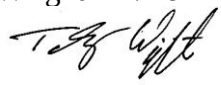
APPENDIX C

TECHNICAL MEMORANDUM

To: Brad Bingham, Closure Manager	**Date:** June 2022
From: Toby Wright Wright Environmental Services, Inc. 	**Re:** **Homestake Mining Company** **Grants Reclamation Project** Calculation of projected future groundwater demand and present value of that projected demand
Cc: File	

Introduction

The purpose of this technical memorandum is to document the technical bases and approach for estimating projected future groundwater use demand and costs for supplying an alternate water supply associated with the area adjacent to the Homestake Mining Company (HMC) Grants Reclamation Project (GRP), in Cibola County, New Mexico. The objective of this memo is to provide a technically sound and defensible basis of estimate for the value of the pre-contaminated groundwater resource per NRC guidance in NUREG-1620 (NRC, 2003).

Although projection of hypothetical future groundwater use demands is a speculative endeavor because the future use of any the lands is uncertain, this application identifies reasonable and conservative estimates of current and projected future water use demand as a means to value the groundwater resource. Current groundwater uses outside the HMC-owned land include:

- Irrigation for crops (forage; e.g., alfalfa)
- Industrial uses
- Domestic uses

Current groundwater use demands are estimated herein based on active groundwater well permits and estimated use rates for each permitted well use type.

Historical Population Patterns:

The HMC GRP is located in Cibola County New Mexico. Cibola County was created from Valencia County in July of 1981 and, therefore, does not have as long a population record. Review of Valencia County population data from 1900 to 2018 (Table 1) indicates an annual average population growth rate of 3.76 percent. Since its creation in 1981, Cibola County's average annual population change has been at a rate of -0.25 percent.

Future groundwater use demand is projected from current water use demand assuming that demand change for all water uses would be proportional to population change over the next 1,000 years for each water use type. Irrigation demand is based on current crop types (e.g., livestock forage such as alfalfa), although historical agricultural practices irrigated crops of carrots, which have a higher water use demand per acre.

Projected future population changes are assumed to be consistent with historical population changes since 1900 based on publicly available census data. Both high and low range of observed population growth rates are modeled. Therefore, the projected future groundwater demand escalates the current

groundwater use demand for each water use type (e.g., domestic, irrigation, stock watering, industrial/commercial, etc.) by the range of identified annual growth rates.

Current census data indicates in Cibola County has an average occupancy per household of approximately 2.67 persons. For this analysis, three persons per household were assumed. US Environmental Protection Agency (EPA) estimates that an average household uses approximately 100 gallon per day (gpd) per person or 300 gpd per household of 3 persons (https://www.epa.gov/watersense/how-we-use-water).

Current Groundwater Wells

The New Mexico Office of State Engineer (NMOSE) data records were queried on April 1, 2021 for all well permits within the proposed control boundary (Figure 1).

This query identified active and inactive water right permit files for wells not currently controlled by HMC. The records used in the assessment discussed in this technical memorandum include only active well permit files, inactive permit files, which are those files with canceled or expired permits that have been otherwise closed, have been removed. Electronic files of this data record are also provided with this technical memorandum.

Active water rights permit file types identified within the area described above include the following uses, some of which are not considered further for reasons noted below.

- Domestic wells (DOM)
- Domestic wells (DOL; no water use diversion allotted; no projected water use demand considered)
- Exploration wells (EXP; no water use diversion allotted; no projected water use demand considered)
- Irrigation wells (IRR)
- Mobile Home Parks (MOB; no water use diversion allotted; no projected water use demand considered)
- Sanitary Wells in Conjunction with Commercial Use (SAN, considered for use with IND wells)

The query was further refined by removing wells with the following attributes:

- A diversion allotment of zero (0) acre feet of water;
- Visual Inspection of recent aerial imagery indicates no current infrastructure supporting beneficial use of the well or water diversion (e.g., no piping, associated structures of power supply, evidence of water irrigation, or other evidence of well use.
- Knowledge of wells abandoned by HMC.

This refinement removed some water rights files from the original query. Table 2 summarizes the results of this refined query. A digital copy of the spreadsheet that includes the original NMOSE database query information and the basis for removal of selected records that do not represent a potential for current groundwater demand is included in Attachment A to this technical memorandum.

