Pipe casing | LF | 300 | $ 400 | $ 120,000 |
| **New Groundwater Well** | | | | | |
| 13 | Groundwater Well | VLF | 560 | $ 1,600 | $ 896,000 |
| 14 | Groundwater Well Sitework & Building | LS | 1 | $ 150,000 | $ 150,000 |
| **Evaporation Ponds (15 acres) 4 cells** | | | | | |
| 15 | Excavation | CY | 21,000 | $ 5.00 | $ 105,000 |
| 16 | HDPE Liner | SF | 705,600 | $ 1.50 | $ 1,058,400 |
| **Solar Array** | | | | | |
| 17 | Earthwork | LS | 1 | $ 10,000 | $ 10,000 |
| 18 | 4-inch Base Course | C.Y. | 2000 | $ 20 | $ 40,000 |
| 19 | Photovoltaic System Array and Service Interconnect | LS | 1 | $ 250,000 | $ 250,000 |
| | | | | **SUBTOTAL OF ITEMS 1 - 19** | **$ 6,024,400** |

## 5 PROJECT PHASING

The estimated project cost of $6 million indicate that the Village of Tularosa may not have sufficient funding to complete all necessary improvements simultaneously. Currently, the village has access to $4.7 million in available funds from loans and grants. To accommodate this budget, a phased implementation plan has been developed, prioritizing the most critical components within the available funding. A second phase will be required to complete the remaining components necessary for the plant to operate as designed.

The proposed project has been evaluated based on both the existing demand and the 20-year projected demand outlined in the Design Criteria (section 4.1), to ensure that the recommended improvements will adequately meet the village's needs throughout the planning period. As discussed in Section 1, the main concern is the declining trend of the Tularosa Creek, which could potentially be unable to provide the required water supply for the village. While it is uncertain exactly when the creek will no longer be a reliable water source, this trend emphasizes the urgency of addressing the water supply challenges.

The phasing of the project has been strategically planned, with an emphasis on critical components that can be installed and put into operation immediately. This approach allows for the most pressing needs to be addressed first, while the remaining components, which are necessary for the efficient utilization of the system, can be installed at a later stage when resources allow.

It is recommended to divide the project as follows.

PHASE 1:

- Install RO treatment facility with one skid with its respective building, electrical systems, and drain structures.
- Install a raw water storage tank for 100,000 gallons.
- Install a 6-inch PVC 900 Transmission line from the Montezuma well to the RO facility.
- Purchase the required land associated with the evaporation ponds.
- Install reject waterline from RO facility to Evaporation Ponds.
- Build one evaporation pond for brine management.

Phase 1 of the proposed project focuses on bringing the Montezuma well back into service to supply water to the proposed Reverse Osmosis (RO) facility. This will enable the village to immediately produce groundwater for beneficial use. It is also recommended that the land required for the evaporation ponds be acquired during this phase. The construction of one evaporation pond is recommended to provide a designated location for the disposal of brine reject (the highly concentrated, brackish water rejected during the reverse osmosis process) from the RO facility. At this stage, the village will be able to utilize their groundwater and RO facility with moderation while the rest of the components are integrated in phase 2.

PHASE 2:

- Install additional RO skid unit.
- Drill new groundwater well located next to the RO facility intended to replace the Montezuma well.
- Construction of remaining evaporation ponds for brine reject from RO facility.
- Installation of solar arrays

Phase 2 of the project aims to further enhance the water supply system by complementing the RO facility and addressing key infrastructure needs. This phase includes several critical components such as a New Groundwater Well: it will be installed adjacent to the RO facility. This well will serve as a replacement for the Montezuma well, which has reached the end of its lifespan. The new well will ensure a reliable and sustainable source of groundwater, providing a long-term solution to meet the village's water demands and supporting the RO facility’s operation. Evaporation Ponds: As part of the RO facility, evaporation ponds will be necessary to manage the disposal of brine water. The construction of the remaining evaporation ponds will allow for the safe and efficient disposal of the brine, ensuring that the water treatment process does not create environmental or operational issues. Solar Array: To manage the significant electricity costs associated with operating the new groundwater well, RO facility, and associated equipment, a solar array will be installed. The solar array will provide a renewable energy source, reducing the village's reliance on traditional power sources and lowering ongoing operational costs. This will help make the new system more sustainable, cost-effective, and energy-efficient in the long term.

## 5.1 TOTAL COST ESTIMATE (ENGINEER'S OPINION OF PROBABLE COST PHASE 1)

| Village of Tularosa DAR (Phase 1): Engineers Estimate | | | | | |
|---|---|---|---|---|---|
| **Item** | **Description** | **Unit** | **Quantity** | **Unit Price** | **Extension** |
| 1 | Mobilization/Demobilization | LS | 1 | $ 414,000 | $ 414,000 |
| 2 | Utility Relocation Allowance | ALW | 1 | $ 50,000 | $ 50,000 |
| 3 | Material Testing Allowance | ALW | 1 | $ 15,000 | $ 15,000 |
| | **Reverse Osmosis Facility** | | | | |
| 4 | Treatment Facility Building | SF | 2,500 | $ 250 | $ 625,000 |
| 5 | Pre-Engineered Water Treatment System | LS | 1 | $ 945,000 | $ 945,000 |
| 6 | Interior Process Piping Installation | LS | 1 | $ 150,000 | $ 150,000 |
| 7 | Exterior Process Drain Structures | LS | 1 | $ 25,000 | $ 25,000 |
| 8 | Treatment Facility SCADA Electrical System | LS | 1 | $ 150,000 | $ 150,000 |
| 9 | Raw Water Storage Tank 100,000 gallons | LS | 1 | $ 250,000 | $ 250,000 |
| 10 | Brine waterline to evaporation ponds | LF | 2,000 | $ 30 | $ 60,000 |
| 11 | 6-inch PVC C-900 Transmission line | LF | 2,500 | $ 30 | $ 75,000 |
| 12 | Pipe casing | LF | 300 | $ 400 | $ 120,000 |
| | **Evaporation Pond (1 cell)** | | | | |
| 13 | Excavation | CY | 5250 | $ 5.00 | $ 26,250 |
| 14 | HDPE Liner | SF | 176,400 | $ 1.50 | $ 264,600 |
| | | | | **SUBTOTAL OF ITEMS 1 - 14** | **$ 3,169,850** |
| | **CONSTRUCTION** | | | | |
| Construction | | | | | $ 3,169,850 |
| Contingencies (15%) | | | | | $ 476,000 |
| Construction NMGRT, (7.6875%) | | | | | $ 281,000 |
| | | | | **SUBTOTAL OF CONSTRUCTION** | **$3,926,850** |
| | **PROJECT DEVELOPMENT COST** | | | | |
| Property Deed Purchases | | | | | $ 390,000 |
| Appraisal Fees | | | | | $ 10,000 |
| Public Permits Fees | | | | | $ 2,500 |
| | | | | **SUBTOTAL OF PROJECT DEVELOPMENT COSTS** | **$ 402,500** |
| **PROFESSIONAL SERVICES** | | | | | |
| **Engineering Services** | | | | 10% | $ 365,000 |
| Preliminary Design Services | | | | | $ 183,000 |
| *Project Management* | | | | | *incl.* |
| *Preliminary Design* | | | | | *incl.* |
| Final Design Services | | | | | $ 122,000 |
| *Final Design* | | | | | *incl.* |
| Bidding and Negotiation Services | | | | | $ 6,000 |
| *Bid Administration* | | | | | *incl.* |
| Construction Services | | | | | $ 55,000 |
| *Construction Administration* | | | | | *incl.* |

| | | | |
|---|---|---|---|
| *Record Drawings* | | | *incl.* |
| **ADDITIONAL ENGINEERING SERVICES** | | $ | 65,000 |
| *Design Field Survey* | | $ | 40,000 |
| *Mapping* | | | |
| *Plat Exhibit* | | | |
| *Easement Exhibits* | | | |
| *R/W Map* | | | |
| *Easement Coordination* | | | |
| *Plat Coordination* | | | |
| *Permit / lease* | | | |
| *Training and Commissioning* | | $ | 10,000 |
| *O&M Manual* | | $ | 15,000 |
| **ADDITIONAL PROFESSIONAL SERVICES** | | $ | 5,000 |
| Geotechnical Report | | $ | 5,000 |
| **ENGINEERING RPR SERVICES** | 4.50% | $ | 164,100 |
| Construction Observation | | | *incl.* |
| PROFESSIONAL SERVICES NMGRT (7.6875%) | | $ | 46,100 |
| **SUBTOTAL OF PROFESSIONAL SERVICES** | | **$** | **646,000** |
| **TOTAL PROJECT COST** | | | |
| Project Development | | $ | 402,500.00 |
| Professional services | | $ | 646,000 |
| Construction w/ Contingencies | | $ | 3,926,850 |
| **TOTAL PROJECT COST w/ NMGRT** | | **$** | **4,975,350** |

## 5.2 ANNUAL O&M COST PHASE 1

The recommended project is expected to incur additional costs for maintenance and operations. Initially, the Montezuma Well will be required to produce 350 gallons per minute (gpm), which will result in higher electricity consumption and increased utility bills. Furthermore, the RO facility will operate concurrently, contributing to additional power demands. Additionally, the village may need to hire additional personnel to manage and operate the RO treatment facility and evaporation ponds efficiently. **Table 9** provides a breakdown of the anticipated added costs for maintenance and operation.

**Table 9: Annual O&M Costs Phase 1**

| Item | Annual O&M Costs |
|---|---|
| RO Operation | $46,000 |
| Evaporation pond Maintenance | $10,000 |
| Short Lived Assets | $26,000 |
| Total | $82,000 |

The operation and maintenance costs for the RO facility include expenses related to power for the well pump, RO skid pump, labor, and chemicals. The estimated annual cost of operating the RO facility is $46,000. Until Phase 2 is completed, daily operational tasks will include managing the brine water rejected by the RO system for a single evaporation pond. Additionally, the RO facility contains several short-lived assets, including the well pump, RO skid pump, and RO membranes, with lifespans of 10 years or less. These components will require replacement within the 20-year projection period. The estimated annual reserve for future replacement of these assets is $26,000. Overall, the Annual estimated O&M costs result in the amount of $82,000

## 5.3 TOTAL COST ESTIMATE (ENGINEER'S OPINION OF PROBABLE COST PHASE 2)

| Village of Tularosa DAR (Phase 2): Engineers Estimate | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Item** | **Description** | **Unit** | **Quantity** | **Unit Price** | | **Extension** | |
| 1 | Mobilization/Demobilization | LS | 1 | $ | 390,000 | $ | 390,000 |
| 2 | Utility Relocation Allowance | ALW | 1 | $ | 50,000 | $ | 50,000 |
| 3 | Material Testing Allowance | ALW | 1 | $ | 15,000 | $ | 15,000 |
| 4 | Groundwater Well | VLF | 560 | $ | 1,600 | $ | 896,000 |
| 5 | Groundwater Well Sitework & Building | LS | 1 | $ | 150,000 | $ | 150,000 |
| 6 | RO Facility Additional Skid | LS | 1 | $ | 315,000 | $ | 315,000 |
| **Evaporation Ponds 3 cells** | | | | | | | |
| 7 | Excavation | CY | 15,750 | $ | 5.00 | $ | 78,750 |
| 8 | HDPE Liner | SF | 529,200 | $ | 1.50 | $ | 793,800 |
| **Solar Array** | | | | | | | |
| 9 | Earthwork | LS | 1 | $ | 10,000 | $ | 10,000 |
| 10 | 4-inch Base Course | C.Y. | 2000 | $ | 20 | $ | 40,000 |
| 11 | Photovoltaic System Array and Service Interconnect | LS | 1 | $ | 250,000 | $ | 250,000 |
| | | | | **SUBTOTAL OF ITEMS 1 - 11** | | **$** | **2,988,550** |
| **CONSTRUCTION** | | | | | | | |
| Construction | | | | | | $2,988,550 | |
| Contingencies (20%) | | | | | | $597,800 | |
| Construction NMGRT, (7.6875%) | | | | | | $275,800 | |
| | | | | **SUBTOTAL OF CONSTRUCTION** | | **$3,862,150** | |
| **Project Development Costs** | | | | | | | |
| Property Deed Purchases | | | | | | $ | - |
| Appraisal Fees | | | | | | $ | - |
| Public Permits Fees | | | | | | $ | - |
| | | | | **SUBTOTAL OF PROJECT DEVELOPMENT COSTS** | | **$** | **-** |
| **PROFESSIONAL SERVICES** | | | | | | | |
| **Engineering Services** | | | | | 10% | $ | 358,700 |
| Preliminary Design Services | | | | | | $ | 179,700 |
| *Project Management* | | | | | | | *incl.* |
| *Preliminary Design* | | | | | | | *incl.* |
| Final Design Services | | | | | | $ | 119,800 |
| *Final Design* | | | | | | | *incl.* |
| Bidding and Negotiation Services | | | | | | $ | 5,400 |
| *Bid Administration* | | | | | | | *incl.* |
| Construction Services | | | | | | $ | 53,900 |
| *Construction Administration* | | | | | | | *incl.* |
| *Record Drawings* | | | | | | | *incl.* |
| **ADDITIONAL ENGINEERING SERVICES** | | | | | | $ | 70,000 |
| *Design Field Survey* | | | | | | $ | 40,000 |

| | | | |
|---|---|---|---|
| *Mapping* | | | |
| *Plat Exhibit* | | | |
| *Easement Exhibits* | | $ | - |
| *R/W Map* | | | |
| *Easement Coordination* | | $ | - |
| *Plat Coordination* | | | |
| *Permit / lease* | | $ | 15,000 |
| *Training and Commissioning* | | | |
| *O&M Manual* | | $ | 15,000 |
| **ADDITIONAL PROFESSIONAL SERVICES** | | $ | 5,000 |
| Geotechnical Report | | $ | 5,000 |
| **ENGINEERING RPR SERVICES** | 4.50% | $ | 161,400 |
| Construction Observation | | | *incl.* |
| PROFESSIONAL SERVICES NMGRT (7.75%) | | $ | 46,200 |
| **SUBTOTAL OF PROFESSIONAL SERVICES** | | **$** | **641,300** |
| **TOTAL PROJECT COST** | | | |
| Project Development | | $ | - |
| Professional services | | $ | 641,300 |
| Construction w/ Contingencies | | $ | 3,862,150 |
| **TOTAL PROJECT COST w/ NMGRT** | | | **$4,503,450** |

## 5.4 ANNUAL O&M COST PHASE 2

To mitigate these costs, the project includes provisions for incorporating solar energy. While the village will experience increased electricity expenses during Phase 1, the completion of Phase 2 will enable the RO system to utilize solar energy, significantly reducing energy costs.

Phase 2 will incur similar operation and maintenance (O&M) costs as Phase 1, with two key differences: The facility will be powered by solar energy, significantly reducing electricity costs. Phase 2 introduces the additional cost of maintaining four evaporation ponds. This includes regular upkeep to ensure optimal functionality and to manage sedimentation. Table 10 provides a breakdown of the O&M costs for Phase 2, highlighting the adjustments and new considerations compared to Phase 1.

