Pojoaque Basin Regional Water System Amended Engineering Report

December 13, 2019

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

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Mission Statements

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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FINAL ENGINEERING REPORT
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COMMON ACRONYMS

ADD	Average Day Demand
AFY	Acre-feet per year
ASME	American Society of Mechanical Engineers
ASR	Aquifer Storage and Recovery
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BEP	Best Operating Point
CIP	Chemical Cleaning
CLSM	Controlled Low Strength Material
CP	Cathodic Protection
CW	Collector Well
DB	Design-Build
DBB	Design-Bid-Build
DBP	Disinfectant Byproduct
ER	Equipment Room
fps	feet per second
gpm	gallons per minute
GWUDI	Groundwater Under the Direct Influence of Surface Water
HDD	Horizontal Directional Drill
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
HMI	Human Machine Interface
JMEC	Jemez Mountains Electric Cooperative
M/E	Mechanical/Electrical
MDD	Maximum Day Demand
MF	Microfiltration
MGD	Million gallons per day
NF	Nanofiltration
NMDOT	New Mexico Department of Transportation
O&M	Operations and Maintenance
OM&R	Operations, Maintenance, and Repair
OEI	Occam Engineers, Inc
PBRWS	Pojoaque Basin Regional Water System
PLC	Programmable Logic Controller
PNM	Public Service of New Mexico
PRV	Pressure Reducing Valve
PS	Pump Station
psi	pounds per square inch
PVC	Polyvinyl chloride
ROW	Right of Way
SCADA	Supervisory Control and Data Acquisition
TOC	Total Organic Carbon
UF	Ultrafiltration
VAC	Volts Alternating Current
VFD	Variable-Frequency Drive
WTP	Water Treatment Plant

1 INTRODUCTION

The centerpiece of the Aamodt Litigation Settlement Act of 2010 (“Settlement Act”), Pub. L. 111-291. 124 Stat. 3134-3156. 8 December 2010, is construction of the Pojoaque Basin Regional Water System (PBRWS). The Settlement Act provides that the Secretary “shall plan, design, and construct” the PBRWS “in accordance with the Engineering Report.” Section 611(a)(1). The Settlement Act defines the Engineering Report as “the report entitled ‘Pojoaque Regional Water System Engineering Report’ dated September 2008 and any amendments thereto….” Section 602(9).[1]

The Settlement Act also allowed for further negotiations regarding cost-share if the original authorized funding for the PBRWS was insufficient. Section 611(g). Having determined that construction of the PBRWS would require funds in excess of the amount authorized in the Settlement Act, pursuant to Section 611(g), the Secretary initiated negotiations with the parties to the Cost-Sharing and System Integration Agreement for an agreement regarding additional federal and non-Federal contributions. On September 17, 2019, the Pueblos of Nambé, Pojoaque, San Ildefonso, and Tesuque; the United States; the State of New Mexico; Santa Fe County; and the City of Santa Fe entered into an agreement pursuant to Section 611(g) (“611(g) Agreement”), which provides that Reclamation will prepare an amended Engineering Report based on and consistent with the consensus design concept, including cost-saving measures, agreed upon by the parties to the 611(g) Agreement for construction of the PBRWS (“Consensus Design Concept”). The 611(g) Agreement provides that this amended Engineering Report amends, supersedes, and replaces the Engineering Report referenced in the Settlement Act.

While amending the Engineering Report referenced in the Settlement Act, consistent with the Act and the 611(g) Agreement, this Engineering Report is not intended to replace the final design drawings, specifications, and basis of design reports for the PBRWS. Figures and numbers in this report may potentially change as designs are confirmed and final design drawings, specifications, basis of design reports, and operations, maintenance, and repair (OM&R) reports, listed as reference documents to this report, will have the latest and most accurate information. Any such changes will comply with the Consensus Design Concept as set forth in the 611(g) Agreement. The procedure used to develop this Engineering Report was to combine essential information relating to the Consensus Design Concept from the CDM Smith 90% design-build basis of design report and the Reclamation Technical Service Center 60% design-bid-build basis of design report.

1.1 Background

The Settlement Act provides that the PBRWS “shall be determined to be substantially completed if the infrastructure has been constructed capable of—(A) diverting, treating, transmitting, and distributing a supply of 2,500 acre-feet of water to the Pueblos; and (B) diverting, treating, and transmitting the quantity of water specified in the Engineering Report to the County Distribution

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[1] All section citations are to the Settlement Act.

System." Section 624(e)(1). The 611(g) Agreement provides the following amended definition of substantial completion: "If Reclamation (i) issues a Notice To Proceed authorizing the start of Phase 1 (as described in Exhibit A [Consensus Design Concept]) construction by December 31, 2019, and subsequently commences construction of the Project; (ii) thereafter diligently proceeds to construct the Project in accordance with this Agreement and Exhibits A and B [the Engineering Report], on a schedule for completion by 2028 as agreed pursuant to subsection V(C); (iii) thereby expends all of the available Federal and non-Federal funding provided for in the Settlement Act and Section IV of this Agreement to construct the Project, as set forth in Exhibits A and B; and (iv) despite diligent efforts cannot fully complete the Project as set forth in Exhibits A and B due solely to the lack of authorized funding, the Project shall satisfy the Settlement Act's requirement of substantial completion."

1.2 Project Description

The PBRWS, located in north central New Mexico (**Error! Reference source not found.**), will p rovide drinking water that meets or exceeds Safe Drinking Water Act standards during initial operations when the demand is expected to be low, as well as when operating at full capacity. The Consensus Design Concept has an initial diversion and transmission capacity of 2,500 acre-feet per year (AFY) to the water treatment plant with a production capability of 3.51 million gallons per day (MGD), and a final build-out design capacity of 4,000 AFY with a peak day demand of 6.21 MGD. The system is designed as a regional, interconnected system among the Pueblos and the County.

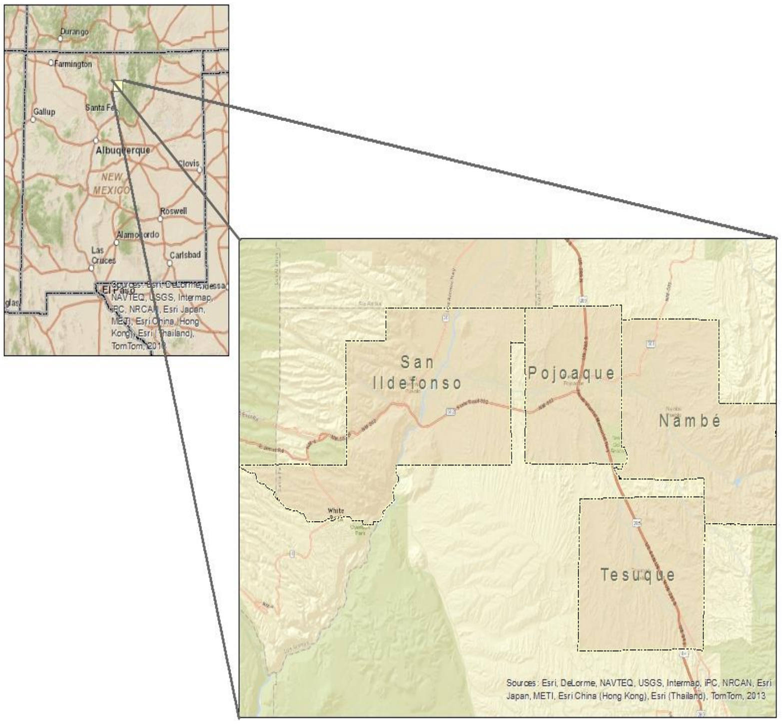
The raw water intake collection system at the Rio Grande consists of subsurface horizontal radial collector wells with submersible pumps to deliver the water to the new water treatment plant via a raw water transmission pipeline. The water treatment process consists of microfiltration/ ultrafiltration (MF/UF) membrane filtration, nanofiltration (NF) membrane filtration, disinfection, and solids/liquid residuals handling. The water treatment plant (WTP) will have an initial production capacity of 3.51 MGD, and ultimate production capacity of 6.25 MGD.

The water transmission system comprises three components necessary to deliver high quality water to the individual Pueblo and County distribution systems. These components include raw and potable water transmission pipelines, transmission pump stations with forebay tanks, and new and existing distribution (storage) tanks. The distribution system includes pipeline downstream of the distribution tanks that will carry the new potable water to customers.

1.3 Phased Design and Construction

To meet the legislated schedule, Reclamation developed a phased approach to design and construct the PBRWS. Phase 1 includes the system river intake facilities, water treatment plant, pump stations, transmission pipeline, distribution pipeline, and distribution tanks that will be connected to existing distribution tanks at San Ildefonso Pueblo and the northern portion of the Pojoaque Pueblo. As existing tanks are connected to the system, they may begin supplying treated water through existing Pueblo water distribution systems. Phase 1 also includes pipeline and a forebay tank for connection to Phase 2 features. Phase 2 includes pump stations, transmission and distribution pipeline, and associated tanks for Nambé Pueblo, the southern portion of Pojoaque and

Tesuque Pueblos, as well as the Bishop's Lodge section with connection and supply of treated water to existing Pueblo water distribution systems. Phases 1 and 2 connect at the forebay tanks located at Nambé and Pojoaque South Pump Stations. Phase 3 consists of new distribution pipeline downstream of Phase 1 and Phase 2 facilities, including service connection taps and service lines to a meter can located within rights-of way, but not including meters, service lines, or connections to residences.



Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013

Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013

Figure 1 – Location Map

1.3.1 Phase 1 – San Ildefonso-Pojoaque Section of the System

Phase 1 of the PBRWS includes a new subsurface water intake system at the Rio Grande and a new 6.25 MGD ultimate capacity Water Treatment Plant (WTP) to serve the Pueblos of San Ildefonso, Pojoaque, Nambé, and Tesuque, and applicable Santa Fe County service areas. Phase 1 also includes approximately 12 miles of new raw water (untreated water pumped to the treatment plant) and finished water (potable water downstream of the treatment plant) transmission pipelines, an NF concentrate return pipeline, two transmission booster pump stations at the WTP and Pojoaque Industrial Park, and six existing and five new distribution and forebay tanks. A chlorine injection facility is provided at the Turtle Tank. Phase 1 will interconnect with Phase 2 and parts of existing distribution systems.

Phase 1 major features and locations include:

- Raw Water Intake System at Rio Grande (Pueblo de San Ildefonso)
- Water Treatment Plant (Pueblo de San Ildefonso)
- Forebay Tanks and Pump Stations:

  - Finished Water Booster Pump Station (Pueblo de San Ildefonso)
  - Pojoaque Industrial Park Forebay Tank (also serves as distribution tank) (Pueblo of Pojoaque)
  - Pojoaque Industrial Park Pump Station (Pueblo of Pojoaque)
  - Pojoaque South Forebay Tank (constructed under Phase 1 for Phase 2) (Pueblo of Pojoaque)
- New Distribution Water Tanks:
  - El Rancho Tank (Pueblo de San Ildefonso)
  - Turtle Tank (Pueblo of Pojoaque)

- Existing Water Distribution Tanks to be connected and supplied by the New System:
  - Tewa Tank (Pueblo de San Ildefonso)
  - Black Mesa Tank (Pueblo de San Ildefonso)
  - New Pajarito Tank (Pueblo de San Ildefonso)
  - White Sands Tank (Pueblo of Pojoaque)
  - Lower Pojoaque Tank #30 (Pueblo of Pojoaque)
  - Lower Pojoaque Tank #31 (Pueblo of Pojoaque)

The details of these features are discussed in their respective sections.

1.3.2 Phase 2 – Nambé and Pojoaque-Tesuque-Bishop's Lodge Sections of the System

Phase 2 of the PBRWS consists of two interconnected sections of the system: the Nambé section of the system and the Pojoaque-Tesuque-Bishop's Lodge section of the system. Both sections receive treated water from the Phase 1 terminal storage reservoir Turtle Tank to serve their designated service areas. Phase 2 includes finished water transmission pipelines, pump stations, forebay tanks, distribution tanks and trunk distribution pipelines. Trunk distribution pipelines are distribution pipelines downstream from distribution tanks that are located and aligned parallel to the transmission mains. Chlorine injection facilities are designed and provided as future installations at the Camel Rock Tank, the Oweenge Day School Tank, and the RKM Tank. The installation of these chlorine injection facilities will be dependent upon the chlorine demand and the operational needs of the constructed water system.

1.3.2.1 Nambé Section of the System

For the Nambé system, the Nambé Forebay Tank receives water by gravity flow from the Phase 1 Turtle Tank via distribution pipelines. The transmission main conveys water from the Nambé Pump Station to the new Nambé Tank. The transmission main system has an elevation range of 6,070 ft to 6,380 ft, with a total length of approximately 2.8 miles. No customer demands are fed directly from the high-pressure transmission main.

Nambé Tank #25 and Nambé Tank #27 are two existing tanks of the current Nambé water system that are integrated into the new water system. Nambé Tank #25 receives water via a short connection pipeline from the new Nambé Tank and Nambé Tank #27 is linked to the new water system through their existing distribution network.

Phase 2 major features associated with the Nambé Section of the System include:

- Forebay Tanks and Pump Stations:
    - Nambé Forebay Tank (Nambé Pueblo)
    - Nambé Pump Station (Nambé Pueblo)
- New Distribution Water Tank:
    - Nambé Tank (Nambé Pueblo)

- Existing Water Distribution Tanks connected to and supplied by the New System:
    - Nambé Tank #25 (Nambé Pueblo)
    - Nambé Tank #27 (Nambé Pueblo)

Details of these features are discussed in their respective sections.

1.3.2.2 Pojoaque-Tesuque-Bishop's Lodge Section of the System

The Pojoaque-Tesuque-Bishop's Lodge section of the system is a complex water delivery system typified by a series of pump stations, forebay tanks, and distribution storage tanks. The system starts at the Pojoaque South Forebay tank, which receives water by gravity flow from the Phase 1 Turtle Tank. The water is then delivered via Pojoaque South, Camel Rock, and Tesuque pump stations to various existing and proposed distribution tanks (listed below), with the RKM Tank located at the end of the system. The RKM Tank will serve County users to the north and some users in the Pueblo of Tesuque, as well as feeding the RKM Pump Station. The RKM Pump Station feeds the existing Bishop's Lodge Tank #15, which then feeds Bishop's Lodge Tank #14. The transmission main system has an elevation range of 5,900 ft to 7,300 ft, with a total length of approximately 15 miles. No customer demands are fed directly from the high-pressure transmission mains.

New and existing water storage tanks, including Nambé South Tank, Camel Rock Tank, Oweenge Day School Tank #18, and Tesuque Casino tanks will receive water directly from secondary transmission mains branched off from the main transmission lines. Two other existing tanks included in the system are the Buffalo Thunder Tank #22 and IGC Tank. The Buffalo Thunder Tank #22 will receive water via a distribution pipeline from Pojoaque South-Nambé Tank while the IGC Tank will receive water from Camel Rock Tank via an existing 8-inch PVC distribution pipeline.

