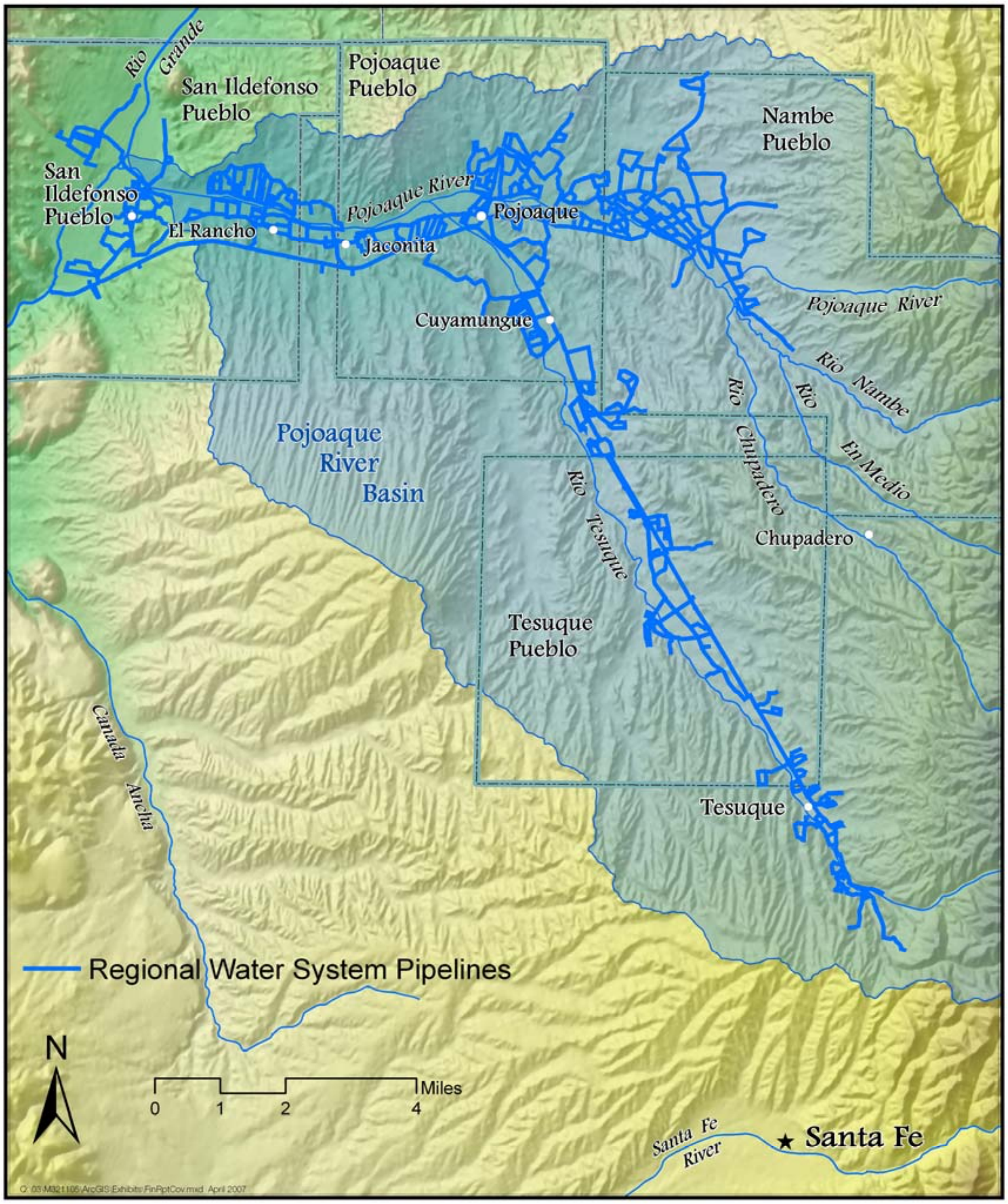
Pojoaque Regional Water System Engineering Report



Prepared for

Northern Pueblo Tributary Water Rights Association

Prepared by

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Acknowledgements

While HKM Engineering Inc. has taken the lead role in the preparation of this Engineering Report, many others have contributed significantly towards it completion.

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Executive Summary

Introduction

In the Pojoaque River Basin, a tributary of the Rio Grande in Northern New Mexico, the conflict over scarce water resources was litigated for decades. In 1966, then State Engineer S.E. Reynolds brought suit against all water right claimants in the Pojoaque River Basin to determine the nature and extent of the claimants' water rights in a case entitled State of New Mexico ex rel. State Engineer v. Aamodt, No. 66cv6639 MV/LCS (D.N.M.) (the Aamodt case). Forty years later, a Settlement Agreement was signed in May 2006 (the Settlement Agreement). An integral and critical component of the Settlement Agreement is the development of a regional water system. A map indicating the location of the Pojoaque River Basin is provided in Figure 1-1.

The Northern Pueblo Tributary Water Rights Association retained HKM Engineering Inc. to prepare an engineering report for the proposed Pojoaque Regional Water System. The scope of this Engineering Report is limited to an analysis of the Regional Water System as described in and anticipated by the provisions of the Settlement Agreement.

This Engineering Report serves multiple purposes. The U.S. Bureau of Reclamation (BOR) prepared and issued a feasibility study for a regional water system in May 2004 pursuant to Public Law 107-66 (the Aamodt Settlement Study Report). That feasibility study facilitated the settlement efforts of the Aamodt parties. A central objective for this Engineering Report is to update the engineering analysis performed by the BOR and their consultants. This is necessary because the Aamodt Settlement, signed by the non-federal governments in 2006, focused on and further refined one of the alternatives discussed in the Settlement Study Report.

In addition to settling the litigation, there are numerous compelling needs for the Pojoaque Regional Water System. The System would serve the needs of four Indian pueblos (San Ildefonso, Pojoaque, Nambe and Tesuque – "the Pueblos") and other residents within the Pojoaque Valley. This is an arid area where drought conditions further exacerbate chronic surface water shortages.

The number of domestic wells in the Pojoaque River Basin has doubled over the past 20 years. Increased use of groundwater has lowered the water table and withdrawals from the alluvium have further reduced surface water flows. Increased groundwater contamination and poor water quality have raised concerns about the sustainability of continued reliance solely on groundwater within the Basin for drinking water. Water produced from many domestic wells exceeds the Safe Drinking Water Act maximum contaminant level (MCL) for uranium and arsenic, and nitrate levels are increasing in some areas as well.

The following major component parts have been integrated into a regional water system design capable of distributing a minimum of 4,000 acre-feet/year (AFY) of a reliable firm supply as contemplated by the Settlement Agreement:

- A surface water diversion would be located on lands belonging to the San Ildefonso Pueblo on the east bank of the Rio Grande River north of Otowi Bridge.

- A water treatment plant to treat water to meet Safe Drinking Water Act standards would be located on lands belonging to the San Ildefonso Pueblo less than a mile from the diversion.

- A potable water transmission and distribution system consisting of pipelines, pump stations, storage tanks and appurtenant items would provide service to Pueblo and other County residents in the Pojoaque River Basin.

- Well fields and hybrid production and injection wells and the connecting pipelines have been included as a means of ensuring a reliable firm supply.

This Engineering Report also analyzes the completion of the barrier dam and infiltration project on the Rio Pojoaque, and channel modifications to improve alluvial recharge on portions of the Rio Tesuque as components of the Pojoaque Regional Water System.

Systems Analyzed For Cost Allocation Purposes

Two potable water systems have been analyzed for the purpose of allocating costs. The Combined System has the capacity to deliver 4,000 AFY while the Pueblo Only System has the capacity to deliver 2,500 AFY. The incremental cost difference between the two systems is the local cost share of the Pojoaque Regional Water System. The Pueblo Only System is not a viable alternative and is only analyzed for the purpose of allocating costs.

The systems have been planned using design criteria appropriate for the area and type of system. Some of the more important design criteria include a peak day factor of twice the average day rate of flow in gallons per minute (gpm), a peak hour factor of three times the average day rate of flow and fire flows of 1,000 gpm in residential areas and 2,000 gpm in commercial areas. The operating pressure in the system should not fall below 20 pounds per square inch under any conditions.

With the exception of capacity and distribution networks the Combined and Pueblo Only Systems are very similar. The major features of the systems are described below. Figure 3-1 and Plate 1 of the Engineering Report provide a schematic and map of the Regional Water System.

A side-channel surface water diversion intake would be located on the east bank of the Rio Grande north of Otowi Bridge. A series of horizontal collection wells and their appurtenant items were considered early but the facilities conflicted with cultural resources. The intake has been planned to reduce the amount of sediment conveyed to the water treatment plant; however, sediment in the surface water will be problematic.

A raw water pump station would be located above the intake and would pump water to a water treatment plant south of New Mexico Highway 502 near the western entrance to the San Ildefonso Pueblo. Rapid mix flocculation followed by enhanced coagulation would help solids settle in three large sedimentation tanks. Water from the sediment tanks would be spun through a large centrifuge to separate solids from the liquid and eliminate the requirement for sludge basins.

A membrane type treatment plant would be used to comply with Safe Drinking Water Act Standards. Microfiltration has been used to lay out the facilities but ultrafiltration units are similar in size and capital cost.

Chlorine would be used as the primary disinfectant. Ammonia would be added to the water prior to entering the transmission system to form chloramines which would provide the residual disinfectant for the transmission and distribution systems.

The transmission systems for both systems would use the same alignments and follow NM Highway 502 as far as the Jacona area. An additional storage tank and reservoir are included in the Combined System to serve the Jacona area. A total of eight pump stations and nine new tanks would be constructed for the Combined System. There is one less of each in the Pueblo Only system. One additional pump station and reservoir would be required to serve the area south of the southern boundary of the Tesuque Pueblo. This reach of the project is referred to as the Bishop's Lodge Extension.

There are over 868,000 feet or about 164 miles of pipelines ranging in size from six to 24 inches in diameter in the Combined System. The Pueblo Only System includes over 476,000 feet or about 90 miles of pipelines ranging between six and 20 inches in diameter. The Bishop's Lodge extension would require about 63,000 additional feet of six and 8-inch diameter pipelines.

Both systems would include several pressure reducing and flow control valves in order to keep pressures within the prescribed range and still be able to meet fire flow requirements.

A supervisory control and data acquisition (SCADA) system would be used with both systems. The SCADA system provides a relatively high degree of automated system operation and increases reliability.

For the purpose of estimating the cost to provide a reliable firm supply, dual completion or hybrid wells have also been included. The wells are the cornerstone of the Aquifer Storage and Recovery component of the project. The wells would provide a mechanism for injecting treated surface water into the aquifer when demand is low and recovering the water when sufficient supply may not be available from the surface water source. For the Pueblo Only System, two 400 gpm wells would provide a firm reliable supply of 800 gpm or 25 gpm more than 50% of the average day requirement of 1,550 gpm. In the combined system, three 400 gpm wells would provide 1,200 gpm or about 40 gpm less than 50% of the average day requirement of 2,480 gpm. The location of and information on the wells is based on the updated material provided by John Shomaker and Associates, the same consultant involved in the 2004 BOR study. There are numerous requirements that would need to be met before the well locations could be finalized.

The systems described above are capable of providing potable water throughout the project area.

Additional Considerations

A construction schedule that complies with the terms of the Settlement Agreement was developed. The schedule calls for building the system outward from the source and completing distribution systems in the service areas after the transmission system components are completed. The system would reach the southern boundary of the Tesuque Reservation by 2016 under the proposed schedule. The part of the Regional Water System south of this point is referred to as the Bishop's Lodge Extension and would be constructed entirely with state and local funds.

Rights-of-way in the form of easements from the Pueblos and individual landowners and permits from the New Mexico Department of Transportation will be needed prior to construction of the Regional Water System. The Pueblos have agreed to grant easements for project facilities in exchange for establishing a fund for the operation and maintenance of the Regional Water System. Within the Pueblo boundaries about 560 acres would be required for Regional Water System facilities. About 85 acres would be required for Regional Water System facilities located outside of the Pueblo boundaries.

Project construction costs are affected by several factors. Several of the distribution system pipelines pass through relatively narrow and congested areas which increases the difficulty of construction.

Costs

An estimate of the probable cost to plan, design, and construct the Regional Water System has been prepared. The cost estimate is based on a variety of data including bid tabs, manufacturers' quotes, earlier estimates and contractor input. Costs are estimated for major items, (e.g., intake, treatment plant, etc) and a series of multipliers are then applied to establish the field cost and project cost. The project cost estimate is provided as table ES-1.

Table ES-1 Project Cost Summary

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
Major Items			
Intake and Pump Station	$1,188,000	$1,071,000	
Water Treatment Plant	$11,231,000	$9,111,000	
Pipelines	$27,597,000	$18,426,000	$1,880,000
Pump Stations	$3,250,000	$2,164,000	$96,000
Storage Tanks	$3,947,000	$3,056,000	$211,000
Hybrid Wells	$4,612,000	$2,883,000	
Service Connections	$11,806,000	$5,716,000	$851,000
PRVs and Control Valves	$530,000	$480,000	$100,000
SCADA Systems	$617,000	$561,000	$39,000
Minor Items	$8,414,000	$5,393,000	$479,000
Unlisted Items (variable)	$10,663,900	$7,493,400	$546,700
Contract Add-ons @ 17.5%	$14,674,783	$9,861,933	$735,473
Contingency @ 20%	$19,706,137	$13,243,167	$987,635
Field Cost (rounded)	$119,659,000	$80,477,000	$5,929,000
Non-contract Costs @ 29.5%-31%	$35,386,236	$23,796,206	$1,837,030
Electrical Improvements	$301,700	$276,650	$12,250
Pojoaque Barrier Dam	$530,000	$530,000	
RT Channel Modifications	$50,000	$50,000	
O&M Assets	$1,254,000	$1,254,000	
Project Cost (rounded)	$157,181,000	$106,384,000	$7,778,000

Conclusions

This Engineering Report used previously developed and new information in conjunction with relevant standards and professional experience to analyze the Regional Water System component of the Aamodt Settlement. Based on that analysis, a Regional Water System capable of providing a reliable firm supply of 4000 AFY to the Pueblos and County could be constructed for about $157,000,000 ($October 2006). The cost of constructing the Pueblo Only system was estimated to serve as the basis for the federal share of the capital cost of the Regional Water System. That cost is estimated to be about $106,000,000 ($October 2006).

This Report provides an estimate of the probable cost of building the water system that is envisioned in the Settlement Agreement as of October, 2006. It is not a final design and should not be used for such. Nevertheless, the procedures that were used provide a reliable estimate because of the inclusion of contingencies and other factors to ensure that the project can be constructed at the estimated cost. The estimate does not account for unforeseeable changes in circumstances. It also depends on effective and efficient construction management and the timely provision of funding to allow construction to proceed on the schedule included in the estimate.