**Table 10: Annual O&M Costs Phase 2**

| Item | Annual O&M Costs |
|---|---|
| RO Operation | $35,000 |
| Evaporation Pond Maintenance | $20,000 |
| Short Lived Assets | $39,000 |
| Total | $94,000 |

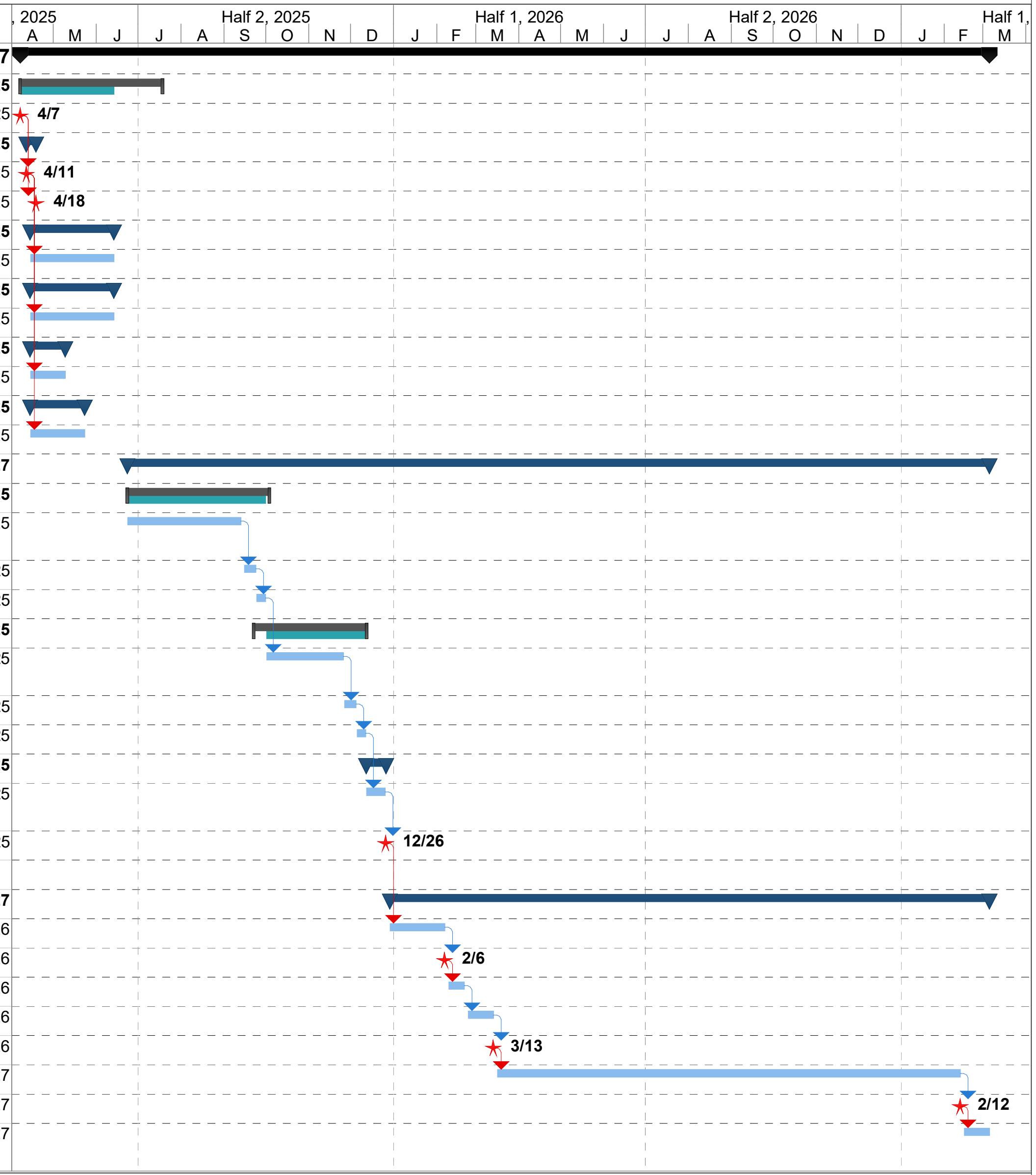
The Operation and Maintenance (O&M) costs for Phase 2 differ from those in Phase 1 due to changes in energy sourcing and infrastructure requirements. The RO operation: energy costs are eliminated, replaced by the maintenance costs for the solar array, estimated at $35,000 annually, brine management costs are incurred for maintaining the evaporation ponds, including sediment management and upkeep for four cells. The projected costs for short-lived assets have increased, as additional components, such as the HDPE liner for the evaporation ponds and the components of the solar array, will require replacement within the 20-year projection period.

Phase 1 is of critical importance as it includes the essential components necessary for the project to be operational. As such, it is the costliest phase. While the village currently has $4.7 million in available funds, the estimated cost for Phase 1 is approximately $5 million. The planning behind Phase 1 was carefully evaluated, and it was determined that this phase represents the optimal approach to ensuring the RO facility becomes functional. However, to successfully implement all items associated with Phase 1, additional funding will be required to cover the remaining costs.

Phase 2 is designed to complement the components installed in Phase 1, which are essential for the plant's efficient operation as intended. It was determined that the additional components required in Phase 2 can be installed at a later stage, allowing the village time to secure additional funding for the completion of the overall project. Considering both design and construction costs, Phase 2 is estimated to cost approximately $4.5 million.

# PROJECT SCHEDULE

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 0 | **Project Name** | **500 days** | **Mon 4/7/25** | **Fri 3/5/27** |
| 1 | **PLANNING PHASE** | **75 days** | **Mon 4/7/25** | **Fri 7/18/25** |
| 2 | Contract Award Notice | 0 days | Mon 4/7/25 | Mon 4/7/25 |
| 3 | **Assembly of Existing Data** | **5 days** | **Fri 4/11/25** | **Fri 4/18/25** |
| 4 | Internal Kickoff Meeting | 0 days | Fri 4/11/25 | Fri 4/11/25 |
| 5 | Client Kickoff Meeting | 0 days | Fri 4/18/25 | Fri 4/18/25 |
| 6 | **Site Survey** | **45 days** | **Mon 4/14/25** | **Fri 6/13/25** |
| 7 | Perform Professional Land Survey | 45 days | Mon 4/14/25 | Fri 6/13/25 |
| 8 | **Geotechnical Investigation** | **45 days** | **Mon 4/14/25** | **Fri 6/13/25** |
| 9 | Site Borings and Report | 45 days | Mon 4/14/25 | Fri 6/13/25 |
| 10 | **Environmental Analysis** | **20 days** | **Mon 4/14/25** | **Fri 5/9/25** |
| 11 | EA Report | 20 days | Mon 4/14/25 | Fri 5/9/25 |
| 12 | **Permits** | **30 days** | **Mon 4/14/25** | **Fri 5/23/25** |
| 13 | Acquire ROW and Permits | 30 days | Mon 4/14/25 | Fri 5/23/25 |
| 14 | **DESIGN PHASE** | **445 days** | **Mon 6/23/25** | **Fri 3/5/27** |
| 15 | **60% Design** | **75 days** | **Mon 6/23/25** | **Fri 10/3/25** |
| 16 | Prepare 60% Design Plans, Specifications, Cost Estimate | 60 days | Mon 6/23/25 | Fri 9/12/25 |
| 17 | Client 60% Review Period | 7 days | Mon 9/15/25 | Tue 9/23/25 |
| 18 | 60% Comments Review | 5 days | Wed 9/24/25 | Tue 9/30/25 |
| 19 | **95% Design** | **60 days** | **Mon 9/22/25** | **Fri 12/12/25** |
| 20 | Prepare 95% Design Plans, Specifications, Cost Estimate | 40 days | Wed 10/1/25 | Tue 11/25/25 |
| 21 | Client 95% Review Period | 7 days | Wed 11/26/25 | Thu 12/4/25 |
| 22 | 95% Comments Review | 5 days | Fri 12/5/25 | Thu 12/11/25 |
| 23 | **Final Stamped Design** | **11 days** | **Fri 12/12/25** | **Fri 12/26/25** |
| 24 | Prepare Stamped Design Plans, Specifications, Cost Estimate | 10 days | Fri 12/12/25 | Thu 12/25/25 |
| 25 | Client Authorization to go to Bid | 1 day | Fri 12/26/25 | Fri 12/26/25 |
| 26 | | | | |
| 27 | **CONSTRUCTION PHASE** | **310 days** | **Mon 12/29/25** | **Fri 3/5/27** |
| 28 | Advertising Period | 30 days | Mon 12/29/25 | Fri 2/6/26 |
| 29 | Contractor Bids Due | 0 days | Fri 2/6/26 | Fri 2/6/26 |
| 30 | Client Council Approval | 10 days | Mon 2/9/26 | Fri 2/20/26 |
| 31 | Contract Document Execution | 15 days | Mon 2/23/26 | Fri 3/13/26 |
| 32 | Pre-Construction Meeting/Notice To Proceed | 0 days | Fri 3/13/26 | Fri 3/13/26 |
| 33 | Facility Construction Period | 240 days | Mon 3/16/26 | Fri 2/12/27 |
| 34 | Substantial Completion | 0 days | Fri 2/12/27 | Fri 2/12/27 |
| 35 | Final Completion, O&M Submittal and Record Drawings | 15 days | Mon 2/15/27 | Fri 3/5/27 |




VILLAGE OF TULAROSA
SUPPLEMENTAL WATER SUPPLY

| | | | |
|---|---|---|---|
| Task | External Tasks | Inactive Summary | Start-only |
| Split | External Milestone | Manual Task | Finish-only |
| Milestone | Inactive Task | Duration-only | Progress |
| Summary | Inactive Task | Manual Summary Rollup | Deadline |
| Project Summary | Inactive Milestone | Manual Summary | |

# 6 FINAL RECOMMENDATIONS

The village of Tularosa requires a supplemental water supply to support its water system. Projections outlined in this report indicate a slight population increase over the next 20 years. Consequently, it is essential to enhance the water system to ensure the continued provision of safe drinking water to residents. After careful evaluation, it has been determined that a Reverse Osmosis (RO) system is the only viable solution for treating the high Total Dissolved Solids (TDS) levels in the groundwater. This study also suggest that a future injection well for Managed Aquifer Recharge (MAR) could further enhance water sustainability, which is a topic to be explored in future planning.

Hydrogeologic studies confirm that the existing wells are capable of producing adequate volume, which is sufficient to meet the village's emergency water supply needs. To manage the costs of construction and allow time to secure additional funding, it is recommended that the project be divided into two phases.

The village has secured funding for the design and construction of Phase 1. It is recommended that the village immediately begin seeking funding for Phase 2, which will further expand the system's capacity. Upon project completion, the village will have a reliable groundwater source in use, with the ability to expand capacity if necessary.

The existing water system includes outdated components and is currently working to implement recommendations from its conservation plan to reduce water losses and per capita consumption (gpcd). The addition of the RO facility will provide increased redundancy and improve the system's reliability. To further enhance this reliability, it is important that the village continues to upgrade outdated components within the system.

The Supplemental Water Supply Project is vital to securing a long-term, reliable, and sustainable water supply for Tularosa. By drilling a new well near the Montezuma Well and implementing an RO treatment facility, the village will ensure access to additional water resources to supplement the surface water treatment plant. This project addresses the potential reduction in surface water availability, providing a comprehensive solution for the village's future water security.

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# APPENDIX A: Hydrogeologic Study for Supplemental Water Supply - Village of Tularosa

# HYDROGEOLOGIC STUDY FOR SUPPLEMENTAL WATER SUPPLY VILLAGE OF TULAROSA OTERO COUNTY NEW MEXICO


prepared by

JSAI


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MAY 2024

# HYDROGEOLOGIC STUDY FOR SUPPLEMENTAL WATER SUPPLY, VILLAGE OF TULAROSA, NEW MEXICO


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May 31, 2023

# HYDROGEOLOGIC STUDY FOR SUPPLEMENTAL WATER SUPPLY, VILLAGE OF TULAROSA, NEW MEXICO

## EXECUTIVE SUMMARY

The goal of this study is to find a solution to the Village of Tularosa's summer potable water-supply shortfall. Currently, surface water from Tularosa Creek is utilized as the main water source, to which the Village has a water right of 701.25 ac-ft. The Village has two water-supply wells, the Montezuma Well and the Stogden Well; neither is connected to a water distribution network. The Montezuma Well is a mild-steel well that is 70 years old, and pumps groundwater with elevated total dissolved solids (TDS), and has 669.05 ac-ft of water rights. The Stogden Well has only 86.3 ac-ft of water rights. Three additional wells in the Village have small irrigation rights. Groundwater is sourced from the shallow alluvium and the Santa Fe Group aquifer. Average well yield for the alluvium is 500 gpm; the Stogden Well pumping is limited to less than 300 gpm (JSAI, 2014). Specific capacity averages 5 gpm/ft of drawdown, and transmissivity averages 1,200 ft$^2$/day. Locally bedrock wells make up to 500 gpm, but average much less. One exploratory well (T-3701) drilled by the Village in 2000 produced only 30 gpm from the Bursum Formation. Average bedrock well specific capacity is less than 0.5 gpm/ft of drawdown in areas accessible to the Village.

Alluvial groundwater quality is poor, characterized by slightly saline to saline water, with TDS concentrations of up to 6,000 mg/L, but averaging between 1,000 and 3,000 mg/L TDS concentration with bedrock wells having high chloride concentrations, whereas shallow groundwater has elevated sulfate concentrations over 1,200 mg/L.

Water-supply options that should be prioritized for the Village include replacing the Montezuma Well with a modern replacement well within 100 ft of the existing well and completing an approximately 1,000-ft water transmission pipeline to convey its water to the Village's distribution network. Water treatment of groundwater is necessary, and options include treatment at the wellhead or in a central location such as near the Village's water storage tanks at the location of the Tularosa Fire Department Training Facility at 1701 Central Avenue. This site is large, could house a potable water treatment building, and could eventually be the location of a moved (replacement) Stogden Well also. At this location, the moved new Stogden Well could then potentially be utilized as an injection well for managed aquifer recharge, or pumping groundwater during times when surface flows in Tularosa Creek are insufficient for meeting the Village's potable water needs. The Village should put all its wells to beneficial use as these wells are assets that could be forfeited. Irrigation wells in the Village's well portfolio should be used to irrigate Village property; the Stogden Well is currently out of NMOSE compliance and out of extension of time requests as of January 31, 2020. Water from the Stogden Well should be put to beneficial use immediately for water sales, or other use, in agreement with its water rights permit.

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## ILLUSTRATIONS

**(follow text)**

# HYDROGEOLOGIC STUDY FOR SUPPLEMENTAL WATER SUPPLY, VILLAGE OF TULAROSA, NEW MEXICO

## 1.0 INTRODUCTION

John Shomaker & Associates, Inc. (JSAI) was contracted by Bohannan Huston, Inc. (BHI) to perform a hydrogeologic assessment for supplemental water supply and a well siting for the Village of Tularosa (Village). Currently, the Village is supplied by surface water from Tularosa Creek (also sometimes referred to as Rio Tularosa), and additionally owns two unutilized back-up groundwater supply wells: the Stogden Well, located in the central part of the Village, and the Montezuma Well, located about 1 mile east of the Stogden Well. Water-supply improvement is needed to meet summer demand when surface-water supply is insufficient, as the demand from all users of Tularosa Creek generally exceeds its summer water budget. The primary goal of this hydrogeologic assessment is to find a solution to the Village's summer water-supply shortfall. Figure 1 is a map showing the study area and selected wells relevant to this study.