Phase 2 major features and locations associated with the Pojoaque-Tesuque-Bishop's Lodge section of the system include:

- Forebay Tanks and Pump Stations:
    - Pojoaque South Forebay Tank (constructed as part of Phase 1) (Pueblo of Pojoaque)
    - Pojoaque South Pump Station (Pueblo of Pojoaque)
    - Camel Rock Forebay Tank (Pueblo of Tesuque)
    - Camel Rock Pump Station (Pueblo of Tesuque)
    - Tesuque Forebay Tank (Pueblo of Tesuque)

  - Tesuque Pump Station (Pueblo of Tesuque)
  - RKM Tank (serves as a forebay and distribution tank) (Santa Fe County)
  - RKM Pump Station (Santa Fe County)
- New Distribution Water Tanks:
  - Nambé South Tank (Nambé Pueblo)
  - Camel Rock Tank (Pueblo of Tesuque)

- Existing Water Distribution Tanks to be Connected to the New System:
  - Buffalo Thunder Tank #22 (Pueblo of Pojoaque)
  - Oweenge Day School Tank #18 (Pueblo of Tesuque)
  - IGC Tank (Pueblo of Tesuque)
  - Tesuque Casino Tank (Pueblo of Tesuque)
  - Bishop’s Lodge Tank #15 (Santa Fe County)

Details of these features are discussed in their respective sections. To limit construction contract amounts to projected funds appropriations, Phase 2 is further broken down into the following stages:

- Phase 2 – Stage 1: South Pojoaque and Tesuque
- Phase 2 – Stage 2: Nambé
- Phase 2 – Stage 3: Bishop’s Lodge

1.3.3 Phase 3 – Distribution Systems

Phase 3 consists of new local distribution lines to serve Pueblo and County customers, including service connection taps and lines to meter cans located within the right-of-way, but excluding meters and service line connections to users’ structures. To limit construction contract amounts to projected funds appropriations, Phase 3 is further broken down into the following stages:

- Phase 3 – Stage 1: San Ildefonso–N. Pojoaque Distribution (about 59 miles)
- Phase 3 – Stage 2: S. Pojoaque, Cuyamunge, and Nambé South Distribution (about 5.6 miles)
- Phase 3 – Stage 3: Nambé Distribution (about 21.8 miles)
- Phase 3 – Stage 4: Tesuque Distribution (about 8.5 miles)
- Phase 3 – Stage 5: Bishop’s Lodge Distribution (about 6.6 miles)

It is anticipated that the first distribution systems to be tied into the PBRWS will include distribution lines serving members of the Pueblo de San Ildefonso that are connected through existing infrastructure to the existing Tewa, Black Mesa, and Pajarito Distribution Tanks in compliance with the Settlement Act. Final decisions on how to group Phase 3 reaches, non-Pueblo distribution and service connections, and which reaches will be deferred for later construction will be made prior to beginning construction of Phase 3.

1.4 Conveyance

Reclamation will transfer title of the PBRWS to the designated project stakeholders upon substantial completion of the PBRWS as provided for in section 611(h)(1) of the Settlement Act.

2 DESIGN CRITERIA

2.1 Water Demand Summary

The PBRWS will divert, treat, and deliver up to 4,000 acre-feet of water, average day demand (ADD), to end users throughout the Pueblos of San Ildefonso, Pojoaque, Tesuque, and Nambé, and portions of Santa Fe County. The Consensus Design Concept is based on the Water Demand Study performed by OEI (Occam Engineers, Inc.) dated April 6, 2018. A copy of this water demand study report is included in Appendix B. Table 1 presents a summary of the flows provided in the OEI Report for years 2024 and 2064. Table 2 shows the OEI water demand allocations to specific service areas within the study area through final buildout.

Table 1 – PBRWS Water Demand

Demand	Year 2024	Year 2064
Yearly Demand in AFY	1,552	4,000
Average Day Demand (ADD) in MGD	1.386	3.571
Average Day Demand (ADD) in GPM	962	2,480
Maximum Day Demand (MDD) in MGD	2.411	6.213
Maximum Day Demand (MDD) in GPM	1,674	4,315

Table 2 – Water Demands per Occam Engineers, Inc. (OEI)

Tanks & Service Areas	2024 ADD AFY	2024 ADD GPD	2024 ADD GPM	2024 MDD GPD	2024 MDD GPM	2064 ADD AFY	2064 ADD GPD	2064 ADD GPM	2064 MDD GPD	2064 MDD GPM
Phase 1 San Ildefonso West	28.98	25,874	18	45,021	31	52.12	46,532	32	80,966	56
Phase 1 San Ildefonso East	50.44	45,034	31	78,359	54	90.72	80,992	56	140,926	98
Phase 1 El Rancho	108.13	96,529	67	167,960	117	194.46	173,602	121	302,067	210
Phase 1 Jacona	88.72	79,202	55	137,811	96	159.55	142,440	99	247,846	172
Phase 1 Pojoaque	124.60	111,239	77	193,556	134	224.09	200,057	139	348,099	242
Phase 1 Upper Pojoaque	45.40	40,528	28	70,519	49	81.64	72,888	51	126,825	88
Phase 1 Pojoaque South	14.02	12,517	9	21,780	15	25.22	22,512	16	39,171	27
Phase 1 Lower Cuyamungue	223.73	199,734	139	347,537	241	1,156.89	1,032,803	717	1,797,077	1,248
Phase 2/Stage 1 Upper Cuyamungue	51.72	46,171	32	80,338	56	170.73	152,421	106	265,213	184
Phase 2/Stage 1 Buffalo Thunder	123.91	110,624	77	192,486	134	184.28	164,518	114	286,261	199
Phase 2/Stage 1 Nambé South	48.24	43,064	30	74,931	52	225	200,869	139	349,512	243
Phase 2/Stage 1 Camel Rock	5.52	4,930	3	8,578	6	26.35	23,526	16	40,935	28
Phase 2/Stage 1 Lower Tesuque Pueblo	8.01	7,153	5	12,446	9	27.77	24,793	17	43,140	30
Phase 2/Stage 1 Tesuque Pueblo	22.47	20,059	14	34,903	24	78.29	69,890	49	121,609	84
Phase 2/Stage 1 Upper Tesuque Pueblo	4.43	3,955	3	6,882	5	17.95	16,025	11	27,884	19
Phase 2/Stage 1 Lower Tesuque Village	28.85	25,759	18	44,821	31	96.28	85,949	60	149,551	104
Phase 2/Stage 1 Tesuque Casino	123.91	110,624	77	192,486	134	184.28	164,518	114	286,261	199
Phase 2/Stage 2 Nambé North	262.47	234,321	163	407,719	283	472.04	421,413	293	733,259	509
Phase 2/Stage 3 Tesuque Village[2]	0	0	0	0	0	0	0	0	0	0
Phase 2/Stage 3 Upper Tesuque Village	137.01	122,318	85	212,833	148	439.41	392,281	272	682,569	474
Phase 2/Stage 3 Bishop's Lodge	51.66	46,120	32	80,249	56	92.91	82,944	58	144,323	100
Total	**1,552**	**1,385,755**	**962**	**2,411,214**	**1,674**	**4,000.0**	**3,570,973**	**2,480**	**6,213,493**	**4,315**

Note 1: Max. Day Demands were calculated with a Peaking Factor of 1.74.

Note 2: Tesuque Village was not included in the OEI areas of study and its water demand allocation is shown as zero in the table. Hydraulic modeling assumed the Upper Tesuque Village allocation is distributed uniformly over Upper Tesuque Village and Tesuque Village service areas.

Note 3: The anticipated lack of rapid growth coupled with New Mexico having been determined to be "Hard to Count" (City University of New York, 2017) leads to caution when anticipating the date at which water demand reaches 4,000 acre-feet per year (p. 18, April 6, 2018, OEI Water Demand Study).

2.2 System Demands

In addition to the OEI-defined water allocations, the Phase 2 Consensus Design Concept infrastructure along the Pojoaque-Tesuque-Bishop's Lodge section of the system is up-sized to convey 1,000 AFY to a tee near the intersection of Bishops Lodge Road and Tesuque Village Road for possible future use by Santa Fe County. Table 3 shows the water allocations conveyed to each service area based on the OEI Water Demand Report, along with which tank and pump station feeds each service area, with and without the modifications required for the 1,000 AFY delivery. Phase 1 infrastructure is not affected by this 1,000 AFY conveyance because this infrastructure was sized for end-of-line growth.

The total system, including the 1,000 AFY delivery, is sized for 4,000 AFY (ADD). The total 1,000 AFY delivery may not be available during periods of peak demand, as the capacity of the water treatment plant and river intake facilities are sized for OEI-defined water allocations.

Table 3 – Flows by Service Area (gpm)

Tanks/Pump Stations (PS)	Service Area	2064 MDD	2064 ADD	2024 MDD	2024 ADD	2064+1000 AFY MDD	2064+1000 AFY ADD	2024+1000 AFY MDD	2024+1000 AFY ADD
Nambé Forebay PS									
Nambé Tank	Nambé North	509	293	283	163				
Subtotal		**509**	**293**	**283**	**163**				
Pojoaque South Forebay PS						*1080**	*1080**	*1080**	*1080**
Nambé South Tank	Upper Cuyamungue	184	106	56	32	184	106	56	32
Nambé South Tank	Buffalo Thunder	199	114	134	77	199	114	134	77
Nambé South Tank	Nambé South	243	139	52	30	243	139	52	30
Camel Rock Tank	Camel Rock	28	16	6	3	28	16	6	3
Camel Rock Tank	Lower Tesuque Pueblo	30	17	9	5	30	17	9	5
Oweenge Day School Tank #18	Tesuque Pueblo	84	49	24	14	84	49	24	14
RKM Tank	Upper Tesuque Pueblo	19	11	5	3	19	11	5	3
RKM Tank	Lower Tesuque Village	104	60	31	18	104	60	31	18
Tesuque Casino Tank	Tesuque Casino	199	114	134	77	199	114	134	77
RKM Tank	Tesuque Village	0	0	0	0	0	0	0	0
RKM Tank	Upper Tesuque Village	474	272	148	85	474	272	148	85
Bishop's Lodge Tank #15	Bishop's Lodge	100	58	56	32	100	58	56	32
Subtotal		**1,665**	**957**	**653**	**376**	**2,745**	**2,037**	**1,733**	**1,456**
Camel Rock Forebay PS						*1080**	*1080**	*1080**	*1080**
Camel Rock Tank	Camel Rock	28	16	6	3	28	16	6	3
Camel Rock Tank	Lower Tesuque Pueblo	30	17	9	5	30	17	9	5
Oweenge Day School Tank #18	Tesuque Pueblo	84	49	24	14	84	49	24	14
RKM Tank	Upper Tesuque Pueblo	19	11	5	3	19	11	5	3
RKM Tank	Lower Tesuque Village	104	60	31	18	104	60	31	18
Tesuque Casino Tank	Tesuque Casino	199	114	134	77	199	114	134	77
RKM Tank	Tesuque Village	0	0	0	0	0	0	0	0
RKM Tank	Upper Tesuque Village	474	272	148	85	474	272	148	85
Bishop's Lodge Tank #15	Bishop's Lodge	100	58	56	32	100	58	56	32
Subtotal		**1,039**	**597**	**412**	**237**	**2,119**	**1,677**	**1,492**	**1,317**

Tanks/Pump Stations (PS)	Service Area	2064 MDD	2064 ADD	2024 MDD	2024 ADD	2064+1000 AFY MDD	2064+1000 AFY ADD	2024+1000 AFY MDD	2024+1000 AFY ADD
Tesuque Forebay PS						*1080**	*1080**	*1080**	*1080**
RKM Tank	Upper Tesuque Pueblo	19	11	5	3	19	11	5	3
RKM Tank	Lower Tesuque Village	104	60	31	18	104	60	31	18
Tesuque Casino Tank	Tesuque Casino	199	114	134	77	199	114	134	77
RKM Tank	Tesuque Village	0	0	0	0	0	0	0	0
RKM Tank	Upper Tesuque Village	474	272	148	85	474	272	148	85
Bishop's Lodge Tank #15	Bishop's Lodge	100	58	56	32	100	58	56	32
Subtotal		**896**	**597**	**373**	**214**	**1,976**	**1,595**	**1,453**	**1,294**
RKM PS									
Bishop's Lodge Tank #15	Bishop's Lodge	100	58	56	32				
Subtotal		**100**	**58**	**56**	**32**				

* 1080 gpm represents the 1,742 AFY MDD (1000 AFY ADD) carried through the system for Santa Fe County.

2.3 Hydraulic Performance Criteria

WaterGEMS hydraulic models were used to assess the Hydraulic Grade Line (HGL) required at each pump station. A maximum and minimum head system curve was created for each pump station to define the range of total dynamic head versus flow conditions that the pump station would experience over the life of the project. The high head system curve includes the following system characteristics to create the highest total dynamic head across the pump station. Table 4 presents performance criteria used to evaluate and size the proposed systems.

Table 4 – Hydraulic Performance Criteria

Parameter	Performance Criteria
Water Demand	• Design flows based on OEI Water Demand Study dated April 2018 (Assumes 1.74 Peaking Factor) • Phase 2 design flows are equal to the peak day water demands for the OEI 2064 conditions, plus 1,000 AFY for Santa Fe County to a tee near the junction of the Bishops Lodge Road and Tesuque Village Road for optional future needs
Pipe sizing	<u>Transmission</u>: • Pipelines are designed for 3-8 feet/second (fps) during Maximum Daily Demand (MDD) (AWWA M22) when pump stations are operating • Minimum size should not be less than 6-inch nominal diameter <u>Distribution</u> • Pipelines are sized to provide a minimum fire flow of 1,000 gpm at a minimum residual pressure of 20 pounds/square inch (psi) • Velocities under maximum hour flows ideally less than 3 fps • Velocities under fire flow conditions shall not exceed 10 fps • All dead-end lines shall be 8-inch nominal diameter minimum

Parameter	Performance Criteria
Pressure	Transmission: • Treated water transmission minimum 5 psi (steady state and surge events) • Raw water transmission minimum -5 psi (steady state and surge events) • Maximum per hydraulic analysis • Pipe material will be selected based on maximum surge pressure along the pipe reach Distribution: • Maximum static service pressure: 100 psi • Minimum pressure under maximum hour conditions: 35 psi

In general, the hydraulic system is characterized into two parts: transmission system and distribution system. The transmission pipelines convey water from the pump stations to the distribution and forebay tanks for distribution throughout the system. The transmission pipeline pressures are determined by the pressure heads required to pump water from the pump stations to the tanks and will have pressures up to about 220 psi during steady state. Static and transient pressures will be greater than steady state pressures.

The system is designed assuming that the distribution tanks will be filled by the pump stations during the low demand portions of the day and will supply the peak flows during the day that are greater than the pump station capacity. Distribution tanks buffer the difference between the pumped peak day demand flow and the actual water demanded by the end users. The distribution system was designed so each tank could supply a specific service area. Buried vaulted pressure reducing valves (PRVs) are at service area boundaries as backup for downstream service areas in the event of emergencies. These PRVs ensure supply to downstream areas should downstream system pressures fall below minimum design requirements.

The PBRWS is divided into several service areas that include one or more pressure zones. The distribution pipelines begin downstream of the distribution tanks and deliver water to valve boxes near the users. These pipelines are designed to deliver the peak day flow (1.74 peaking factor) or fire flow, whichever is greater. In most cases, the fire flow requirements control design. Distribution line pressure zones are established to maintain the operating pressure within the desired range. For this project, the distribution system is designed for a working pressure between 35 and 100 psi, except in an area where it is designated for additional future development where the maximum pressure may exceed 100 psi. The minimum working pressure of 35 psi was set in accordance with Indian Health Services requirements. For normal system operation, the water system working pressures will be approximately between 60 to 80 psi to meet the standards published by the New Mexico Environmental Department Construction Programs Bureau. During a fire flow event, the minimum residual pipeline pressure is 20 psi throughout the distribution system and 35 psi at the location of the fire per AWWA M31.

Where multiple pressure zones are served from one tank, the pressure of the water in the pipeline is reduced before entering the lower elevation pressure zone with a pressure reducing valve. Individual PRVs may also be required at service connections if there are users in a high-pressure area where the distribution line pressure is more than 100 psi. Areas of high pressure will be identified in the basis of design reports. Stakeholders are to install individual PRVs in these areas as part of the user's connection.

Table 5 provides a summary of calculation methods and parameters used for the hydraulic modeling for both the transmission and distribution systems.

Table 5 – Modeling Methods and Parameters

Parameter	Method / Related Performance Criteria
Friction coefficients	Method: Hazen William Transmission and distribution pipelines (new): PVC C = 150; HDPE C = 150 Transmission and distribution pipelines (long-term): PVC C = 135 Distribution pipelines (existing): PVC C = 100
Diameter	Inside diameter
Pipeline material	Transmission: PVC (C-900) Distribution: PVC Jack and bore and/or casing pipes located near fuel station(s): steel HDD: HDPE
Elevations	Junction and hydrant elevations based on LIDAR data Junction elevations equal to ground elevation for distribution system Junction elevations equal to ground elevation minus 4 feet of coverage for transmission system Hydrant elevations equal to ground elevation + 3 ft Control valve (PRV, altitude) elevations equal to ground elevation Tank elevations from survey and as-builts or best available information for existing tanks Tank elevations from USBR criteria, and LIDAR data for new tanks
Steady State Analyses	<u>Transmission</u> Ultimate System: Maximum day Initial System: Average day (water age analysis) <u>Distribution</u> Ultimate System: Static conditions (maximum pressure) Ultimate System: Maximum day plus fire flow (fire flow availability), maximum hour (minimum pressures), average day (water age analysis) Initial System: Static (verify maximum pressures), maximum day with fire flow (verify fire flow availability) Initial System: Average day (water age analysis)

The main function of a transmission main is to deliver water from a supply source at a lower elevation to a storage facility at a higher elevation. The system working pressure of a transmission main is a function of the static head between the lower and higher storage tanks, the pipe size, pipe length, pipe material, and the rate of flow during the conveyance operation. Transmission pipe sizing was based on the demands provided in the OEI 2018 report modified for the 1,000 AFY delivery to the Tee located at the intersection of Bishops Lodge and Tesuque Village roads, and the above design criteria with consideration of optimizing pumping system operations (i.e., total dynamic head). Hydraulic transients (or surge) can occur when flows change in a pressurized water transmission system. Detailed transient models were created for the raw water and treated water transmission systems to analyze these conditions and design mitigation features. The 2064 MDD scenario was used to model the system under high demand conditions.