The Report also examines operation, maintenance and replacement costs associated with the operation of the Regional Water System. However, these costs are more difficult to estimate because of the various assumptions that must be made regarding future conditions. The assumptions used to estimate OM&R costs are described in Section 6. Based on the assumptions used, the total OM&R cost for the system over the 50-year life cycle analysis would be about $137,000,000 for a Combined System and $95,000,000 for a Pueblo Only System. The federal share of that amount is estimated to be about $5,238,000 for O&M during construction and about $37,608,000 for other aspects of OM&R until full demands and capacity are realized.

1. Introduction

1.1. Background

Water is a scarce resource in the arid West. When resources are scarce and demand exceeds supply, conflicts are likely. In the Pojoaque River Basin, a tributary of the Rio Grande in Northern New Mexico, the conflict over scarce water resources was litigated for decades. In 1966, then State Engineer S. E. Reynolds brought suit against all water right claimants in the Pojoaque River Basin to determine the nature and extent of the claimants' water rights in a case entitled State of New Mexico ex rel. State Engineer v. Aamodt, No. 66cv6639 MV/LCS (D.N.M.) (the Aamodt case). On May 3, 2006, the Pueblo de San Ildefonso, the Pueblo of Pojoaque, the Pueblo of Nambe, the Pueblo of Tesuque, (collectively – the Pueblos) the City of Santa Fe, Santa Fe County (the County), and the State of New Mexico signed an agreement to settle the Aamodt case (Aamodt Settlement).

Just days before the signing ceremony, the Aamodt case turned 40 years old, making it one of the oldest unresolved cases on the federal docket for the entire nation. The Aamodt Settlement provides the path to end this divisive litigation. An integral and critical component of the Aamodt Settlement is the Regional Water System which would import and distribute water into the Pojoaque River Basin.

This Engineering Report does not discuss all parameters of the Aamodt Settlement but focuses on updating the planning for, and the costs associated with, the Regional Water System.

1.2. Purpose

This Engineering Report serves multiple purposes. A key purpose is to update the engineering analysis performed by the Bureau of Reclamation (BOR) and their consultants in the 2004 Aamodt Settlement Study Report. This is necessary because the Aamodt Settlement signed by the non-federal governments in 2006 focused on and further refined one of the alternatives in the Aamodt Settlement Study Report.

Based upon the Aamodt Settlement, the Regional Water System includes surface water diversion facilities at San Ildefonso Pueblo on the Rio Grande, treatment, transmission, storage, County and Pueblo distribution facilities, including distribution facilities for each Pueblo, and well fields necessary to supply a minimum of 4000 acre-feet per year (AFY) of water for consumptive use within the Pojoaque Basin, all to be managed and operated for the purpose of ensuring a reliable firm supply of water to all users served by the Regional Water System. Thus, another purpose of this Engineering Report is to ensure that the Regional Water System is designed to supply a "reliable firm supply" as is described in that definition.

Because federal legislation is required to approve the Aamodt Settlement and authorize funding for the Regional Water System, another key purpose of the Engineering Report is to provide updated cost estimates for use in the decision-making process.

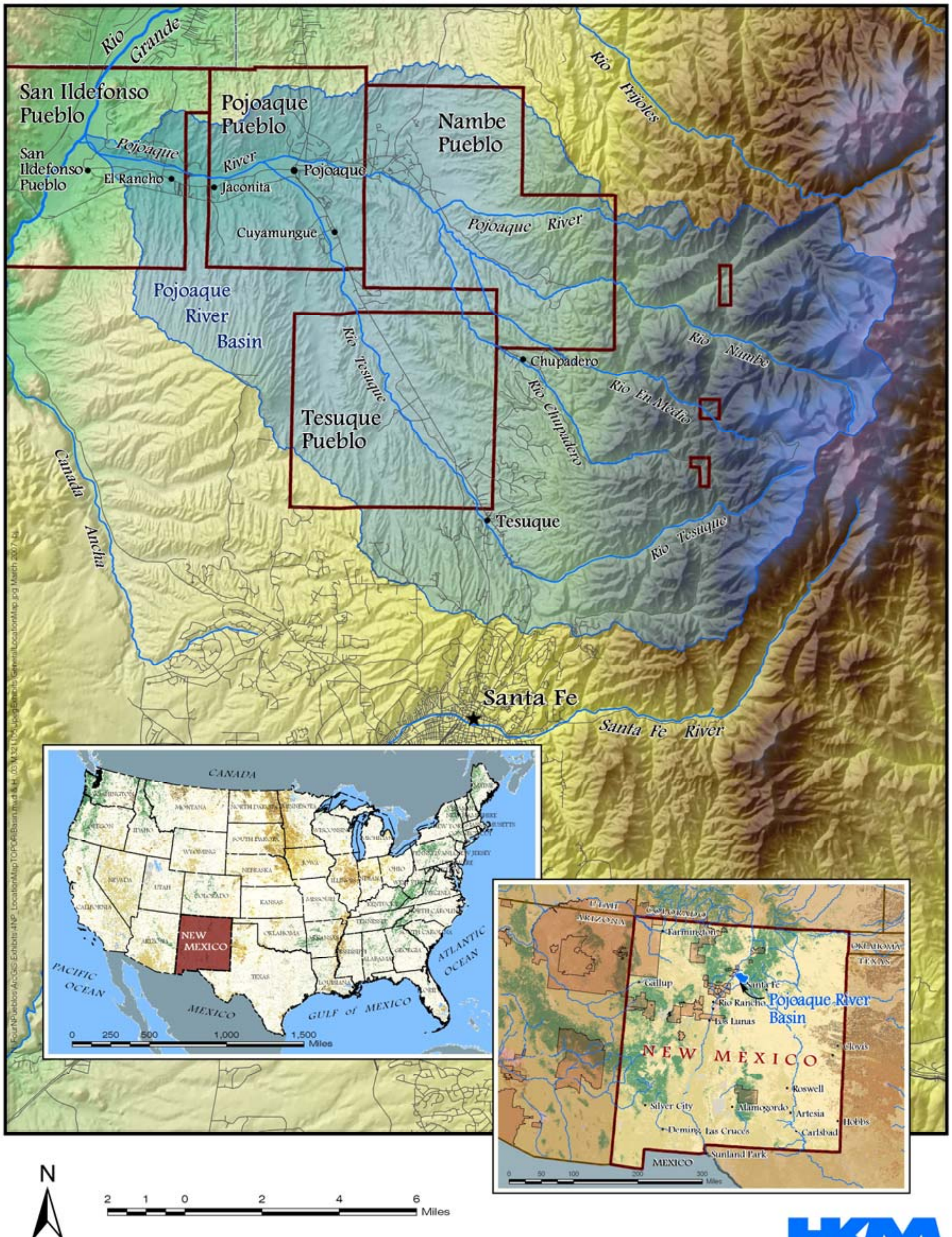
1.3. Need

In addition to settling the litigation, there are numerous compelling needs for the Regional Water System. The Regional Water System would serve four Indian pueblos and others in the area north of Santa Fe. Figure 1-1 shows the general location of the study area and Regional Water System. This is an arid area where chronic surface water shortages have been exacerbated by drought conditions.

In addition, the number of domestic wells in the Pojoaque River Basin has doubled over the past 20 years. The increased use of groundwater has lowered the water table and withdrawals from the alluvium have further reduced surface water flows. There is increased concern about the sustainability of continued reliance solely on groundwater in the basin for drinking water from a water quality perspective as well. Many of the domestic wells exceed the Safe Drinking Water Act maximum contaminant level (MCL) for uranium and arsenic, and nitrate levels are increasing in some areas as well (ASCG, 2006).

While each of the four Pueblos currently has its own domestic water system, the majority of these systems have small lines that cannot support future growth or provide water for fire suppression. There are also concerns about the asbestos in many of the older undersized Pueblo waterlines.

Figure 1-1 General Location of the Study Area



Confidential Settlement Document - Not Available For Use In Court

1.4. Scope

The scope of this Engineering Report is limited to an engineering analysis of the Regional Water System as described by the Aamodt Settlement. The following major component parts have been integrated into a Regional Water System capable of distributing a minimum of 4000 AFY:

- A surface water diversion located on the east bank of the Rio Grande north of Otowi Bridge.

- A water treatment plant to treat water to meet Safe Drinking Water Act standards.

- A potable water transmission and distribution system consisting of pipelines, pump stations, storage tanks and appurtenant items.

- Well fields and hybrid production and injection wells and the connecting pipelines as means of “ensuring a firm reliable supply.”

The completion of the Rio Pojoaque River barrier dam and Channel modifications to improve alluvial recharge on portions of the Rio Tesuque are also integral parts of the settlement and are also analyzed in this report.

The scope of this Engineering Report is an engineering analysis of the Regional Water System and its individual components as defined in the Aamodt Settlement and generally described above. While environmental factors and cultural resources have been considered in the analysis of the Regional Water System, National Environmental Policy Act (NEPA) compliance activities are beyond the scope of this report. Sources of supply (water rights) for the Regional Water system are not discussed in this report.

1.5. How This Engineering Report Builds Upon Previous Studies

This is not the first report on regional water systems for the Pojoaque River Basin. The authors of this report are familiar with at least one study on the subject from the early 1990s. More recently, studies on the subject were conducted by the Bureau of Reclamation and consulting engineers. The Bureau of Reclamation completed a Special Study on the Pojoaque Regional Water System in February 2001. ASCG completed a Pre-Feasibility Study on the matter in July 2001.

In November of 2001, Congress enacted and the President signed P.L. 107–66, the *Energy and Water Development Appropriations Act, 2002*, which included the following: "*Provided further, That of such funds, not more than $1,500,000 shall be available to the Secretary for completion of a feasibility study for the Santa Fe-Pojoaque Regional Water System, New Mexico*...." The Bureau of Reclamation and their consultants subsequently completed the Aamodt Settlement Study Report in April 2004.

The purpose of the Aamodt Settlement Study Report was to analyze multiple alternatives for a regional water system. This Engineering Report refines one of the alternatives (alternative 2) of the Aamodt Settlement Study Report to conform the Regional Water System to the Aamodt Settlement. Many of the design criteria used in the Aamodt Settlement Study Report are the same but the Engineering Report updates the design to conform to the Aamodt Settlement. Alternative 2 of the Aamodt Settlement Study Report design did not provide sufficient capacity in the Regional Water System to use the full amount of water required by the Aamodt Settlement. This is corrected in this Engineering Report. In addition, the engineering work regarding diversion and treatment of the water for the Regional Water System and some of the transmission and distribution system routes are updated.

The cost estimates for all components of the Regional Water System have been updated based on the revised system. Both the Aamodt Settlement Study Report and this Engineering Report use similar approaches for costing in that costs of system components are estimated and then a series of multipliers are applied to estimate contract and project costs. This Engineering Report refines and updates the construction cost estimate for the revised Regional Water System.

2. Systems Analyzed For Cost Allocation Purposes

The parties to the Aamodt Settlement have agreed upon the fundamental structure of a combined Indian/non-Indian Regional Water System as described in Section 1.2 and it is that system for which the parties seek federal authorization. For the purpose of allocating costs, a Pueblo Only System has also been analyzed and a cost estimate prepared. The Pueblo Only System is only presented for cost allocation purposes; it is not acceptable to the parties and is not a viable alternative to the Combined System.

The current effort analyzes and establishes cost estimates for the following three systems:

Pueblo Only System – this system would deliver 2500 acre-feet per year (AFY) of potable water to the San Ildefonso, Pojoaque, Nambe and Tesuque Pueblos. It is analyzed only to assist in the allocation of costs for the Combined System.

Combined System – this system would deliver the 2500 AFY to the four pueblos and 1500 AFY of potable water to non-Indian county residents via a County Water Utility distribution system for a total system demand of 4000 AFY. In the Combined System, only non-Indian county residents are served in the area south of the southern boundary of the Tesuque Indian Reservation in an area referred to as the "Bishop's Lodge Extension". Because this portion of the Combined System would only serve non-Indians, it would be funded entirely by state and local contributions and is shown separately in the cost estimate.

In order to plan and evaluate the systems design criteria are established. Those criteria are described in the following section. The Pojoaque River Barrier Dam and Rio Tesuque Channel Modifications are discussed separately.

2.1. Design Criteria

Design criteria are based on government regulations or standards, professional standards, experience, and local conditions. The Safe Drinking Water Act (SDWA) and federal and state regulations establish standards that the system must comply with. The New Mexico regulations incorporate by reference American Water Works Association (AWWA) standards and the Upper Great Lakes Recommended Standards for Water Works (commonly referred to as the Ten State Standards). The potable systems planned in this study are intended to comply with the Recommended Standards for Water Facilities (New Mexico Environment Department, 2006).

The more significant of these criteria are discussed in the following sections.

2.1.1. Per Capita Use

While this Engineering Report uses acre-feet per year to define the average day demand, a per capita rate of water use is still useful for projecting use and demands in an area and estimating the number of service connections required. For this study a per capita rate of use of 102 gallons per capita per day (gpcpd) is used. This amount includes domestic, institutional, light commercial, community and educational uses. This amount is similar to the 112 gpcpd reported for the city of Santa Fe in 2005 (City of Santa Fe and Santa Fe County, 2006) and is comparable to what was used in the Aamodt Settlement Study Report. Large commercial use is not included in the 102 gpcpd.

2.1.2. Peaking Factors

Water systems need to provide an adequate supply of water throughout the course of the year. The proposed regional water system is being planned based on an annual allocation of water, 2500 AFY for the Pueblo Only System and 4000 AFY for the Combined System. As defined by the Aamodt Settlement, these are the minimum amounts the systems must be capable of providing.

Dividing the total annual volume by the number of days in the year establishes the average day use. The water system also needs to be able to provide adequate volumes of water during periods of peak use. Some water system components (generally upstream from storage) are designed to meet the peak day use, while other components (generally downstream from storage) are designed to meet peak demands occurring over a shorter period of time, usually the peak hour.

The peak day to average day factor is the ratio of the amount of water used on the day of the year with maximum use to the average day. The peak hour factor is the ratio of the rate of water used during the hour of the day when the most water is used to the rate of water use during the average day. These factors can be measured and calculated for existing water systems. For planning future systems they are based on professional experience, relevant data and local conditions.

The following peaking factors have been used for planning the potable water components of the Regional Water System:

1) the peak day rate of use is twice the average day rate of use; and
2) the peak hour rate of use is three times the average day rate of use.

These peaking factors are the same as used in the Aamodt Settlement Study Report.

Rates of water use for potable water systems of similar size to the proposed Regional Water System are typically expressed in gallons per minute (gpm) rather than cubic feet per second (cfs). Intake and treatment facility capacities are typically expressed in millions of gallons per day (MGD).