### 1.1 Summary of Village Wells

In 1954, the Montezuma Well (a listed municipal well with New Mexico Office of the State Engineer (NMOSE) File No. T-03861), was drilled near Montezuma Avenue, on the eastern side of the Village. According to NMOSE (2023) records, the well was completed with 12-in. casing to a depth of 364 ft below ground level (bgl). NMOSE records list the well capacity at approximately 550 gallons per minute (gpm) with a non-pumping water level (when constructed) of 202 ft bgl. The wellhead was sealed and no water levels could be obtained on April 20, 2023 during the site visit. The field-verified outside casing diameter was 10.75-in., and during the JSAI site visit, the flowmeter was broken; the estimated pumping rate was in excess of 400 gpm based on the 18-in. discharge length measured from the 4-in. open-horizontal discharge pipe. The current casing and screen condition of this well are unknown; however, it is a mild-steel cased well and 70 years of age, and exceeds the common well life expectancy of 40 to 60 years.

In 2007, the Stogden Well (NMOSE File No. T-0020-B) was drilled near the intersection of NM-54 and NM-70 to a depth of 350 ft bgl. It was completed with 10.75-in. steel casing and has a screen interval from 250 to 350 ft bgl, with an unknown slot size and 8-12 Colorado silica sand as filter pack (JSAI, 2014). During the JSAI site visit, its 50-hp submersible pump and 260 ft of 6-in. drop pipe were found on the ground; the operator stated that the pump contractor reported the well as dry: it has been reported that the well has not produced water in recent years. JSAI measured a water level of 154.30 ft bgl and tagged a total depth of 366 ft bgl on April 20, 2023. A video survey is recommended to reassess the condition of this well. In 2014, JSAI suggested a pumping rate above 250 gpm, with a tested capacity of 283 gpm (and a non-pumping water level of 143.20 ft bgl at that time (on April 20, 2023: 154.30 ft bgl); JSAI, 2014). Both wells are likely completed in Quaternary-age alluvium and Santa Fe Group basin-fill sediments, and have elevated total dissolved solids (TDS) and sulfate concentrations requiring treatment before consumption. Neither well is connected to the distribution system.

A third (exploratory) borehole, with NMOSE File No. T-3701, located within 200 ft of the surface-water treatment plant and about 2.5 miles from the Village, was drilled to 6-in. diameter in 2000 to a depth of 600 ft bgl within the Bursum Formation. The borehole was cemented back to the surface due to inadequate production of about 30 gpm with a depth to water of 55 ft bgl (NMOSE, 2023).

Tularosa Well No. 1 is detailed in the NMOSE Aquifer Test database (2010); it was likely completed in or before 1928, drilled to 1,060 ft bgl and had a maximum yield of 167 gpm, however, only for 35 minutes. A capacity of 2.75 gpm over 80 minutes is detailed in 1930 with a final pumping water level of 60 ft bgl. A starting water level is not given; it is possible that this well is no longer in service. A water-quality analysis for a Tularosa Well No. 1 is given in NMED (1980) report; however, it has a different location as the NMOSE-listed well.

**Table 1. Summary of Village of Tularosa wells and selected nearby wells**

| name | date drilled | total depth drilled, ft | screen interval, ft bgl | casing diameter, in. | depth to water, ft bgl | reported yield, gpm | total dissolved solids, mg/L |
|---|---|---|---|---|---|---|---|
| Tularosa Well No. 1* | May 1928 | 1,060 | 57 - 67; 410 - 418 | 12.5 | <60 | 167 | **2,170** * |
| Stogden Well (T-0020 B) | 5/30/2007 | 350 | 250 - 350 | 10.75 | 154.30 (4/20/23) | 283 | **2,500** |
| Montezuma Well | 12/31/1954 | 364 | – | 10.75 | 202 (1954) | 550 | **1,900** |
| T-3701 EXPL | 11/20/2000 | 600 | – | 6 | 55 | <40 | unknown |
| NMOSE listed wells (2-mile radius) | na | 303 (avg.) | – | various | 153 (avg.) | – | **1,000** to **3,000** [1] |

* - Powell, 1930; NMED, 1980 (no further well information found)
[1] - McLean, 1970
– not available
**bold** indicates above standard

ft bgl - feet below ground level
gpm - gallons per minute
mg/L - milligrams per liter
na - not applicable

Over 500 wells or well permits located within a 2-mile radius of the Stogden Well are listed with the NMOSE. The wells listed are generally completed to similar depths as the Village production wells; only 33 of the completed wells are deeper than 400 ft bgl. The average domestic well depth is 303 ft bgl, with an average depth to water of 153 ft bgl (see Table 1). Table 1 summarizes current Village well completion details. Figure 1 shows the wells within the Village.

# 2.0 CURRENT WATER SUPPLY

## 2.1 Current Water Rights and Previous Recommendations

The Village has water rights and permits for the surface-water diversion on Tularosa Creek, and groundwater production from the Village's Stogden and Montezuma Wells, in the Tularosa Underground Water Basin (UWB). A court-decreed water right of 701.25 acre-feet per year (ac-ft/yr) for surface-water diversion, Cause No. 293 (surface point of diversion on Tularosa Creek about 2 mi upstream from the Village), provides most of the potable supply for the Village, and an additional 755.35 ac-ft/yr of municipal supply from two wells (File Nos. T-0020 B and T-3861) represents the backup groundwater supply (NMOSE, 2023). Table 2 summarizes the Village's water rights and permits. It is not known if the groundwater rights are supplemental to the surface water rights; it seems all water rights are stand-alone water-rights.

**Table 2. Water rights summary, Village of Tularosa, Otero County, New Mexico**

| NMOSE File No. | use | type of right | water right, ac-ft/yr |
|---|---|---|---|
| Cause No. 293 | municipal | surface water right | 701.25 |
| T-0020 B (Stogden Well) | municipal – city or county supplied | groundwater permit | 86.30 |
| T-3861 et al. (Montezuma Well) | municipal – city or county supplied | groundwater permit | 669.05 |
| T-0006 G, N | irrigation | irrigation declaration | 5.54 |
| T-0013 BBA | irrigation | irrigation declaration | 2.25 |
| T-3417 A | irrigation | licensed irrigation rights | 65.51 |
| T-3701 (EXPL) | exploratory borehole was cemented back; no water right | exploratory permit | 0 |
| sum | | | 1,529.90 |

Sources: NMOSE NMWRRS, 2023 files; Bohannan Huston personal communication
NMOSE - New Mexico Office of the State Engineer
ac-ft/yr - acre-feet per year

Village irrigation rights exist under File Nos. T-0006 G, T-0006 N, T-0013 BBA, and T-3417A. Well T-3417A meter records from 2002 through 2014 average 58.64 ac-ft/yr, with a maximum of 93.92 ac-ft/yr in 2005; meter records from 2015 to present were not available.

In 2014, JSAI tested the Stogden Well (JSAI, 2014) and noted its theoretical capacity as 200 ac-ft/yr, which is considerably more than the permitted right of 86.3 ac-ft/yr. JSAI recommended that the Village put its water to beneficial use by irrigating park and green spaces, and/or commercial uses such as for dust control or road construction by pumping 200 gpm for one summer in any given year.

JSAI also suggested that the Village explore using the Stogden Well as an injection well to store excess (winter) surface water from Tularosa Creek, and pump groundwater back out in summer (JSAI, 2014) when the Village runs low on potable supplies from Tularosa Creek. With this approach, fresh injected surface water would create a “bubble” within the Stogden Well’s elevated-TDS groundwater, and slightly heavier, slightly saline groundwater would remain below and outside the fresher injected surface water, with little mixing of the two waters expected to occur over time. If the existing groundwater permit is used to pump the stored surface water, it is likely that no NMOSE Managed Aquifer Recharge (MAR) permit would be required; however, a discharge permit from the New Mexico Environment Department (NMED) would be needed to inject surface water into the Stogden Well. To take advantage of the larger surface water right by injecting water into the well in excess of the groundwater right, an NMOSE demonstration project would be required, along with permit applications to both the NMOSE and the NMED as part of the MAR permitting.

## 3.0 HYDROGEOLOGIC SETTING

The Tularosa Basin has three sub-regions: Northern, Western, and Eastern Tularosa Basin, of which the Eastern sub-region contains Tularosa Creek draining the Sacramento Mountains on the east. The Eastern Tularosa Basin is a half-graben, bounded on the east by the Alamogordo Fault (Koning, 1999) at the foot the Sacramento Mountain Escarpment (Figs. 1 and 2). Groundwater in the basin is found in two general geologic settings: 1) the basin-fill aquifer, and 2) bedrock aquifers. The majority of the existing wells produce from the basin-fill aquifer.

### 3.1 Surface Water and Recharge

Tularosa Creek is one of the major streams that emerges from the Sacramento Mountains and discharge into the Eastern Tularosa Basin. A portion of runoff from the Tularosa Creek watershed infiltrates into alluvial fans and the basin-fill aquifer near the Village of Tularosa.

Table 3 shows the estimated watershed yield (runoff plus recharge), runoff (streamflow), and potential mountain block recharge for Tularosa Creek estimated by JSAI (2006). During drought years and with fully allocated surface-water diversions, recharge to the basin-fill aquifer is limited, especially in summer.

**Table 3. Tularosa Creek estimated average watershed yield, runoff, and recharge**

| watershed | estimated average total watershed yield, ac-ft/yr | estimated average streamflow (maximum potential recharge to basin-fill aquifer), ac-ft/yr ** | average potential recharge to bedrock aquifer, ac-ft/yr |
|---|---|---|---|
| Tularosa Creek | 25,237 | 17,520 | 7,717 |

** from Waltemeyer (2001)
ac-ft/yr - acre-feet per year

### 3.2 Geologic Units and Aquifers

The distribution of geologic units in the study area is shown on Figure 2, and an east-west hydrogeologic cross-section is presented as Figure 3. Bedrock aquifers occur east of the Alamogordo Fault; Permian-age bedrock units are successively younger to the east and upslope due to the eastward-dip of the strata. The basin-fill aquifer is thickest just west of the Alamogordo Fault, and gradually thins to the west (Mamer et al., 2014; Allen, 2008). A summary of geologic units near the Village is presented in Table 4.

**Table 4. Summary of select geologic units near Tularosa**

| age | symbol | stratigraphic unit | thickness, ft | description |
|---|---|---|---|---|
| Quaternary | Qa | alluvium | 200 - 500 | basin fill – unconsolidated clay, silt, sand, and gravel |
| | Qb | basalt | 10 - 50 | basalt lava flows |
| | QTsf | Santa Fe Group | 2,000 - 3,500 | basin fill – silt, sand, and gravel |
| Permian | Py | Yeso Formation | 1,200 - 1,800 | interbedded limestone and shale |
| | Pa | Abo Formation | 400 - 1,400 | mudstone and conglomerate |
| | Pb | Bursum Formation | 550 - 1,000 | interbedded siltstone, sandstone, shale, and conglomerate |

### 3.2.1 Basin-Fill Aquifer

Quaternary-age basin-fill deposits consisting of alluvial, eolian, and piedmont materials, range in thickness from 200 to 500 ft (JSAI 2006) and are underlain by Quaternary- and Tertiary-age basin-fill sediments of the Santa Fe Group (QTsf). Over 3,500 ft of these basin-fill sediments, comprised of sand, pebbles, and cobbles with lesser amounts of clay, represent the primary aquifer in the study area. The deposits are typically coarser-grained and thickest near the mountain front, and finer-grained and thinner to the west (see Fig. 3). An oil and gas test hole, located 15 miles north of Tularosa, penetrated 3,850 ft of basin-fill sediments (Reynolds, 1986).

### 3.2.2 Bedrock Aquifer

The Permian-age Bursum, Abo, and Yeso Formations dip about 10 degrees east, and respectively crop out in the Tularosa Creek watershed to the east (Mamer et al., 2018). The oldest, the Bursum Formation, present near the surface-water treatment plant, is composed of interbedded siltstone, sandstone, shale, and conglomerate, and ranges from 550 to 1,000 ft in thickness. The Abo Formation is approximately 800 ft thick and consists of dark-red mudstone, which is locally arkosic and conglomeratic (Griswold, 1959). The youngest, the Yeso Formation, is about 1,200 ft in thickness, composed of pinkish-gray and yellow silty sandstone, gypsum, and limestone (Griswold, 1959), and lies at least 10 miles east of the Village. Most bedrock wells in the study area produce water from the Yeso; however, most produce only a few gallons per minute (JSAI, 2006). The yield from the Village exploratory well T-3701 (Fig. 1) completed in the Bursum Formation was about 30 gpm. Older Paleozoic-age units are present at depth east of the study area.

## 3.3 Aquifer Characteristics

### 3.3.1 Direction of Groundwater Flow

The direction of groundwater flow in the study area is predominantly from east to west (Meinzer and Hare, 1915; Hood and Herrick, 1965; McLean, 1970; Morrison, 1989; Finch and Shomaker, 2003, and Mamer et al., 2014). The water table is steep in the bedrock aquifer of the Sacramento Mountains, indicating low transmissivity. Bedrock-aquifer groundwater discharges to the basin fill (JSAI, 2006). Locally, springs and flowing wells indicate upward movement of groundwater.

### 3.4 Aquifer Properties

Results of pumping tests performed in the Eastern Tularosa Basin sub-region are summarized in Table 5. Most of the pumping tests were performed in wells completed in the basin-fill aquifer. Estimates of transmissivity for the basin-fill aquifer range from 400 to 5,000 ft$^2$/day, with corresponding hydraulic conductivity of 5.3 to over 100 ft/day (Table 5). Irrigation wells locally yield from 200 to over 1,000 gpm, indicating a trough-like area of high transmissivity aquifer, parallel to, and close to the mountain front (eastern basin margin).

**Table 5. Summary of pumping test data and calculated basin-fill aquifer properties for the Village of Tularosa area**

| well location * | NMOSE POD No. | specific capacity, gpm/ft | trans-missivity, ft$^2$/day | hydraulic conductivity, ft/day | reference |
|---|---|---|---|---|---|
| Stogden Well | T-0020-B | 3.2 | 1,340 | 130 | JSAI (2014); Fig. 4 |
| 14S.09E.11.422 | (likely T-0768-S) | 11 [1] | 2,150 | - | Garza and McLean (1977) |
| 14S.09E.36.422 | (likely T-1957) | 30 [1] | 5,000 | - | |
| 14S.10E.18.424 | (likely T-0496) | 3 [1] | 400 | - | |
| 5-miles radius | na | 1.0 to 20 (4.5 avg.) | 1,100 | 5.3 - 7.8 | JSAI (2006) |
| Tularosa area | na | 2.1 to 16 (5.5 avg.) | 1,000[1] | - | McLean (1970) |

* NMOSE location-number system of township, range, section, and quarters, with NW=1, NE=2, SW=3, and SE=4.
[1] - Walton, 1970
gpm/ft - gallons per minute per foot of drawdown

JSAI performed a step-drawdown pumping test at the Stogden Well on November 14, 2013. A plot of drawdown and recovery data is presented as Figure 4. The pre-pumping water level was 143.20 ft bgl. The test consisted of pumping the well for 60 minutes at each of the following rates: 72, 132, 200, and 283 gpm. Recovery measurements were collected upon completion of the pumping period. An objective of the step-drawdown pumping test was to calculate the efficiency of the well (Bierschenk, 1964), which was calculated at between 70 and 89 percent. The step-drawdown pumping test was also plotted on a semi-logarithmic plot (Fig. 4), and the recovery data were analyzed using the Cooper-Jacob (1946) "straight-line" method, using an average pumping rate of 171.75 gpm over 240 minutes. Maximum drawdown after 240 minutes of pumping was 54.32 ft, with a corresponding specific capacity of 3.16 gpm/ft of drawdown. The specific capacity is a measure of the productivity of the well in terms of discharge rate and drawdown; this well was capable of producing water at a rate of 3.16 gpm for each foot of water-level decline in the well at the end of the pumping period. Transmissivity of 1,340 $ft^2$/day was calculated from the recovery curve. Based on a 100-ft screen interval in this well, this translates to an average hydraulic conductivity of about 130 ft/day. Table 5 summarizes the Stogden Well pumping test information, and a semi-logarithmic plot of the drawdown and recovery curves is presented as Figure 4.