Minimum pressure for both steady state and surge conditions was set at -5 psi in the raw water and +5 psi in the finished water transmission systems. Exceptions were made in the finished water systems along pipelines near tanks where the normal operating pressure or static pressure is nearly zero due to the pipeline elevation being close to the tank hydraulic grade line. Maximum surge pressure was limited to the pressure class rating of the pipeline. Though the pipeline specifications may allow higher pressure limits for surge conditions, this criterion provides a margin of safety and reduces unnecessary wear on the pipelines.

In general, the low-pressure transient condition controlled the sizing of surge mitigation equipment. Reclamation practice is to avoid the use of air vacuum relief valves and other mechanical devices for surge control. Thus, hydropneumatic tanks, also known as air chambers, were the preferred method of surge mitigation. Closed surge tanks, or air chambers, are sized large enough that they will not be fully empty of water during a surge event. As a margin of safety, a minimum of 15 percent water must remain in the tank during a surge event.

Distribution pipelines downstream of the distribution tanks are designed to deliver the MDD plus fire flow. Distribution systems were designed so that each tank could supply the specific service area(s) associated with it.

2.4 Tank Sizing Criteria

Two types of water tanks are proposed for the new water systems: forebay tanks and distribution tanks. The main function of a forebay tank is to provide adequate volume of storage during the transmission of water through the transmission mains. The storage volume allows for buffering pump station start-ups and shut-downs. The water surface elevation required in the forebay tank provides back pressure on the pump station to control air entrainment and cavitation damage to pump units. The main function of a water distribution tank is to provide sufficient storage volume for system equalization, emergency fire flow storage, and emergency storage for tank service areas. As a cost-savings measure, some forebay tanks were upsized to also function as a distribution tank to the local service area.

2.4.1 Sizing Forebay Tanks

Forebay tanks are sized to have a greater than one-hour flow volume of incoming flow to the tank, in addition to the submergence and freeboard allowance. This criterion provides sufficient tank capacity to minimize potential forebay tank overflow during a power loss scenario while the upstream pump station continues to operate. It also provides adequate capacity to prevent the need for frequent pump cycling and to mitigate the potential for a pump to operate with a water level below submergence design requirements. Forebay tanks are sized based on pump run time and required depth for the net positive suction head. The forebay tank design volumes provide a minimum pump run time of 20 minutes for the entire pump station flow at maximum design demand. The tank dimensions provide the minimum pump run time for the pump station which is filling the tank in addition to the required submergence depth at the bottom of the tank plus a minimum two feet of freeboard to the top of the tank shell.

2.4.2 Sizing Distribution Tanks

Distribution tank volumes are designed to provide two days of storage (two times ADD) for the service zones of each tank at the 2064 water demand conditions, or combination of existing and new tanks in the same service area. This two days of storage includes the required daily operational (equalization) volume, fire flow, and emergency storage. The submergence depth required at the bottom of each tank and the freeboard at the top of each tank is considered unavailable for normal daily operations. Figure 2 shows a typical distribution tank storage allocation. Existing tanks are not relied upon to provide storage volume for fire flows; however, their volume is credited to the total storage requirement.

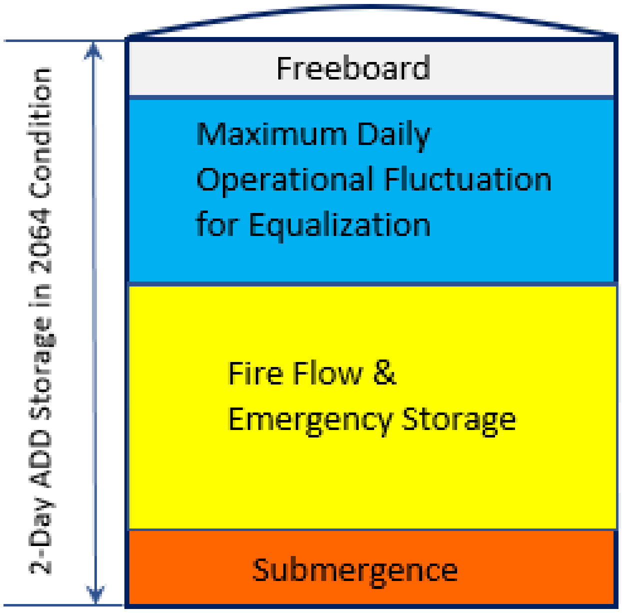


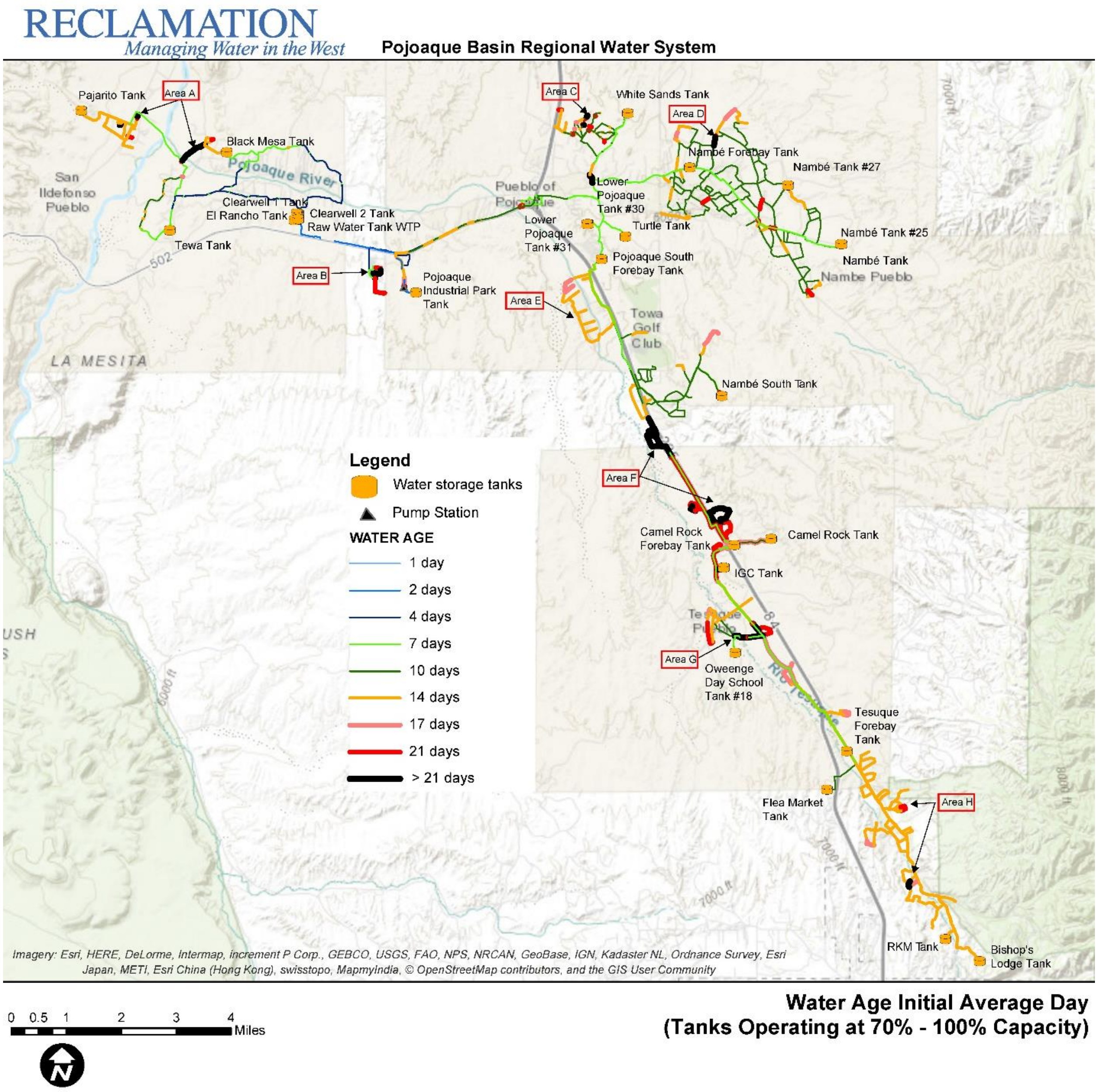
Figure 2 – Typical Distribution Tank Storage Allocation

2.5 Extended Period Water Age

Water age in the transmission and distribution system is based on travel time in pipelines and detention time in storage facilities. Water age can be a general indicator of water quality as high water age can result in loss of chlorine residual, increased risk of bacterial regrowth, increased disinfectant byproduct (DBP) formation, and a higher chance of contamination, among others. Extended-duration chlorine demand tests were conducted on nanofiltration (NF) permeate samples collected from the pilot treatment plant in October 2017. During this testing, samples of NF permeate were chlorinated with an initial dose of 1.2 mg/L and held for periods of up to six weeks. Results showed that there was very little chlorine demand and very little DBP formation in the treated water. There was sufficient chlorine residual in the water samples after 6 weeks, implying that water age up to 6 weeks is acceptable assuming the clean holding vessel is representative of chlorine demand in the transmission and distribution systems.

To evaluate water age, an extended run simulation model of the transmission and distribution systems was developed. A limit of 21 days or 3 weeks was selected for analysis. This is half the water age that piloting implied could be sustained with little or no chlorine demand. As such, this was considered a conservative assumption for analysis purposes and to guide design decisions related to booster chlorination.

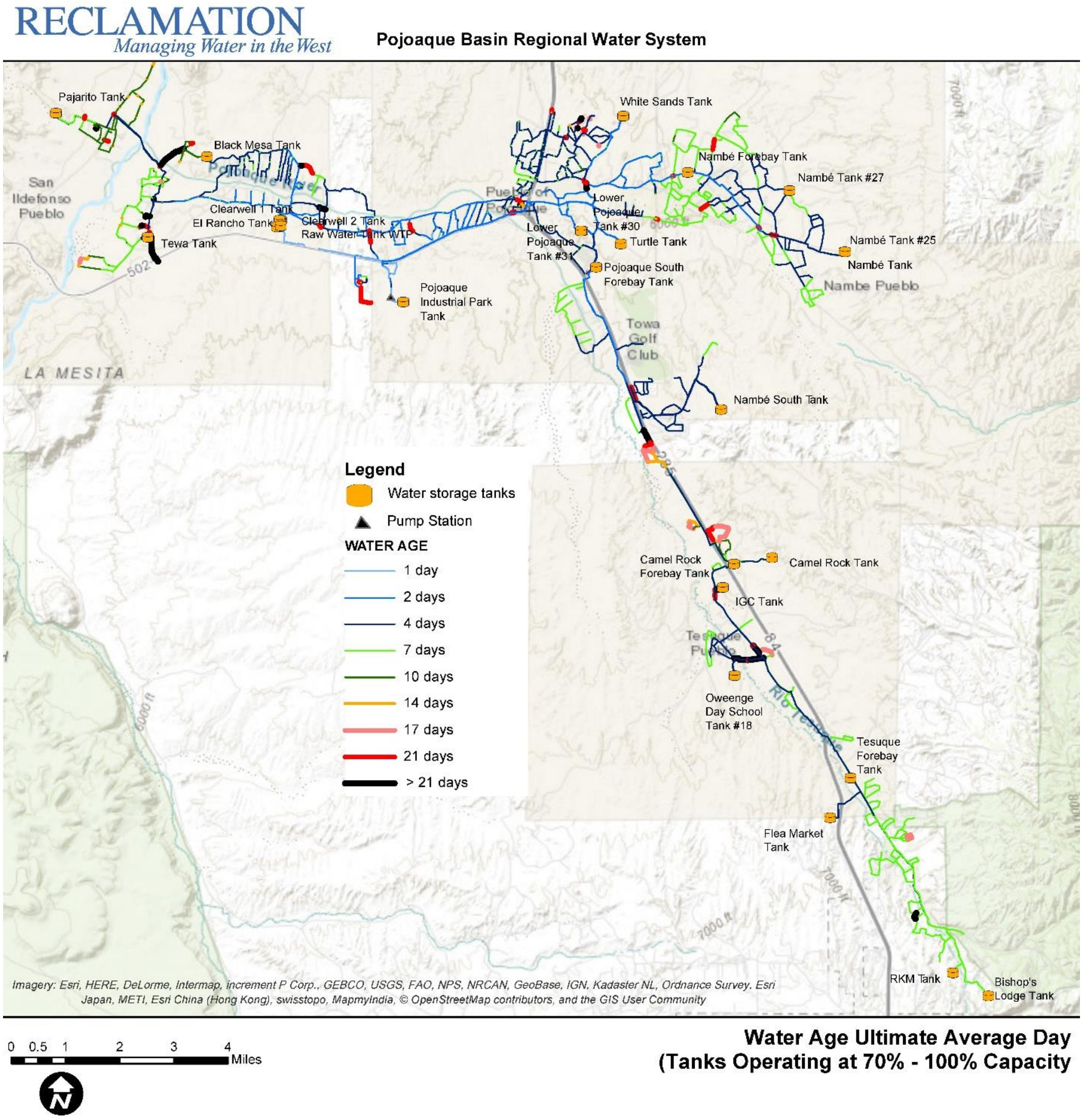
Figure 3 illustrates the predicted water age for the transmission and distribution pipelines for initial ADD conditions assuming tanks are in a high water level range (70% to 100% full). As shown, water age in the Nambé water system averages less than 10 days, however there are some segments with low demands between 14 and 21 days and one segment has water age higher than 21 days (model limit). In the Pojoaque-Tesuque-Bishop's Lodge water system, water age is between 7 days and 14 days. The Camel Rock service area has a water age of 21 days or more due to low demands. High water age occurs downstream of the Oweenge Day School tank #18, also due to very low demands, and for most of the RKM service area, water age is less than 14 days except for two pipeline segments that are greater than 21 days due to low demands. To reduce water age under initial ADD conditions, the model was re-run with some of the tanks operating at lower water levels. This increases turnover rate in the tanks and decreases water age. However, modeling of this condition indicated that reducing tank operating levels did not significantly improve water age in these areas.



Source: *Basis of Design Report (BDR), Date: June 8, 2018, Prepared by and Reviewd by: CDM SMith Technical Design Team, Submittal: 01 81 05-6*

Figure 3 – Water Age Results for Initial (2024) Average Day Demand (High Tank Operating Levels)

Figure 4 illustrates the predicted water age for the transmission and distribution pipelines for 2064 ADD, or 3.57 MGD conditions with tanks operating near full. For Pueblo de San Ildefonso, the highest values of water age are 10 days downstream of the New Pajarito, Tewa, and Black Mesa tanks. Water age averages between 1 day and 7 days for the Pueblo of Pojoaque, and between 4 days and 7 days for the Pueblos of Nambé and Tesuque. Similar to the initial (2024) ADD scenarios, dead-ends and pipelines with little to no demands show water age exceeding the model simulation time of 21 days.



Source: *Basis of Design Report (BDR), Date: June 8, 2018, Prepared by and Reviewd by: CDM SMith Technical Design Team, Submittal: 01 81 05-6*

Figure 4 – Water Age Results for 2064 Average Day Demand

Based on the water age results for the initial (2024) ADD and ultimate (2064) ADD scenarios, chlorine injection facilities are not required at any of the Pueblo de San Ildefonso tanks because the maximum water age is estimated to be 14 days or less. The Nambé and Pojoaque area tanks also did not show excessive water age values that would justify building chlorine injection facilities. However, since results show high water age (21 days or greater) along some pipelines within the Tesuque area, a chlorine injection building will be constructed at the Turtle Tank. Provisions for future installation of a chlorine system, if deemed necessary in the future, will be provided at the Camel Rock Tank, Oweenge Day School Tank, and RKM Tank.