No reported actual water use rates for the active well permits were identified from State records. Therefore, estimates of current and projected future groundwater demand from the well infrastructure based on use type is developed herein.

Groundwater Use Demand

Wells in the Chinle water-yielding units typically have limited yields that average approximately 1 gallon per minute (gpm; or 1,440 gpd), the range of pumping rates for the alluvial aquifer varies depending on the specific composition of the alluvium. As such, shallow wells from the area of study may not realistically support the long-term projected future water use demand rates, which are based on hypothetical growth rates

for centuries into the future. In addition, escalation of water use demand over such long periods of time result in water use rates that may exceed the total annual flow of these relevant water-yielding units in the area of study (alluvium and Chinle). However, these hydrologic limitations are ignored for estimating the projected future water use demand, resulting in a conservative over estimation of achievable water yield and a related over estimation of potential water resource value.

Estimates of groundwater use rates for each groundwater use type are made based on the following assumptions and approach (also see Table 3):

Private Land Parcels

- No active well permits, access to municipal water line
  - No current or projected future groundwater use demand
  - No current groundwater access is available
- Active well permits
  - ***Irrigation Wells:***
    - Visual inspection of recent aerial imagery to estimate acres potentially under cultivation
    - Approximately 226 acres are estimated to be privately owned land (non-HMC land) available for irrigation with local groundwater at this time. Note: HMC is actively acquiring such lands, so irrigation may not be performed as a future groundwater use.
    - Two wells are currently permitted for irrigation within the proposed control boundary; there is a State of New Mexico prohibition on new wells permits in this boundary for the affected groundwater. Neither of these wells appear to be irrigating cropland based on a review of aerial imagery.
    - It is assumed that 1.5 square miles (960 acres or roughly 80 percent of the land not currently owned by HMC within the control boundary as of May 31, 2022) is the upper limit for arable land for projected future irrigation within the area of study, although some if this land may be purchased by HMC in the future and may not be available for irrigation in the future.
    - Multiply estimated acres under cultivation by water application rate, assume alfalfa as irrigated crop (34.2 in per season, 6 month growing season, April through September; see Table 4.4-2 of the ACL Application)
    - Escalate acres under irrigation by population growth rates up to limit of available land for irrigation.
- Active well permit with access to municipal water line
  - ***Domestic wells:***
    - All parcels with permitted DOM and MUL wells within the proposed control boundary have access to the existing municipal water lines.
    - Assume each well supports one household of three persons
    - Assume indoor water use (cooking, bathing, etc.) are supplied by municipal water, groundwater use accessed for outdoor water use only (lawns, gardens, etc.)
    - 50% use rate of full residential demand which equals 150 gpd/household of 3 persons
      - Per EPA: https://www.epa.gov/watersense/how-we-use-water
  - ***Industrial Wells (SAN):***
    - Two well permit files for SAN use are within the proposed control boundary.

- This water use is considered for sanitary water associated with bathrooms and sinks for the light commercial properties in this area. A use rate of 86 gallon per day per employee is assumed (Pacific Institute, 2003).
- Ten employees per well is assumed based on average small-scale industries present in the proposed control boundary area.

Table 3 summarizes the estimated current groundwater demand rates for each category of well and the references that supports the basis for those rates. Table 4 summarizes the projected total amount of groundwater demand over the next 1,000 years by use type. The spreadsheets used to develop these calculations are provided in Microsoft Excel format in Attachment A. It should be noted that this approach allocates overlapping land uses to the land area (i.e., both grazing and crop irrigation), which likely overestimates actual water use demand.

Costs of Alternate Water Supply

An alternate water supply is currently available for the area of study via water mains from the Village of Milan (Figure 1). Costs for alternate water supply are based on the Village of Milan 2021 rates (Table 5). These costs are tiered based on the volume of water used and vary based on the type of water service (i.e., residential vs commercial/bulk water). These rates are escalated annually by an average rate of inflation of 1.5 percent, which is the approximate average consumer price index (CPI) over the period of 1913 through 2019.

Nominal and Present Value of Groundwater Demand Costs

The sum of all annual undiscounted costs over the 1,000-year period is herein called the nominal cost. The present value of future costs (discounted costs) is calculated using a discounted cash flow analysis, which treats the future monthly payment for the alternate water supply as a periodic cash flow and is calculated using the following equations.