### 3.4.1 JSAI Analysis of Specific-Capacity Data

Using available data from NMOSE records (Proof of Completion forms and water-right declarations) and unpublished sources, specific capacity was calculated for wells in the area near Tularosa, and used to estimate aquifer transmissivity and hydraulic conductivity by JSAI in 2006. A summary of results from this analysis is shown in Table 5. Specific capacity is a measure of well yield per unit drawdown and is related to well efficiency and properties of the portion of the aquifer tapped by the well. Using a rearranged form of the Theis equation (Walton, 1970), transmissivity from wells in the basin-fill aquifer was estimated using an unconfined storage coefficient (0.1) for near-water-table conditions. The calculation of transmissivity from specific capacity also requires an estimate of well efficiency (assumed to be 50 percent). An estimate of the hydraulic conductivity was made by dividing the estimated transmissivity by the portion of the aquifer available to the well-screen interval. Near Tularosa, the aquifer has an estimated median and average hydraulic conductivity of 5.3 and 7.8 ft/day, respectively (Table 5), with the geographic distribution concentrated in the basin-fill aquifer along the eastern basin margin.

Reported hydraulic conductivity values for the Yeso Formation aquifer vary by several orders of magnitude depending on degree of fracturing. Wasiolek (1991) reported hydraulic conductivity values for the Yeso Formation in the eastern Sacramento Mountains and eastern Mescalero Reservation to vary from 0.007 to 1.5 ft/day (Table 6). Expected values of horizontal hydraulic conductivity representative of the regional bedrock aquifer are likely less than 0.7 ft/day, the average reported by Wasiolek (1991). These values are thought to represent higher than average hydraulic properties in an area where groundwater flow may have enhanced permeability by dissolving soluble minerals, leaving void spaces within the rock. Aquifer test data from Well VP-13 (NMOSE, 2010) representative of the Abo Formation is also listed in Table 6. Well capacity is not listed for this well, but a nearby well with a similar total depth and screened depth reportedly made 32 gpm.

**Table 6. Summary of bedrock hydraulic properties in the Sacramento Mountains, east of the study area**

| well | test pumping rate gpm | specific capacity gpm/ft | trans-missivity $ft^2$/day | total depth/screen length, ft | hydraulic conductivity ft/day |
|---|---|---|---|---|---|
| Yeso Fm. wells (n=4)[1] | 15 - 500 (avg. 285) | - | 4 - 960 | -/420 - 777 | 0.007 - 1.5 |
| Abo Fm. VP-13[2] | 32 | 0.2 | 40 - 50 | 310/20 | 2 |

[1] – Wasiolek (1991)
[2] – NMOSE (2010)

gpm - gallons per minute
gpm/ft - gallons per minute per foot of drawdown

### 3.5 Water-Level Trends

Depth to water in the Village area ranges between 50 and 250 ft bgl (Fig. 5). The NMOSE-reported average depth to water within a 2-mile radius of the Stogden Well is 153 ft bgl and ranges from 15 to 403 ft bgl (Fig. 5). Local water levels may be affected by nearby heavy irrigation pumping. Depths to water in U.S. Geological Survey (USGS) monitored wells have generally been declining over the period of record, showing declines that range from 0.20 to 1.55 ft/yr, and average 0.82 ft/yr over the 1952 to 2023 period of record, while also showing up to 10 ft of seasonal variation (see Fig. 5).

### 3.6 Well Yield and Performance

Wells completed in the basin-fill aquifer in the study area could be capable of producing up to 500 gpm given an efficient well, proper screen length, screen openings, and gravel pack. The Village's Stogden and Montezuma Wells are documented to produce 250 to 300 and about 400 gpm, respectively (cf. JSAI, 2014). It is unclear why the submersible pump and column pipe are out of the Stogden Well; the 50-hp submersible pump present onsite suggests a pump capable of between 500 and 600 gpm, thus exceeding the tested capacity of 283 gpm and the recommended pumping rate of "up to 300 gpm" (JSAI, 2014). As the 50-hp pump is too large for this well, we recommend a smaller pump, perhaps a 25-hp.

Due to its age, the Montezuma Well should be scheduled for replacement to give the Village the possibility of pumping at least 400 gpm into the system from a well close to the mountain front. Production rates for large-diameter supply wells completed in coarse-grained alluvial sediments close to the mountain front were characterized by JSAI (2006) as over 500 gpm.

## 3.7 Water-Quality and Salinity Distribution

### 3.7.1 Total Dissolved Solids

Distribution of water quality in the Eastern Tularosa Basin sub-region is controlled by geology and groundwater-flow patterns (Hood, 1959). The bedrock aquifer has variable TDS content ranging from 1,000 milligrams per liter (mg/L) to over 6,000 mg/L (e.g., McLean, 1970), depending on proximity to recharge, residence time, and soluble mineral content (Table 7). About 33 percent of recoverable groundwater in the Eastern Tularosa Basin is slightly saline (less than 3,000 mg/L TDS); only 5 percent of recoverable groundwater is fresh (less than 1,000 mg/L TDS; McLean, 1970). TDS values over 500 mg/L exceed the maximum contaminant level (MCL) of the National Secondary Drinking Water Regulations, which are non-enforceable guidelines for contaminants that may cause cosmetic effects or aesthetic effects.

The basin-fill aquifer groundwater quality in the vicinity of the Village is 2,000 to 3,000 mg/L TDS (Table 8), consistent with the water-quality analysis for the Stogden Well. The change in TDS with depth in the basin-fill aquifer is not well understood, but well data near Tularosa suggest that TDS is relatively uniform with respect to depth (JSAI, 2006). McLean (1970) states that "a well 1,440 ft deep in sec. 19, T 14 S., R. 10 E., about 0.7 miles north of the Stogden Well, has a salinity of about 1,600 mg/L."

### 3.7.2 Other Water-Quality Data

In addition to the elevated TDS concentrations, local wells completed in the bedrock, alluvial, and Santa Fe Group basin-fill aquifers and springs have elevated sulfate concentrations ranging between 1,200 and 1,800 mg/L, which is over the 250 mg/L secondary MCL. Nitrate was reported above the NMED Drinking Water Bureau (DWB) standard in TB-0007, likely NMOSE well T-4656, completed in the basin-fill aquifer (Mamer et al., 2014). Other water-quality parameters including pH, chloride, fluoride, nitrate, manganese, and total arsenic have been reported to be within NMED/DWB standards (Tables 7 and 8). There are limited data available with regard to the quality of water in wells completed in the Bursum and Yeso Formations, but Abo Formation water quality is listed in Table 7. Some of these wells and springs in bedrock have chloride concentrations above the NMED/DWB secondary standard of 250 mg/L, with concentrations ranging up to 1,010 mg/L.

**Table 7. Summary of available water-quality data for the bedrock aquifer in the study area**

| well/spring ID | | USGS 330555105580501 | T-1283 (TB-0001) | spring TB-1027 | spring TB-1039 | NMED DWB standard |
|---|---|---|---|---|---|---|
| **source** | **units** | **NWIS** | **Mamer et al., 2014** | | | |
| formation | - | Abo | Abo | Abo | Abo | - |
| screen interval(s) | ft bgl | spring | 50 - 300 | spring | spring | - |
| pH | standard | 7.8 | 7.3 | 7.8 | 7.9 | 6.5 to 8.5 [a] |
| bicarbonate | mg/L | 162 | 260 | 145 | 235 | no standard |
| sulfate | mg/L | **622** | **790** | **2,150** | **1,190** | 250 [a] |
| chloride | mg/L | 67 | 210 | **1,010** | **450** | 250 [a] |
| fluoride | mg/L | 0.6 | 0.82 | 1.2 | 0.91 | 2 [a]-4 |
| nitrate-N | mg/L | 0.29 | 4.6 | 6.4 | 5.6 | 10 |
| calcium | mg/L | 223 | 260 | 665 | 360 | no standard |
| magnesium | mg/L | 53 | 90 | 240 | 130 | no standard |
| manganese | mg/L | - | <0.025 | <0.05 | <0.025 | 0.05 [a] |
| potassium | mg/L | - | 2.3 | 12 | 2.6 | no standard |
| sodium | mg/L | - | 155 | 540 | 270 | no standard |
| TDS | mg/L | **-** | **1,664** | **4,727** | **2,552** | 500 [a] |
| uranium | mg/L | - | <0.005 | 0.011 | 0.006 | 0.030 |
| total arsenic | mg/L | - | <0.005 | <0.01 | <0.005 | 0.010 |
| iron | mg/L | - | <0.02 | <0.05 | <0.05 | 0.30 [a] |

[a] secondary drinking water regulation (non-enforceable guidelines) for aesthetic or cosmetic effects
**bold** above NMED/DWB standard
USGS NWIS - U.S. Geological Survey National Water Information Site website
NMED DWB - New Mexico Environment Department Drinking Water Bureau
TDS - total dissolved solids
mg/L - milligrams per liter
ft bgl - feet below ground level

**Table 8. Summary of available water-quality data for the alluvial and basin-fill aquifers in the study area**

| well/spring ID | | spring-TB-1028 | Stogden Well (T-0020 B) | Tularosa Well No. 1 | USGS 33071910 6045701 | likely T-4656 (TB-0007) | NMED/DWB standard |
|---|---|---|---|---|---|---|---|
| **source** | **units** | **Mamer et al., 2014** | **JSAI, 2014** | **NMED, 1980/ NMOSE, 2010?** | **NWIS, 2023** | **Mamer et al., 2014** | |
| formation | - | alluvium | Santa Fe Group | alluvium/ Santa Fe Group | alluvium | Santa Fe Group | |
| screen interval(s) | ft bgl | spring | 250 - 350 | 57 - 67; 410 - 418 | spring | 185 - 285 | |
| pH | | 7.4 | 7.12 - 7.29 | 7.49 | 7.4 | 7 | 6.5 to 8.5 [a] |
| bicarbonate | mg/L | 150 | - | 257.1 | 200 | 300 | no standard |
| sulfate | mg/L | **1,220** | **1,383 - 1,400** | **1,207** | **1,500** | **1,790** | 250 [a] |
| chloride | mg/L | 150 | 140 - 190 | 175.8 | 180 | 170 | 250 [a] |
| fluoride | mg/L | 0.81 | - | 0.67 | | 0.52 | 2 [a]-4 |
| nitrate-N | mg/L | 2.1 | - | 2.99 | 0.2 | **13** | 10 |
| calcium | mg/L | 420 | 329 - 350 | 364.6 | 500 | 480 | no standard |
| magnesium | mg/L | 110 | 130 - 149 | 140.7 | 110 | 195 | no standard |
| manganese | mg/L | <0.05 | 0.0091 | <0.05 | - | <0.05 | 0.05 [a] |
| potassium | mg/L | 3.5 | 0.8 - 2.7 | 2.73 | - | 3.5 | no standard |
| sodium | mg/L | 80 | 100 - 155.5 | 118.5 | - | 190 | no standard |
| TDS | mg/L | **2,029** | **2,460 - 2,632** | **2,168** [b] | - | **3,023** | 500 [a] |
| uranium | mg/L | <0.01 | - | - | - | <0.01 | 0.030 |
| total arsenic | mg/L | <0.01 | - | <0.005 | - | <0.01 | 0.010 |
| iron | mg/L | <0.1 | 0.089 | <0.025 | - | <0.05 | 0.30 [a] |

[a] secondary drinking water regulation (non-enforceable guidelines) for components causing aesthetic or cosmetic effects
[b] total filterable residue
**bold** indicate above NMED/DWB standard
USGS NWIS - U.S. Geological Survey National Water Information Site website
NMED DWB - New Mexico Environment Department Drinking Water Bureau
TDS - total dissolved solids
pCi/L - pico-Curies per liter
ft bgl - feet below ground level
mg/L - milligrams per liter

# 4.0 OPTIONS FOR IMPROVING THE WATER SUPPLY

## 4.1 Water-Supply Options

### 4.1.1 Groundwater

Options considered for improving the ability to supply additional potable water to the Village include storing excess surface water as groundwater in winter, and pumping that water back out of a well as needed (JSAI, 2014). Also, bringing the Montezuma Well back on-line with water treatment to treat its slightly saline groundwater is a good first step. That is because ample water rights already exist for the Montezuma Well, although records indicate it was completed from before 1955 (NMOSE, 2024) and should be replaced. Other options discussed at the project kick-off meeting include a bedrock well near the water treatment plant, or farther east of the Village. Table 9 gives a summary of new-well options for the different aquifers near the Village, including the bedrock wells option.

### 4.1.2 Replacing Existing Montezuma Well

The existing Montezuma Well is 70 years old and is most likely nearing the end of its useful lifespan; however, no recent or old pumping test data are available to verify the condition of this well. It has 669.05 ac-ft/yr of water rights, a significant amount (0.60 million gallons per day (MGD)), is closest to the Alamogordo Fault and the mountain front, and therefore, offers the Village's best chance for a low TDS concentration and a high production capacity without transferring water rights. Coarser sediments, closer to the mountain front result in a potentially higher production capacity (Mamer et al., 2014). In addition, the Montezuma Well is located in a favorable residential area away from major corridors of transportation, gas stations, and other potential environmental threats, which potentially impact a shallow aquifer (e.g., NMED, 2023). The area available for a replacement well near this well is, however, very limited (0.10 acres), which could make drilling, construction, and testing of a replacement well difficult and potentially more expensive than if it were located on a larger parcel. This is because there may be a need for sound mitigation during drilling and construction, the use of, or the arrangement of a construction easement from an adjacent site to utilize during construction or to store materials, and the limiting of work hours to honor its residential location.

A replacement well would theoretically be capable of producing over 500 gpm, and would need water treatment due to the likely elevated TDS and sulfate concentrations. Additionally, an approximately 1,000-ft pipeline north to Highway 70 would need to be constructed to distribute any Montezuma Well production. A proposed well construction diagram for a Montezuma replacement well is presented as Figure 6 and recommendations for well construction are provided below.