Chlorine residuals should be monitored via a grab sampling program at all distribution tanks, so that chlorine injection facilities could be built in the future, as needed, according to the performance of the system. For pipelines showing water age of greater than 21 days in areas with little to no water demand, the development of a routine flushing program including specific flush locations, amount flushed, and frequency is highly recommended. A flushing program would need to be developed after the system is online so that water age can be monitored throughout the system via grab samples to test the chlorine residuals. This would be an operational decision at the stakeholders' discretion.

3 RAW WATER INTAKE SYSTEM

The Raw Water Intake System is comprised of two main sub-systems: (1) the Intake Collector System; and (2) the Intake Pumping System. Ancillary systems include electrical feed, surge protection, flow metering, and instrumentation and control. At final buildout, the intake system will include four horizontal radial collector wells spread across the north-south extents of the intake site near the bank of the Rio Grande just north of NM 502. The collector wells are sequentially numbered CW-1, CW-2, CW-3, and CW-4 beginning at the south end of the site (**Error! Reference source not found.**). Each collector well will house submersible multi-stage vertical turbine pumps to develop the driving head necessary for conveyance to the Raw Water Equalization Tank located at the WTP. The quantity of pumps varies by collector well based on its predicted water production rate. At ultimate buildout, a single redundant pump should be provided in each well in addition to the required number of duty pumps (N+1) to provide back-up redundancy in the pumping system.

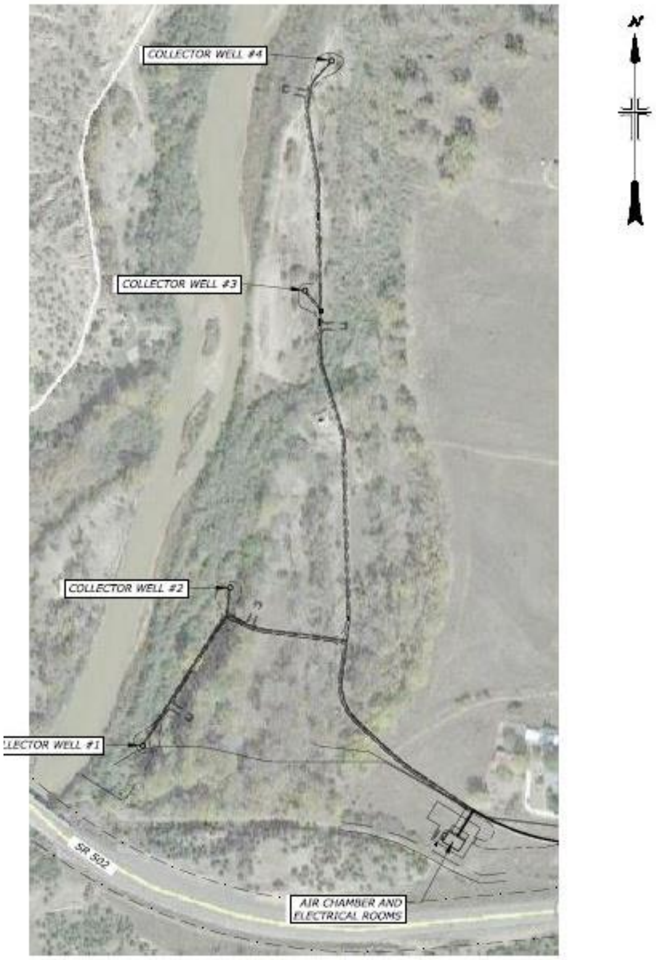


Figure 5 – Intake Location Map

The initial finished water demands for the project are much less than the required ultimate system capacity. Therefore, the intake system will be constructed in phases to increase available raw water supply as finished water demands increase. The phases will include construction of collector wells and expansion of mechanical equipment until ultimate build-out is reached. The phases of construction and required minimum capacities for the Raw Water Intake System are provided in Table 6. As shown, the minimum required intake system capacity is identical for Facility Expansion 2 and Ultimate Build-Out at 6.5 MGD and therefore, the required number of pumps is also identical. The finished water capacity increase associated with Ultimate Build-Out will be achieved by increasing the WTP water recovery rate from 90% to 96%.

Table 6 – Intake System Minimum Required Capacity

Construction Phase	Minimum Firm Capacity (MGD)	Installed Pumps CW-1	Installed Pumps CW-2	Installed Pumps CW-3	Installed Pumps CW-4
Initial Construction	3.9	3	0	4	0
Facility Expansion 1	5.2	3	2	4	0
Facility Expansion 2	6.5	3	2	4	3
Ultimate Build-Out	6.5	3	2	4	3

Note: Increase in WTP finished water capacity from Facility Expansion 2 to Ultimate Build-Out will be achieved by increasing the WTP water recovery rate from 90% to 96%. The Minimum Firm Capacity in the table assumes Summer Average Conditions.

Collector wells will be located along the east side of the established river bank. Each collector well will be constructed as a reinforced concrete caisson approximately 30 ft deep with an inside diameter of 16 ft and an outside diameter of 19 ft. As designed, each collector well will have four lateral screens located on the river side of the caisson. The lateral screens will project from within the caisson through port assemblies and be terminated within the caisson by gate valves. This caisson design and the use of submersible pumps within the collector wells minimizes the visual impact of the above ground components of the system. The sealed top of the collector wells and submersible pumps enables the system to operate in submerged (flood) conditions.

The intake pumping system will provide the necessary driving head to convey water from the collector wells to the Raw Water Equalization Tank located at the water treatment plant. The intake system includes the submersible pumps located in the collector wells, control and isolation valves, flow meter, surge control tanks, all associated piping (buried and exposed) from the pumps to the mechanical/electrical (M/E) building and connecting to the pipeline, and all pipeline ancillary equipment necessary to assemble a complete and operational system. Ancillary equipment includes isolation and check valves at each pump, air release valves, and instrumentation to monitor well levels and system pressure.

Access roads to each collector well will be developed to provide truck access to the wells for maintenance and inspection. It is acknowledged that there will be times when high river levels will impede access to the wells, specifically in the lower-lying areas (e.g., CW-3 and CW-4). The access roads and turnaround areas for each well will include approximately 6 inches of gravel basecourse with additional material providing drainage away from the collector wells. Erosion control measures included in the Consensus Design Concept will help minimize changes to existing site grades and aesthetics surrounding access roads; however, erosion from stormwater runoff and high water events will deteriorate the access roads and turnaround areas. Void-filled rip rap with native vegetation will be installed surrounding the collector well caissons to protect the structures from erosion. Regular monitoring and maintenance will be required to keep the roads and turnaround areas in operating condition.

Discharge piping from each well is manifolded and connected to the raw water transmission line to the treatment plant. Discharge piping from each collector well will be buried parallel to the access roads and ultimately join into a single pipe prior to entering the intake M/E building site. Each collector well will also have a vent line that runs to the intake M/E building in the same alignment as the discharge piping. The vent is necessary to account for variable water levels in the collector wells and remote venting allows for air displacement in the well while eliminating any exposed piping or means for water intrusion at the collector well sites.

The intake M/E building is located at the south end of the intake site near the site entrance. The 100-year frequency floodplain elevation at the proposed M/E building site is 5,512.5 ft. While the existing grade of the site is below this floodplain elevation, development of the site includes re-grading to establish the finished floor of the M/E building at 5,514.75 ft , approximately 2 ft above the 100-yr flood elevation. The mechanical room of the intake M/E building will include floor drains that will discharge to the surface outside; no chemicals or sanitary connections are used at this facility, so no additional treatment is envisioned for the drainage of the raw water that may collect on the floor.

3.1 Phased Intake Construction

The major project elements included in the initial construction are:

- Two (2) of the four (4) collector wells (CW-1 and CW-3) complete with radial collector screens, intermediate floors, access ladders/covers, and interior piping, with accommodations for future equipment installation;
- Three (3) pumps in collector well CW-1, and four (4) pumps in collector well CW-3;
- All access roadways and site improvements required for final buildout; and
- An intake M/E building to house air chamber tanks, a flow meter, I&C equipment and SCADA communications equipment for the entire raw water intake system (initial through ultimate build-out). It will also house the electrical switchgear and motor starters for all collector wells and provide space for the installation of additional motor starters and electrical appurtenances during expansion phases.

At Facility Expansion 2, collector wells CW-2 and CW-4 should be constructed with radial collector screens, intermediate floors, access ladders/covers, all pumps, and interior piping. At Ultimate Buildout, 6.5 MGD is achieved by increasing the WTP recovery rate from 90% to 96%; no work is required at the intake wells. The anticipated division of flows at ultimate buildout is presented in Table 7.

Table 7 – Well Production Design Capacities at Final Buildout

Well ID	Design Capacity at Ultimate Build-Out	Percent of Total Flow	No. of Installed Pumps (N+1)	Pump Design Flow
CW-1	1.96 MGD / (1362 gpm)	30%	3 (2+1)	681 gpm
CW-2	1.00 MGD / (693 gpm)	16%	2 (1+1)	693 gpm
CW-3	2.41 MGD / (1676 gpm)	37%	4 (3+1)	559 gpm
CW-4	1.13 MGD / (782 gpm)	17%	3 (2+1)	391 gpm
TOTAL	**6.5 MGD / (4513 gpm)**	**100%**	**12 (8+4)**	**4513 gpm**

3.2 Aquifer Storage and Recovery (ASR) System

ASR was a proposed method of providing a backup water supply for the PBRWS. The deep hybrid (injection and extraction) method has been evaluated and determined to be prohibitively expensive and complex, due to ground water incompatibility and the lack of alluvial soils to store the amount of water required. The feasibility of a shallow ASR production in different fields in the PBRWS service area was investigated by USGS (2013) and it was determined that the hydrologic and geochemical conditions at the site presented numerous technical challenges. This backup water supply for the PBRWS is not being pursued under the scope of this project. Future additional characterization of aquifer properties and geochemical conditions could improve the understanding of the feasibility of integrating ASR at a later time.

4 WATER TREATMENT PROCESS FACILITIES

The WTP site is located on the west side of Entrada El Rancho Road, south of County Road 84 (**Error! Reference source not found.**). The site will have four buildings including the main P rocess Building, the Residual Treatment Building, the Finished Water Pump Station Building and an outdoor Chemical Storage Canopy. The Process Building measures approximately 120-feet x 276-feet, and includes the process equipment area, supporting mechanical and electrical rooms, and administrative areas including an entry vestibule, two offices, the Control Room and Laboratory, an IT/Server Room, a Multipurpose Room, two restrooms, and a service/storage area. The Residual Treatment Building measures approximately 48-feet x 53-feet and includes the residual treatment area, an enclosed electrical room and mechanical room, and an outdoor canopy for the clarifiers. The Chemical Storage Canopy measures 26-feet x 92-feet and serves as the chemical systems storage area. The Finished Water Pump Station Building measures approximately 32-feet x 82-feet.

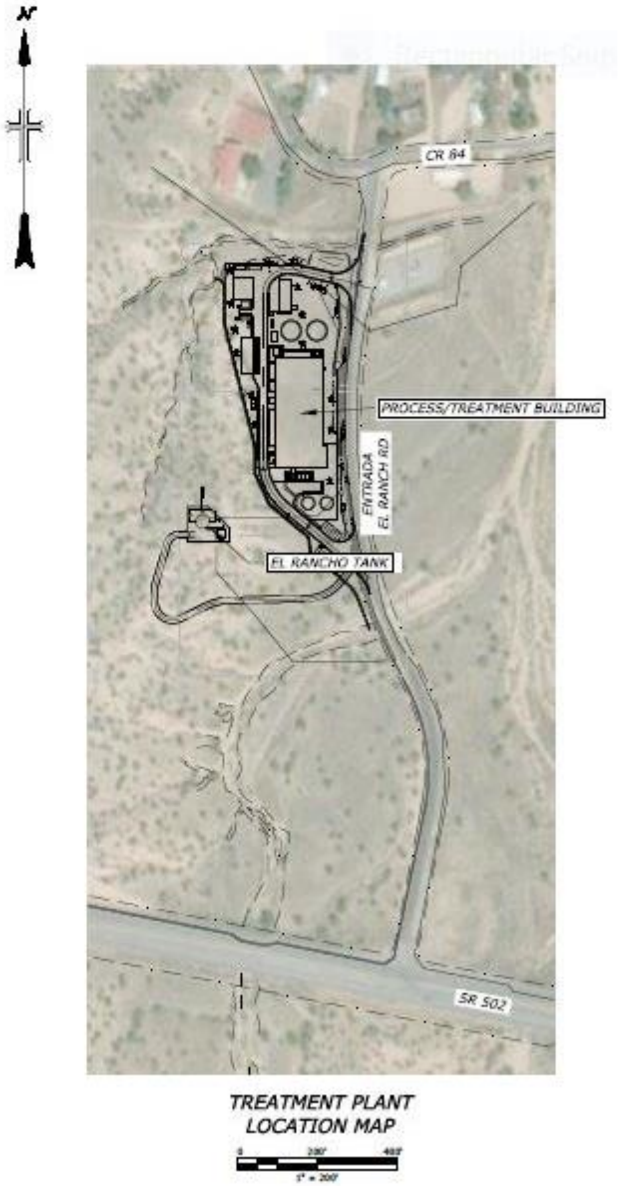


Figure 6 – WTP Location Map

4.1 Treatment Process

The basic treatment process proposed for the treatment plant consists of microfiltration (MF) or ultrafiltration (UF) to remove fine sediments and provide a barrier to bacteria and viruses, followed by nanofiltration (NF) for the removal of total organic carbon (TOC) and some dissolved solids, and then free chlorine disinfection to meet multi-barrier treatment requirements and to provide a disinfectant residual in the distribution system. Residuals handling includes MF/UF backwash water recovery with coagulant addition, flocculation, and plate settlers. Washwater recovery residuals will be thickened in gravity thickeners. Clarifier effluent will make up the recycled water that will be returned to the raw water pipeline at the entrance to the raw water tanks. NF flush water will also be included with this recycled flow stream. Final thickened solids will be hauled away for subsequent disposal. Non-recoverable wastes include NF concentrate and membrane cleaning wastes. NF concentrate will be discharged back to the Rio Grande through the NF concentrate discharge transmission line. Other non-recoverable wastes will be disposed to the sanitary system. See Figure 7 for a schematic of the water treatment process.

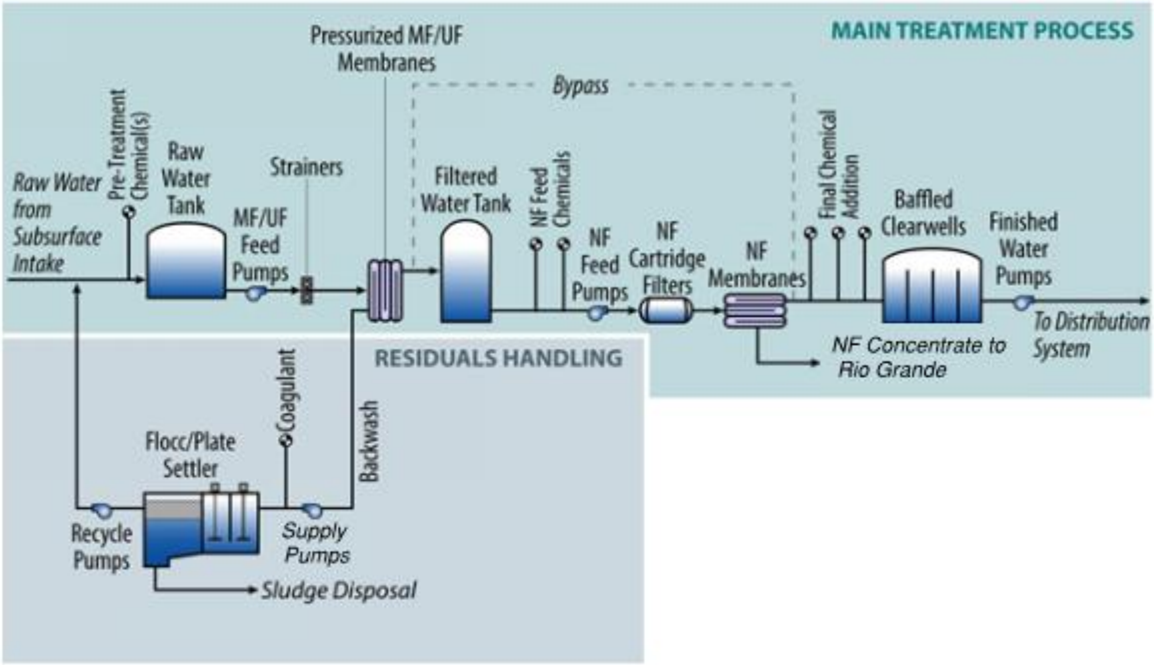


Figure 7 – Water Treatment Process Schematic

4.1.1 Microfiltration/Ultrafiltration Membrane System

MF/UF membrane filtration systems are package treatment processes that provide a physical barrier to lower turbidity by removing colloids, suspended solids, and many water-borne pathogens, such as *Cryptosporidium*, *Giardia*, and some viruses. During membrane filtration, water is forced through micro-porous material by applying pressure, leaving particles and precipitated solids on the surface of the membrane fibers. Short-duration backwash processes are conducted periodically to remove the accumulated particles from the membrane surface. Over time, chemical foulants also accumulate on the surface of the membrane fibers. Chemical cleaning processes are conducted to remove these foulants from the membranes.