Table 2-1
Relationship of Annual Volume to Average Day and Peak Demands

System	Annual Volume (AFY)	Average Day (AD) (gpm)	Peak Day (gpm) = AD X 2	Peak Hour (gpm) = AD X 3
Pueblo Only	2,500	1,550	3,100	4,650
Combined	4,000	2,480	4,960	7,439

Peaking factors are used in the sizing of different system components. The peak day factor is typically used to calculate the capacity of intakes, water treatment plants transmission mains and pump stations between tanks. When applied to treatment plants the peak day is usually shortened to less than 24 hours to allow for filter backwashing. The peak hour factor is typically used for pipes and pumps downstream from storage facilities.

Peaking factors are determined by local water use patterns. Lawn watering and the length of the growing season can significantly affect the ratio of average to peak day water use. Based on the average day per capita use of 102 gpcpd, familiarity with the service area and local water conservation practices, it is assumed that lawn watering will not be a significant use.

The difference between average day and peak day system capacities could be used to distribute additional water, such as reuse water, if it were available. The maximum capacity of the system would be unchanged; however, the peak day factor (i.e., the ratio of peak day to average day use) would be lowered.

If the water system is designed for fire suppression (many rural water systems are not) the needed fire flow, in addition to the peaking factors described above, impact the size of pipelines and tank volumes. The Aamodt Settlement Study Report used fire flows of 1,000 gpm in residential areas and 2,000 gpm in commercial areas. These flows are consistent with the general requirements of the Uniform Fire Code (National Fire Protection Association, 2006).

2.1.3. Operating Pressure

Potable water systems are pressurized. If the source of supply is at a higher elevation than the water users, gravity may provide adequate pressure and pumps may not be needed. The Rio Grande, the surface water diversion point for the Pojoaque Regional Water System, is at a lower elevation than the water users. Because of this, all water must be pumped uphill before it is delivered to users.

The New Mexico Standards establish a general range of normal operating pressures of between 60 and 80 pounds per square inch (psi) and not less than 35 psi for distribution systems. Transmission mains are frequently designed to operate at significantly higher pressure than distribution systems. Under no conditions is the pressure in the pipe to fall below 20 psi.

Pressure zones are established to maintain the operating pressure within the desired range. The Study Area has been divided into several service areas that include one or more pressure zones. The operating pressure of the distribution system within each pressure zone is generally designed to be between 45 to 95 psi.

Where multiple pressure zones are served from one storage tank, the pressure of the water in the pipeline needs to be reduced before entering the lower elevation pressure zone. This is accomplished by the use of a pressure reducing valve (PRV). In a typical application, pressure reducing valves are hydraulically operated valves that constantly sense upstream and downstream pressures and reduce the downstream pressure to a preset value. Individual pressure reducing valves may also be used in meter pits at service connections if there are relatively few users in the high pressure area and the pressure to be reduced is less than 125 psi.

2.1.3.1. Other Criteria and Factors

Other factors or criteria that affect system sizing or cost are summarized below.

Depth of cover –the top of the pipe will be buried four feet below ground surface. This factor is consistent with Figure 4 of AWWA D100 (AWWA, 2006).

Meters- each connection will be metered in order to account for water usage.

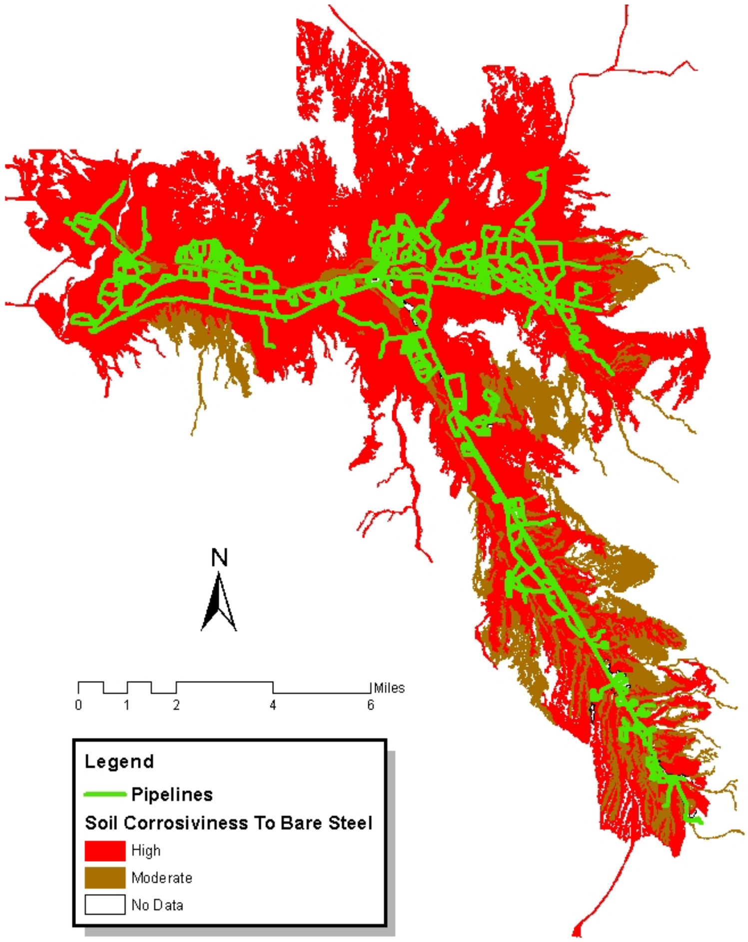
Pipeline materials –polyvinyl chloride (PVC) is the material of choice for most pipelines. The operating pressures of the system are conducive to using pipeline materials that meet AWWA Standard C900 for 4-inch to 12-inch pipelines and AWWA C905 for pipelines larger than 12-inch diameter. Pipe meeting AWWA standards is specified rather than American Society for Testing and Materials (ASTM) 2241 pipe because the AWWA C900 pipe has a higher margin of safety. The safety factor also makes the C900 pipe relatively “tougher” which is relevant in areas where the pipe is installed in close proximity to other buried utilities and is subject to multiple future “taps” for individual service connections.

The only exception to using PVC pipe materials is in the Pueblo Only System on the discharge side of the high service pumps at the water treatment plant. In the Pueblo Only System the discharge pressures exceed the pressure rating of the available PVC pipe and alternative materials, such as steel, ductile iron or fiberglass are required. Steel pipe is used in this application.

Steel and other metallic materials present additional challenges. The Natural Resources Conservation Service (NRCS) county soil survey data were obtained for this study and the potential corrosiveness of the soils to bare metal and concrete analyzed. Figure 2-1 shows the extent of soils in the study area that are highly corrosive to metal. For most areas, the potential soil corrosiveness to concrete was low and further discussion is not required.

Measures are available to protect bare metal from corrosive soils. Common measures used to protect against corrosion include: coating systems, impressed electrical current systems and sacrificial anodes. A protective coating and impressed current would be used on metallic pipelines and buried pump stations. Protective coatings and sacrificial anodes would be used on metallic appurtenances (e.g., valves, hydrants, etc.).

Figure 2-1 Corrosiveness of Soils in the Study Area to Bare Steel



Note: Soil data are from NRCS tabular and spatial data sets for Santa Fe County released September 2006. Tabular data quiered through NRCS 2002-2003 Access database national version.

Friction loss – During static conditions, when water is not moving through the pipelines, there is no loss of pressure within the system. Once water starts moving, pressure is reduced as result of friction between the water and the pipeline. As water velocity increases friction losses increase exponentially. In pipelines of the size proposed for these systems, water velocity is commonly limited to five feet per second (5 fps) at peak day flows to limit friction losses and transient pressure surges. This is value consistent with the New Mexico Standards and used for this study.

Velocity is not the only factor that affects pressure losses due to friction. The roughness of the interior wall of the pipeline is also a major factor. There is little documentation of how roughness, particularly in PVC pipes, increases with pipeline age. Most water system designers allow for some increase in roughness as the pipelines age, which is different from a loss of pipe diameter resulting from either biofilms or mineral precipitates. For a system supplying high quality water there is anticipated to be little increase in pipe roughness and minimal loss of diameter from biofilms. For this study, a roughness factor of 135 is used in hydraulic modeling of the systems.

2.2. System Demands

The allocation of water demands within a water system is important for sizing of the system components. The two potable systems analyzed in this effort have been allocated the amount of water shown in Table 2-2. Table 2-2 shows the allocation of water to the respective entities on an annual and average day basis. Additional water rights are granted to the pueblos in the Aamodt Settlement but are not distributed through the Regional Water System, and thus are not discussed in this report.

Table 2-2
Annual Allocation and Average Day Flow by Party
for Regional Water System Only

Entity	Amount (AFY)	Average Day (gpm)
San Ildefonso Pueblo	375	232.5
Nambe Pueblo	375	232.5
Tesuque Pueblo	500	310.0
Pojoaque Pueblo	1,250	774.9
Total Pueblo Only System	2,500	1,549.9
Santa Fe County	1,500	929.9
Total Combined System	4,000	2,479.8

The allocations described above have been distributed within the study area through an iterative process. The first iteration was based on the distribution systems developed by Arctic Slope Consulting Group (ASCG) for the Aamodt Settlement Study Report. Those layouts were reviewed with each pueblo and the distribution system and associated demands were revised based on both present and future needs. The authors anticipate that there will be changes to the layout of the system until the last phase of construction is complete. The use of a Master Plan, as a means to provide flexibility while guiding construction and controlling costs, is recommended.

The present and future needs include both residential and commercial demands. Based on information from the litigation, previous studies, and the iterative process described above, the demands have been allocated both in space and time. Table 2-3 shows the allocation of demands by type and time. The initial period is synonymous with the construction phase and would end sometime around 2020.

Table 2-3
Summary of Regional Water System Demands (AFA)

Demand Type/Party	Nambe	Pojoaque	Tesuque	San Ildefonso	Santa Fe County
Initial Residential, Educational & Community	118	82	118	173	529
Initial Commercial	137	784	205	85	60
Post Construction Residential, Educational, Community & Commercial	120	384	177	117	911
Total Demand	375	1,250	500	375	1,500
Water Allocation	375	1,250	500	375	1,500

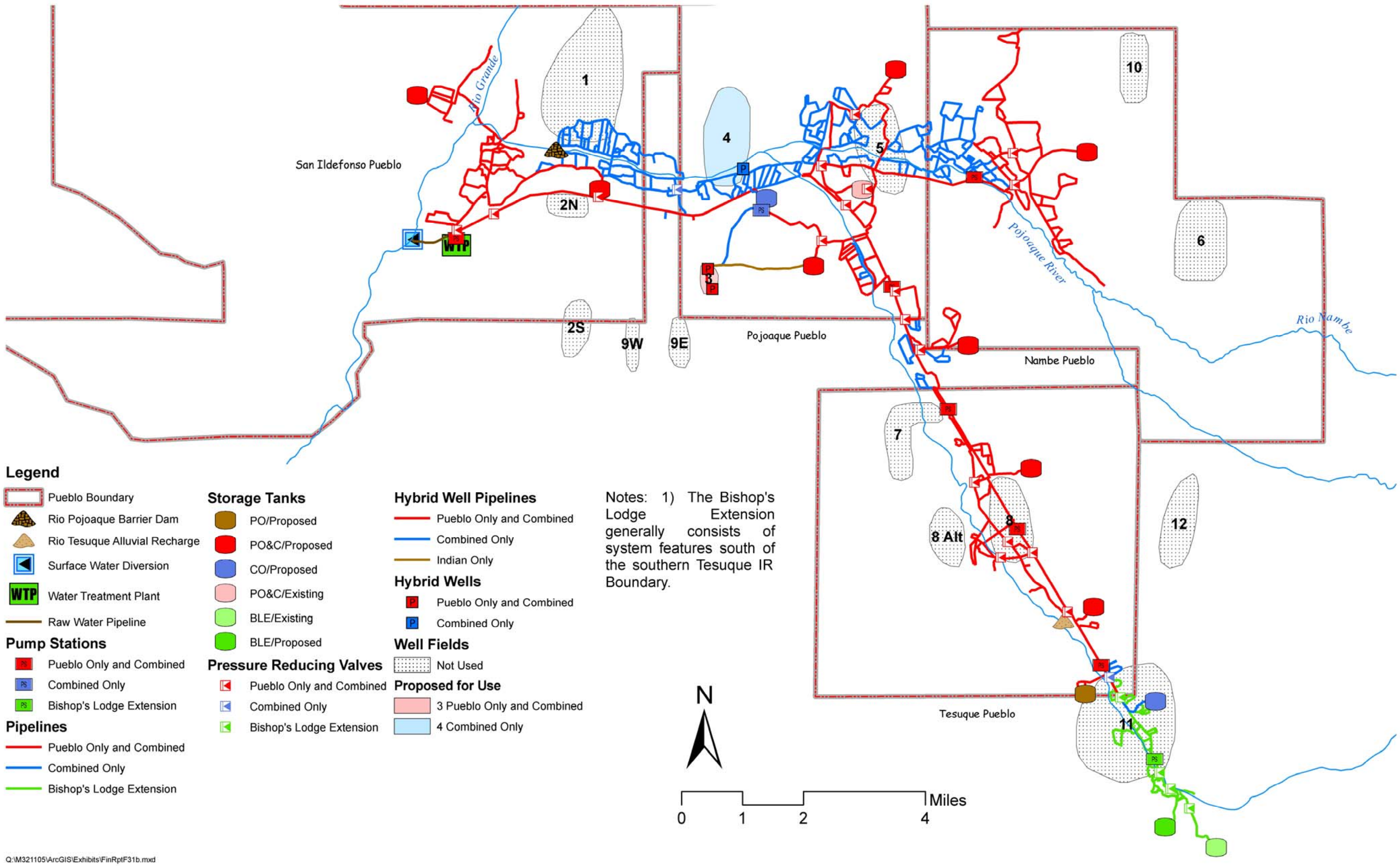
The demands have been distributed within the appropriate service areas and pressure zones shown on Plate 1.

3. Facilities

This section of the Engineering Report describes the facilities that would be constructed as part of the Regional Water System. The facilities for the two potable water systems are described first. The two systems are very similar and the primary differences are capacity and extent of the distribution systems. The two potable water systems have been hydraulically modeled using ArcGems and WaterCad software. Figure 3-1 is a schematic of the major components of the Regional Water System. Plate 1 in the map pocket in the back of the report provides greater detail and location information.

The Pojoaque River Barrier Dam and the Rio Tesuque Alluvial Recharge Project are discussed after the potable water system.

Figure 3-1 Schematic of Regional Water System



3.1. Surface Water Intake & Raw Water Pump Station

The surface water diversion is located on lands belonging to the San Ildefonso Pueblo, just north of the Otowi Bridge. The Aamodt Settlement Study Report analyzed three alternative diversion types: horizontal collection (Ranney®) wells, infiltration galleries, and a direct surface water intake. As a part of this study, representatives of the San Ildefonso Pueblo were shown potential locations for horizontal collection wells. The wells would require electrical power, access roads and connecting pipelines near the east bank of the Rio Grande. The location of wells and appurtenant facilities conflicted with traditional uses; therefore, a surface water intake has been analyzed for use in the Regional Water System.