Completing a replacement well to a depth of about 550 ft may produce enough water to help meet the Village demands. The pilot hole should be drilled to a depth of 580 ft using mud-rotary drilling methods. It is recommended that the production well completion include stainless-steel louvered screen for the expected elevated TDS and sulfate concentrations, and to maximize production from the aquifer. Costs for a production well are estimated to be around $800 to $1,000/ft for an 12-in. nominal-diameter stainless-steel-cased production well completed with screen, gravel pack, developed, and tested (see Fig. 6). Estimated costs do not include hydrogeologic well site supervision, permanent pump, water-level-measuring equipment, and the like. A little money could be saved by completing the upper 120 ft of this well with mild steel and a dielectric coupling and this could be achieved as an alternate bid item.

**Table 9. Summary of aquifer options for Village of Tularosa**

| parameter | Montezuma replacement well option | Bursum Formation near surface-water plant | other Permian-age options (farther east) | source |
|---|---|---|---|---|
| estimated water level, ft bgl | 143 - 154 | 55 | unknown | this study |
| approx. recommended well depth, ft bgl | 350 - 550 | 700 - 1,000 | at least 800 | Fig. 3 |
| formation completed in | alluvium and basin fill | Bursum | Abo/Yeso | Figs. 2 and 3 |
| approximate expected TDS range, mg/L | 2,200 - 3,630 | >2,000 | 1,665 - 4,725 | McClean, 1970 |
| approximate expected production, gpm | up to 500 | 30 - 40 | up to 300 | Sec. 3.2.2 and 3.6 |
| approximate length of pipeline required, ft | 1,000 | <300 ft | >5,000 ft | Google Earth |
| pros | Village owned; existing water -rights of 669.05 ac-ft, managed aquifer recharge possible with pipeline connection | alternate source | alternate source | |
| cons | current well life limited, existing site small | water rights permitting, low capacity (more than one well required); exploratory well T-3701 low yield | expensive wells; high pumping costs, water rights permitting, far from Village, no land owned by Village | |

ft bgl - feet below ground level
mg/L - milligrams per liter
ac-ft - acre-feet
TDS - total dissolved solids
gpm - gallons per minute

The proposed production well will need to be equipped with a test pump capable of at least 500 gpm from about 300 ft bgl, and will need to be developed and test pumped to ascertain the properties of the aquifer. JSAI recommends sampling for water-quality constituents at the end of the pumping test program.

### 4.2 Existing Stogden Well

The existing Stogden Well could be a reliable back-up production well, but it would likely need a smaller pump (a maximum of 25 horsepower is proposed) to limit the pumping rate to less than 300 gpm, but "over 250 gpm" (JSAI, 2014). Water rights for the Stogden Well are limited to 86.3 ac-ft/yr. (0.08 MGD). The well is currently not connected to a service pipeline; it is only occasionally pumped and flushed. A review the Village of Tularosa water rights file suggests that the T-0020-B water-right will not be approved for "further extensions of time (beyond 01/31/2020) unless significant and continued diligence is shown applying the permitted water to beneficial use." We suggest a continuation of filing for extensions of time explaining the current lack of production due to the pump being removed. Water from the Stogden Well will need to be put to beneficial use as soon as possible.

Any production from the Stogden Well would also need water treatment for elevated TDS and sulfate concentrations before being utilized as municipal supply, something that a 2014 JSAI report called potentially uneconomical, due to its high cost and limited water-right, especially if the pipeline construction costs are included. In addition, the well location is not optimal, as it lies in proximity to sources of documented pollution near US-70 and US-54 (e.g., NMED, 2024). In 2014, JSAI recommended either using this well for non-potable demands, such as green-spaces irrigation, or water sales, or using this well for MAR with a suitable supply pipeline. In this case, the Village would use the Stogden Well to inject treated surface water with a low TDS concentration in winter, and pump it into the potable distribution system when needed. Injected low-TDS concentration-water will form a "bubble" within the higher TDS groundwater, and can likely be pumped back out as groundwater with approximately the same low TDS concentration. Careful study of chemical compatibility, and modeling of the injection-withdrawal cycle, would be needed. If the well is relocated, costs for a pipeline connection to the Stogden Well could be minimized, but legal costs related to a change of the location of this water right could be substantial if the NMOSE decides to move forward with a permit cancellation due to non-use.

### 4.3 Water-Supply Options and Potential New Well Location

Replacing the existing Montezuma Well with a functioning potable groundwater source for the Village will allow planning for drought-resistance and possible additional future water resources.

The Stogden Well could then also be considered as a Village water resource supply option. A possibly better location for this well exists farther east, nearer to other Village water supply infrastructure. A 3.3-acre Village-owned lot, occupied by the Fire Department training facility, exists at 1701 Central Ave., astride the Alamogordo Fault, about 500 ft from existing Village water tanks, and directly south of Tularosa Creek. It could be investigated as a future well site for a new Stogden Well, which would need to include an exploratory test borehole, due to the uncertain location of the Alamogordo Fault, any conjugate faults, and the depth of the Permian-age bedrock in relation to the shallow water table (Fig. 2).

This existing Village parcel lies just outside the Critical Management Area (CMA) by at least 50 ft, at its closest point. We recommend that a test hole be drilled as close as possible to the west side of the property to maximize the probability of a thick section of basin fill above the Permian-age bedrock. Since the Stogden Well lies within a CMA, transferring to a non-CMA site would enhance the likelihood of a water-rights transfer, though the transfer could still be protested by local water-rights owners in the matter of impairment of water rights of other owners. The shallow alluvium closer to the Alamogordo Fault at the new location is also potentially coarser, and TDS concentrations could be less as at Well T-5424 (Fig. 1), where it is about 1,700 mg/L (Mamer et al., 2014). This site also lies about 4,400 ft downstream from the surface water treatment plant (Fig. 7). This site is also a good potential site for a water treatment facility for groundwater as it has some room, unlike the small Montezuma site (about 0.1 acres) and existing Stogden Well site (approximately 0.4 acre). Should a future surface water scarcity occur, a temporary transfer of surface water rights to a relocated Stogden Well or even a replaced Montezuma Well, if pursued as a groundwater permit supplemental to a surface water right, could in our opinion potentially be received favorably by the NMOSE, as such a well would pump groundwater that is recharge from Tularosa Creek that has infiltrated a few miles downstream from the Village's surface-water diversion and those rights have already been counted in the NMOSE accounting as surface water. These water rights are not new rights, nor are they different rights, and such a transfer would allow the Village to meet its potable water needs, provided the Stogden Well is moved, it produces groundwater, and water treatment exists at this site.

A possible replacement well for the Stogden Well could be a slightly deeper well (about 550 ft bgl; Fig. 8), a more efficient (modern) design, allowing for more efficient groundwater production, and possibly higher capacity. In the future, if excess treated surface water or groundwater water is available, this site would also make for a possibly advantageous MAR site study, using the relocated Stogden Well for injection of surplus water to be pumped out as needed. Table 10 gives a summary of new well options for moving the Village of Tularosa Stogden Well and its water-rights.

**Table 10. Options summary for moving the Village of Tularosa Stogden Well and its water rights**

| parameter | existing Stogden Well | alternate Stogden Well | source |
|---|---|---|---|
| water level, ft bgl | 154 | ~260 | this study |
| well depth, ft bgl | 350 | about 550 | Fig. 3 |
| formation completed in | alluvium and basin fill (CMA) | alluvium and basin fill (non-CMA) | Figs. 2 and 3 |
| approximate TDS range, mg/L | ~2,500 | 1,700 - 3,000 | JSAI, 2014; Mamer et al., 2014 |
| approximate production, gpm | 250 - 300 | up to 500, if basin fill is sufficiently thick | Sec. 3.2.2 and 3.6 |
| approximate length of pipeline required, ft | unknown | ~250 | Google Earth |
| pros | Village-owned site; existing well - current well asset worth utilizing; existing water - rights of 86.3 ac-ft.; MAR possible (JSAI, 2014) | CMA move-from, non-CMA move-to; new, efficient well design possible, near tanks, 150 ft higher elevation, 2.8 miles from surface water diversion along Tularosa Creek; MAR possible | |
| cons | no pipeline, needs treatment, possible high reject quantity makes treatment uneconomical | significant risk that aquifer will be too thin, water rights permitting move required, new well may be expensive | |

TDS - total dissolved solids
CMA - Critical Management Area
MAR – Managed Aquifer Recharge

ft bgl - feet below ground level
mg/L - milligrams per liter
gpm - gallons per minute

### 4.4 Water-Rights Considerations

It is strongly encouraged that the Village consistently utilize its additional irrigation wells at their respective points-of-diversion (PODs) and put water available under its irrigation water rights to beneficial use to irrigate Village-owned green space, school grounds, or other property to the maximum extent practicable. It is recommended that before equipping any existing dormant irrigation well, a well video survey be performed to maximum depth to obtain information about well completion and condition, and the non-pumping water level, to determine an ideal pump setting. JSAI could help with the video-survey review, as well as the irrigation well inventory.

### 4.5 Risks

1. A NMOSE water-rights review is likely for any permit application, including a replacement well permit for the Montezuma Well. Such a review risks a full review of the Village's water-rights holdings and could trigger a NMOSE request for, missing documents or for additional documentation.

2. Any water-rights move (Stogden Well) can be protested and this process could be elaborate and expensive, and potentially time consuming.

3. Drilling close to the Alamogordo Fault could result in lost circulation, potential water quality with TDS concentration greater than 1,700 mg/L, and borehole problems. A shallow well (less than 500 ft bgl) would likely avoid those problems, but they cannot be discounted entirely, as fault zones are complex and pose risks, such as unknowns and drilling problems. Advanced drilling methods, such a dual-tube, or casing-advance rotary drilling methods could be more expensive to guard against borehole problems, when drilling into a fault zone.

4. New NMOSE maps showing where artesian plans of operation are required include all of the Village's area. This could make drilling a replacement well or a new well more costly due to additional paperwork requirements, and make having a registered Hydrogeologist overseeing and documenting the drilling operation imperative.

5. Doing nothing could potentially result in the NMOSE curtailing the Village's water rights and if no Proof of Beneficial use can be proven for either the Montezuma Well or the Stogden Well, the Village could lose these rights entirely. If extensions of time to put water to beneficial use are not current, the Village could forfeit part of its water-rights portfolio.

6. All groundwater will need some form of water treatment, which is expensive, and potentially maintenance intensive. Operators may be difficult to find for complex water treatment systems.

## 5.0 CONCLUSIONS

The following conclusions are based on review of available data:

1. Current Tularosa Creek surface-water supplied to the Village are insufficient to reliably satisfy peak summer demand due to surface-water diversions by other users. They are especially challenging during droughts, when higher temperatures result in more evapotranspiration, lessening runoff in the creek.

2. The Montezuma Well is close to 70 years old and will need to be replaced; NMOSE replacement well permitting should be pursued as soon as a funding source is secured for both the well and the 1,000-ft pipeline.

3. Current water level at the Stogden Well indicates a remaining water column of about 200 ft, or remaining supply of over 100 years based on an average water-level decline rate of 1.0 ft/yr. The remaining water column at the Montezuma Well is unknown, as it was not possible to access the well for a non-pumping water level during the site visit in April 2023. Both wells are unavailable as potable water sources because water treatment does not exist, and neither well is connected to a water delivery system.

4. The current Stogden and Montezuma Wells' capacities would be sufficient for the Village if water treatment were available; however, there are concerns related to reliance on these wells due to the age of the Montezuma Well, and water-rights limitations of the Stogden Well, which would likely result in an uneconomical water treatment system expense for the latter.

5. Slightly saline and saline groundwater are available near the Village from the alluvial aquifer and the underlying Santa Fe Group basin-fill aquifer as well as from bedrock wells (generally at increasing depth, and thus costs). In terms of production capacity, the alluvium and basin-fill aquifer have the highest capacity, at over 500 gpm per well. In contrast, the bedrock Bursum and Abo Formations have an estimated capacity that can vary locally between 0 and 30 gpm (locally higher). Table 9 summarizes the options.

6. From a water-rights standpoint, existing or replacement wells within close proximity of existing wells are the most feasible, the least controversial, and likely quickest approach to establishing the security of the Village's potable water supply. However, moving the Stogden Well to another location could be useful and allow the Village to utilize this resource. New points of diversion in the alluvium, basin fill, or bedrock aquifers, will need to be carefully evaluated due to potential impacts within CMAs and Tularosa Creek.

7. From a technical standpoint, a deeper (bedrock) well is more expensive than a shallow replacement well. A bedrock exploratory well has already been tried at the Village surface water treatment plant (T-3701 EXPL). Water quality for either a replacement well in the alluvial and basin-fill aquifer, or a bedrock well, would be similar; water treatment of slightly saline water is required for groundwater supply throughout the study area.

8. A comprehensive water-resource approach where the Montezuma Well is brought back online, water treatment is sought for this supply, and it is connected to the Village potable water infrastructure as a first step of improving the reliance of the Village on surface water from the Tularosa Creek and provide redundance of water resources, and then explore moving the Stogden Well closer to the storage tanks, and potentially making it not only a back-up well, but also a means to store excess surface water to be used in time of need, is recommended here.

## 6.0 RECOMMENDATIONS

The following actionable items are also recommended:

1. Test existing irrigation wells for well capacity and evaluate the use for each well as needs or funding becomes available.
2. Utilize irrigation PODs and inventory any existing wells and identify any areas where they may be of use. If not feasible, consider leasing the water-right temporarily to provide an income stream to the Village.
3. Seek funding to replace the Montezuma Well (see Fig. 6 for proposed replacement well diagram). Include funding for a pipeline.
4. Equip the Stogden Well with an appropriately sized pump, and/or motor, for use in water sales, immediately (or as soon as possible).
5. Perform an engineering feasibility study of groundwater treatment or blending of water sources to achieve acceptable level of TDS, sulfate, and other regulated parameters in the Village's groundwater supply.
6. If blending is not an option, explore water treatment options including where such a facility may be located. It may be best located near the water storage tanks near 1701 Central Avenue.
7. Explore water-rights transfer for the Stogden Well water right and the implications for Village's water-rights portfolio.
8. Evaluation of feasibility study of well injection of surplus surface-water supply in winter season to recharge aquifer and improve quality of groundwater supply.