The building block of the proposed membrane system is the membrane module. Each module consists of thousands of hollow membrane fibers combined into a single element. The MF/UF membrane modules will be mounted on factory-assembled skids with all interconnecting piping for the membrane modules, appurtenances, and some instrumentation. A redundant skid allows the treatment plant to maintain production capacity whenever an MF/UF skid requires backwashing. The number of membrane modules on each skid is dependent on water quality and desired production rate.

Each membrane skid will be equipped with a control valve and a set of flow meters to allow control of the filtrate production rate. Typically, one or more skids will be filtering water while the other skids are in standby mode or are undergoing a downtime activity such as backwash, chemical cleaning, or integrity testing. The design flow rate for the system can be achieved with one skid in backwash and a second skid offline for a long-duration chemical clean. This configuration complies with the project redundancy requirements. Under normal operation, the membrane control system will automatically cycle skids in and out of standby mode. Table 8 summarizes the design criteria for the MF/UF skids.

Table 8 – MF/UF Skids Design Criteria

Parameter	Initial Criteria	Ultimate Criteria
Type	**Pressurized UF**	**Pressurized UF**
Membrane System	Spectrum™ Series Universal Rack by Wigen Water Technologies	Spectrum™ Series Universal Rack by Wigen Water Technologies
Membrane Modules	Toray HFU2020N ultrafiltration membrane modules	Toray HFU2020N ultrafiltration membrane modules
Membrane Characteristics	Cylindrical hollow-fiber, outside-in flow, PVDF with 0.01 micron nominal pore size	Cylindrical hollow-fiber, outside-in flow, PVDF with 0.01 micron nominal pore size
Number	4 (3 Duty, 1 Standby)	6 (5 Duty, 1 Standby)
Capacity, each	1.30 MGD	1.30 MGD
Total Filtrate Capacity	3.9 MGD	6.50 MGD
Recovery Rate	90%	96%
Maximum Instantaneous Design Flux at 5°C	50 gal/ft^2/day	50 gal/ft^2/day

4.1.2 Nanofiltration Membrane System

Unlike MF/UF membranes, which focus on physical removal of contaminants, NF membranes use a semi-permeable membrane material that can separate dissolved ions and elements through a diffusion-controlled process. NF membranes reject dissolved organics as wells as divalent ions and some monovalent ions, which will allow the system to meet the project TOC reduction goals. NF membranes require feedwater with minimal suspended solids and colloids to prevent fouling and high headloss across the membranes. The polyamide membranes are also degraded by free chlorine and other oxidants, so the NF system relies on a system such as the MF/UF filtration process to minimize suspended solids and biological organisms in the filtered water storage tank.

One dedicated membrane feed pump with a variable-frequency drive (VFD) will be provided for each NF membrane skid. The VFD will allow the membrane unit to maintain water production under varying water quality conditions, membrane age, water temperatures, and degrees of fouling that affect the feedwater pressure requirements. These VFDs conserve energy by allowing the pump and motor to operate at the minimum pressure required for the operating conditions.

Pressurized water from the discharge of NF feed pumps will be fed to the semi-permeable membranes in the NF skids which will separate the water into a high-quality stream (permeate) and a more concentrated stream (NF concentrate). The overall 2064 ADD plant minimum recovery is 96%. The initial plant recovery will be 90% using a three-stage NF system. The potential for mineral scaling and fouling increases as recovery increases and all the suspended and dissolved solids become more concentrated. The concentrate (feedwater minus permeate) from the first stage is fed to the second stage, which separates the first stage concentrate into second stage permeate and concentrate streams. The permeate from the second stage is blended with the permeate from the first stage. The concentrate from the second stage is fed to the third stage and the process continues in similar fashion until it reaches the fourth stage. Inter-stage booster pumps are required to increase the pressure of the concentrate between the second discharge and third stages inlet to offset for the tangential headloss through the NF membranes and the increase in osmotic pressure. An inter-stage booster is also provided between the first concentrate discharge and the second stage inlet to avoid exceeding the flux limits on the first stage or adding a lot of permeate backpressure to stage 1. Table 9 summarizes the design criteria for the NF membrane skids.

Table 9 – NF Membrane Skids Design Criteria

Parameter	Initial Criteria	Ultimate Criteria
NF Skids		
Wigen Water Technologies	Wigen Water Technologies	Wigen Water Technologies
Membrane Modules	Toray/CSM NE8040-40	Toray/CSM NE8040-40
Type	Three Stage NF	Four Stage NF
Number	3 (3 Duty, 0 Standby)	5 (5 Duty, 0 Standby)
Total Permeate Capacity	3.51 MGD	6.23 MGD
Minimum Recovery	90%	96%
Number of Pressure Vessels – Stage 1	18	18
Number of Pressure Vessels – Stage 2	8	8
Number of Pressure Vessels – Stage 3	4	4
Number of Pressure Vessels – Stage 4	N/A	2
Average Flux	13.9 gal/ft^2/day	13.9 gal/ft^2/day

4.1.3 Post-Treatment Stabilization

The NF system can produce permeate that is low in hardness and alkalinity, which can be a contributing factor in corrosion of components in the distribution system. Although the permeate from an NF system using the type of loose NF membrane proposed for this project is expected to have greater than 100 mg/L of hardness and 150-200 mg/L of alkalinity as calcium carbonate, stabilization of the final permeate may be required to protect the distribution system. Post-treatment chemicals include sodium hydroxide to raise the pH and calcium chloride to increase the calcium carbonate precipitation potential to a minimum of 4 mg/L. A corrosion inhibitor can also be added to aid in the development of a protective film in the distribution system and prevent corrosion of piping and appurtenances.

4.1.4 Solids and Liquids Disposal

Thickened solids generated by the residuals handling facility (1 to 3 percent solids) will be transported by tanker truck to the City of Santa Fe, NM, wastewater treatment plant septic discharge site. The other residual streams generated as part of the MF/UF membrane waste backwash treatment process, including building floor and sink drains, will be discharged to the treatment plant sanitary system. The MF/UF membrane chemical cleaning (CIP) waste will gravity-drain into the Pueblo de San Ildefonso sewer system if the future sewer connection is made. Until the possible sewage treatment plant upgrades at the Pueblo de San Ildefonso are constructed, CIP waste and sewage will be stored and routinely hauled to the City of Santa Fe wastewater treatment plant. The combined flows and water quality to the sanitary wetwell will vary significantly based on plant operation. The combination of flows will range from only the sanitary waste to also including wash-down water and MF/UF CIP waste in addition to rapid flushes from the CIP tanks. NF concentrate will be discharged separately to the Rio Grande via the NF concentrate transmission line.

5 WATER TRANSMISSION AND DISTRIBUTION PIPELINES

Raw water transmission pipelines include the raw water transmission pipeline between the raw water intake collector wells and the raw water equalization tank located at the WTP, as well as the brine return pipeline from the WTP back to the Rio Grande. Treated water transmission lines downstream of the water treatment plant connect water distribution tanks and pump station forebay tanks. Trunk distribution pipelines are co-located in transmission pipeline trenches. Other distribution pipelines downstream of new and existing distribution tanks carry potable water to customers.

5.1 Pipeline Alignment

Pipeline alignments are generally restricted to existing rights-of-way along existing transportation corridors to reduce the need for additional land purchases or easements. However, there are many factors that can affect an alignment's placement. Sites that carry great historic, religious, and cultural importance to the respective Pueblos have been recognized in the planning of pipeline alignments. Limitations for construction around these areas were identified during the Environmental Impact Statement process and are to be followed through the design and construction process.

There are extensive subsurface utilities located within the project area, including water lines, sewer lines, gas lines, power lines, fiber cables, etc. Identification and location of subsurface utilities are at a Class D survey level. Utility information provided in the construction drawings is based on GIS supplied database and has not been field verified. Existing subsurface utility locations are approximate and will require further field investigation by the construction Contractor to verify true locations prior to starting any excavation work. Verification of utility locations must be planned far enough ahead to allow for addressing identified conflicts.

A formal property survey of the project area has not been performed. A GIS database of property boundaries is available but cannot be relied on for accuracy. The Contractor will need to stake the construction right-of-way and identify any potential disturbance to properties not cleared for construction work. Identified conflicts will need to be brought to the attention of the Construction Manager so alternative solutions can be prepared. Verification of property boundaries must be planned far enough ahead to allow for addressing identified conflicts. Solutions to conflicts may include but are not limited to relocating the pipeline alignment to avoid property intrusion or obtaining clearance from property owner(s) to perform construction.

5.2 Excavation and Trench Installation

Three types of surfaces will be encountered during pipeline installation: paved roads, unpaved roads, and natural ground surfaces. Trench excavations will include trench-box excavated trenches and open-cut trapezoidal trenches. The trench excavation method will be determined by the soil type. Open-cut trapezoidal trenches are the preferred method of excavation, but there are many areas where excavation must be confined due to traffic, existing utilities, easements, or rights-of-way, and where there is insufficient lateral space to allow open-cut trapezoidal trenches. In these confined areas, trench-box excavation will be used to keep the trench width as narrow as possible.

On a limited basis, additional reduction in trench width will be achieved in select locations by reducing the trench bottom width dimension to no less than 8 inches on either side of the pipe. This method would require utilizing easily consolidated fill, such as pea gravel vibrated in place, self-consolidating sand slurry, or Controlled Low Strength Material (CLSM) since sufficient space for compaction equipment is not available. CLSM is a plastic soil-cement used as pipe bedding, and is a self-compacting, cementitious material. CLSM is composed of water, cement, aggregate, and fly ash. It is a fairly fluid material typically placed at a slump of 8 to 10 inches. For the PBRWS, CLSM compressive strength will be limited to 50 to 150 psi.

Where the transmission water line alignment parallels the distribution water line alignment, the trench width will be minimized by locating the lines as close as possible to each other, while allowing sufficient separation to service or repair each line individually. In these areas, a minimum horizontal separation of 18 inches from outside of pipe to outside of pipe will be provided.

In most areas, minimum cover over the top of pipe will be 4 feet. This may be increased to accommodate subsurface utilities, variations in ground profile surfaces, to minimize pipe bends, thrust blocking, steep slopes, etc. In areas where there are existing culvert roadway crossings and the minimum 4 feet cover cannot be achieved, concrete encasement of the water line may be allowed.

5.2.1 Pipe Bedding Material

Pipe bedding is the portion of the pipe zone between the trench subgrade and the bottom of the pipe. The purpose of pipe bedding is to cushion and uniformly support the installed pipeline. The bedding is not to be compacted. At the location of valves and other appurtenances, compaction requirements of bedding material will be a minimum of 95 percent of maximum dry density, per ASTM D1557. Pipe bedding material will be imported commercially produced sand and gravel mixture or excavated onsite material having a sand equivalent of at least 30 percent and a maximum particle size of 1/2-inch. CLSM may also be used for pipe bedding material to facilitate construction and ensure adequate pipe support.

5.2.2 Pipe Zone (Pipe Embedment) Material

The pipe zone or pipe embedment is from the top of the pipe bedding material to 12 inches above the outside surface of the pipe, including the full width of the trench. Pipe zone material will be an imported, commercially produced sand and gravel mixture or excavated onsite material having a sand equivalent of at least 30 percent and a maximum particle size of 1/2-inch. Compaction requirements will be a minimum of 90 percent of maximum dry density in off road, undeveloped areas; a minimum of 95 percent of maximum dry density beneath dirt roadways; and a minimum of 95 percent of maximum dry density adjacent to or beneath paved roads, per ASTM D1557. CLSM may also be used for pipe zone or pipe embedment material to facilitate construction and ensure adequate pipe support. The low compressive strength of CLSM will allow the material to be removed by shovel without damage to the pipe.

5.2.3 Trench Zone (Pipe Backfill)

The trench zone is from the top of the pipe zone (pipe embedment) to the bottom of the specified surface restoration, including the full width of the trench. Trench zone material will be native material free of any rock larger than 8 inches and free of frozen or organic material. Compaction will be a minimum of 90 percent of maximum dry density in off-road, undeveloped areas; a minimum of 90 percent of maximum dry density beneath dirt roadways; and a minimum of 95 percent of maximum dry density adjacent to or beneath paved roads, per ASTM D1557.

5.3 Roadway Crossings

The pipeline alignment was established to minimize the number of major road crossings. The following three installation methods were considered in highway crossings for the project:

- Open cut trenching with traffic control and/or detours
- Pipe jacking trenchless technologies
- Horizontal directional drilling (HDD) trenchless technologies.

5.3.1 Open Cut Trenching

The first potential pipeline installation method is the traditional open cut. The advantage of traditional open cut construction is allowing the project to progress in a continuous steady pace fashion. The open cut method is suitable for nearly all soil conditions except for mud and running sand. Open cut may not be feasible for places where dewatering cost would be high or when traffic interruption is not acceptable.

5.3.2 Jacking

The pipe jacking method involves the installation of a casing pipe using hydraulic jacks to push it through the ground then by pulling a carrier pipe and spacers through the casing pipe. Casing pipes for this project will be steel. During jacking operations, hydraulic jack(s) push the casing pipe forward through the ground while a drive shaft within the casing pipe helps to extrude the displaced soil.

5.3.3 Horizontal Directional Drilling

The third pipeline installation method is horizontal directional drilling. The advantages of HDD include: no interruption of traffic flow, minimal surface and subsurface disturbance, and little surface restoration is required after completion of the pipeline installation. When there is limited accessibility to the pipeline installation site, HDD can be used where the traditional methods are prohibited or impractical. For purposes of this project, HDPE is assumed for HDD applications as it has a much higher stiffness modulus compared to other plastic pipe which limits long-term deformation under soil loadings.

5.4 River and Arroyo Crossings

The project area contains many ephemeral arroyos (also called washes) which are dry most of the year but convey potentially high peak flows from local runoff usually generated by thunderstorm rainfall. Ephemeral channels pose a risk to buried pipelines due to potentially high bed erosion and lateral migration. This erosion may cause pipelines to become exposed and thus become prone to damage or freezing temperatures. The pipeline must be buried sufficiently deep while crossing these arroyos to protect the pipeline. A scour analysis for the proposed pipeline crossings of arroyos, rivers, and ephemeral flow paths within the project limits was completed to ensure that the proposed system is not exposed by the various short-term and long-term channel scour mechanisms under 100-year discharge conditions. Depending on the crossing width, predicted scour depth, and physical constraints of the crossing site, a variety of crossings such as open cut trenching, horizontal directional drilling, open cut trenching with a protective concrete cap, and grade control structures are methods that may be applied to protect the pipe.

Where standard trenching and compacted backfill operations may not be suitable, HDD may be considered. HDD allows for adequate bury depths without a large surface cut; instead relying on entrance and receiving pits outside the ordinary high-water mark and calculated lateral migration limits where a prescribed bore path is drilled and the pipe is then pulled back as the drill shaft is retrieved. Arroyos with significant scour depths of greater than 6 feet and crossings posing access and/or environmental impact concerns were suggested for HDD. For the remainder of the crossings, it was determined that standard trenching and compacted backfill to a recommended bury depth would provide adequate pipeline protection.