The proposed intake site is just upstream of the bridge near the east abutment. Figure 3-2 is a conceptual illustration of the proposed facility. Access to the site will require a utility occupancy permit from the New Mexico Department of Transportation. A PNM natural gas line on the north side of the site will also have to be avoided.

The surface water intake will draw water directly from the river channel through a series of fine screens near the channel bank. These screens will be protected from debris and other hazards with a concrete structure and trash racks. An automated air backwash system will be provided to clean the screens and maintain the required flow capacity. The conceptual intake is shown in relation to the Otowi Bridge and Rio Grande in Figure 3-2. More detailed drawings of the intake are provided in the Appendix.

Historical river flows at the nearby USGS gaging station have been reviewed to determine water availability in the Rio Grande. The average annual flow over the last 35 years is 1,460 cfs (944 mgd), and the lowest flow on record during that period is 195 cfs (126 mgd). The river stages at the gage associated with these two flows are 4.02 ft and approximately 1.5 ft above the datum, respectively. The associated river levels at the intake site are unknown, but are presumed to be higher than at the gage due to the lower flow velocities compared to the gaging site. A detailed river survey and hydraulic analysis would be required to determine the actual river levels at the intake during all flow conditions. The intake configuration can be lowered or modified during final design to accommodate low flows if necessary.

A pump station is required at the intake site to lift the raw (untreated) water to the nearby treatment plant. The pump station will generally consist of wet well and vertical turbine pumps, with the necessary piping, valves, meters and other instrumentation to effectively deliver the water. The pump station will also include sand separators that are capable of removing fine sediment from the raw water stream. This pre-treatment process should only be required on a seasonal basis when the river has high turbidity, so equipment by-pass lines will be included for operational flexibility. The removed sediment will be returned to the arroyo adjacent to the site. This should reduce permitting complications that could result from discharging to the Rio Grande.

Figure 3-2 Rendering of Intake and Raw Water Pump Station.

The pump station will be located on the hillside near the highway bridge in order to keep the electrical equipment (motors, control panels, screen backwash system, etc.) above the 100-year floodplain, which has been estimated from Federal Emergency Management Agency (FEMA) mapping to be at an elevation of 5512 feet. A gravel access road and fenced enclosure will be provided for the pump station. A new 3-phase powerline and transformer would be located at the pump station. A diesel generator should also be located on site to provide emergency backup power.

Finally, a low-pressure pipeline will be required to convey the raw water to the treatment plant. Figure 3-3 shows a preliminary layout for the facility.

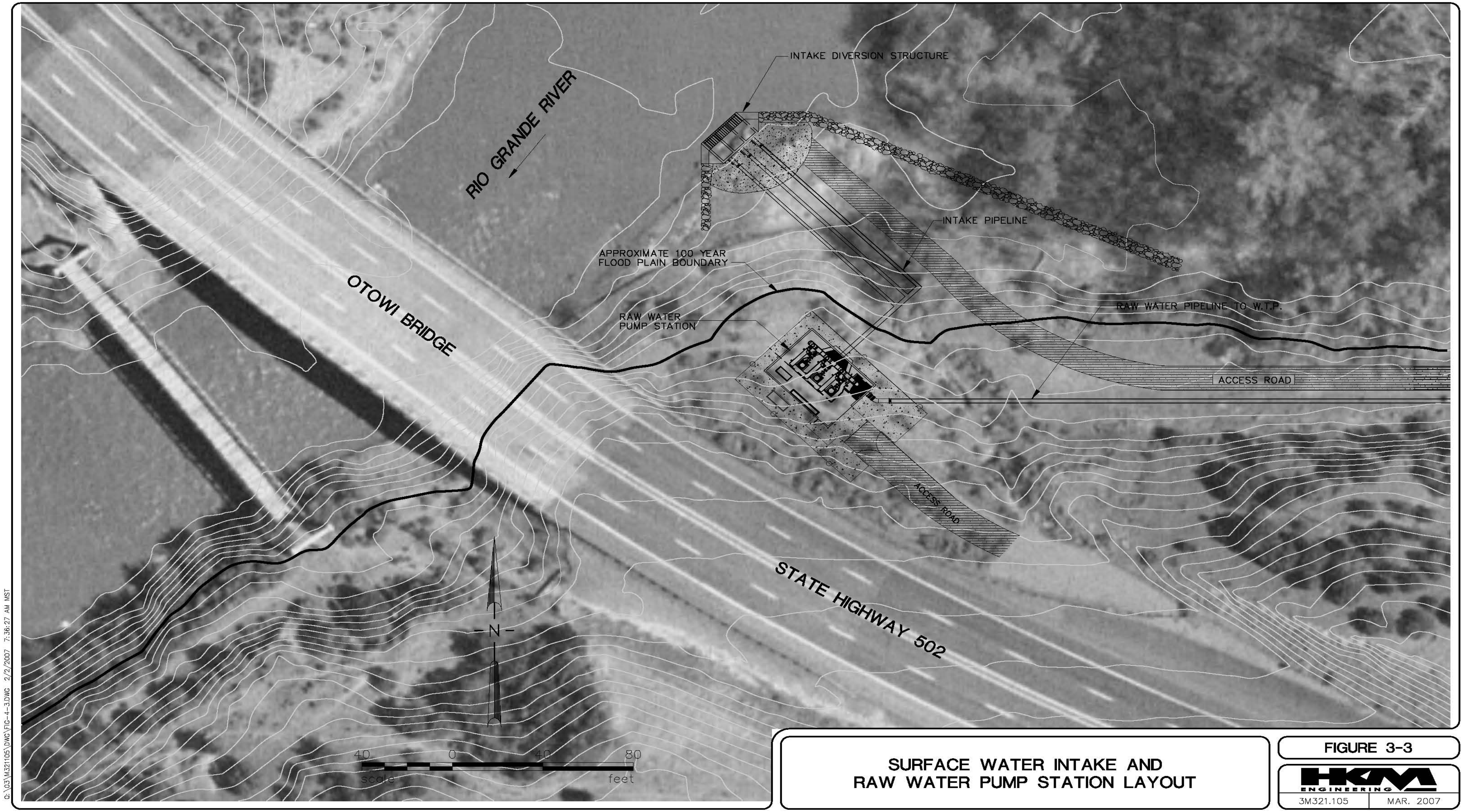
The intake, raw water pump station, and pipeline are all designed to deliver peak day water requirements, plus additional allowances for treatment plant operations and return-flow from the sediment removal system. Each of the major intake components, such as the screens and pumps, include a redundancy to allow one of the items to be taken out of service while still maintaining the ability to deliver peak day flows.

3.2. Source Water

HKM has reviewed the work completed by the Bureau of Reclamation for the Aamodt Settlement Study Report and incorporated many of the water treatment concepts from that report into the current effort. There are however some significant differences. The following sections describe source water quality and the water treatment process and facilities proposed for both the Pueblo Only and Combined Systems.

The water treatment plant would be located on lands belonging to the San Ildefonso Pueblo on the south side of NM 502 near the lower entrance to the San Ildefonso Pueblo. The location of the treatment plant complex is shown on Figure 3-1.

Figure 3-3 Intake Site Plan



Water from the Rio Grande will be diverted for treatment for both the Pueblo Only and Combined System. A partial summary of water quality data from the USGS stream sampling station #08313000 Rio Grande at Otowi Bridge was published in the Bureau of Reclamation report "Water Treatment Plant Design Components and Costs Estimates", May 14, 2003 and is shown below in Table 3-1.

Table 3-1
Source Water Quality

Parameter	Average	Design Range	SMCL
Electrical Conductivity (EC), µmhos/cm	309	462-204	
pH	8.2	8.7-7.7	
Temperature, °C	12.6	25.2-1	
Turbidity, NTU	49	480-1.1	
TDS, mg/L[1]	236	258-223	500
Sulfates (SO_4^-), mg/l	42.5	50-33	250
TOC, mg/l[1]	3.9	7.5-1	
Alkalinity, mg/l	102	139-62	
Chlorides, mg/l	7.3	9.1-5	250

1. All data, except TDS and TOC, are samples taken from January 1980 to September 2001; TDS and TOC data are from four samples Collected in September, October, November 2001 and January 2002.

A wide variety of water quality data are also available for the USGS sampling station #08313000 with a period of record from October 1959 to September 14, 2005 published at the USGS National Water Information Center web site. (http://waterdata.usgs.gov/nwis/qw). A summary of those data are provided in the Appendix. The USGS data include 205 sample points for turbidity and show a greater range in values. While the average was slightly lower (48 NTU), the maximum was 950 NTU or more than twice the maximum from the smaller data set. The higher value has been taken into consideration in the planning of the treatment process.

3.2.1. Water Treatment Process

The treatment process proposed in the Aamodt Settlement Study Report consisted of pre-sedimentation, enhanced coagulation (rapid mix and coagulation), microfiltration membranes, ultraviolet filtration, followed by chloramination to maintain a chlorine residual in the distribution system. Wastewater generated in the membrane backwashing and cleaning process was to be discharged to wastewater polishing ponds where fine suspended solids removed by membrane filtration would be settled out and the "polished" water would be recycled back to the head of the plant. For this Engineering Report, we have based our cost estimates on the same general treatment scheme with some exceptions.

A mechanical sand and silt removal system will be incorporated into the intake to remove sands at the diversion point. HKM recommends moving the chemical addition, rapid mix, flocculation stage ahead of the pre-sedimentation basin to take full advantage of the solids removal capacity of the basins. With this change the pre-sedimentation basin will function as a more conventional flocculation/sedimentation basin. The chemical addition/coagulation process will also reduce the natural organic matter (NOM) thus reducing the potential disinfection by-product formation.

The Aamodt Settlement Study Report proposed the use of dewatering boxes for sediment removed from the pre-sedimentation basins and the wastewater polishing ponds with the dewatered sediment being hauled to a landfill. HKM has included the cost of a centrifuge for dewatering alum sludge generated in the flocculation/sedimentation basin.

Figure 3-4 shows the process flow diagram for the proposed treatment plant. Drawings of facility and the equipment are provided in the Appendix. Figure 3-5 shows a preliminary layout for the facility.

3.2.2. Pilot Testing

The Aamodt Settlement Study Report recommended a 12-month pilot plant study prior to final design to assess the treatment performance during changing water conditions. HKM agrees with the recommendation with the clarification that two or three different membrane suppliers should be tested in a side by side comparison. The BOR proposed the use of a Pall microfiltration system and the layouts and cost based in this Engineering Report are also based on a Pall system. However, without a side by side test it is not possible to conclude that the Pall system is the most cost effective treatment system. Zenon, US Filter and Koch are other established manufacturers of membrane treatment systems and their systems could be tested as well.