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# ILLUSTRATIONS

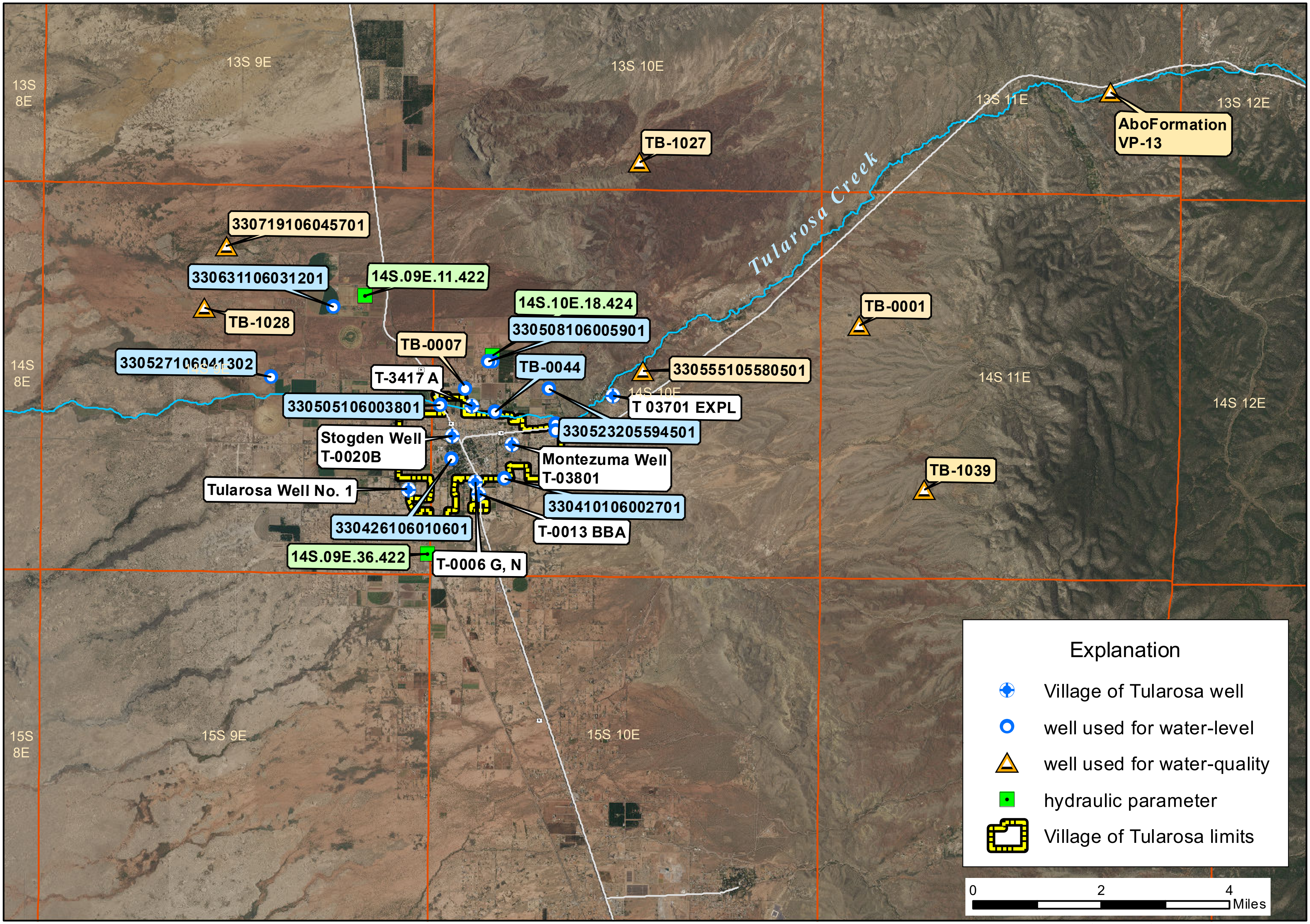

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Figure 1. Aerial photograph of the study area, major landmarks, and selected wells, Village of Tularosa, Otero County, New Mexico.

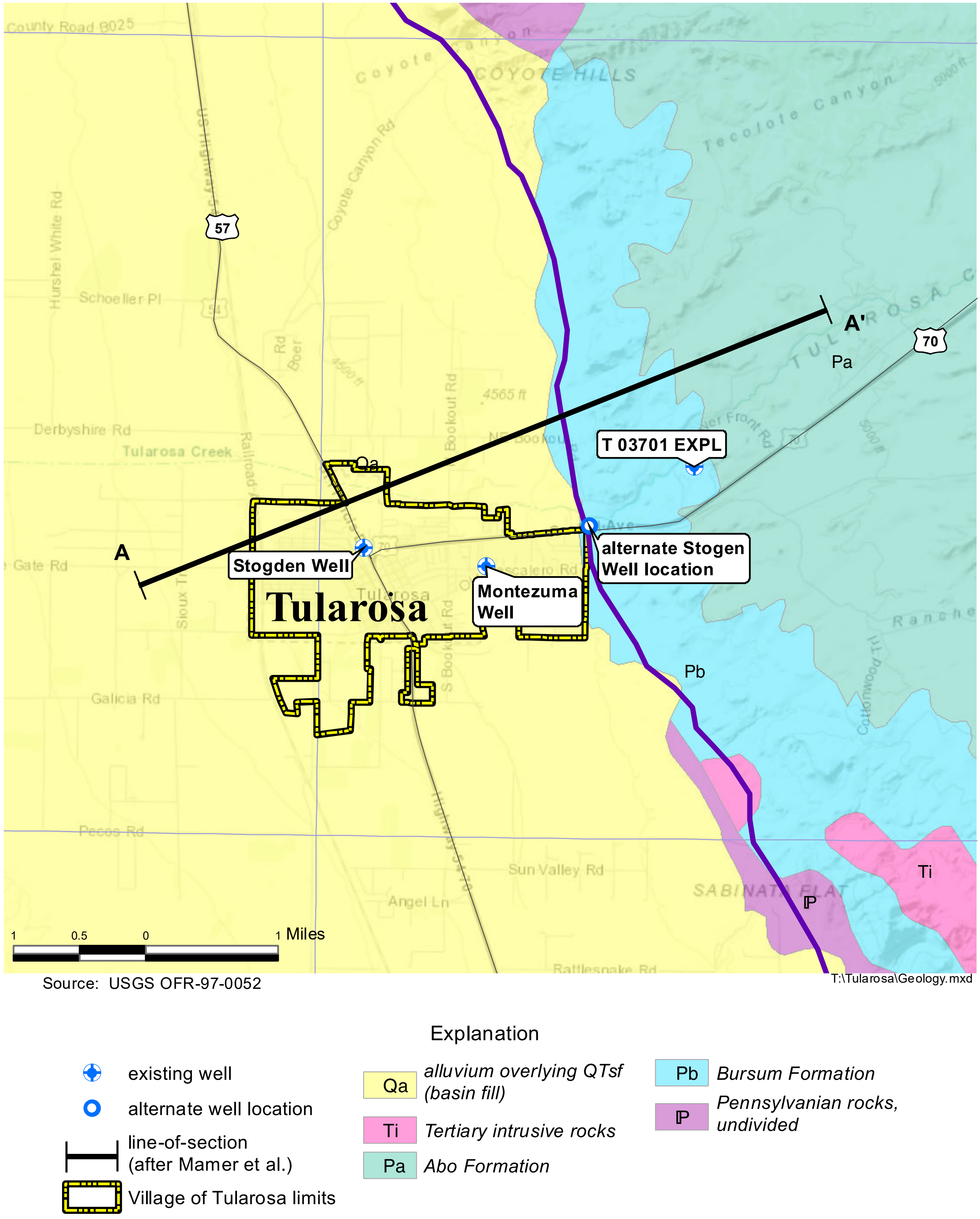



Figure 2. Geologic map showing study area, locations of selected wells, and line of section, Village of Tularosa, Otero County, New Mexico.

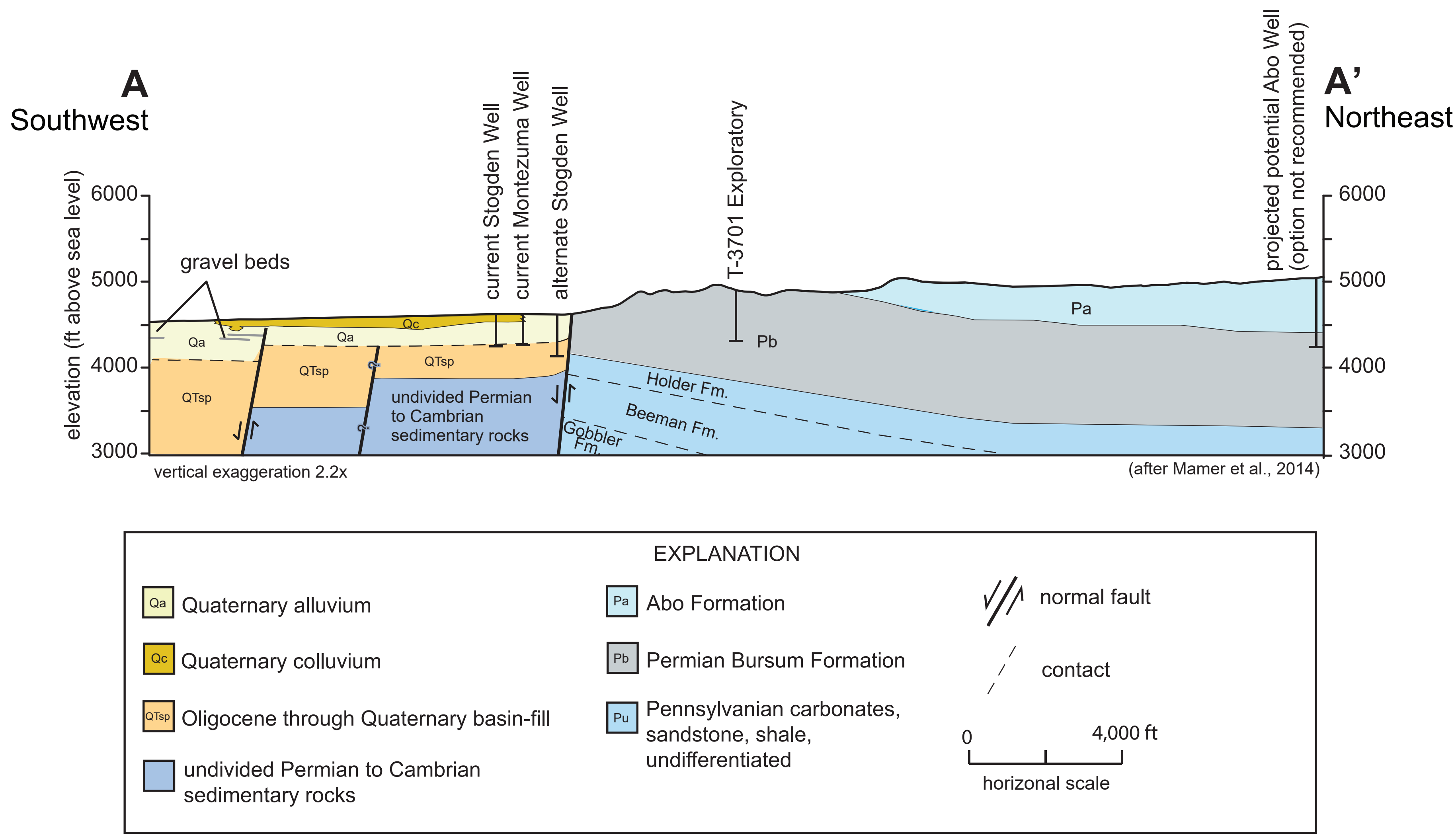



Figure 3. West to east geologic cross-section (after Mamer et al., 2014), Village of Tularosa, Otero County, New Mexico.

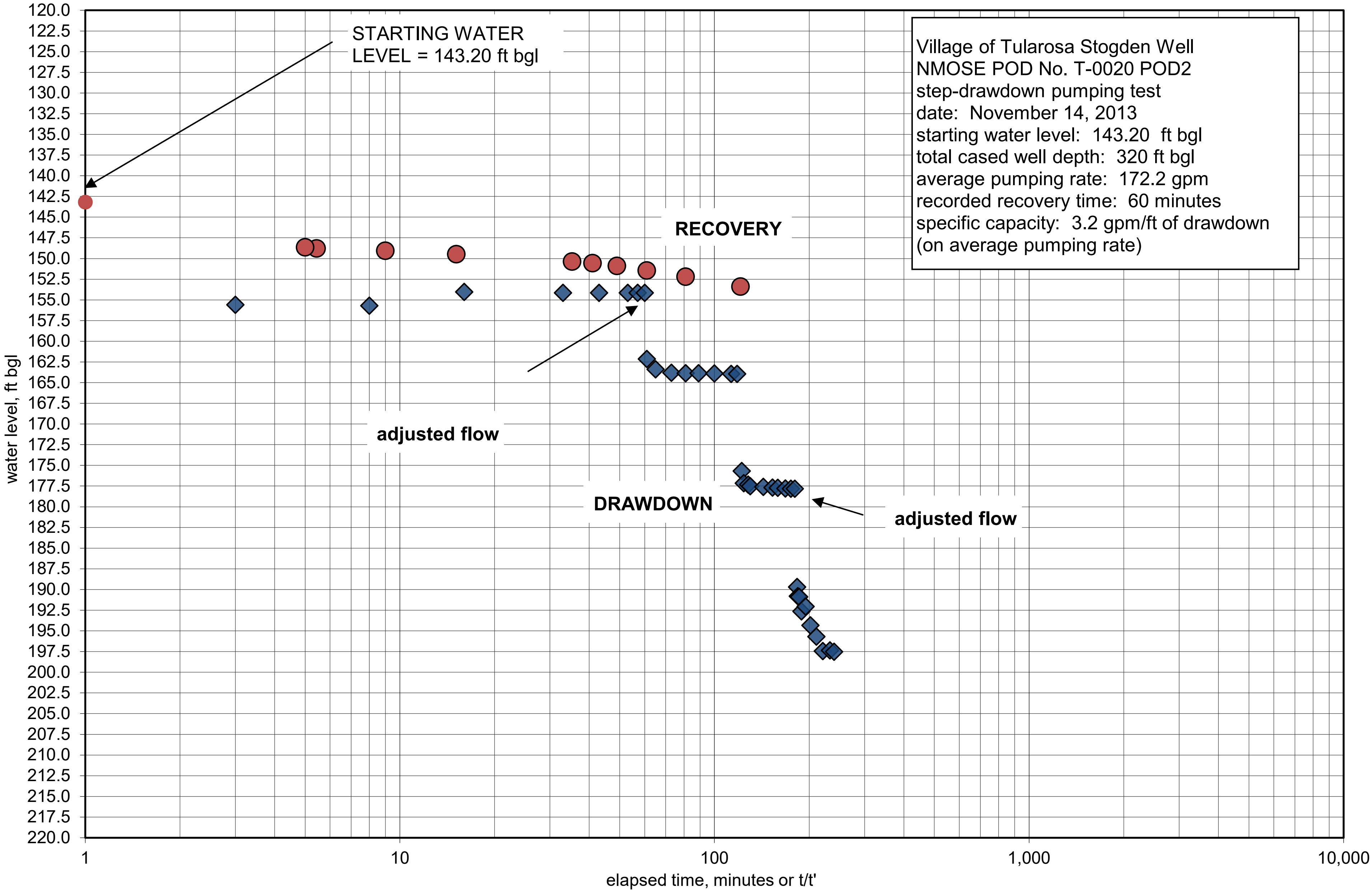



Figure 4. Semi-logarithmic plot of transducer-recorded drawdown and recovery data from the 240-minute step-drawdown pumping test, Village of Tularosa Stogden Well, Otero County, New Mexico.