Grade-control structures are commonly used in-stream structures that serve to provide stability for arroyos that exhibit signs of vertical instability. These structures incorporate large changes in the vertical profile of an arroyo or waterway at a single location and effectively serve to reduce the overall bed slope. In addition, they can also serve to stabilize headcuts by providing an armored "hard point" that prevents the headcut from migrating further upstream. While the structures can be constructed out of a variety of materials, it is assumed that the PBRWS will typically use standard gabion retaining walls, per the New Mexico Department of Transportation's standard details.

In certain scenarios, it is not feasible to bury the pipe to an adequate depth, the use of horizontal directional drilling is not practical, or a grade-control structure does not provide any applicable benefits. In such cases, concrete caps and encasements will be considered as a viable recommendation. These caps will serve to protect the pipe from exposure due to channel scour. It may not be possible to protect the pipeline to the full design scour depth; however, by encasing the pipeline in concrete and possibly placing a small cut-off wall, the pipeline will have added protection measures that would prevent a sudden collapse or pipe failure if the future scour depth reaches the pipe bury depth. In some areas, the waterline can be left aligned with the road. The road's embankment and culvert(s) serve to protect the road from scour and can also work for protecting the pipeline. Pipelines can be placed over the culvert where clearance is available, or HDD under the culvert.

Some arroyo banks have side slopes steeper than the bank material angle of repose. In these locations, compacted trench backfill will be placed at the angle of repose with an upstream and downstream transition to the steeper natural bank slope. The compacted backfill and transitions will be protected with fabric erosion control blanket, coir wattles (about 9-inch diameter rolls made from coconut fiber), and a small amount of toe rock in each transition to prevent toe scour.

5.5 Surface Restoration

In general, surface restoration will consist of returning the disturbed surface to pre-construction conditions. This includes open, unimproved areas, unimproved existing roads (dirt roads), gravel roads, and paved roads. Revegetation on unpaved, disturbed Bureau of Indian Affairs right-of-way will follow FP-14 specifications and NMDOT right-of-way will follow NMDOT specifications. For Phase 1 paved roads, a full lane will be replaced for the length of disturbance, if any part of the lane is disturbed. If the existing pavement has the necessary thickness and the roadway foundation is sound, the pavement rehabilitation process from Phase 2 will be allowed. For Phase 2 and Phase 3 paved roads, the full lane will be milled 2 inches, road base course and asphalt above trench replaced, and the full lane overlaid with 2 inches of asphalt to maintain a uniform driving surface. In order to reduce the quantity of road lanes replaced, all efforts will be made to confine the disturbance to a single lane where an alignment is parallel to the road, unless it is absolutely necessary to disturb more than one lane. In general, crossings of NMDOT roads would be completed with the water line installed within a casing placed by a jack and bore. Open cut road crossings will be constructed in accordance with Figure 8 and Figure 9, or approved equals.

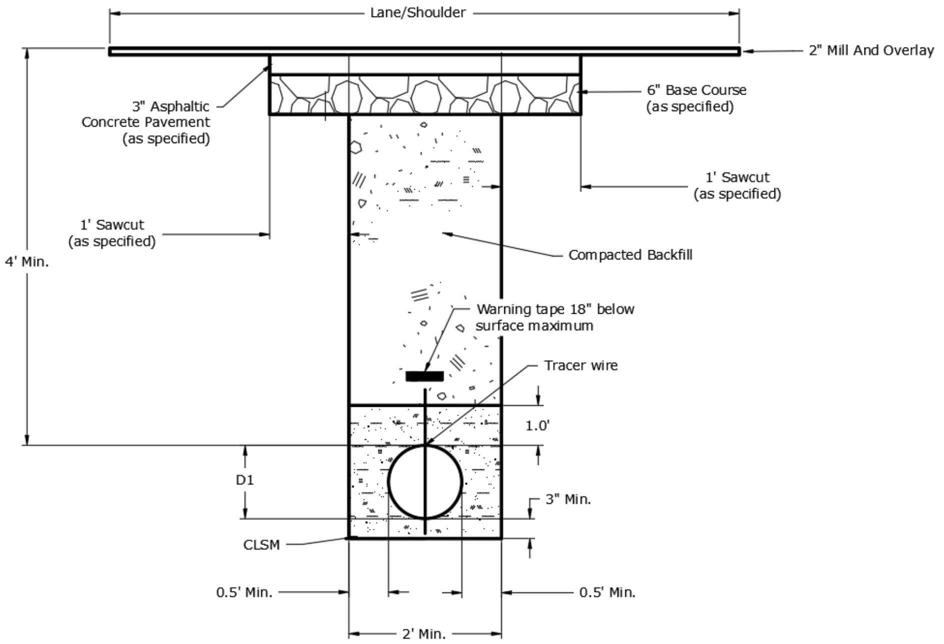


Figure 8 – Phase 2 Pipe Trench and Bedding Configuration for Paved Road Installation

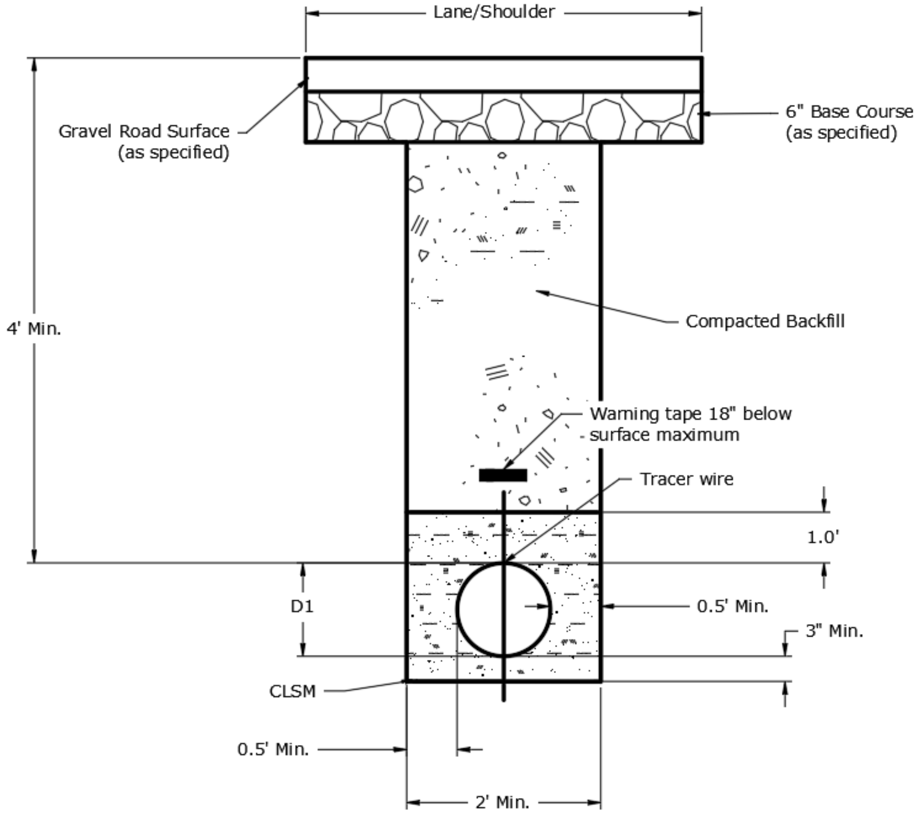


Figure 9 – Phase 2 Pipe Trench and Bedding Configuration for Unpaved Road Installation

5.6 Pipe Materials and Pipe Pressure Classes

The transmission and distribution pipelines are either PVC pipes meeting AWWA C900-16, steel pipes meeting AWWA C200, or Ductile Iron pipe meeting AWWA C151 standards. The minimum PVC pressure class used in the project is DR25 with a pressure rating of 150 psi. The maximum pressure class of the PVC used in the project is DR14 with a pressure rating of 305 psi. PVC pipe joints will use push-on bell and spigot type joints with an integral rubber gasket. PVC pipe is designed for a maximum of 5% deflection computed using the methodology in Method for Prediction of Flexible Pipe Deflection, M-25 Third Edition (February 2019).

5.7 Thrust Restraint

Changes in pipeline direction (normally greater than 3 degrees), cross-sectional area, or isolation points develop forces which act on the pipeline resulting in the need for thrust restraints. All PBRWS thrust restraints are accomplished using mechanical restraint joints. PVC pipe restrained joints will be “locked type” joints consisting of mechanical joint restraint, similar to Megalug restraint as manufactured by EBAA Iron, or equivalent. The restrained joints are designed to accommodate the combination of static and transient pressures, as well as the testing pressure, which is equal to 1.5 times the maximum working pressure. In general, concrete thrust blocks are not used as physical restraints. Site-specific requirements which may require concrete thrust blocks will be considered on an individual basis.

5.8 Steep Slopes

Pipeline placed on steep slopes (typically greater than 20%) will be examined to determine where special engineering features may be required to stabilize the pipeline as well as the finished grade. This would require pipeline reinforcement such as concrete collars, simple restrained joints, blocking, or deeper cuts. Ground restoration will also be required, which may include jute netting, reinforced soil covers, revegetation, or even terraces.

5.9 Pipeline Fittings

5.9.1 Elbows, Tees, Wyes, Bends

Ductile iron elbows, tees, wyes, and other bends will be used, as needed, to construct the PVC pipelines.

5.9.2 Flexible Couplings

Flexible couplings will be used where the pipeline is installed through a structure to allow for limited differential settlement. For unrestrained locations, a standard flexible coupling will be detailed, and for a restrained location, a restrained flexible coupling will be used.

5.9.3 Transition Couplings

Transition couplings will be called out where the new pipe will be joined to an existing or installed pipe of differing material or dimensions, or a new pipe of differing material and dimensions. The transition coupling will be rated for the higher of the two joined pipe pressure classes and be installed following the manufacturer's instructions.

5.10 Pipeline Appurtenances

5.10.1 Isolation Valves

Isolation valves are used to limit the length of pipeline shutdown when a segment of pipe needs repair, cleaning, or maintenance. They also help to limit spillage of water in the event of an emergency such as pipeline ruptures. Isolation valves will be placed at tees and along every 2,500 feet of transmission and every 1,500 feet of distribution pipeline. Most isolation valves will be buried, except where they are co-located with air valves or other pipeline appurtenances requiring vaults.

Below-grade isolation valves 12 inches or less will be gate valves including valves in vaults. Butterfly valves will be used for all valves when pressures exceed 250 psi and for below-grade isolation valves greater than 12 inches, including valves in vaults. All above-grade isolation valves will be flanged ductile iron body, resilient seated-type butterfly valves. Isolation valves will be rated to meet or exceed the adjoining pipe pressure class.

5.10.2 Pressure Reducing Valve Assembly

Proper maintenance and control of the system pressures requires careful consideration of pressure zone planning, Pressure Reducing Valve (PRV) installation, and pressure settings. Water demand also plays an important factor in PRV design. A pressure reducing valve is designed to function effectively for low and high water demands as well as fire flow. To achieve this objective, a parallel configuration will be implemented. As shown in Figure 10, a PRV assembly consists of two PRVs: a main PRV and a smaller bypass PRV. The main PRV operates during peak water demand and during fire flow, while the bypass PRV functions during lower water demand periods. The main PRV opening is set about 5 psi below the pressure set point of the smaller PRV to provide for a smooth transition. The parallel installation also facilitates operations and maintenance (O&M) without water supply interruption.

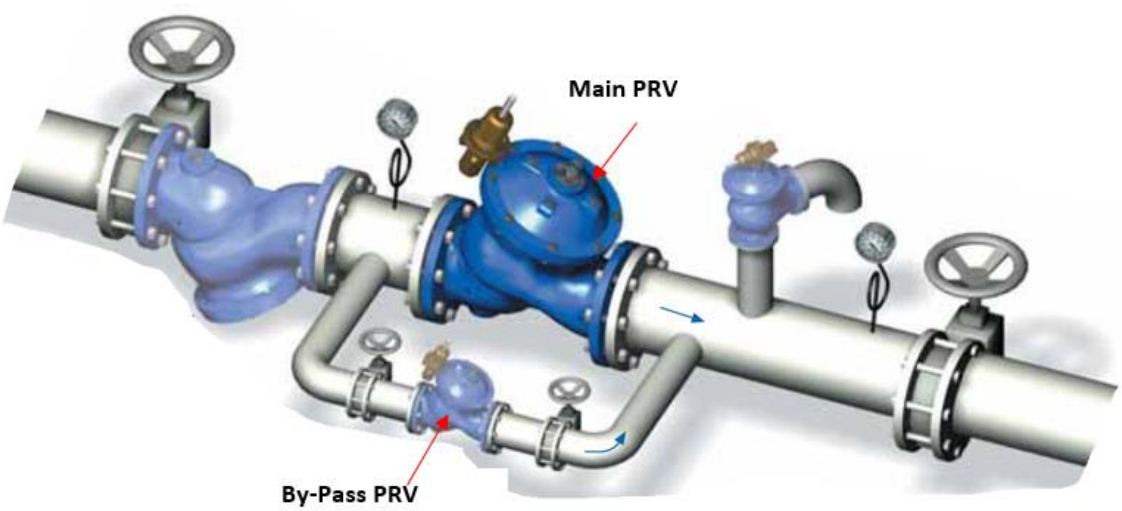


Figure 10 – Schematic of Parallel PRV Installation, Courtesy of Bermad Publication

5.10.3 Air Valve Assembly

Combination air-vacuum/air-release valves will be installed at all defined high points along the pipeline profiles, as well as on the appropriate downhill or uphill side of PRVs and isolation valves. The air valves have a large orifice which vents air from the pipeline during pipeline filling and admits air during draining operations to avoid developing negative internal pressures. Two valve types are available for use depending on field and pressure conditions required. The first is an in-line option which sits directly on top of the pipe, which is to be used in areas with restrictive rights-of-way and high pressure segments of pipe. The second option is an off-line option which allows for the placement of the valve to the side of the road. The off-line valve option is used by I.H.S. and existing on many of the existing waterlines currently in the project area.

5.10.4 Blow-Off Valves

Blow-off valves provide the ability to drain segments of pipeline for maintenance and repairs. Blow-off valves are generally installed at low points of pipelines and on the downhill sides of mainline in arroyo crossings. Blow-offs consist of 6-inch minimum diameter vertical pipe, blind flanges, and a ball valve to facilitate draining water from pipeline low points. In locations of high pressures or sensitive environments, an orifice plate may be necessary to limit discharges. In Phase 3, automatic flush hydrants are detailed to be installed at the end of non-looped laterals at the lowest point of loops and pressure zones to aid in draining the pipeline for repair and maintenance and to maintain water quality.

5.10.5 Fire Hydrants

In Phase 1, fire hydrants will be installed at 1,000-foot maximum spacing along distribution lines or a maximum of 500 feet from the end of the lateral. In Phase 2, fire hydrants will be installed on the downstream side of distribution tanks only. At the DBB 30% final design level, fire hydrants are not included in Phase 3, but will be included as designs progress. All hydrants will be in compliance with IHS Standard detail 4C. Fire hydrants will be AWWA C502 compliant. Hydrants will be the three opening, dry-barrel, traffic model type with a 5¼-inch valve opening against the distribution line pressure. The three openings will include one 4-inch pumper opening and two 2½-inch hose openings.

5.10.6 Service Connections

Service connections will be installed at identified residences and in compliance with IHS standard detail 5A. The service connection equipment installed will consist of the full wrap-around tapping saddle on the water main and the corporation stop, service line to the water meter can located within the right-of-way, but not including meters, service lines, or connections to residences.

5.11 Corrosion Mitigation

The majority of pipeline corrosion mitigation is handled by specifying non-metallic pipe where it can safely accommodate the pipeline design pressures. All buried metallic pipe, fittings, and appurtenances will be coated with fusion bonded epoxy. In addition, cathodic protection (CP) is provided for steel casings, steel pipe sections, steel or ductile iron pressure reducing valves, and steel or ductile iron air valves. CP systems are designed for a 20-year life and to comply with NACE SP0169-2013 "Control of External Corrosion on Underground or Submerged Metallic Piping Systems." High potential magnesium anodes are sized appropriately for the surface area to be protected and installed horizontally in trenches at the approximate depth of the protected structure and a minimum of 30 feet from the protected structure as calculated to achieve remote earth. The casing pipes and steel pipe sections are connected to the anode bed though test stations with shunts and variable resistors for monitoring and adjusting the CP system. Valves are protected with a direct-connect anode.