Figure 3-4 Water Treatment Process Flow Diagram

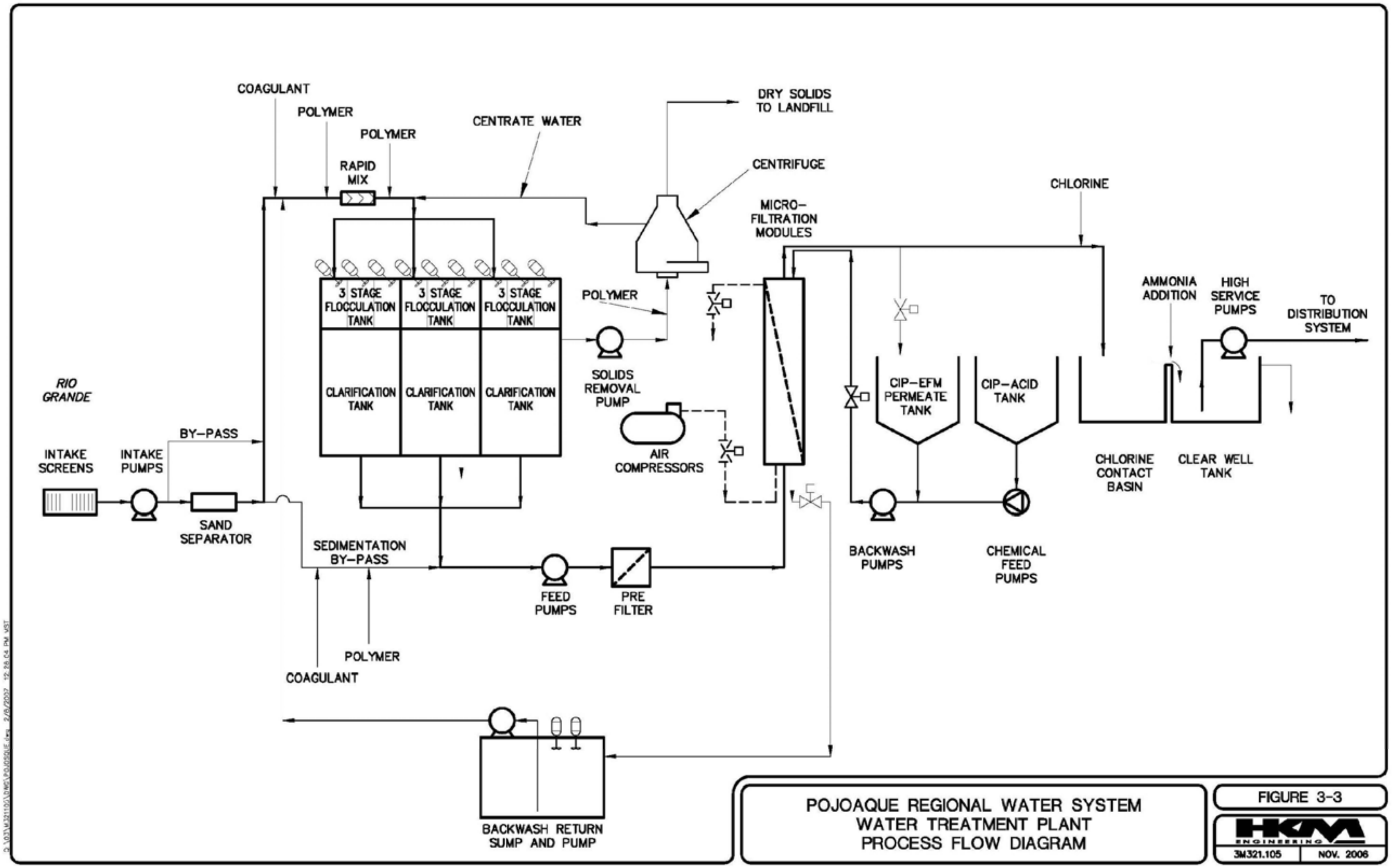


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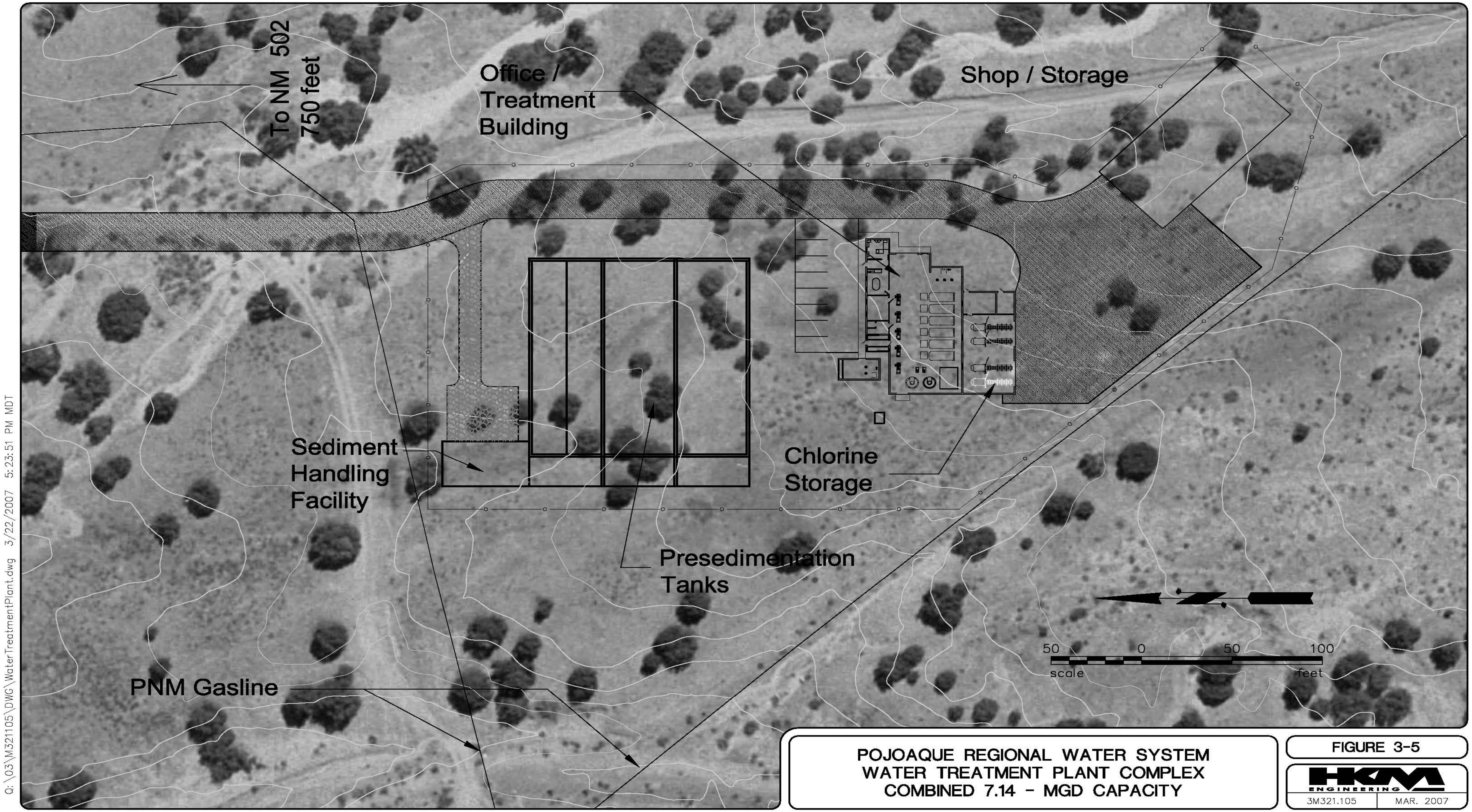
Figure 3-5 Combined Water Treatment Plant



3.2.3. Pre-sedimentation

In the Aamodt Settlement Study Report, two 10 foot deep concrete lined basins, each with a 3-hour detention time were proposed. It was indicated the ponds would have to be cleaned every 15-20 years. With a 3-hour detention time any particle with a settling velocity greater than 0.055 feet per minute (10 feet/ 180 minutes =0.055 ft/min) would be expected to be removed in the basin. Based on settling velocities of particles published in *Integrated Design and Operation of Water Treatment Facilities*, 2nd edition, Kawamura, a settling velocity of 0.055 feet per minute corresponds to a particle diameter between 0.01 and 0.02 millimeters. Data (9 data points) from the USGS sampling station indicate the suspended solid concentration averages 540 mg/l (median value 364 mg/l). Additionally, the data show 47.5 percent of the sediment is less than 0.063 millimeters in diameter (250 data points) and 76.7 percent is less than 0.125 millimeters in diameter. While the basin configuration will impact the removal efficiency, it is expected that the majority of particles larger than 0.063 millimeters would be removed in the pre-sedimentation basins. At the average flow rate of 2.23 MGD for the Pueblo Only System it is projected that approximately 0.87 cubic yards per day of sand and silt (assumed specific gravity of 2.65) would be removed. For the Combined System flow rate of 3.57 MGD, it is projected approximately 1.4 cubic yards per day of sand and silt will be removed. A basin with a 3 hour detention time would fill at a rate of 21% per year.

Due to the sediment load to be removed prior to membrane filtration, HKM recommends using flocculation/sedimentation basins with mechanical solids removal. In addition, as mentioned above HKM recommends moving the rapid mix and coagulation step ahead of the sedimentation basins to maximize the solids removal ahead of the membranes. The proposed system would consist of a three separate treatment trains with each train having a 3-stage flocculation arrangement and a sedimentation basin. Each sedimentation basins would have mechanical sludge removal. Piping would be configured to allow any basin to be taken off line for servicing. The three basin arrangement would allow flexibility in matching the basins in service to the flow conditions.

Prior to finalizing a design, additional suspended solid data and pilot testing should be completed to verify solids loading and chemical addition requirements.

3.2.4. Enhanced Coagulation

The Aamodt Settlement Study Report recommended a chemical addition coagulation step just upstream of the membranes. As discussed above, HKM recommends moving the coagulation step ahead of the sedimentation basins to minimize the solids load on the membranes.

Coagulant addition just ahead of the membranes runs an increased risk of fouling of the membranes due to interactions between the coagulants, feed water, and membrane materials.

3.2.5. Membrane Filtration

The Aamodt Settlement Study Report recommended membrane filtration with microfiltration membranes which will remove particles large than 0.1 microns in diameter. Microfiltration is very effective for removing bacteria and Giardia cysts but is not as effective in virus removal. Additional disinfection after the microfiltration membranes is typically needed to meet the virus removal requirements. The additional disinfection also provides another disinfection barrier to account for inevitable membrane breaks.

3.2.6. Disinfection

Ultraviolet (UV) disinfection was proposed in the Aamodt Settlement Study Report. In addition, chloramination was proposed to maintain a disinfection residual in the distribution system. The need for both UV and chloramination is questionable. Even though the manufacturers may rate the membranes for 6 log removal, the regulatory agencies will typically still require a post membrane disinfection system that will achieve 0.5 log Giardia inactivation. The cost estimates contained in this Engineering Report are based on providing a 128,500 gallon chlorine contact basin for the Pueblo Only System and a 203,400 gallon basin for the Combined System to achieve the 0.5 log Giardia inactivation. In this disinfection scenario free chlorine would be added at the front of the contact basin with ammonia added at the end of the basin. The addition of ammonia at the end of the basin produces the chloramines to maintain a residual in the distribution system.

After disinfection, treated water will typically flow to a clearwell which provides an operating volume so the membranes are not operating in an on/off mode. The clearwell volume also provides additional storage volume to meet peak hour demands in the distribution system. A clearwell volume equal to one hour production is provided. Both the clearwell and chlorine contact basin will be located below the treatment process floor.

Chlorine gas is an extremely hazardous gas and therefore the New Mexico Recommended Standards for Water Facilities contains many requirements governing the design of chlorine facilities. Some of the key criteria impacting the cost of the facilities include:

- Chlorine gas feed and storage should be enclosed and separated from other operating areas
- Chlorine storage separate from ammonia storage

- Ventilation system should provide one complete air change per minute
- Automatic switchover units should be provided
- A gas leak detection system should be provided for both the chlorine storage and chlorinator room
- A chlorine scrubber system meeting the requirements of Article 80 of the Uniform Fire Code should be provided.

In developing costs for the Regional Water System, HKM has assumed the use of a total containment system for the chlorine cylinders rather than a scrubber system. The total containment system meets the requirements of Article 80 and eliminates the need for a separate scrubber system. During the design stage a more detailed evaluation should be completed to determine the least cost alternative between the total containment system and the scrubber system.

3.2.7. Solids Handling

Solids removed in the flocculation/sedimentation process will consist of a combination of chemical sludge and sands/silts. It is estimated that approximately 1,115 pounds/day and 1,785 pounds/day of sludge will be produced in the Pueblo Only and Combined System treatment plants respectively. The estimate is based on an alum dosage of 25 mg/l and an average TSS concentration of 53 mg/l remaining in the feed water to the flocculation/sedimentation basins.

Solids from the flocculation/sedimentation basins will be thickened using a centrifuge. A solids concentration of 17% to 20% is expected with the centrifuge. With a thickened solids concentration of 17%, approximately 3.8 and 6.0 cubic yards per day of solids will be produced in the Pueblo Only System and Combined System respectively. Solids from the centrifuge will be hauled to a landfill for final disposal or could possibly be land applied as a soil supplement. Concentrate water from the process would be returned to the head of the flocculation/sedimentation tank.

3.3. Transmission System

The major components of the Regional Water System transmission system include pump stations, storage tanks and the pipelines connecting the pump stations to storage tanks. Transmission pipelines generally do not include service connections; however, closer to the ends of the system the transmission lines are also used for distribution in order to avoid installing parallel pipelines.

Both the Pueblo Only and Combined System transmission mains originate at the high service pump station at the water treatment plant. The transmission main would be located near the north side of NM Highway 502 in order to mitigate potential conflicts with cultural resources. In the Pueblo Only System the high service pumps would pump through an 18-inch diameter pipeline to a storage tank with a ground elevation of 6,115' located on the ridge west of Cuyamunque. This requires the use of higher pressure rated pipelines on the discharge side of the high service pumps to accommodate pressures of about 225 psi in the Combined System and 325 psi in the Pueblo Only System. Steel pipe has been used in this Engineering Report but ductile iron or fiberglass may prove to be more economical at the time of construction. A control valve would regulate the filling of the San IIdefonso storage tank near the El Rancho entrance to the Pueblo.

The configuration for the Combined System is different because of the demands in the Jacona and El Rancho area. In the Combined System the high service pumps would pump through a 24-inch diameter to the San IIdefonso PRV and then reduce to a 20-inch line to the Jacona area then reduce to an 18-inch line supplying a storage tank located on a ridge on the south side of 502 east of the access road to the wastewater treatment facility. The San IIdefonso storage tank would still be filled through a control valve and an additional pump station near the Jacona tank would be required in the Combined System to pump to the 6,115' storage tank on ridge west of Cuyamunque.

In both systems the transmission main (18-inch diameter) would parallel the wastewater access road and then follow the Pojoaque Pueblo's sewage force main to the Cuyamungue Ridge. One or more large storage tanks would be located on the ridge. Water from the storage tank would flow to the two branches of the transmission system (12-inches for both systems).

The transmission main bifurcates in Pojoaque. One reach heads north and east to serve the Pojoaque, Upper Pojoaque, Nambe Village and Nambe Pueblo pressure zones. A lateral in this area would supply a second tank above the White Sands area constructed at the same elevation (6,115') as the Cuyamunque ridge tank. A pump station would be used on the branch serving the Nambe area to pump water to a storage tank at an elevation of 6,383' located east of the

Nambe Pueblo area. The transmission pipelines vary in size from 8-inches to 12-inches in diameter in this area for both systems.

The other reach of the transmission main heads south up the Rio Tesuque valley. The southerly main bifurcates near the Tesuque Pueblo's trailer court south of Tesuque Village. A westerly branch serves the Flea Market area and in the Combined System also supplies Tesuque Village area. Four pump stations would be required on this branch to lift the water from about 6,000' in the Cuyamunque area to an elevation of about 6,800' in the Flea Market area near the southern boundary of the Tesuque Reservation. The transmission pipelines vary in size from 8-inches to 12-inches in diameter in this area for both systems.

There is one significant difference in the transmission systems for the Pueblo Only and Combined System in this area. In the Pueblo Only System the last pump station would pump to an elevated tank at the Flea Market. In the Combined System the last pump station would pump to a ground level tank with the same base elevation (6,960') east of the Lower Tesuque Village area. Because the elevated storage reservoir in the Pueblo Only System is closer to the commercial fire flow planned for the Flea Market area a smaller diameter (6-inches) pipe is used. The corresponding pipe for the Combined System is 12-inches in diameter.

The transmission system serves both Indian and non-Indian users as far as the southern boundary of the Tesuque Indian Reservation. From that point south, only non-Indians would be served by the system. This portion of the system has been referred to as the Bishop's Lodge Extension. The Bishop's Lodge Extension would require one additional pump station and storage tank. The pump station would be located above the Tesuque Village area and pump to a tank at an elevation of 7300' through 6-inch and 8-inch diameter pipelines. The tank elevation is approximately the same elevation as an existing reservoir at Bishop's Lodge.

The systems described above require several pressure reducing valves (PRV) to keep pressure within the design criteria in the lower pressure zone of each service area. The PRVs, pump stations and storage tanks are described in the following sections.

3.3.1. Pump Stations

Pump stations are required in a water system to deliver water to storage facilities and customers that are at a higher elevation than the source. In this regional water system, all of the service areas will require some amount of pumping. The first pump station will be located at the water treatment plant. A pump station with this function is often referred to as a high-service pump (HSP) station. Integrating the HSP into the water treatment plant facility provides an economy of scale in construction.

Pump stations can be designed with various configurations, and be located either above ground or below grade. For this study below grade encapsulated fabricated stations with above grade entrances have been used. Because of its proximity to the Pojoaque River, an above ground facility maybe better suited for the Nambe area pump station.

It is expected that all of the booster stations will utilize in-line centrifugal pumps except the Jacona station. Vertical turbine pumps would be used at Jacona. The booster stations will also contain pump control valves and/or surge relief valves to control transient pressures. An additional standby pump will be included at each location as a redundancy to allow for maintenance without interrupting operation.

On-site emergency power generators would also be included at each pump station. The emergency power generators help ensure a “reliable firm supply” of water and reduce the volume of water needed to be stored for emergency purposes. Excessive volumes of water in storage can contribute to water quality deterioration.