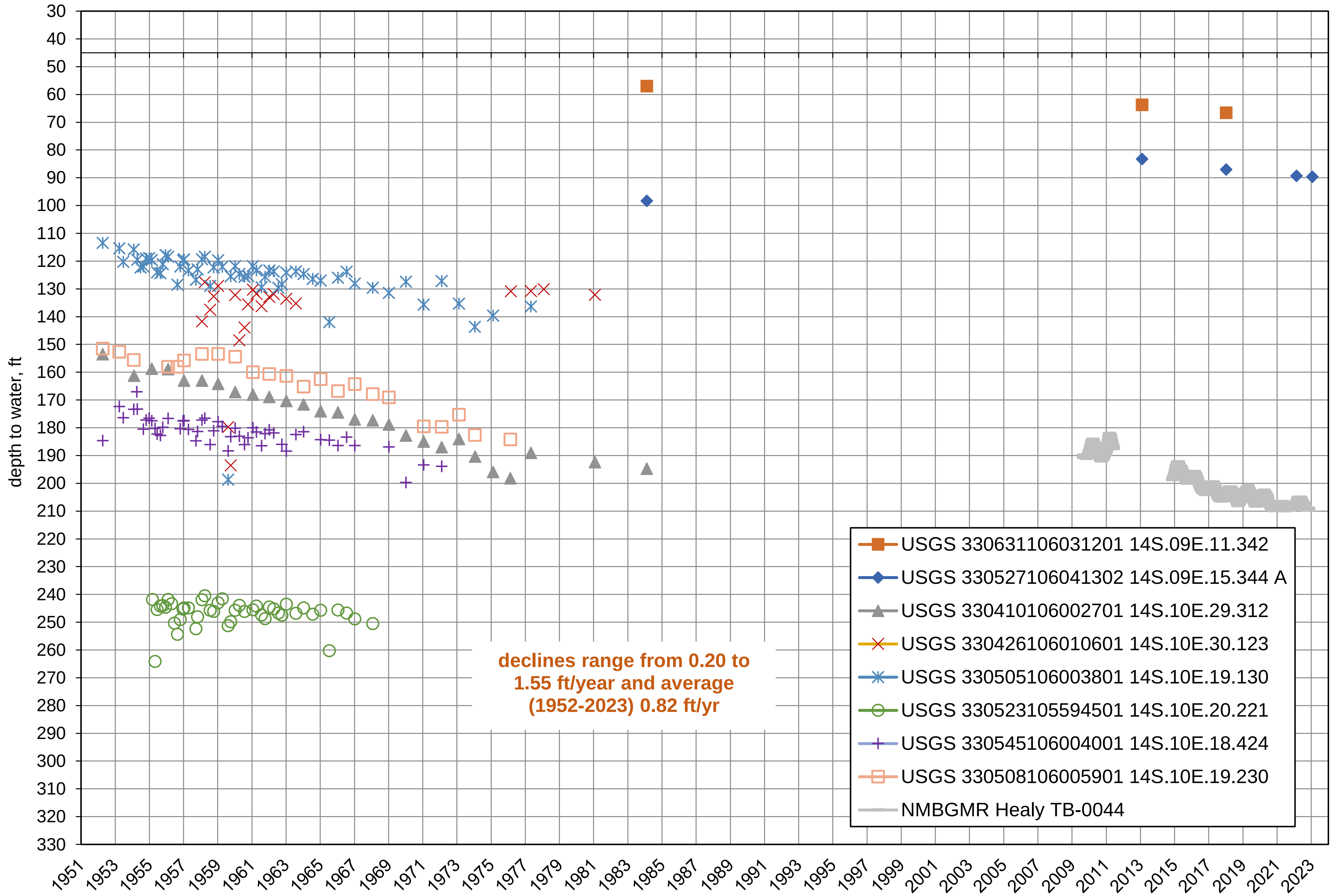



Figure 5. Hydrographs for USGS-monitored wells near the Village of Tularosa, Otero County, New Mexico.

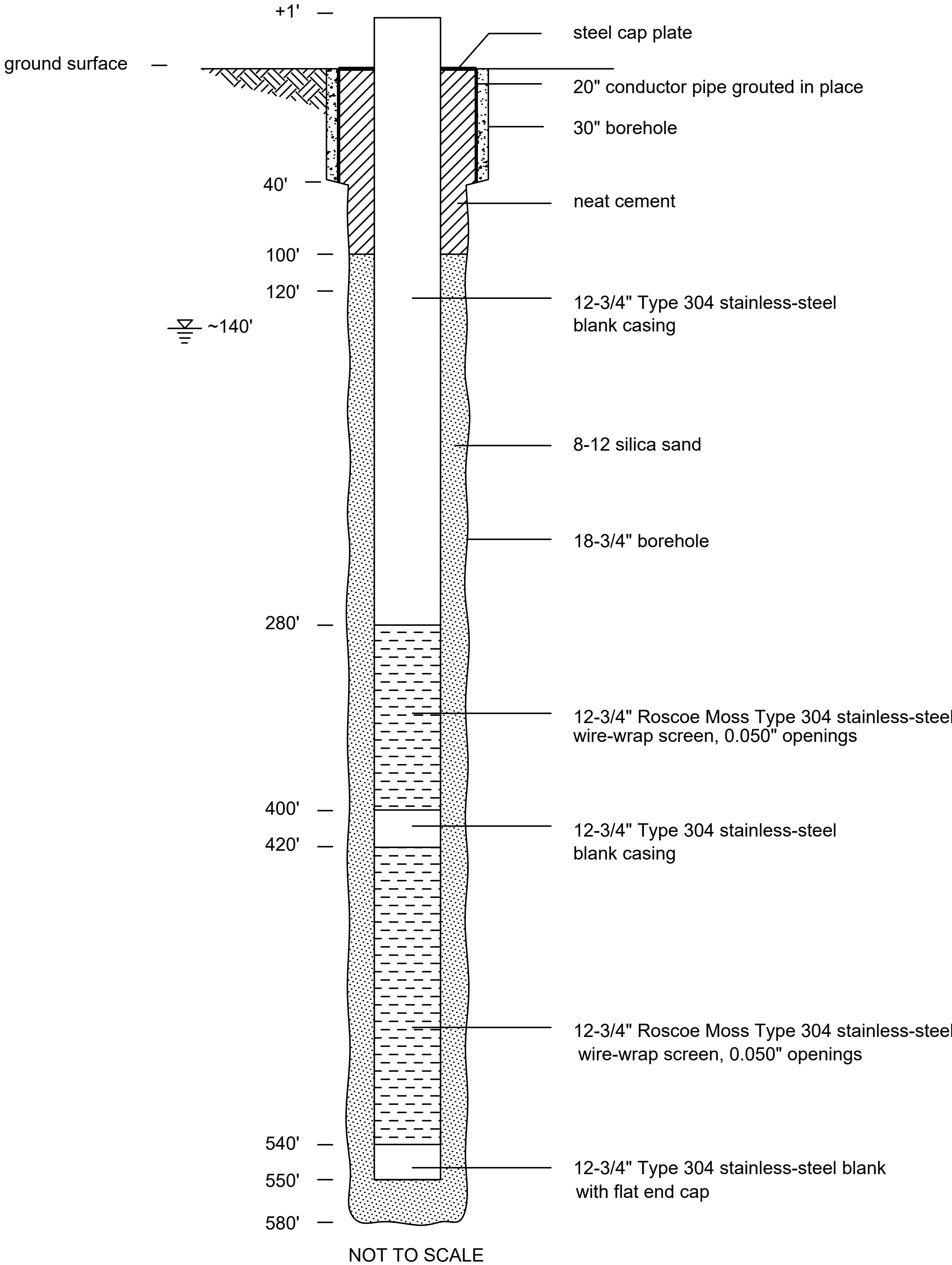
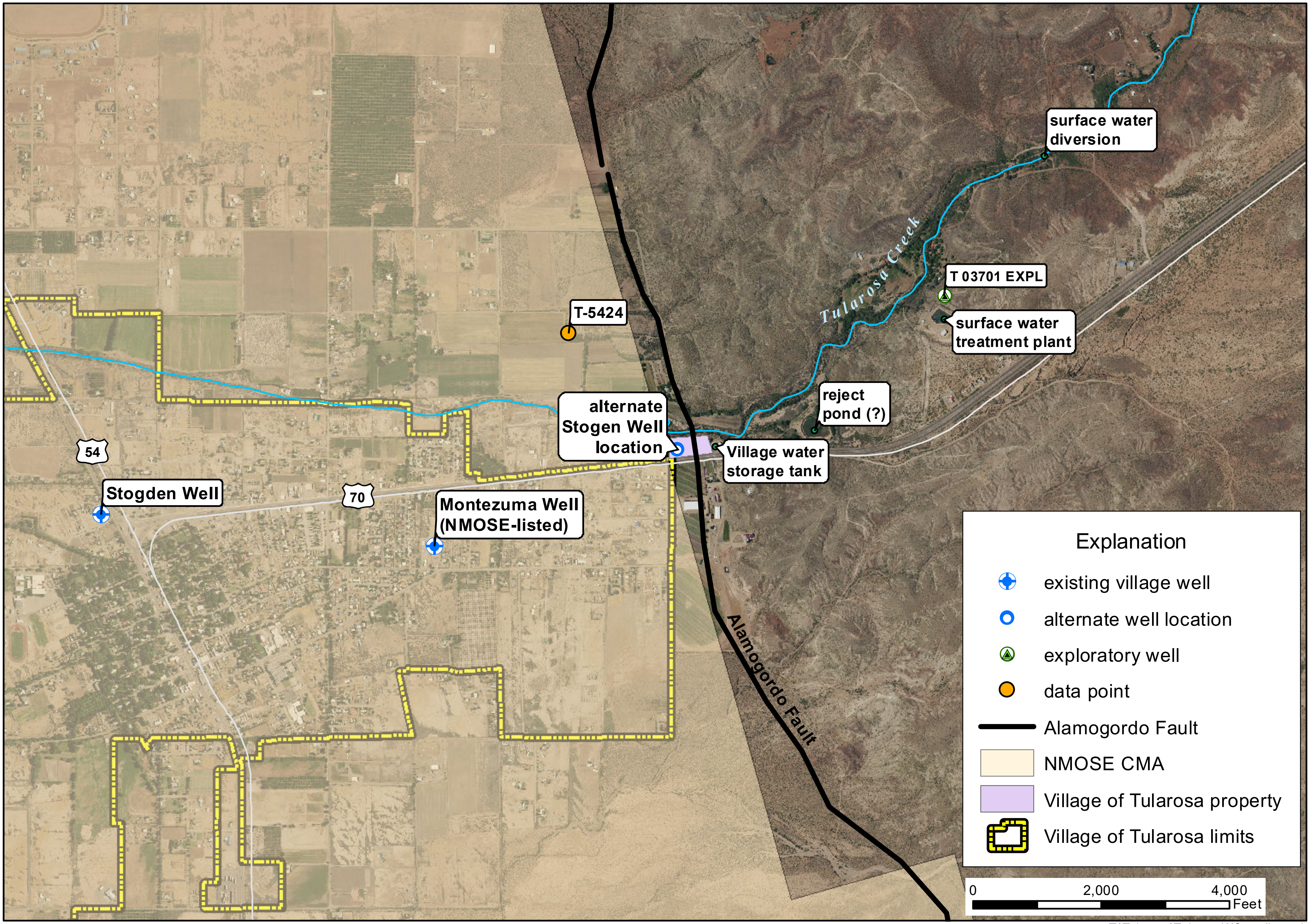



Figure 6. Proposed completion diagram for Village of Tularosa Montezuma Replacement Well, Otero County, New Mexico.




T:\Tularosa\TularosaWS_wells.mxd

Figure 7. Aerial photograph of the existing well sites, alternate Stogden Well site, and existing potable water supply infrastructure, Village of Tularosa, Otero County, New Mexico.

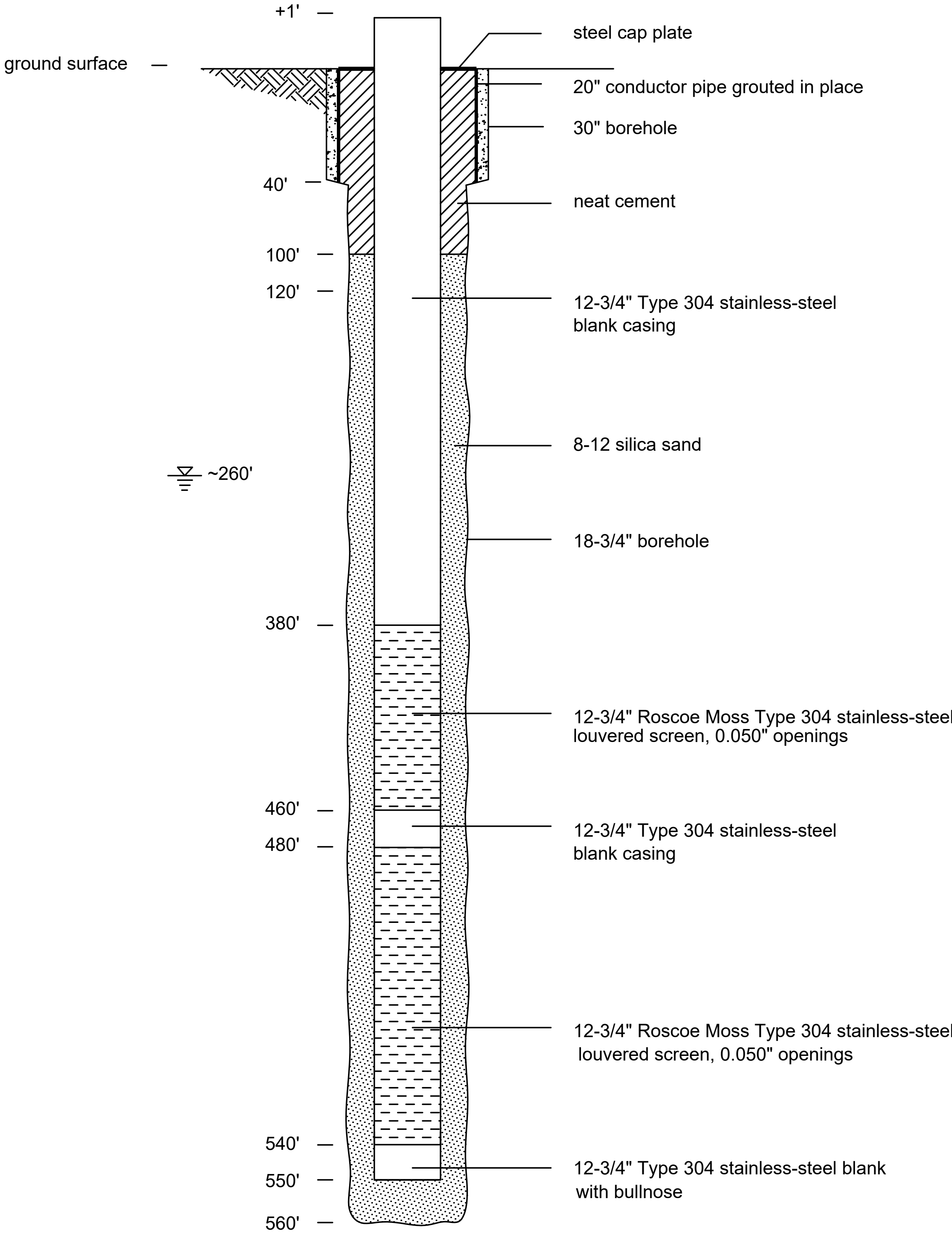



Figure 8. Proposed completion diagram for Village of Tularosa Stogden Replacement Well, (location at 1701 Central Ave.) Otero County, New Mexico.

JOHN SHOMAKER & ASSOCIATES, INC.

06/03/2024

# APPENDIX B: Wigen Water Technologies - 0.5 MGD Brackish Water Treatment RO Membrane Equipment

Corporate Headquarters
4201 Norex Drive, Suite 100
Chaska, MN 55318 USA

Phone 800-240-3330
Web WIGEN.COM

Water.
Process.
Solutions.