Equation 1:

$$\text{Percent Cash Flow Discount} = \frac{1}{1+(r/n)^{(n \, x \, y_f)}}$$

Where:

r = Annual discount rate (inflation rate, or 1.5%)
n = Number compounding periods per year (12)
y_f = Year fraction of total period for each payment period (e.g., y_f for 2nd month of 3rd year = 25 months = 25/12 = 2.08)

Equation 2:

Present value of monthly payments = sum of (percent cash flow discount x nominal monthly cost)

These costs calculations are provided in a Microsoft Excel spreadsheet included as a digital attachment to this Technical Memorandum.

Projected Future Domestic Groundwater Demand Cost

The initial groundwater use demand for domestic or residential use is based on the existing active domestic and sanitary well permits (classified in NMOSE database as DOM and SAN) on private land not owned by HMC within the study area as identified in the NMOSE database on April 1, 2021. Review of the NMOSE database and recent aerial photography using Google Earth and ArcGIS software identified 23 active well permit files on land not controlled by HMC within the area of study. Of these 23 well permit files, 19 are permitted for domestic use and all parcels on which these 19 well permits are located have access to existing municipal water lines.

Each domestic well permit file is assumed to service a single household of three persons. Each person in a household is assumed to consume 100 gallons per day. Households with access to municipal water lines are assumed to only use groundwater for outdoor applications (garden and lawns) for a use rate of 50 percent of a household with access to the municipal water lines, or 150 gallons per day. For calculating water use demand, households with access to municipal water lines, which are assumed to use half the water of a household without municipal water line access and considered half a household. Therefore, solely for the purposes of estimating the value of the pre-contaminated groundwater resources, there are an assumed 10 initial full household equivalents (19 x 0.5 = 9.5 rounded to 10) hypothetically using groundwater. However, it is emphasized herein that there is **no identified current domestic groundwater use in the area of study**.

The population and the associated water use demand are escalated annually by the high and low range of historical population growth rates, discussed above. The cost for new water tap deposits are added in the seventh month of each year for years when new households of three are added to the population.

Projected Future Industrial Groundwater Demand Cost

None of these businesses have identified practices that use water for primary economic activity (e.g., water-consuming manufacturing or production). Therefore, it is assumed that water is principally used for sanitary (e.g., bathrooms/washrooms) and maintenance activities (e.g., equipment and site cleaning). A daily water consumption of 860 gallons per day is assumed per well based on the following assumptions:

- Each business has a full-time staff of 10 persons
- 86 gallons per day per person, based on SIC code 39 for miscellaneous manufacturing industries (Pacific Institute, 2003)
- Initial daily water use demand = 860 gallons/day

The number of SAN wells is escalated annually in fractions by the high and low range of historical population growth rates, discussed above. The groundwater use demand is increased annually by the fraction of escalated wells, not just whole wells added to the well population (e.g., a single well uses 860 gallons per day, in a later year there may be a fractionally escalated 1.3 wells with an escalated use of 1,118 gallons per day use). Note that there is a State of New Mexico prohibition on new wells in this area. Conceptually, this means that the increase demand is actually met by the existing wells.

Projected Future Irrigation Groundwater Demand Cost

The initial groundwater use demand for agricultural irrigation of crops use is based on the existing active irrigation well permits (classified in NMOSE database as IRR) on private lands not owned by HMC within the study area as identified in the NMOSE database on April 1, 2021. In addition, inspection of recent aerial photography using Google Earth and ArcGIS software identifies no acres of land under recent irrigation by these two wells. However, the parcels that contained these two wells and additional acreage were estimated to be available for irrigation (226 acres). The acres of land identified are escalated by the high and low range of historical population growth rates, discussed above. A maximum of 960 acres (1.5 square miles) is assumed to be available for irrigation, approximately 80 percent of the land not currently owned by HMC as of May 31, 2022 and represents a conservative upper bound on potential future use demand. It is noted that the groundwater volume needed for this hypothetical future irrigation area is almost four times larger than could be supported by combined maximum permitted groundwater diversion for these two wells at a typical irrigation rate. Specifically, the permitted annual water diversion for these two wells is 691 acre-feet per year or approximately 428 gpm on an annual average basis and twice that rate, 856 gpm, if the groundwater is only pumped during the six-month growing season. Assuming a water irrigation application rate of 2.85 feet/six months (Table 3), this permitted water diversion would irrigate a maximum of 245 acres per year. It is highly unlikely that the existing wells could sustain this demand pumping rate from the affected groundwater of the alluvium and Chinle.