3.3.2. Storage Tanks

Storage tanks fulfill several functions within the Regional Water System. They store water to meet demands and because the water is stored at a higher elevation than the service area, they provide pressure when pump stations are not pumping. They also provide water for emergency operation and equalization storage between peak day and peak hour demands. In this system, the storage tanks also provide positive pressure to the suction side of the next pump station.

Welded steel ground level reservoirs are prevalent in northern New Mexico. Local ground relief is sufficient that the reservoirs can be located sufficiently high enough in relation to the service area to provide pressure but are still in close enough proximity that pipeline lengths are not excessive. The only exception to the ground level reservoirs would be the elevated tank proposed in the Pueblo Only System for the Flea Market pressure zone.

In the proposed system the storage tanks only serve one or two pressure zones in order to better manage pump station discharge pressures. The only exception is in the Bishop’s Lodge Extension where the pump station serves three zones.

3.3.3. Pressure Reducing and Flow Control Valves

Pressure reducing and flow control valves have been used to maintain pressures within the design criteria and control flow to pressure zones or storage tanks. Pressure reducing valves are used at pressure zone boundaries. These valves are hydraulically operated and "automatically" reduce pressure to a preset value compatible with the downstream zone when more than one zone is supplied by the same tank. These types of valves are used in both the transmission and distribution systems.

Control valves can either work hydraulically, without electrical inputs, or they can be controlled electronically. While both types would be used in the proposed systems, electronically operated control valves will primarily be used when multiple storage tanks serve the same pressure zone, in order to better regulate filling and provide the capability to adjust set points. These valves will be connected to the SCADA system.

3.3.4. Hybrid Wells

While the only situation where the New Mexico standards specifically require a backup supply is for groundwater systems served from a well, the largest systems in the state, Albuquerque and Santa Fe, are both developing alternative sources to ensure that redundant supply is available. The Aamodt Settlement Study Report analyzed the use of groundwater to ensure a firm reliable supply for the Regional Water System. That report considered separate production and injection wells or hybrid wells as an alternative. Hybrid wells were not recommended at that time but the technology has advanced and they are analyzed in this Engineering Report. Hybrid wells provide the capability to both withdraw groundwater from an aquifer and inject water back into the aquifer.

John Shomaker and Associates (JSAI) performed the initial analysis of hybrid wells as part of the Aamodt Settlement Study Report. JSAI has updated the earlier material using the recently updated detailed geologic mapping completed by the New Mexico Bureau of Geology and Mineral Resources. Information on well fields, well design, and costs is taken from the JSAI letter report. The drawdown values in the letter report are based on production wells and do not take into consideration the stabilizing effects of the injection cycles.

Well locations for this Engineering Report were based on the JSAI evaluation of the well fields, impact on surface water resources and compatibility with the Regional Water System. However, it must be emphasized that the effort to date has been to determine how many wells would be required and the cost to include hybrid wells in the Regional Water System. Before any wells are actually sited, there would need to be compliance with the NEPA, the siting criteria in the Cost Sharing and System Integration Agreement and numerous other requirements.

Each hybrid well is estimated to be capable of producing 400 gpm. The number of wells to be used is based on the average day demand requirements for each system. For the Pueblo Only System, two 400 gpm wells would provide a supply of 800 gpm or 25 gpm more than 50% of the average day requirement of 1,550 gpm. In the Combined System, three 400 gpm wells would provide 1,200 gpm or about 40 gpm less than 50% of the average day requirement of 2,400 gpm. It should be noted that hybrid wells and wellfields are the component of the system with the must uncertainty. The wellfields and wells shown on Figure 3-1 have been selected based on the information available and with the objective of meeting demands at the least cost. As this component of the system becomes better understood the location and cost of the hybrid wellfields and wells could substantially change.

For cost estimating purposes, the wells would require several appurtenant items to function with the system. In order to develop a cost estimate for the wells, the minor items associated with the wells have been identified. Each well would be metered for production and injection. Drawdown would be monitored and water level and flow data would be reported by the SCADA system. A treatment facility would be located at the tank that is connected to a wellfield. The treatment facility would monitor disinfectant residual levels. If needed, chlorine or ammonia would be added to maintain an adequate residual and desired chlorine to ammonia ratio. The treatment facility would also be connected to the SCADA system.

New water rights would not be obtained for the wells. The wells would balance production of groundwater with injection of surface water to have no net withdrawal. The wells would be developed as part of an aquifer storage and recovery (ASR) project. The preliminary analysis was done for cost estimating purposes and did not take into account how the injection of water through an ASR project could offset drawdown effects. No ASR projects have been approved yet in New Mexico. There are several possible permitting issues associated with the development of the hybrid ASR wells. The permitting issues are discussed in greater detail in the JSA report in the Appendix.

3.4. SCADA and Electrical

A supervisory control and data acquisition (SCADA) system will be used in the operation of the Regional Water System. The SCADA system will include the following major components: sensors, programmable logic controllers (PLC), remote telemetry units (RTU) and a master control center. The sensors detect system conditions, such as pressure (or water levels at tanks), flow at pump stations, and numerous environmental conditions (temperature, intrusion, flood alarms, etc) and convey that information through a RTU to the central control facility. The local terrain appears favorable for use radios to transit and receive information.

Information from the sensors is processed and analyzed at the local level, (tank, pump station, etc) and the central control facility. The SCADA system proposed for this Regional Water System would have both distributed and central control, meaning that the some "decisions" regarding system operation could be made at either the local level (tank, pump station, etc) and/or at the central control facility. All system control could be managed through the central control facility.

The central control facility would be located in the office at the water treatment plant. It would include a radio connection, two computers (one is a backup) with "man machine interface" or "human machine interface" (MMI or HMI) software and a touch screen display. The SCADA computers can also be networked with one or more additional computers used for other purposes, such as hydraulic modeling, system billing, and geographic information system (GIS) analysis. All Regional Water System personnel would be trained in the use of the SCADA and different security levels assigned to individuals who could change parameters and those who could not.

In addition to the SCADA system electrical improvements will be needed at the intake, treatment plant, tanks and booster stations. Jemez Mountain Cooperative and PNM, the local electric utilities, have been contacted regarding these improvements. The Jemez improvements are more extensive because the raw water pump station, water treatment plant and high service pumps are all located in their service area.

3.5. Distribution Systems

The distribution systems consists of a network of 6-inch through 12-inch diameter pipelines, PRVs, service connections and appurtenant items. The vast majority of the pipelines are 6-inches and 8-inches in diameter but larger pipelines are needed in some areas to provide for

2,000 gpm commercial fire flows. The distribution system networks are based on the networks developed by ASCG for the Aamodt Settlement Study Report. The networks have been modified to reflect changes in the pressure zones and reflect the input of the Pueblos and County in the planning process.

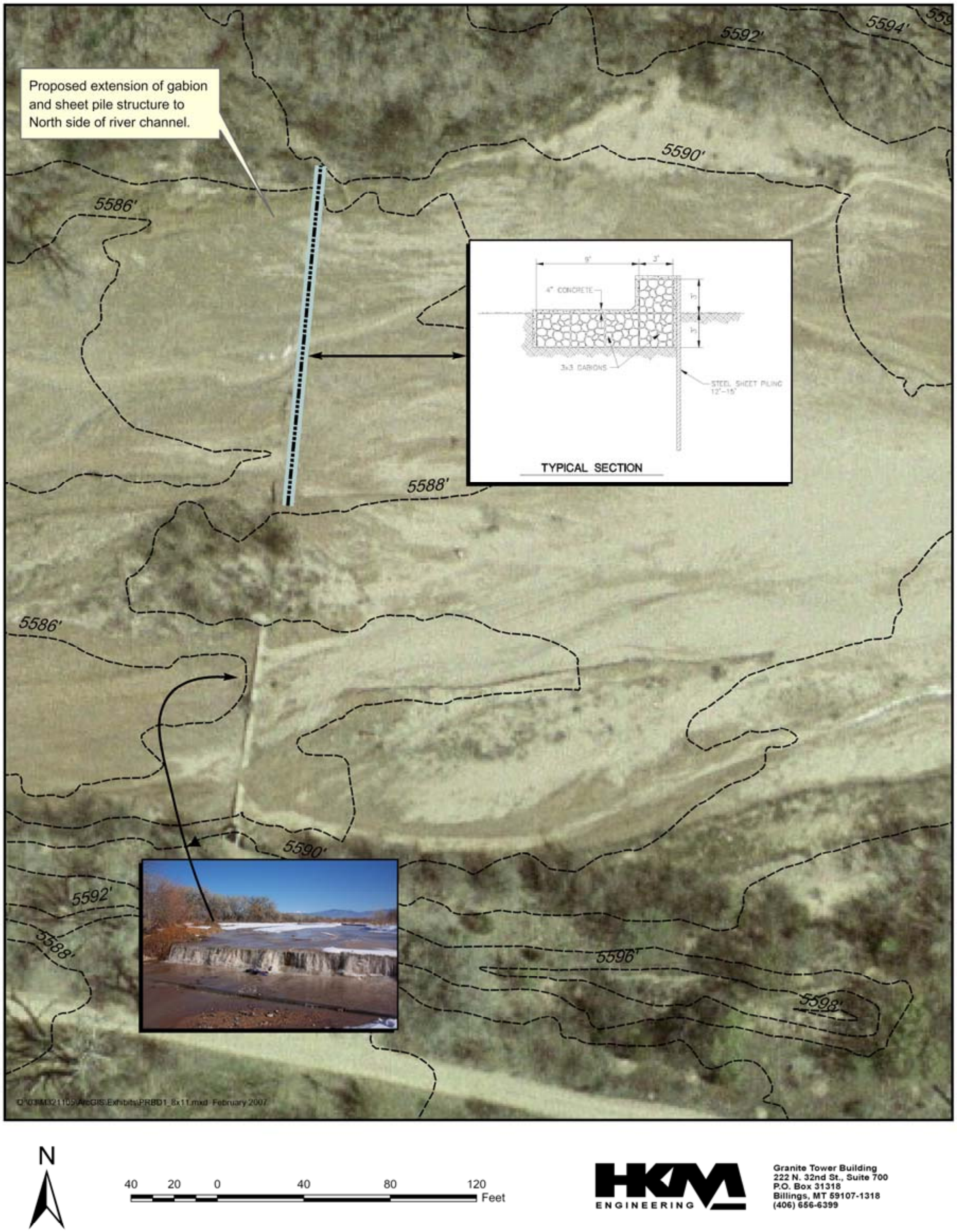
3.6. Pojoaque River Barrier Dam

The existing Pojoaque River Barrier Dam was constructed in the 1980s and consists of a sheet pile and concrete capped gabion structure across the southern channel of the Pojoaque River near the San Ildefonso Pueblo. The purpose of the dam was to improve flow to the Pueblo of San Ildefonso infiltration gallery and surface water diversion. As part of the Pojoaque Regional Water System the barrier dam will be extended from the north edge of the existing dam across the river to the north bank. The extended barrier dam will improve the effectiveness of the barrier dam in recharging the alluvium and diverting alluvial flows to the infiltration gallery under drought conditions.

The extended section of the dam would be constructed similar to the original dam. Steel sheet piling will be driven to a depth between 12 and 15 feet below the river bed. Downstream of the sheet piling, the river bed, which generally consists of sandy gravel, will be excavated to allow a 12-foot wide layer of 3-foot high gabions to be placed. One 3-foot layer of gabions will placed on top of the bottom layer of gabions downstream and adjoining the sheet piling. The sheet piling and top layer of gabions will provide an approximate drop of 3 feet to the bottom gabions which will act as an apron to prevent erosion downstream of the drop. All gabions would be encased with a concrete cap to prevent erosion and extend the design life of the structure. The concrete cap would be further protected by installing angle iron on the edges.

Bank protection consisting of riprap or gabions would also be included as part of the dam extension to prevent scour of the river banks and to maintain the course of the river channel. Figure 3-6 shows the existing facility, river conditions and typical section of the proposed barrier dam improvements The section represents a possible configuration of the dam extension used in developing the cost estimate and should not be considered as final design. The construction of the dam would require Section 404 (Clean Water Act) permitting.

Figure 3-6 Pojoaque River Barrier Dam



3.7. Rio Tesuque Channel Modifications and Alluvial Recharge

The Rio Tesuque Channel Modification and Alluvial Recharge project is planned to allow high flows in the Tesuque Pueblo reach of the Rio Tesuque to infiltrate and recharge the alluvium. This component was added to the Regional Water System to alleviate concerns over the effects of the continued use of groundwater in the Bishop's Lodge Extension area. The improvements contemplated in this Engineering Report are relatively simple and would be developed in the following manner.

The first step in the process would be to evaluate the stream for gaining and losing reaches. Inactive channel meanders above losing reaches would be identified. For this Engineering Report, two meanders have been identified. The location of the meanders relative to losing stretches would need to be confirmed prior to development.

After the meanders are selected, excavation of the meander would begin. The excavation would be "bowl" shaped and deeper near the downstream bank. Riprap would be installed on this bank to protect against over topping and bank erosion by high surface flow. The excavation would be shallower as it extended upstream to connect to the existing channel. The structures would need to have sediment removed periodically to maintain effectiveness. The structures could be built and maintained with relatively light equipment such as skid steer loaders and rubber tired backhoes.

4. Additional Considerations

4.1. System Ownership

The Settlement Agreement requires creation of a Regional Water Authority whose members would be the four Pueblos and the County. The Board of Directors would be comprised of representatives of each Pueblo and the County and would own, operate and maintain the joint facilities of the Regional Water System pursuant to the Cost Sharing and System Integration Agreement, the federal legislation, and an Operating Agreement required by the federal legislation.

Pursuant to the federal legislation, the Secretary, acting through the Commissioner of Reclamation, will be authorized to plan, design and construct the Regional Water System. Upon completion of construction, the United States will transfer ownership of the Regional Water System to (1) the Pueblos with regard to that portion of the Pueblo Water Facilities (as defined in the Cost Sharing and System Integration Agreement and Federal Legislation) located within each respective Pueblo's boundaries; (2) the County Water Utility, the County Distribution System (as defined in the Cost Sharing and System Integration Agreement and Federal Legislation); and (3) the Regional Water Authority all remaining portions of the Regional Water System (diversion and treatment facilities, transmission main, and other joint facilities).

The Regional Water Authority will operate and maintain the common portions of the system to which it maintains ownership subject to the ability to subcontract such operation and maintenance. The County Water Utility will operate and maintain those portions of the facilities for which it maintains ownership and each Pueblo will operate and maintain those portions of the system for which it maintains ownership. The County Water Utility and any Pueblo may contract with the Regional Water Authority to operate and maintain their portions of the system.

4.2. Construction Schedule and Project Sequencing

The Settlement Agreement requires that the Regional Water System be substantially complete by 2016. The construction schedule shown in Table 4-1 was developed as a means to identify how the system could be logically constructed and meet the requirements of the Aamodt Settlement.