# Tularosa, New Mexico

# (2) 0.5 MGD Brackish Water Treatment

# RO Membrane Equipment

## Conceptual Proposal #110824-350A

## November 8, 2024

**Revision 0**

**Manufacturer**
Wigen Water Technologies
Abigail Antolovich, PE
Sales Director – West Region
Tel.: 303-598-7743
Email: abigail.antolovich@wigen.com

**Manufacturer's Representative:**
Chase Knox
Cogent
Tel: 970-691-0805
Email: cknox@cogentcompanies.com

## PERFORMANCE (PER SKID)

| | |
|---|---|
| **Feed Flow** | 315 - 350 gpm max. |
| **Permeate Flow** | 220 - 250 gpm max. |
| **System Array** | 8:4, 5L |
| **Membrane Element Diameter** | 8-inch |
| **Membrane Element Area** | 400 square feet |
| **Membrane Flux Rate** | 12 - 15 gfd |
| **System Design Recovery** | 71% |
| **Cartridge Filter Size** | 5 micron |

## RO SKID COMPONENTS (2 TOTAL, N+1 REDUNDANCY)

| | |
|---|---|
| **Membrane Elements** | |
| Membrane Quantity | 60 per Skid (120 total) |
| Manufacturer | Toray |
| Type | Polyamide, Thin Film Composite |
| **Membrane Pressure Vessels** | |
| Vessel Quantity | 12 per Skid (30 total) |
| Manufacturer | Protec, 5 Long 8" Housings |
| Vessel Construction | FRP, 300 psig |
| Sample Ports | ¼" sample valves |
| **Valves** | |
| Type | Bray Butterfly Valves w/ Electric Actuators |
| **Controls/Electrical** | |
| Processor (PLC) | (1) Allen-Bradley CompactLogix (on RO#1) |
| Operator Interface (HMI) | (1) Allen-Bradley PanelView Plus 7, 17" Color Touchscreen (on RO#1) |
| Enclosures | Painted Steel, NEMA 4/12 |
| Conduit | Liquid-Tight Flexible Conduit |
| Location | Master PLC Panel with HMI mounted RO#1 skid and connected to panel on RO#2 by others. |
| **RO Skid** | |
| Skid Quantity | (2) |
| Construction | Powder coated carbon steel per specifications. |
| Dimensions (L x W x H) | 240"x84"x96" (approx. dimensions) |

| Piping Materials | |
|---|---|
| RO Skid Inlet | Schedule 10 316 Stainless Steel |
| RO Skid Permeate | Schedule 80 PVC |
| RO Skid HP Concentrate | Schedule 10 316 Stainless Steel |
| RO Skid LP Concentrate | Schedule 80 PVC |
| RO Skid CIP Feed / Return | Schedule 80 PVC |
| *NOTE* | *Interconnecting Piping by Others* |

| Instrument | Location | Display |
|---|---|---|
| (4) Flow Meters | Feed Flow Meter, Bank 1 Permeate, Bank 2 Permeate, and Concentrate | HMI/Local |
| (2) Pressure Switches | Low Feed Pressure, High Permeate Pressure | HMI |
| (6) Pressure Transmitters | Feed, Interbank, Bank 1 Permeate, Bank 2 Permeate, Combined Permeate, Final Concentrate | HMI/Local |
| (6) Pressure Gauges | Bank 1 feed, Bank 2 feed, Final Concentrate, Bank 1 Permeate, Bank 2 Permeate, Combined Permeate | Local |
| (4) Conductivity | Bank 1 Permeate, Bank 2 Permeate, Combined Permeate, and Concentrate | HMI/Local |
| (2) pH | Feed, Combined Permeate | HMI/Local |

## UTILITY REQUIREMENTS & CONNECTIONS (by contractor)

| | |
|---|---|
| **RO Inlet** | 8" Flange |
| **CIP Inlet** | 6" Flange |
| **Permeate Outlet** | 4" Flange |
| **Concentrate to Drain** | 3" Flange |
| **CIP Permeate Return** | 2" Flange |
| **CIP Concentrate Return** | 6" Flange |
| **Main Control Panel Power:** | 120V/1Ø/60 Hz/20A |
| **RO Motor Control Panel Power** | 480V/3Ø/60 Hz/100A |
| **Influent Water Pressure** | 140 – 190 psi |

Other Exclusions:
- Offloading/siting equipment
- Loading membranes (under Wigen supervision)
- All utility connections
- Control system integration
- Chemicals/storage

## START-UP SERVICES

| ONSITE DAYS | SERVICES PROVIDED |
|---|---|
| 4 days | **Equipment Start-up** |
| 4 days | **Performance Demonstration Test** |
| 4 days | **Operator Training** |
| 3 Trips | **Operational Support Services** |

## PRICING

Concept level pricing for the equipment and services described in this proposal is $900,000. Budget pricing is in US Dollars and includes freight and excludes all applicable taxes. All pricing, estimates, and fees described above are valid for a period of 90 days. A final quotation will be provided upon confirmation of scope, equipment specifications, schedule, and delivery responsibilities.

Customer understands that this proposal has been issued based upon the information provided by customer, and currently available to WWT at the time of issuing this proposal. Any changes or discrepancies in site conditions, including but not limited to system influent water characteristics, changes in environmental health and safety conditions, Customer financial standing, Customer requirements, or any other relevant change, or discrepancy in, the factual basis upon which this proposal was created, may lead to changes in the offering, including but not limited to changes in pricing, warranties, quoted specifications, or terms and conditions.

# APPENDIX C: USGS SURFACE WATER DATA – TULAROSA CREEK

Click to hideNews Bulletins

- Explore the *NEW* USGS National Water Dashboard interactive map to access real-time water data from over 13,500 stations nationwide.

USGS Surface-Water Annual Statistics for New Mexico

Click to hide state-specific text

**The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.**

## USGS 08481500 TULAROSA CREEK NEAR BENT, NM

Available data for this site: Time-series: Annual statistics GO

| | Output formats |
|---|---|
| Otero County, New Mexico<br>Hydrologic Unit Code 13050003<br>Latitude 33°08'41.6", Longitude 105°53'52.45" NAD83<br>Drainage area 120 square miles<br>Gage datum 5,450 feet above NGVD29 | HTML table of all data<br>Tab-separated data<br>Reselect output format |

| Water Year | 00060, Discharge, cubic feet per second |
|---|---|
| Period-of-record for statistical calculation restricted by user | |
| 2003 | 14.8 |
| 2004 | 14.6 |
| 2005 | 15.1 |
| 2006 | 15.9 |

| Water Year | 00060, Discharge, cubic feet per second |
|---|---|
| 2007 | 15.8 |
| 2008 | 15.2 |
| 2009 | 13.9 |
| 2010 | 14.3 |
| 2011 | 14.1 |
| 2012 | 14.3 |
| 2013 | 13.3 |
| 2014 | 16.3 |
| 2015 | 15.3 |
| 2016 | 12.7 |
| 2017 | 12.6 |
| 2018 | 12.7 |
| 2019 | 11.1 |
| 2020 | 10.8 |
| 2021 | 10.1 |
| 2022 | 10.1 |
| 2023 | 10.5 |
| ** No Incomplete data have been used for statistical calculation | |

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Click to hideNews Bulletins

- Explore the *NEW* USGS National Water Dashboard interactive map to access real-time water data from over 13,500 stations nationwide.

USGS Surface-Water Monthly Statistics for New Mexico

Click to hide state-specific text

**The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.**

## USGS 08481500 TULAROSA CREEK NEAR BENT, NM

Available data for this site Time-series: Monthly statistics GO

| | |
|---|---|
| Otero County, New Mexico<br>Hydrologic Unit Code 13050003<br>Latitude 33°08'41.6", Longitude 105°53'52.45" NAD83<br>Drainage area 120 square miles<br>Gage datum 5,450 feet above NGVD29 | **Output formats**<br>HTML table of all data<br>Tab-separated data<br>Reselect output format |

| 00060, Discharge, cubic feet per second, | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **YEAR** | **Monthly mean in ft3/s (Calculation Period: 2002-05-01 -> 2024-03-31)<br><br>Period-of-record for statistical calculation restricted by user** | | | | | | | | | | | |
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **2002** | | | | | 13.4 | 12.2 | 23.7 | 15.5 | 17.3 | 16 | 15 | 16.8 |
| **2003** | 18.3 | 16.5 | 14.5 | 14.1 | 13.7 | 14 | 12.7 | 13.3 | 13.4 | 14.9 | 15.2 | 15.6 |
| **2004** | 15.5 | 15.7 | 16.2 | 15.8 | 11.8 | 11.7 | 12.1 | 14.2 | 16.9 | 19.6 | 15.8 | 14.8 |
| **2005** | 16.5 | 18.1 | 18.2 | 16.6 | 14.5 | 12.5 | 10.8 | 12.3 | 12 | 12.7 | 8.27 | 12.2 |
| **2006** | 12.7 | 13.4 | 13.6 | 11.7 | 10.4 | 9.08 | 18.1 | 52.3 | 15.8 | 17 | 18.1 | 17.7 |
| **2007** | 17.5 | 16.4 | 15.8 | 16.5 | 15 | 12.2 | 15.6 | 14.7 | 13.4 | 13 | 13.6 | 15.8 |
| **2008** | 15.8 | 15.8 | 15.3 | 14.3 | 13.4 | 13.4 | 21.3 | 15.2 | 15.7 | 14.4 | 13.8 | 14.8 |
| **2009** | 14.2 | 14.7 | 15.4 | 14 | 13.2 | 14 | 14.7 | 11.9 | 12.1 | 12.5 | 12.7 | 15.1 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2010** | 16 | 16 | 16.8 | 15.4 | 13.6 | 10.9 | 12.2 | 16.7 | 13.5 | 15.3 | 15.9 | 15.9 |
| **2011** | 16.1 | 12.1 | 13.8 | 14.8 | 13.9 | 12.3 | 11.4 | 13.1 | 14 | 14.2 | 14.2 | 16.2 |
| **2012** | 16 | 17 | 16.1 | 14.7 | 14.4 | 13 | 11.9 | 11.4 | 12.2 | 13 | 13.9 | 14.6 |
| **2013** | 14.6 | 15.9 | 15.7 | 13.6 | 11.6 | 13.2 | 8.34 | 13 | 12.7 | 13.6 | 14.3 | 14.4 |
| **2014** | 15.8 | 18.9 | 18.7 | 16.9 | 17.6 | 17 | 15.6 | 15.8 | 16.9 | 15.4 | 15.6 | 16.2 |
| **2015** | 17.6 | 18.7 | 18 | 16.7 | 13.7 | 13.2 | 13.5 | 13 | 12.5 | 12.7 | 11.8 | 12.7 |
| **2016** | 13.8 | 14.4 | 14.7 | 14 | 11.6 | 10.7 | 10.1 | 11.3 | 15.1 | 14.5 | 14.5 | |
| **2017** | 13.6 | 13.2 | 13.1 | 12.6 | 11.1 | 9.71 | 12.8 | 12.6 | 9.63 | 11.3 | 13.2 | 13.8 |
| **2018** | 14 | 16.1 | 16.1 | 14.6 | 11.1 | 12 | 10.6 | 9.17 | 11.2 | 15.3 | 13 | 13.5 |
| **2019** | 14.8 | 14.7 | 9.71 | 9.88 | 10.7 | 8.06 | 7.16 | 8.31 | 8.73 | 8.56 | 9.73 | 13.2 |
| **2020** | 13.6 | 13.6 | 13 | 10.8 | 8.21 | 8.74 | 10.8 | 10.4 | 8.79 | 9.76 | 9.96 | 10.3 |
| **2021** | 10.7 | 10.8 | 10.4 | 10.5 | 7.64 | 5.38 | 11 | 13.8 | 10.8 | 9.66 | 10.3 | 10.7 |
| **2022** | 10.9 | 11.4 | 11.6 | 11.1 | 8.69 | 6.11 | 6.74 | 12.5 | 11.3 | 12.1 | 12.2 | 12.2 |
| **2023** | 12.4 | 12.5 | 12.7 | 10.7 | 9.66 | 8.03 | 7.44 | 8.06 | 8.35 | 8.42 | 9.85 | 11.3 |
| **2024** | 11.6 | 11.9 | 12.1 | | | | | | | | | |
| **Mean of monthly Discharge** | 15 | 15 | 15 | 14 | 12 | 11 | 13 | 14 | 13 | 13 | 13 | 14 |

** No Incomplete data have been used for statistical calculation

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# APPENDIX D: POND EVAPORATION CALCULATIONS

| | |
|---|---|
| CLIENT | Village of Tularosa |
| PROJECT | Tularosa DAR - Surface Water Improvements |
| PROJECT NO. | 20230413 |
| TOPIC | Pond Evaporation |
| BY | Hector Garcia |
| DESIGN DATE | 23-Dec-24 |

Design Recovery 71%

RO plant rated at 500000 gpd

Q 101

| | Q (gpm) | Q (MGD) | T (hrs) | TDS (mg/L) |
|---|---|---|---|---|
| Summer Inflow = | 101 | 0.145 | 4,380 | 14,000 |
| Winter Inflow = | | | | |
| Average Flow = | 101 | 0.145 | | |

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pan Evaporation Rate (in) = | 3.73 | 4.35 | 8.21 | 11.30 | 12.88 | 14.43 | 13.66 | 11.59 | 9.17 | 7.19 | 4.89 | 3.46 |
| Precipitation (in) = | 0.41 | 0.40 | 0.36 | 0.08 | 0.12 | 1.09 | 1.63 | 2.65 | 0.33 | 0.96 | 0.17 | 0.59 |
| Pond Rate Reduction (%) = | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| Salinity Factor Reduction (%) = | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| Pond Evaporation Rate (in) = | 2.61 | 3.12 | 6.27 | 9.04 | 10.28 | 10.57 | 9.40 | 6.71 | 7.07 | 4.85 | 3.78 | 2.21 |

| | | |
|---|---|---|
| Assumed Water Surface Area (acres) = | 15 | |
| Assumed Water Surface Area ($ft^2$) = | 653,400 | |
| Assumed Water Depth (ft) = | 2 | |
| Pond Side Slope (h:v) = | 3 | |
| Total Depth of Pond (ft) = | 3.5 | |
| Pond L:W Ratio = | 1 | |
| Pond Length (ft) = | 808 | |
| Pond Width (ft) = | 808 | |
| Calculated Pond Water Volume ($ft^3$) = | 1,287,544 | |
| Max Storage Volume Required ($ft^3$) = | 1,247,833 | |
| Calculated Pond Water Volume (gal) = | 9,630,829 | |
| Calculated Pond Volume ($ft^3$) = | 2,228,259 | |
| Annual Sediment Volume ($ft^3$) = | 39,612 | 3,301 |
| Initial Water Volume ($ft^3$) = | 0 | |

| | |
|---|---|
| Number of Ponds = | 4 |
| Water Surface Area per Pond ($ft^2$) = | 163,350 |
| Pond Length @ Water Surface (ft) = | 404 |
| Pond Width @ Water Surface (ft) = | 404 |
| Total Water Surface Area ($ft^2$) = | 653,400 |
| Freeboard (ft) = | 1.5 |
| Pond Length (ft) = | 410 |
| Pond Width (ft) = | 410 |
| Pond Surface Area ($ft^2$) = | 168,100 |
| Pond Volume ($ft^3$) = | 558,987 |