6 WATER TANKS

6.1 Existing Tanks

There are a number of existing tanks that are part of the PBRWS. New tank penetrations are required to tie the PBRWS into these tanks. These modifications, including associated coating repairs, should be designed, analyzed, and approved by an experienced tank manufacturer. Active tank mixing systems will be installed at each existing tank to mitigate thermal stratification and promote uniform chlorine residual throughout the storage tank. A summary of existing tanks tied into the PBRWS and their features are shown in Table 10.

Table 10 – Existing Tanks

Tank Name	Phase/ Stage	Tank Diameter (ft)	Base Elevation (ft)	Overflow Height (ft)	Working Capacity (Gallon)
Black Mesa	P1	20	5663.4	22.62	53,159
Pajarito	P1	31	5730.5	27.69	156,339
Tewa	P1	32	5642.7	17.21	103,538
Lower Pojoaque #30 (west)	P1	39	6039.6	22.73	203,118
Lower Pojoaque #31 (east)	P1	39	6039.6	24.70	220,723
White Sands	P1	24	6047.7	38.95	131,032
Buffalo Thunder Tank #22	P2/S1	51	6122.2	20.8	317,830
IGC Tank	P2/S1	38	6364.0	21.0	178,150
Oweenge Day School Tank #18	P2/S1	30.77	6511.7	20.0	111,460
Tesuque Casino Tank	P2/S1	38	6815.0	23.0	195,110
Nambé Tank #25	P2/S2	25	6338.5	24.0	88,120
Nambé Tank #27	P2/S3	24.25	6212.5	25.5	88,110
Bishop's Lodge Tank #15 (County)	P2/S3	60	7298.0	11.8	249,560

All existing tanks (excluding the Lower Pojoaque tanks) will be severely depleted without supplemental flows from the transmission system during a fire flow event. However, hydraulic analyses confirm that supplemental flow from the transmission system will allow existing tanks to quickly refill after a fire flow event.

6.2 New Tanks

Distribution tanks are tanks located at the terminus of finished water transmission pipelines and provide water supply to meet fire and domestic water demands in designated service zones. Forebay tanks are tanks located just upstream of the pumping plants that function primarily to provide a constant suction head for efficient pump operations. A summary of the new distribution and forebay tanks and their features are listed in Table 11.

Table 11 – New Tanks

Tank Name	Phase/ Stage	Base Elevation (ft)	Tank Diameter (ft)	Overflow Height (ft)	Working Capacity (Gallon)	Tank Material
New Forebay Tanks						
Nambé Forebay Tank	P1	6060.0	30.0	18.0	95,170	Steel
Pojoaque South Forebay Tank	P1	5947.5	30.0	39.0	206,200	Steel
Camel Rock Forebay Tank	P2/S1	6365.0	30.0	36.0	190,340	Steel
Tesuque Forebay Tank[1]	P2/S1	6625.5	30.0	36.0	90,340	Steel

Tank Name	Phase/ Stage	Base Elevation (ft)	Tank Diameter (ft)	Overflow Height (ft)	Working Capacity (Gallon)	Tank Material
New Distribution Tanks						
El Rancho	P1	5747.0	34.0	41.5	281,840	Steel
Turtle	P1	6102.0	108.0	32.0	2,192,750	Concrete
Pojoaque Industrial Park (also serves as Forebay tank)	P1	5915.0	34.0	51.0	346,350	Steel
Pojoaque Nambé South Tank	P2/S1	6377.5	68.0	39.0	1,059,440	Concrete
Camel Rock Tank[1]	P2/S1	6513.5	33.0	37.0	236,710	Steel
Nambé Tank	P2/S2	6342.5	58.0	39.0	770,750	Concrete
RKM Tank (also serves as Forebay Tank)	P2/S3	7130.0	68.0	39.0	1,059,440	Concrete

[1] – Camel Rock Tank and Tesuque Forebay Tank may be combined during final design.

All steel tanks are to be glass-lined bolted-steel tanks designed, manufactured, and tested in accordance with AWWA D103. Bolted-steel tank foundations will consist of either a reinforced, cast-in-place concrete ring foundation or concrete slab. Concrete tanks are used where tank volumes are greater than 500,000 gallons based on life cycle cost considerations. Compression in the concrete tank walls is provided by either AWWA D110 (Type III) for tanks using prestressed wire compression or AWWA D115 for tanks using post tensioned cables. All concrete tanks are designed in accordance with ACI 350 when determining wall thickness and cover requirements for structural and crack control design criteria. Except for the RKM Tank, concrete tanks are above-ground installations. Roof and foundation slabs for concrete tanks are a minimum of 6 inches thick with pre-stressing reinforcement in accordance with ACI 350.

An active tank mixing system will be installed at each new tank to mitigate thermal stratification and promote uniform chlorine residual throughout the storage tank. Inlet and outlet piping for all new tanks will be located at the bottom of each tank. Phase 1 tank drains and overflow pipes will discharge into a drainage vault, adjacent to the tank, and Phase 2 tank drain and overflow pipes will discharge onto a concrete pad, adjacent to the tank. A ladder with fall protection will provide access to the top of each tank for maintenance and inspection.

To monitor water levels in the new distribution tanks, level sensors and floats will be installed. These can be used in pump control algorithms to manage pumping system operations at upstream pump stations. Control valves will be provided in a vault at tanks, when necessary, to control tank filling. Water level indicator gages will be provided at each new tank.

6.3 Chlorine Injection Buildings

Additional water treatment will be provided as necessary with chlorine injection equipment at selected distribution tank sites. Since chlorine dissipates over time, a additional chlorine may be needed at various locations within the system. These locations are determined based on the amount of time between initial treatment and delivery. Based on the water age analysis, only Turtle Tank will initially be equipped with a chlorine injection building.

New distribution tanks will have space provisions for potential future installation of a chlorine injection system. Chlorine needs are based on projected 2040 demands. Injection will be controlled by monitoring and maintaining a chlorine residual in the storage tank not to exceed 2 ppm. Chlorine buildings provide a controlled environment for chlorine storage and injection operations. Bulk containers of sodium hypochlorite would be located in the chlorine injection building. Emergency Drench Shower/Eye-Face Wash Stations would be installed at each chlorine injection building in accordance with ISEA Z358.

6.4 Corrosion Mitigation

For corrosion protection of bolted-steel tanks, both the interior and exterior of the steel tanks will be glass-lined at the factory. In addition, CP is provided for the interior of all new bolted-steel tanks. The cathodic protection system is designed for a 20-year life and to comply with NACE SP0196-2015 “Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks.” High potential magnesium rod anodes are sized appropriately for the surface area to be protected and installed in a single ring from the tank walls. The tank structure is connected to the anode ring and reference electrodes though a junction box with shunts and variable resistors for monitoring and adjusting the CP system. A high resistivity foundation material will be used for tank bottoms based on AWWA D100.

7 PUMP STATIONS

Phase 1 pump stations will be pre-engineered metal buildings designed in accordance with local building codes. Phase 1 pump station foundations will be reinforced concrete slab-on-grade with encased manifold piping below the building. A thickened concrete edge will be used for anchoring building structures to their foundations as well as extending the foundation perimeter below the frost depth for the region.

Phase 2 pump stations will be preassembled to the greatest extent possible prior to shipping to the site. The pump stations will be supported by a reinforced concrete slab-on-grade. The pump stations will have all pumps for the 2064 flows installed during the initial installation with no spare pumps at the 2064 flows.

The pump stations' design will comply with international building codes and be classified as Moderate-hazard Factory Industrial, Group F-1 spaces. Final pump type will be determined by the pump station manufacturer.

7.1 Pump Selection

Pumps will be selected at a rated point to satisfy the 2064 MDD design condition. Based on the wide variation of system requirements between 2024 to 2064, variable speed drives may be included in the design. Multiple pumping units, with adequate head and capacity, will be installed at each pump station to provide flexibility for 2024 and 2064 water demand, in coordination with downstream distribution tank sizing.

Flowmeters are provided at each pump station. For accuracy of readings, the flowmeters are located with sufficient straight runs of pipe on either side of the flowmeter (10 times the internal diameter of the pipe upstream and 5 times the internal diameter downstream of the flowmeter).

7.2 Surge Mitigation Equipment

Air chambers are provided for surge protection to prevent formation of water column separation due to down surge. In addition, they will maintain the maximum pressure, due to the upsurge, below the design pressure limits of the pipe, fittings, and valves. The selected air chambers are horizontal bladder style design. The principle advantage to this style of tank is that the bladder pre-charge occurs just prior to putting the system into service and no supplemental compressor or level adjustment equipment is needed. Each tank has been sized specifically for its pump station with adequate storage so that it will not be fully emptied during a surge event. Table 12 lists the minimum capacities for the air chambers by location:

Table 12 – Air Chamber Minimum Capacities

Site	Capacity (Gallons)
Intake PS	9,100
Finished Water PS – West	150
Finished Water PS – East	1,400
Pojoaque Industrial Park	260 + 1,300
Pojoaque South PS	2,327
Camel Rock PS	5,140
Tesuque PS	1,422
RKM PS	479
Nambé PS	591

Air chambers will be fabricated from ASTM A516-10, grade 70 steel or a comparable steel chosen by the air chamber fabricator. The air chambers will be designed and fabricated in accordance with the requirements of Section VIII, Division I of the ASME Boiler and Pressure Vessel Code (ASME 2013).

Phase 1 air chambers are located inside the pump stations (mechanical/electrical building at intake PS). To accommodate the prepackaged pump stations proposed for Phase 2, air chambers are placed outside of the pump station. Phase 2 air chambers are located on a concrete pad and visually screened. Phase 2 air chambers will utilize a heating blanket with insulation jacket and aluminum cladding on the exterior of the air chamber and heat trace.

7.3 Corrosion Mitigation

All buried metallic yard piping, fittings, and appurtenances are coated with a bonded dielectric. In addition, CP is provided. The CP system is designed for a 20-year life and to comply with NACE SP0169-2013 "Control of External Corrosion on Underground or Submerged Metallic Piping

Systems." High potential magnesium anodes are sized appropriately for the surface area to be protected and installed horizontally in trenches at the approximate depth of the protected structure and a minimum of 30 feet from the protected structure. The yard piping is connected to the anode bed though test stations with shunts and variable resistors for monitoring and adjusting the CP system.

8 INTEGRATION OF EXISTING INFRASTRUCTURE

The PBRWS is designed with consideration for existing infrastructure. Where feasible, existing infrastructure will be integrated into the design to minimize capital construction costs and minimize the extent of construction activities. The existing Pojoaque Basin water systems include wells, transmission lines, storage tanks, distribution system, valves, hydrants, and other related infrastructure. Some of these facilities will be integrated into the new PBRWS system and some will be abandoned in place. New distribution pipelines may be connected to an existing pipeline if the existing pipeline is rated as being in "excellent" or "very good" condition. Other existing infrastructure rated "very good" or "excellent" may also be integrated. "Very good" is defined as having less than 80% but more than 50% of its lifespan remaining, "Excellent" is defined as having 80% or greater of its lifespan remaining.

8.1 Transition from Well Water to System Water

The existing distribution systems currently use wells as a groundwater supply. The new system is classified as groundwater under the direct influence of surface water (GWUDI). Existing wells will be isolated from the new system by manual isolation valves. Existing wells are not precluded from use for emergency backup water supply but are not incorporated as such in the final designs for the project. The new Regional Water Authority may decide to use or not use existing wells as emergency back-up in the future and pursue any necessary permits.

Compatibility concerns arise when connecting new equipment to existing infrastructure and when supplying a new water source to existing infrastructure. For the PBRWS system, compatibility was reviewed for locations where the existing wells could be used as an emergency supply to serve new transmission pipelines, storage tanks, and distribution systems and where treated water from the treatment plant will be conveyed into existing tanks and into existing pipelines for transmission and distribution. A well evaluation report was completed by CDM Smith in May 2017 for eighty-six existing groundwater supply wells and is provided as a reference for information should each Pueblo decide to continue to pump groundwater after the Reginal Water System is operational.

During the transition from well supply to treated water supply, certain regulatory requirements applicable to the overall distribution system are likely to be triggered and should be considered as the overall system is being brought into service (or back online, if the wells are ever used as a backup emergency supply). Those requirements will be determined during the permitting process and may include establishing distribution system sampling locations and integrated system water quality. These may include monthly total coliform and detectable disinfection residuals, quarterly disinfection byproducts, as well as lead and copper sampling. A transition plan will be developed and will include recommendations for sampling to proactively address these regulatory issues. In some cases, this may include baseline sampling to identify water quality prior to transitioning to a new integrated system with a new potable water source.

The transition from existing wells to the new PBRWS water may result in a period of instability within the existing transmission and distribution piping, until the system reaches an equilibrium with the new water quality. Fortunately, the majority of the water will be distributed through the existing storage tanks and in the same flow pattern. Nonetheless, there are likely deposits within pipes, especially ferrous piping, that could be released, resulting in high levels of iron ("red water") or manganese in the water. The new PBRWS water is conditioned to mitigate corrosion and the development of scale deposits. During the transition to the new PBRWS, it is recommended that an extensive sampling and unidirectional flushing program be implemented, along with a public notification to advise of the flushing program and potential for a temporary period of discolored water as the transition occurs. It is also recommended that existing distribution water quality data be reviewed to help identify areas of potential concern, supplemented by additional sampling as needed. Advance planning should also be considered for a round of customer tap sampling as may be required to comply with the Lead and Copper Rule. This is likely to be required of the new consolidated system. Fortunately, the new treatment process will help to mitigate corrosion throughout the system. Additional compatibility evaluations will be performed during system start-up.

9 ELECTRICAL

Jemez Mountains Electric Cooperative (JMEC) is the utility for the intake, WTP, and Pojoaque Industrial Park. The utility supplier(s) for all the different PBRWS sites have not yet been identified, however all will be supplied by either JMEC or Public Service of New Mexico (PNM).

9.1 Pump Station Sites

A new 3-phase, 480-volt electrical service will be provided at each pump station. All main pump motors will be 3-phase, 480-volt, induction motors with power factor correction capacitors where necessary. The estimated connected load assumes all pumps running with no demand factor applied. The step-down transformer will be provided by either JMEC or PNM. A buried feeder cable will deliver power to the buildings. The South Pojoaque Pumping Plant has a foundation for a pad-mounted power transformer; all other pump stations will have a pole-mounted transformer.

A new 3-phase, 480-volt motor control center or power panel will be the central distribution point for all 480-volt electrical loads. Where motor control centers are used, they will include the main pump motor starters and feeder circuit breakers for the pump station 480-volt auxiliary loads. Where 480-volt power panels are used, the main pump motor starters will be separate and installed against the walls or in control panels. The feeder circuit breakers will be the molded-case type with thermal-magnetic trip units. Power factor correction capacitors are provided for the main pump motors where necessary.

Low-voltage power distribution will be supplied from a power panel(s) located on the site. Electrical loads like station lighting and power receptacles will be supplied from these power panel(s). The power panels will be supplied from the new 480-volt distribution system via new transformers which will be located at the sites.

The pumps will be operated either from soft starters or from variable frequency drives, depending on the design of the individual pumping plant. Most of the pumps will be operated from soft starters, which will allow reduced voltage starting with a standard full-voltage motor connection after startup.

9.2 Tank Sites

Electrical service to the tank sites will be 120/240-volt electrical service from utility-supplied pole-mounted transformers. Each tank site will have power for instrumentation, controls, and a chlorine injection building. The connected load at each site is 10kVA. This electrical service is sized to support all project site loads, including chlorination booster system loads at applicable sites. When installed, each tank site chlorine injection building would have dedicated electric unit heaters that would maintain the building at a minimum temperature of 45°F in the winter. Chlorine injection buildings will be provided a high-velocity discharge chemical exhaust fan, as well as a chemical detection alarm system.