The schedule assumed that the system would be authorized in the first session of the 110th Congress. It is also assumed that because of the timing of authorization, funds would not be included in fiscal year (FY) 2008 appropriations but would be available for FY 2009.

There are several pre-construction activities that would need to occur before any construction contracts are awarded. A Final Engineering Report (FER) and National Environmental Policy Act (NEPA) Compliance would be required before federal funds can be used for construction activities. In addition, rights-of-ways and easements would need to be acquired as well.

If funding can be obtained to complete these items, construction could begin after a Record of Decision (ROD) is issued by the lead federal agency for NEPA compliance. This assumes that the state of New Mexico would accept the federal NEPA process or that the federal process was modified to conform to any New Mexico specific requirements. The proposed schedule calls for these items to be completed by late 2009 or early 2010.

Table 4-1
Pojoaque Regional Water System
Timeline for Settlement Compliance

Item --Yea	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Authorization	■													
Appropriations			■	■	■	■	■	■	■	■				
Administration / Pre-Construction		▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒		
Final Egineering Report		State Funds?	■											
NEPA/NHPRA Compliance			■	■										
Right-of-Way Acquisition and Design			■	■	■	■	■	■	■	■	■			
Construction														
Intake				■	■									
Raw Water Line				■	■									
Water Treatment Plant				■	■									
Phase I Transmission					■									
San Ildefonso Distribution					■									
Phase 2 Transmission						■								
El Ranch/Jacona Distribution						■								
Phase 3 Transmission						■								
Pojoaque/U Pojoaque/Cuyamunque Dist.						■								
Phase 4a Transmission							■							
Nambe Village and Pueblo Distribution							■							
Phase 4b Transmission							■							
Upper Cuyamunque/Lower Camel Rock							■							
Phase 5 Transmission								■						
Camel Rock/Tesuque Pueblo								■						
Transmission Segment 6									■					
Upper Tesuque Pueblo									■					
Transmission Segment 7										■				
Lower TV/TV/U TV/Flea Market										■				
Transmission Segment 8											■			
Bishop's Lodge Extension											■			
OM&R					▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Initial O&M Staff and Equipment					■									
Phase 1						■								
Phase 2							■							
Phase 3							■							
Phase 4								■						
Phase 5									■					
Phase 6										■				
Phase 7											■			
Phase 8												■		
Notes: L is Lower U is Upper TV is Tesuque Village.														

If these events occur, construction could begin in 2010. The proposed systems would be constructed from the source outward using competitively bid construction contracts. It is proposed to construct the potable systems outward from the source. The surface water diversion (SWD) and intake would be constructed as one contract as would the water treatment plant.

A single contract would be awarded for each phase of the transmission system. Each of these contracts would include the transmission pipeline, pumping station and reservoir for the service area. The distribution system(s) served from the respective transmission main would be bid at about the same time as the main. Bid packages would be structured so that the owner retains the ability to limit the number of contracts that could be awarded to any one bidder.

The hybrid wells could be bid as single contracts or multiple wells could be combined into one contract. The latter approach may have some cost benefits. The hybrid wells would generally be constructed concurrently with the transmission phase that each connects to.

4.3. Constructability

The intake, treatment plant, pumps stations and storage tanks do not appear to require any special considerations for construction. Geotechnical investigations could reveal “hidden” problems that could complicate construction. Geotechnical investigations would be undertaken during the design effort for these facilities and the results would be incorporated into the final design.

Construction of many of the pipelines will be difficult. While portions of the transmission pipeline are planned for relatively open areas the majority of the distribution systems are located in confined areas with several preexisting utilities. PNM has provided information on their gas transmission and distribution system in the project area. There will be frequent conflicts with gas pipelines. Buried phone and power lines as well as overhead power also complicate construction as do the numerous arroyo and road crossings.

Narrow roads and frequent occurrences of walls will complicate construction and increase costs. The Indian Health Service (IHS) constructed an 8-inch water line from the Pojoaque area to the North Village or White Sands area in the fall of 2006. The total length of 8-inch pipe in the contract was 8,130’ of which 3,177’, or roughly 40%, was installed in a county road. Figure 4-1 shows pipeline installation parallel to NM 502 and the trench scar on the county road. The unit cost per foot of pipeline on the left was $30 per linear foot and $63 per linear foot for the pipeline on the right.

Figure 4-1 Recent IHS Pipeline Installation Parallel to NM 502 and in County Road

The pipeline distribution systems planned for this system have not been laid out at the level of detail where it is possible to estimate the cost of the pavement restoration. That level of detail will not occur until the design phase of the project when routes are defined and right-of-way obtained. The higher cost for the construction in the more difficult areas is taken into consideration in the unit cost for installed pipe and unlisted items factor. Refer to the Cost section for additional information.

4.4. Rights-of-Way and Utility Permits

Rights-of-way in the form of easements and occupancy permits from the New Mexico Department of Transportation will be needed prior to construction of the Regional Water System. The Pueblos have agreed to grant easements for project facilities in exchange for establishing a fund for the operation and maintenance of the Regional Water System. Easements will have to be negotiated with the other landowners. The desired widths for pipeline right-of-ways are 50 feet for pipelines larger than 12-inches in diameter and 30 feet for smaller pipelines. In many areas right-of-ways of these widths will overlap existing right-of-ways for utilities or roads.

Utility occupancy permits will be needed from the New Mexico Department of Transportation for numerous road crossings and some pipelines placed parallel to state or federal highways. There are also numerous utility conflicts with electrical, phone and gas lines. Encroachment into existing right-of-ways will require coordination and cooperation.

Within the Pueblo boundaries about 560 acres would be required for Regional Water System facilities. About 85 acres would be required for Regional Water System facilities located outside of the Pueblo boundaries.

4.5. Cultural Resources

A Class 1 (file search) cultural resource inventory was undertaken for the Aamodt Settlement Study Report. An Appendix to the Aamodt Settlement Study Report provides a narrative and mapping showing approximate locations of inventoried resources.

For this study the Bureau of Reclamation authorized their consultant, Southwest Archeological Associates, to release geographic information system (GIS) data for the inventoried resources. Those data were used in laying out the Regional Water System and the inventoried sites have been avoided to the extent practicable.

The “uninventoried” sites are cause for concern. The majority of sites that have been inventoried were found during Class III (pedestrian survey) inventories for other projects. A Class III inventory would be undertaken during the design phase of this project. It is almost a certainty that “new” sites will be identified. Most of the “new” sites can probably be avoided or mitigated prior to construction. Mitigation imposes additional costs on the project.

It is quite possible that the Class III inventory will not identify all cultural resources and their will be “inadvertent discoveries” during construction. These inadvertent discoveries have the potential to stop construction, require rerouting of pipelines and impose additional costs. The delays caused by the inadvertent discoveries can possibly be lessened by entering into a programmatic agreement between the lead federal agency, the advisory council, the state historic preservation officer and, where applicable, the tribal historic preservation officer.

The costs of avoiding conflicts with cultural resources through Class III investigations are included in the project cost estimate as non-contract costs for archeological investigations (2%) and as a component of design (6%). The delay cost associated with inadvertent discoveries would need to come from the project contingency. Refer to the Cost Section for additional information.

5. Costs

An estimate of the probable cost to plan, design and construct the Regional Water System has been prepared. Table 5-1 provides a cost summary for the Regional Water System. The derivation of the project cost estimate is then discussed.

5.1. Project Construction Costs

The project construction cost estimate has been developed by estimating the cost of major and minor items and then applying a series of additive multipliers to estimate the total cost to plan, design and construct the Regional Water System. These terms and their application in the project cost estimate are described below.

The major items in the Pueblo Only and Combined systems include the following:
Surface Water Diversion and Raw Water Pump Station; Water Treatment Plant; Pipelines; Pump Stations; Storage Tanks; Pressure Reducing and Control Valves; Service Connections, and the SCADA System. The cost of the major items and how they have been estimated are described separately in Section 5-2.

Table 5-1
Regional Water System Cost Summary

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
Major Items			
Intake and Pump Station	$1,188,000	$1,071,000	
Water Treatment Plant	$11,231,000	$9,111,000	
Pipelines	$27,597,000	$18,426,000	$1,880,000
Pump Stations	$3,250,000	$2,164,000	$96,000
Storage Tanks	$3,947,000	$3,056,000	$211,000
Hybrid Wells	$4,612,000	$2,883,000	
Service Connections	$11,806,000	$5,716,000	$851,000
PRVs and Control Valves	$530,000	$480,000	$100,000
SCADA Systems	$617,000	$561,000	$39,000
Minor Items	$8,414,000	$5,393,000	$479,000
Unlisted Items (variable)	$10,663,900	$7,493,400	$546,700
Contract Add-ons @ 17.5%	$14,674,783	$9,861,933	$735,473
Contingency @ 20%	$19,706,137	$13,243,167	$987,635
Field Cost (rounded)	$119,659,000	$80,477,000	$5,929,000
Non-contract Costs @ 29.5%-31%	$35,386,236	$23,796,206	$1,837,030
Electrical Improvements	$301,700	$276,650	$12,250
Pojoaque Barrier Dam	$530,000	$530,000	
RT Channel Modifications	$50,000	$50,000	
O&M Assets	$1,254,000	$1,254,000	
Project Cost (rounded)	$157,181,000	$106,384,000	$7,778,000

The isolation valves, hydrants and road crossings needed for the transmission and distribution systems are a significant cost of the total project. These are referred to as minor items and their costs have been estimated for the Pueblo Only and Combined Systems.

The major and minor items are then added together and multiplied by a factor to account for items that have not been specifically identified or listed in the estimate for the major item. These are frequently referred to as unlisted items and in this study range between 0% and 25% of the cost of the major item.

The resulting number is then multiplied to account for several additional costs are there are typically included in a construction contract. These items are referred to as Contract Add-Ons in this Engineering Report and the respective percentages are as follows: mobilization @ 5.0%; taxes @ 6.5%; bonds and insurance @ 4%; and Tribal Employment and Rights Ordinance

(TERO) fee @ 2%. The Contract Cost is the result of adding the Contract Add-Ons to the sum of the major, minor and unlisted items.

The contract cost is multiplied by 20% as a contingency to take into account unanticipated conditions or changes in conditions. The result is referred to as the field cost and is the total cost to construct the system.

There are also costs associated with both the planning and design of the project facilities and the administration of engineering and construction contracts. These costs are characterized as non-contract costs. The non-contract cost categories and factors are as follows: rights-of-ways and easements @ 0.5 - 2.0%, contract administration @ 8.0%, design @ 6.0%, construction administration and inspection @ 10.0%, survey @ 1.5%, environmental and cultural resources @ 2% and geotechnical investigations @ 1.5%. The multiplier for right-of-way across Indian lands is reduced to 0.5% to cover administrative costs associated with right-of-way acquisition. The Pueblos have agreed that compensation for consenting to the grant of easements for Regional Water System facilities shall be through a fund established for the Pueblo's share of the OM&R costs of the Regional Water System. Applying the factor for non-contract costs to the field costs results in the project cost. The project cost is the total cost to plan, design, and construct the system.

5.2. Intake and Raw Water Pump Station

The cost for the intake and raw water pump station was estimated by preparing preliminary plans of the facilities and estimated the cost of the component parts. Appendix 4 provides a detailed estimate of the component parts. The derivation of the project cost estimate for the intake and raw pump station is shown in Table 5-2.

Table 5-2
Intake and Raw Water Pump Station Costs

Cost Factor	Combined	Pueblo Only
Intake and Raw Water Pump	$1,188,000	$1,071,000
Minor Items	$0	$0
Unlisted Items @ 15%	$178,200	$160,650
Contract Add-ons @ 17.5%	$239,085	$215,539
Contingency @ 20%	$321,057	$289,438
Field Cost (rounded)	$1,927,000	$1,737,000
Non-contract Costs @ 29.5%	$568,465	$512,415
Project Cost (rounded)	$2,495,000	$2,249,000

5.3. Water Treatment Plant

The cost of each water treatment plant has been prepared similar to those for the intake and raw water pump station. Preliminary plans of the facilities were prepared and the cost of the component parts estimated. Appendix 4 provides a detailed estimate of the component parts. The derivation of the project cost estimate for the intake and raw pump station is shown in Table 5-3.

Table 5-3
Water Treatment Plant Costs

Cost Factor	Combined	Pueblo Only
Intake and Raw Water Pump	$11,231,000	$9,111,000
Minor Items	$0	$0
Unlisted Items @ 15%	$1,684,650	$1,366,650
Contract Add-ons @ 17.5%	$2,260,239	$1,833,589
Contingency @ 20%	$3,035,178	$2,462,248
Field Cost (rounded)	$18,212,000	$14,774,000
Non-contract Costs @ 29.5%	$5,372,540	$4,358,330
Project Cost (rounded)	$23,585,000	$19,132,000

5.4. Pipelines

Pipelines are the single most expensive item in the Regional Water System. The cost of the pipelines has been estimated by developing a unit cost and applying that cost to the number of units. In the case of pipelines, the units are linear feet. The unit cost for the diameters of pipe used in the project are shown in Table 5-4. The unit costs have been developed based primarily on bid tabs for similar work and other engineering estimates. Although several minor items such as isolation valves, hydrants and road bores have been identified the potential for unlisted items is higher for this project component than any other. A factor of 25% is used for unlisted items.

The length of the pipelines in each system has been estimated from the hydraulic models of the systems and the geodatabase used to maintain data. The pipeline lengths have been multiplied by a factor of 1.018 to account for local relief.

Table 5-4
Pipeline Unit Costs

Diameter	Unit Cost (per foot)
6	$26.00
8	$32.50
10	$39.00
12	$45.50
14	$65.00
16	$78.00
18	$97.50
20	$110.00
24	$123.50

The summary of pipeline costs for the Combined, Pueblo Only and Bishop's Lodge Extension are presented in Table 5-5.

Table 5-5
Pipeline Costs

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
Pipelines	$27,597,000	$18,426,000	$1,880,000
Minor Items	$7,177,000	$4,301,000	$479,000
Unlisted Items @ 25%	$6,899,250	$4,606,500	$470,000
Contract Add-ons @ 17.5%	$7,292,819	$4,783,363	$495,075
Contingency @ 20%	$9,793,214	$6,423,373	$664,815
Field Cost (rounded)	$58,760,000	$38,541,000	$3,989,000
Non-contract Costs @ 29.5% ~ 31%	$17,381,208	$11,400,428	$1,236,590
Project Cost (rounded)	$76,141,000	$49,941,000	$5,226,000

5.5. Pump Stations

The cost of the pump stations for the systems has been estimated using information provided by suppliers and compared to bid tabs for similar sized pump stations. Engineering Fluids Inc., a supplier of manufactured encapsulated pump stations provided budget quotes to HKM for the pump stations required. Those costs were compared to bid tabs for pump stations similar to those proposed and a cost curve was developed. Estimated pump station costs are provided in Table 5-6.