Projected Future Stock Watering Groundwater Demand Cost

No active stock water well permits were identified in the proposed control boundary.

Results and Conclusions

Table 4 summarizes the nominal water use cost (total dollar amount) and present value of the monthly water use payments over the next 1,000 years, considering the range in potential population growth rates. The majority (96 percent) of the projected future groundwater demand comes from the assumed irrigation demand (high peak demand rate of approximately 3,392 gpm) and 83 percent of the present value of the projected groundwater use demand. Hypothetical domestic water use demand accounts for less than five percent of the total future demand and present value of the projected groundwater demand (high growth rate). Projected future commercial water demand comprises one percent of projected demand and between 5 and 13 percent of the present value of the projected groundwater demand (Table 4).

Attachment A to this technical memorandum includes an electronic copy of the Microsoft Excel spreadsheet that develops the calculations. These calculations indicate that the conservative upper bound on present value for the cost of supplying an alternate water supply for the projected future water use demand from the municipal water provider over the next 1,000 years is approximately $6,700,000. This estimate is considered a conservative upper bound on the value of this groundwater resource for the following reasons. First, this analysis is based on a projected peak total water use demand for all uses of approximately 3,392 gallons per minute, which likely exceeds the reasonable yield of the affected water-yielding units in the area of study alluvium and Chile sandstone units. Second, these estimated groundwater demand rates are not based on escalation of actual current groundwater use rates. Rather, SAN, MUL, and DOM use rates are

assumed although no current groundwater use is documented for these well permit types and all properties are connected to municipal water lines. Therefore, the projected and escalated use rates for these well types are hypothetical and likely overestimate future groundwater use demand. Third, this analysis assumes that the existing wells authorized under the identified permits are operable for 1,000 years despite the fact that well replacement at the end of their capital life are prohibited under the State restrictions for this area.

References:

https://aces.nmsu.edu/pubs/research/livestock_range/RR759.pdf

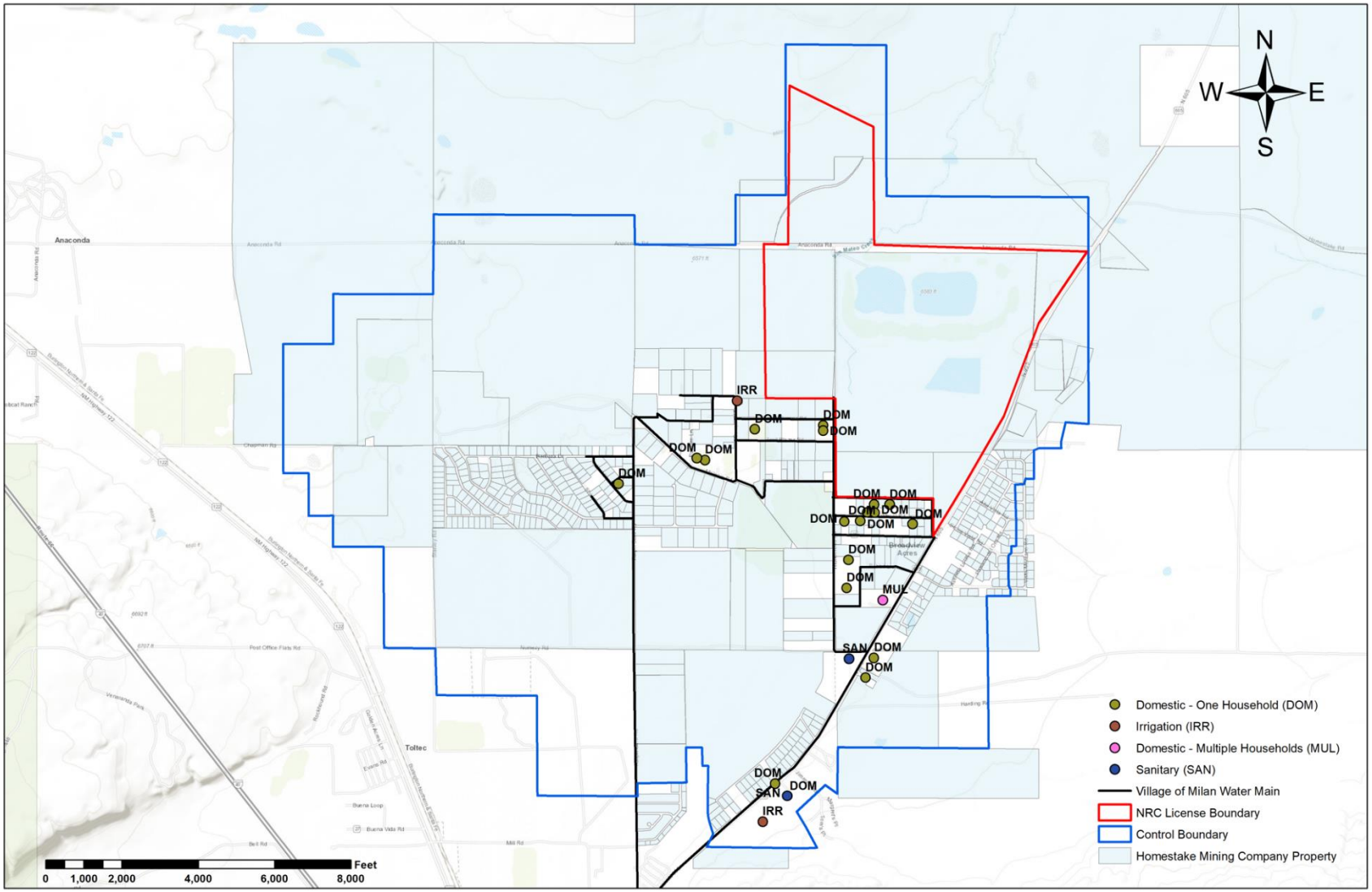
NMU, 2007. Perspectives on Rangeland Management: Stocking Rates, Seasonal Forecasts, and the Value of Weather Information to New Mexico Ranchers. New Mexico State University, College of Agriculture and Home Economics; Research Report 759. Brian H. Hurd, L. Allen Torell, Kirk C. McDaniel. December 2007.