9.3 Backup Power

Permanent backup generators are provided at the WTP and Pojoaque Industrial Park Pump Station with a portable generator, manual transfer switch, and quick connect box for the generator supplied with the Intake Pump Station. Backup power for Phase 2 will be supplied from the portable engine generator supplied with the Intake Pump Station that can be moved between the pumping plants as needed. The Phase 2 pump stations will have a manual transfer switch and quick connect box, which can be connected to the portable engine-generator. The portable generator can also be connected at the WTP at a quick connect panel located at that facility to supply additional backup power to the WTP.

10 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

The supervisory control and data acquisition (SCADA) system for the PBRWS project will provide the ability to monitor critical process parameters and initiate automatic and manual control functions to ensure each process in the system operates in a reliable, economical, and efficient manner while performing its intended purpose. The SCADA system provides human machine interface (HMI) software on the Operator Workstations for remotely monitoring and operating the WTP from the WTP central control room, and for remotely monitoring the water system from the WTP central control room.

The SCADA system will be capable of audible annunciation of critical alarms at each Operator workstation at the control room in the WTP process/chemical building. In addition, the SCADA system will provide remote dial-out software to alert off-site operators when an alarm is active and provide associated process data information. SCADA system hardware includes programmable logic computers (PLCs), computers, control panels, operator interface terminals, wireless equipment, networking equipment, etc. SCADA system computers will be provided for use as HMI server, Historian server, and Operator workstations. The rack-mount servers will be located in the Communications Equipment Room (ER). Operator workstations will be located in the control room. Operator process controls will be designed and built around ease of use. The operators will be able to readily view the modes of operation of intake pumps, WTP processes, chlorine injection facilities, storage tanks, and booster pump stations.

10.1 Transmission System Monitoring and Operation

PLCs will perform local control of the equipment and components at the site where each PLC is located. Both manual and automatic control functions will be included in the PLC as well as monitoring functions for site status indication. This data will be communicated back to the WTP; however, operator-initiated control actions and control set point changes will only be able to be made locally at the site. Local touchscreens will be provided for operators to interface with the PLC, with small touchscreens provided at tank sites and larger touchscreens provided at the pumping plants.

At each pump station site, the facility's PLC will monitor the operation of the pumps, the level in the associated forebay tank, and the pressure along the pipeline. This data will be used in the control schemes for the pump stations.

At each distribution tank site, level sensors are used to monitor the levels of tanks directly connected to the transmission system while flow meters will be used to monitor the flow out of the main transmission system. In general flow meters will be located on the outlet of the new tanks and the inlet of the existing tanks.

10.2 Security

Security features such as fencing, cameras, and an intrusion alarm system will be supplied at the WTP site. These security features will include monitoring of potential entrance points to the site or to vulnerable locations within the site. The pump stations sites will not include an intrusion alarm system, but will include security features such as fencing, cameras, and monitoring status of ingress points to the facility.

11 CONSTRUCTION SEQUENCING

11.1 Phased Construction

The Consensus Design Concept will be constructed in three major phases that may be broken down further into smaller stages.

- Phase 1 uses a design-build (DB) methodology and includes the intake system, raw water transmission line, WTP, transmission and distribution pipeline, three new storage tanks, and three pump stations in Pueblo de San Ildefonso, Pueblo of Pojoaque, and parts of Santa Fe County.
    - Limited construction of Phase 1, as described in Exhibit C of the 611(g) Agreement, will likely be initiated first and would include work at the intake area.
- Phase 2 uses a design-bid-build (DBB) methodology and includes four new storage tanks, five pump stations, transmission pipeline, and distribution pipeline in the same trench as transmission in Pojoaque, Nambé, and Tesuque Pueblos and parts of Santa Fe County.
- Phase 3 includes distribution pipeline throughout both the DB and DBB project areas.

While the designs for the PBRWS will include provisions for the full supply of 4,000 acre-feet per year (AFY) of water described in the Settlement Act, the Consensus Design Concept will only include features to supply 2,500 AFY initially. Features in addition to the Consensus Design Concept will be constructed as necessary in the future without using Federal or non-Federal funds provided for in the Cost-Sharing and System Integration Agreement or 611(g) Agreement (deferred features), unless such funding remains for construction of the deferred features.

11.1.1 Phase 1 Limited Construction (Design-Build)

In accordance with section VI of the 611(g) Agreement and further described in Exhibit C to that agreement, limited construction of DB Stage 1 – Phase 1, in an amount of approximately $10M federal, will commence in early 2020 with construction of the following Major Items of Work:

- Clearing, grubbing and grading work for collector wells (“CW”) and the temporary access;
- Caissons for CWs 1 & 3;
- Radial collector pipes for CWs 1 & 3;
- Raw water PVC pipes from CWs to the Mechanical/Electrical (M/E) building;
- Electrical duct banks from CWs to the M/E building;
- NF concentrate PVC pipe from M/E building to river discharge;
- Access roads from M/E building to CWs; and
- Site grading at the M/E building.

Limited construction of as many of the above items that $10 million will afford would be completed in approximately 12 months.

11.1.2 Phase 1 Construction (Design-Build)

The schedule for DB construction of Phase 1 facilities, beyond the limited construction discussed above, will begin shortly after Congress amends the Settlement Act to authorize additional funding to construct the PBRWS. Phase 1 construction is expected to take 3 years to complete after notice to proceed is issued for full Phase 1 construction.

11.1.3 Phase 2 Construction (DBB) and Phase 3 Construction (DB and DBB)

The tentative schedule for construction of Phase 2 and Phase 3 facilities is shown in the following table:

Table 13 – Contract Award and Completion Phasing for Phase 2 DBB and Phase 3 DB & DBB Portions of the Project

Contract	Award	Completion
Phase 2: Transmission Pipelines:		
Phase 2 Stage 1 (S. Pojoaque/Tesuque)	10/2022	9/2024
Phase 2 Stage 2 (Nambé)	9/2024	9/2026
Phase 2 Stage 3 (Bishop's Lodge)	9/2026	6/2028
Phase 3: Distribution Pipelines:		
Phase 3 Stage 1 (San Ildefonso)	9/2024	9/2025
Phase 3 Stage 2 (Jacona/Pojoaque)	6/2024	6/2025
Phase 3 Stage 3 (Nambé)	6/2025	6/2026
Phase 3 Stage 4 (Cuyamungue/Tesuque)	6/2026	6/2027
Phase 3 Stage 5 (Tesuque Village/Bishop's Lodge)	6/2027	6/2028

As currently configured, with the assumption that sufficient funds will be timely appropriated, Phase 2 and Phase 3 will be constructed in the following stages. Phase 2 construction is planned to be accomplished by awarding three separate construction contracts for Stage 1 (South Pojoaque and Tesuque Water System), Stage 2 (Nambé Water System), and Stage 3 (Bishop's Lodge). Phase 3 construction is planned to be accomplished by awarding five separate construction contracts for Stage 1 (San Ildefonso), Stage 2 (Jacona/Pojoaque), Stage 3 (Nambé), Stage 4 (Cuyamungue/Tesuque), and Stage 5 (Tesuque Village/Bishop's Lodge).

Section 617(a)(3) of the Act prioritizes the San Ildefonso and Pojoaque portions of the project. Phase 3 of construction was phased to allow treated PBRWS water to be used to perform hydrostatic pressure tests and to disinfect the pipes prior to being accepted into the system (from the plant outward). Otherwise, the installed pipe would sit idle until being connected to the system.

Construction timelines for these stages will be finalized when future appropriation amounts are known; however, the stages are generally not sequential in nature, allowing most major phases to be constructed concurrently with other features, subject to available funding and the schedule of $24 million deferred construction for Santa Fe County distribution lines. Alternative procurement strategies for construction of Phase 2 and Phase 3 features will be evaluated as final designs progress to the 90% design level.

12 OTHER FEATURES

12.1 Pojoaque River Irrigation System at the Pueblo de San Ildefonso

The existing infiltration gallery located near the Pojoaque River Barrier Dam is no longer able to convey the Pueblo's allotted water into the Pueblo de San Ildefonso's irrigation system. Several alternatives to improve water flow into the irrigation system were studied and presented to the Pueblo de San Ildefonso in a report prepared by Reclamation, "Pojoaque Barrier Dam – Extension Alternatives," dated September 2014. The resulting selected alternative would combine a new infiltration gallery and conveyance pipeline located at the east boundary of Pueblo de San Ildefonso, on Pueblo-owned lands, on the south side of the Pojoaque River. The purpose of the Rio Pojoaque Irrigation Improvements is to improve flow into the existing Pueblo de San Ildefonso irrigation system. Modifications to the design have caused the construction estimate to increase beyond the indexed ceiling amount. The Pueblo de San Ildefonso has indicated that they will seek non-Federal funding to cover the shortfall.

12.2 Rio Tesuque Channel Modifications

The preferred alternative for the Rio Tesuque Channel Modifications would increase the flow capacities under the TP-806 Bridge. Due to high levels of sediment transport along the Rio Tesuque, the waterway upstream and under the TP-806 Bridge has experienced a buildup of sediment that reduces the flow capacity below the bridge. Along with this sediment transport, there is a large spoils stockpile in the right side of the channel. In the preferred alternative, the stockpile and the sediment under the bridge would be removed and hauled offsite to be used elsewhere in Tesuque Pueblo. By removing the sediment and stockpile, the Rio Tesuque will be able to convey higher flows under the TP-806 bridge and reduce the amount of sediment buildup under the bridge. The majority of Federal funding for this project was exhausted in the development of the feasibility study with the outcome being the preferred alternative described above. The Pueblo of Tesuque has indicated that they will pursue other funding to implement the preferred alternative.

13 COST ESTIMATES

Cost estimates for the Consensus Design Concept have been developed at varying levels of design maturity. Phase 1 is at the 90% final design level. Phase 2 is at a 60% final design level, and the Phase 3 cost estimate is at a 30% final design level. Phase 1 and Phase 2 costs are at the July 2018 price level. Phase 3 costs are at the July 2017 price level.

13.1 Project Cost

Table 14 – Consensus Design Concept Cost Breakdown

Feature Description	Consensus Concept (July 2018 Price Level)
Phase 1 – San Ildefonso and North Pojoaque	
Intake	$22,470,042
Water Treatment Plant	$54,628,250
Transmission Pipelines	$24,728,583
Pump Stations	$3,046,449
Storage Tanks	$13,729,847
Distribution Pipelines	$16,901,859
TOTAL PHASE 1 FIELD COST	**$135,505,030**
Phase 2 – Stage 1 – South Pojoaque and Tesuque	
Transmission Pipelines	$16,660,941
Distribution Pipelines	$15,670,643
Pump Stations (w/Forebay Tank)	$7,974,356
Distribution Tanks (w/Disinfection)	$4,725,088
Valves and Valve Vaults	$999,800
Electrical, SCADA, CP	$3,503,430
Mobilization	$2,500,000
Design Contingencies and APS	$5,965,741
Gross Receipts Tax	$4,000,000
CONTRACT COST	$62,000,000
Construction Contingencies	$11,000,000
Phase 2 – Stage 1 Field Cost	**$73,000,000**
Phase 2 – Stage 2 – Nambé	
Transmission Pipelines	$1,983,490
Distribution Pipelines	$3,131,659
Pump Stations (w/Forebay Tank)	$1,079,463
Distribution Tanks (w/Disinfection)	$2,118,666
Valves and Valve Vaults	$151,400
Electrical, SCADA, CP	$1,108,310
Mobilization	$480,000
Design Contingencies and APS	$1,167,012
Gross Receipts Tax	$780,000
CONTRACT COST	$12,000,000
Construction Contingencies	$2,000,000
Phase 2 – Stage 2 Field Cost	**$14,000,000**
Phase 2 – Stage 3 – Bishop's Lodge	
Transmission Pipelines	$ 3,837,163
Distribution Pipelines	$ 3,858,857
Pump Stations (w/Forebay Tank)	$ 1,252,000

Feature Description	Consensus Concept (July 2018 Price Level)
Distribution Tanks (w/Disinfection)	$ 1,991,055
Valves and Valve Vaults	$ 296,800
Electrical, SCADA, CP	$ 527,910
Mobilization	$ 590,000
Design Contingencies and APS	$ 1,186,215
Gross Receipts Tax	$ 960,000
CONTRACT COST	$ 14,500,000
Construction Contingencies	$ 3,000,000
Phase 2 – Stage 3 Field Cost	**$ 17,500,000**
TOTAL PHASE 2 FIELD COST	**$ 104,500,000**
TOTAL PHASE 3 FIELD COST	**$ 70,870,993**
REMAINING OTHER COSTS*	$ 4,425,313
NON-CONTRACT COSTS**	$ 91,000,000
TOTAL PROJECT COST	**$ 406,301,336**

* REMAINING OTHER COSTS include the Pojoaque Barrier Dam, Tesuque Channel Modifications, Electrical Improvements, and O&M Assets.

** NON-CONTRACT COSTS include PBRWS project/contract management, environmental compliance, feasibility design, design data collection, final design, lands and realty, design activities associated with the Rio Tesuque Channel Modifications and Pojoaque Barrier Dam.

13.2 Revised Cost Share Obligations

The 2008 Engineering Report by HKM Engineering determined separate cost share rates for the major features of the project (intake and pump station, water treatment plant, pipelines, storage tanks, etc.) based on what it would cost to build a Pueblo-only system vs. a regional water system. Those percentages were useful in negotiating cost-share commitments by the Federal, State, and County governments at that time. However, the 611(g) Agreement provides that additional Federal and non-Federal cost-share shall be provided in the amounts shown in Table 15. Reclamation will allocate expenditures at 72% Federal and 28% non-Federal, as set forth in Section II of Exhibit A of the 611(g) Agreement. Reclamation will further allocate non-Federal expenditures at 86% State and 14% County. Reclamation is not authorized to spend more than the amounts shown in Table 15, appropriately indexed. The State and County will, in accordance with their individual Contributed Funds Agreements with Reclamation, including all amendments thereto, provide their cost-share commitments in advance of expenditures to Reclamation for their use as the project continues to be designed, constructed, and ultimately conveyed.

Table 15 – Cost-Share Commitments (all figures are in 2018 dollars)

	Federal	State	County	Total
Original Commitments	$139.8M	$62.8M	$10.4M	$213M
Non-deferred New Commitments	$137M	$37.2M*	$4M	$178.2M
Total Non-deferred	**$276.8M**	**$100M**	**$14.4M**	**$391.2M**
Deferred New Commitments			*$24M*	*$24M*
Total With Deferred Commitments	***$276.8M***	***$100M***	***$38.4M***	***$415.2M***

* The State's contribution to cover the shortfall will be an additional amount that, after indexing of the State's current obligation in the Cost-Sharing Agreement, provides a combined total of $100 million for the State's contribution to the Settlement. Because the State's contribution is essentially already indexed to the end of the project, the Total With Deferred Commitments is higher than the 2018 $406.3M cost estimate shown in Table 14. The original Federal commitment of $56.4M in mandatory funding stopped indexing in 2016.

14 OPERATION, MAINTENANCE, REPAIR, AND REPLACEMENT

Specific OM&R requirements for Phase 1 and Phase 2 components of the PBRWS are not repeated in this report. Rather, the details are described in the referenced OM&R reports for Phase 1 and Phase 2.

13.3 Purpose of the OM&R Reference Documents

The PBRWS requires operation and maintenance (O&M) to ensure safe, potable drinking water to meet all State and Federal regulations. The reference documents provide O&M procedures specific to the PBRWS to meet all regulations and the needs of the customers, while maintaining the system's facilities in a manner which allows them to run as safely and effectively as possible for many years.

The O&M reference documents provide a working reference for the overall O&M of the PBRWS and as a resource document for staff. The plans contain system contact information, a description of system features along with their O&M, worksheets, record-keeping forms, safety and emergency procedures, and a sampling plan for monitoring the water quality of the system.

The reference documents are "Living Documents" that are to be updated when any changes occur to any aspect of the water system, such as equipment, treatment, personnel, or procedures. These revisions will be tracked on the plan's revision tracking page and an updated version is sent to the New Mexico Environment Department-Drinking Water Bureau Compliance Office within 1 month of the plan revision(s) for approval and finalization.

13.4 O&M Reference Documents Content Overview

The reference documents contain all of the information required to operate and maintain the facilities on an ongoing basis. The intent is for the documents to be updated when policies, procedures, or processes change. The documents can also be used as a training tool for new hires and an ongoing reference guide for all employees.

15 REFERENCES

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