NRC, 2003. U.S. Nuclear Regulatory Commission. Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978. NUREG-1620, Revision 1. June 2003.

Pacific Institute, 2003. Waste Not, Want Not: The Potential for Urban Water Conservation in California. November 2003. Appendix C: Industrial and Commercial Water Use: Table C-1 Water Use Coefficients by SIC Code, Industrial Sector.

FIGURES

Figure 1 Existing Well Permit Locations and Alternative Water Supply Lines



TABLES

Table 1 Summary of Population Data

Year	McKinley Co.		Valencia Co.		Cibola Co.	
	Population	% Change	Population	% Change	Population	% Change
1900	NA		13,895			NA
1910	12,963		13,320	-4%		NA
1920	13,731	6%	13,795	4%		NA
1930	20,643	50%	16,186	17%		NA
1940		NA		NA		NA
1950		NA		NA		NA
1960		NA		NA		NA
1970	43,208		40,539			NA
1980	56,449	31%	61,115	51%		NA
1981				4.25%	29,756	
1982					29,756	
1983					26,321	
1984					24,700	
1985					24,372	
1986					23,528	
1987					23,602	
1988					23,819	
1989					23,905	
1990	60,686	8%	45,235	-26%	23,794	
2000	74,798	23%	66,152	46%	25,595	8%
2010	70,663	-6%	74,554	13%	27,179	6%
2011	71,290	1%	75,640	1%	27,316	1%
2012	71,888	1%	76,172	1%	27,293	0%
2013	72,373	1%	76,461	0%	27,296	0%
2014	73,082	1%	76,480	0%	27,392	0%
2015	73,998	1%	76,297	0%	27,382	0%
2016	74,346	0%	75,993	0%	27,373	0%
2017	72,849	-2%	75,845	0%	27,049	-1%
2018	72,849	0%	75,956	0%	26,978	0%
2019	72,438	-1%	76,027	0%	26,891	0%
Average Change Persons/yr	**546**		**522**		**82**	
Annual Average Percent Population Change (%)	**4.21%**		**3.76%**		**-0.25%**	
2019 Population Density (persons/sq. mi.)	**13.3**		**71.3**		**5.9**	

Source: https://www.socialexplorer.com/a9676d974c/explore

Table 2 Summary of Private Wells Not Currently Owned by HMC

Use Code	Use Description	No. of Wells
DOL	Domestic and Livestock Watering	0
DOM	Domestic One Household	18
EXP	Exploration	0
IND	Industrial	0
IRR	Irrigation	2
MUL	Multiple Domestic Households	0
MUN	Municipal - City or County Supplied Water	1
SAN	Sanitary In Conjunction With A Commercial Use	2
STK	Livestock Watering	0
SUB	Subdivision	0
	Total:	23

Table 3 Water Application Rates and Bases of Estimates

Water Use	Application or Use Rate	Basis of Estimate	Source
Irrigation			
Alfalfa	34.2 inches/year (2.85 ft/year)	Water Application and Requirements for Crops, New Mexico.	https://nmwrri.nmsu.edu/wp-content/uploads/2015/watcon/proc2/Diebold.pdf
Carrots	55 inches/year (4.58 ft/year)	Commercial Production and Management of Carrots, Bulletin 1175, University of Georgia	https://extension.uga.edu/publications/detail.html?number=B1175&title=Commercial%20Production%20and%20Management%20of%20Carrots
Stock Watering			
NO Permitted Wells	None		
Domestic Well			
Full Domestic Use	100 gpd/person	EPA: How We use Water; Domestic Water Use in Gallons Per day Per Person and Percent Population Growth from 2000 to 2015	https://www.epa.gov/watersense/how-we-use-water
Outdoor Use Only	50 gpd/person (50% of Total use)	New Mexico Water Use by Categories Supplemental Report 2005	https://www.nrc.gov/docs/ML1030/ML103080984.pdf
Industrial//Commercial Sanitary			
10 staff per well	86 gpd/per staff	Industrial and Commercial Water Use: Table C-1 Misc. manufacturing industries (SIC 39)	Pacific Institute, 2003, Appendix C
Exploration			
No diversion allocation	None	Exploration wells for natural resources are not used for groundwater diversion and are not considered a current or projected future point of groundwater diversion.	

AMU = Animal Management Unit, 1,000 lb cow ft = feet gal = gallon gpd = gallons per day yr = year lb = pounds

Table 4 Summary of Projected Water Use Demand and Water Resource Value

		1,000-year Projected Water Use		Nominal Water Use Cost ($)		Present Value of Water Use Cost ($)					
Population Growth Rate	Current Demand Rate Estimate (gpm)	High Growth Rate (3.76%/yr) (total gallons)	Low Growth Rate (-0.25%/yr) (total gallons)	High Growth Rate (3.76%/yr)	Low Growth Rate (-0.25%/yr)	High Growth Rate (3.76%/yr)	Low Growth Rate (-0.25%/yr)	Demand		Present Value	
								High	Low	High	Low
Domestic	2.1	21,702,243,000	244,951,500	$615,239,665	$1,613,107	$226,384	$149,548	2%	1%	3%	5%
Commercial	1.2	12,411,091,593	114,547,444	$21,558,562,382	$11,527,969	$902,885	$168,155	1%	0%	13%	5%
Irrigation	399.3	861,669,528,408	23,747,396,722	$2,762,661,210	$22,649,689	$5,613,413	$2,793,877	96%	98%	83%	90%
Total	402.6	895,782,863,001	24,106,895,665	$24,936,463,257	$35,790,765	$6,742,682	$3,111,580				

1.5% annual inflation rate for water rates

Discounted Cash Flow basis for present value

7% Discount Rate for first 100 years per NUREG-1757, Vol. 2, Appendix N, Section N.1.1.

3% Discount Rate after 100 years per NUREG-1757, Vol. 2, Appendix N, Section N.1.1.

Table 5 Village of Milan, NM Water Department 2021 Water Rates

Cost Element	Residential	Commercial	Cost Element
Deposit	$300.00	$500.00	
Fixed Fee, 1st 1,000 gal	$17.71	$29.77	Fixed Fee, 1st 1,000 gal
Commodity Fee per 1,000 gal: 1,000 - 5,000 gal	$2.50	$2.63	Commodity Fee per 1,000 gal: 1,000 - 5,000 gal
Commodity Fee per 1,000 gal: 5,000 - 20,000 gal	$2.62	$2.71	Commodity Fee per 1,000 gal: 5,000 - 20,000 gal
Commodity Fee per 1,000 gal: 20,000 - 40,000 gal	$2.71	$2.78	Commodity Fee per 1,000 gal: 20,000 - 50,000 gal