Table 5-6
Pump Station Costs

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
Pump Stations	$3,250,000	$2,164,000	$96,000
Minor Items			
Unlisted Items @ 20%	$650,000	$432,800	$19,200
Contract Add-ons @ 17.5%	$682,500	$454,440	$20,160
Contingency @ 20%	$916,500	$610,248	$27,072
Field Cost (rounded)	$5,499,000	$3,662,000	$163,000
Non-contract Costs @ 29.5% -31%	$1,622,205	$1,080,290	$50,530
Project Cost (rounded)	$7,121,000	$4,742,000	$214,000

5.6. Storage Tanks

The cost of storage tanks has also been estimated using budgetary quotes from suppliers and bid tabs for similar tanks. Two Albuquerque tank manufacturers provided quotes for tanks between 100,000 gallons and 1,000,000. A cost curve was prepared from the average of the two and used to calculate the cost of the tanks used in each system. The one exception is the elevation tank for the Flea Market in the Pueblo Only System. The cost of that tank was developed from the bid tabs and estimating guides. The cost of foundations has also been estimated.

An unlisted factor of 15% has been used to account for items not include in the quote. Foundation systems were specified for each tank and their cost estimated.

Table 5-7 shows the derivation of the project cost estimate for storage tanks.

Table 5-7
Storage Tank Costs

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
Storage Tanks	$3,947,000	$3,056,000	$211,000
Minor Items			
Unlisted Items @ 15%	$592,050	$458,400	$31,650
Contract Add-ons @ 17.5%	$794,334	$615,020	$42,464
Contingency @ 20%	$1,066,677	$825,884	$57,023
Field Cost (rounded)	$6,401,000	$4,956,000	$343,000
Non-contract Costs @ 29.5-31%	$1,888,295	$1,462,020	$106,330
Project Cost (rounded)	$8,289,000	$6,418,000	$449,000

5.7. *Hybrid Wells*

The cost of the hybrid wells includes the cost of exploratory test drilling and drilling and completion a dual completion well. The costs for the wells were developed by JSAI and are more fully explained in their letter report. That materials does not include a cost for the deeper wells. JSAI subsequently provided a cost for drilling the deeper wells on the order of $3,000,000. Cost curves were then developed from the JSAI information and the cost of developing each well field was then calculated from the cost curve. A 10% factor for unlisted items has been used to allow for the installation of ancillary items.

Table 5-8 shows the derivation of the project cost estimate for the hybrid wells capable of providing 50% of average day demands. No separate hybrid wells are planned for the Bishop's Lodge Extension.

Table 5-8
Hybrid Well Costs

Cost Factor	Combined	Pueblo Only
Hybrid Wells	$4,612,000	$2,883,000
Minor Items		
Pipelines	$507,026	$362,336
Building and Treatment	$529,500	$529,500
On-site Electrical	$200,000	$200,000
Subtotal (rounded)	$1,237,000	$1,092,000
Unlisted Items @ 10%	$461,200	$288,250
Contract Add-ons @ 17.5%	$1,104,285	$745,981
Contingency @ 20%	$2,900,002	$2,015,013
Field Cost (rounded)	$10,315,000	$7,024,000
Non-contract Costs @ 29.5%-31%	$3,068,713	$2,089,640
Project Cost (rounded)	$13,384,000	$9,114,000

5.8. *Service Connections*

The cost of service connections has been estimated by identifying all the component parts in a service connection and then estimating the number of connections that would be made as a project cost. The cost of each service connection is estimated at $4,000 and a factor for unlisted items is not used. The number of service connections has been estimated based on the anticipated connections to be made during the construction period. Commercial connections are not a project cost and would be paid for by the customer. Indian connections made after the construction phase should be completed programmatically through the IHS P.L. 86-121 process which authorizes the construction of sanitation facilities. The project cost estimate for service connections is shown in Table 5-9.

Table 5-9
Service Connection Costs

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
Service Connections	$11,806,000	$5,716,000	$851,000
Minor Items			
Unlisted Items @ 0%	$0	$0	$0
Contract Add-ons @ 17.5%	$2,066,050	$1,000,300	$148,925
Contingency @ 20%	$2,774,410	$1,343,260	$199,985
Field Cost (rounded)	$16,647,000	$8,060,000	$1,200,000
Non-contract Costs @ 29.5% -31%	$4,924,183	$2,384,148	$372,000
Project Cost (rounded)	$21,571,000	$10,444,000	$1,572,000
Post Construction Local Cost	$14,025,000		$2,378,000

The cost of the post construction County service connections for the balance of the County water has been estimated at $4,000 per connection plus 20% for contract add-ons and oversight.

5.9. Pressure Reducing and Control Valves

The cost of the pressure reducing valve and control valves and their associated vaults were estimated based on bid tabs for similar work. A factor of 20% has been used for unlisted items. The derivation of the project cost estimate for control valves is shown in Table 5-10.

Table 5-10
Pressure Reducing and Control Valves

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
Valves	$530,000	$480,000	$100,000
Minor Items			
Unlisted Items @ 20%	$106,000	$96,000	$20,000
Contract Add-ons @ 17.5%	$111,300	$100,800	$21,000
Contingency @ 20%	$149,460	$135,360	$28,200
Field Cost (rounded)	$897,000	$813,000	$170,000
Non-contract Costs @ 29.5%-31%	$265,333	$240,485	$52,700
Project Cost (rounded)	$1,162,000	$1,053,000	$223,000

5.10. SCADA System

The cost of the SCADA system for the systems has been estimated by identifying the major components and applying a cost to each component. The costs of the components are based on experience with similar projects. A factor of 15% has been used for unlisted items.

Table 5-11
SCADA System Costs

Cost Factor	Combined	Pueblo Only	Bishop's Lodge Ext.
SCADA System	$617,000	$561,000	$39,000
Minor Items			
Unlisted Items @ 15%	$92,550	$84,150	$5,850
Contract Add-ons @ 17.5%	$124,171	$112,901	$7,849
Contingency @ 20%	$166,744	$151,610	$10,540
Field Cost (rounded)	$1,001,000	$910,000	$64,000
Non-contract Costs @ 29.5%	$295,295	$268,450	$18,880
Project Cost (rounded)	$1,296,000	$1,178,000	$83,000

5.11. Pojoaque River Barrier Dam

The cost estimate for the Pojoaque River Barrier Dam is based on the preliminary plan for the facility. Unit costs were applied to the major construction components and the number of units estimated from the preliminary drawings. A factor of 20% has been used for both the contingency and unlisted items. The 17.5% multiplier for contract add-ons has also been applied. A lower rate of 20% for non-contract costs has been used because the project is not as complex as the pressurized water systems.

Table 5-12
Pojoaque River Barrier Dam Cost Estimate

Item Description	Quantity		Unit Price	Total Cost
Gabion Baskets and Rockfill	370	CY	$200.00	$74,000.00
Excavation	320	CY	$20.00	$6,400.00
Concrete Cover	65	CY	$800.00	$52,000.00
Steel Sheet Piling and Installation	1	LS	$120,000.00	$120,000.00
Riprap	200	CY	$55.00	$11,000.00
Cofferdam/Water Control	1	LS	$50,000.00	$50,000.00
Unlisted Items/Contingencies (20%)				$62,680.00
Contract Add-ons @ 17.5%				$65,814.00
Non-Contract Costs @ 20%				$88,378.80
Project Cost				$530,272.80

5.12. Rio Tesuque Channel Modifications

The Rio Tesuque Channel Modifications are simple to construct and do not require the same level of contingencies and non-contract support as other Regional Water System features. Lower amounts are used for unlisted items, contingencies and non-contract costs. The estimated cost is presented below.

Table 5-13
Rio Tesuque Channel Modification Cost Estimate

Item Description	Quantity		Unit Price	Total Cost
Excavation	2,000	CY	$15.00	$30,000.00
Riprap	100	CY	$55.00	$5,500.00
Unlisted Items/Contingencies (10%)				$3,550.00
Contract Add-ons @ 17.5%				$6,800.00
Non-Contract Costs @ 10%				$4,585.00
Project Cost				$50,435.00

6. Operation, Maintenance and Replacement

All water systems require operation and maintenance (O&M) in order to deliver a reliable supply of water. Even though the facilities proposed for the Regional Water System would involve a high level of automation through the SCADA system, human effort and adequate funding are still essential for the successful operation and maintenance of the RWS. Water system components do not last forever and require replacement at some point in the future.

Developing an appropriate OM&R model must take several factors into consideration. Some of these factors are engineering related while others are not. The ownership of the system may be the single most important consideration. The Aamodt Settlement and this Engineering Report place the ownership of Common Facilities in a Regional Water Authority. The Regional Water Authority would own, operate, maintain and be responsible for replacement of the following system components which are referred to as Common Facilities: surface water diversion and raw water pump station, water treatment plant, transmission pipelines and appurtenant items (e.g., valves, etc.), pump stations, storage tanks, control valves, hybrid wells and the supervisory control and data acquisition (SCADA) system.

For purposes of this analysis, it is assumed that each Pueblo would own the Distribution System within its respective Pueblo boundary and Santa Fe County would own the Distribution System facilities in the remaining areas but that the OM&R for the Distribution Systems would be performed by one consolidated organization.

A model Regional Water Authority organizational model with consolidated OM&R is described below and a model annual budget is presented in Table 6-1.

The Regional Water Authority (RWA) would incur both fixed and variable costs in the operation and maintenance of the Common Facilities. For the purpose of this analysis, fixed costs are those that do not vary proportionately with the volume of water produced. This category of cost includes items such as personnel and support services. Variable costs vary directly with the amount of water produced and include costs for electricity for pumping and water treatment chemicals.

For this analysis, it is also assumed that one consolidated organization will be responsible for the OM&R of the Distribution Systems. However, this approach is for cost estimating purposes and any of the five governments comprising the RWA would have the option to not participate in the consolidated organization and operate and maintain their respective Distribution System.

It should be noted that unlike the Common Facilities, there are no variable costs associated with the Distribution Systems. The power costs shown in Table 6-1 are for lighting and other electrical uses. All project pumping and water treatment costs, the only costs that vary directly with the amount of water produced, are charged to the Common Facilities.

Table 6-1 provides an example budget for the RWA that divides the costs into the two major headings of Common Facilities and Distribution Systems. The fixed costs presented in Table 6-1 are for the system at or near the completion of construction at the end of year 2017. The variable costs are estimated for when full demands are provided. It should be noted that in the fifty-year life cycle cost analysis presented later in this section both types of costs are “ramped up” over time and as demand increases.

The budgeting elements for the Common Facilities are described first and then followed by a similar description for the Distribution Systems. The costs depicted in Table 6-1 break out the costs associated with the Common Facilities and the Distribution Systems which are not overlapping or duplicative costs. The costs are broken out as shown in Table 6-1 for purposes of allowing an analysis of total estimated O&M costs for the Combined System and estimating costs until full demands are met. Table 6-1 also shows the allocation of the costs to the Pueblo Only System.

While it is envisioned that a board of directors would provide general guidance and direction, a manager or director would be responsible for day-to-day operation of the system. A clerk would provide assistance.

Two certified water treatment operators would be employed to operate the water treatment plant. The operators could either be certified under the state of New Mexico's operator certification program or possibly through the EPA's guidance for certification of operators in Indian Country. The operators would alternate weekends off and share on-call responsibilities. At least one certified treatment operator would be available at any time should the need arise and the SCADA system's auto dialer calls out a critical alarm.

Two people would be employed by the RWA for the O&M of the intake (including raw water pump station) and raw water line. Three additional people would be required for O&M of the remaining RWS shared facilities. These individuals should be certified water Distribution System operators. Two operators would be responsible for O&M activities associated with the transmission pipeline, pump stations and water storage tanks. One operator would be required for O&M of the hybrid wells. This operator and the operators for the transmission system and raw water facilities would be cross-trained.

The RWA would require both heavy and light equipment. Heavy equipment would include an excavator, dump truck and trailer, a skid-steer loader and a vacuum truck. Light equipment would include a car and two ¾-ton pick-up trucks. Shop tools and supplies would also be needed. The cost of equipment and a shop totals $885,500 for the Regional Water Authority and is included in the project cost. The useful lives and replacement costs for the equipment are provided in Table 6-2.

The cost model for the Distribution System OM&R organization is similar to the one described above. Four distribution operators would be employed to operate and maintain Distribution System pipelines and valves. Two meter readers and clerk would be required to read water service meters, bill customers and process water samples. Fringe costs are calculated similar as for the Common Facilities staff.

Table 6-1
Annual Consolidated OM&R Budget

Line Item	Common Facilities	Distribution System	Combined System Total	Pueblo Only System
Personnel and Indirect Costs				
Director	$70,000		$70,000	$43,750
Treatment Plant Operators (2)	$110,000		$110,000	$68,750
Other Operators (5)	$225,000		$225,000	$140,625
Distribution Operators (4)		$192,000	$192,000	$153,600
Meter Readers and Other Duties (2)		$80,000	$80,000	$64,000
Clerk & Clerk/Bookkeeper	$37,000	$40,000	$77,000	$55,125
Transition Staff (4)/[1]		$200,000	$200,000	$200,000
Salary Subtotal	$442,000	$512,000	$954,000	$725,850
Fringe @ 24%	$106,080	$122,880	$228,960	$174,204
Personnel and Fringe Costs Subtotal	$548,080	$634,880	$1,182,960	$900,054
Type I Fixed Costs - Support				
Building Insurance	$12,000	$1,000	$13,000	$8,300
Protective/Emergency Equipment	$1,000	$4,000	$5,000	$3,825
Office Supplies/Furnishings	$1,200	$1,200	$2,400	$1,710
Vehicle License and Insurance	$7,500	$12,000	$19,500	$14,288
Fuel	$12,000	$16,000	$28,000	$20,300
Vehicle Maintenance	$2,500	$20,000	$22,500	$17,563
Heavy Equipment Maintenance	$7,500	$14,000	$21,500	$15,888
Shop Tools and Equipment	$1,000	$2,000	$3,000	$2,225
Equipment Rental	$2,000	$5,000	$7,000	$5,250
Facilities Maintenance	$3,000	$1,000	$4,000	$2,675
Mail/Postage/Phone/Communications	$3,600	$25,000	$28,600	$22,250
Travel and Training	$5,000	$8,000	$13,000	$9,525
Meetings and Conference Costs	$1,500	$2,500	$4,000	$2,938
Reference Materials/Subscriptions	$1,000	$1,200	$2,200	$1,585
Sampling	$6,000	$8,000	$14,000	$10,150
Materials	$20,000	$50,000	$70,000	$52,500
Contracted Services	$50,000	$30,000	$80,000	$55,250
Subtotal	$136,800	$200,900	$337,700	$246,220
Type II Variable Costs - Direct				
Water Treatment Chemicals	$63,000		$63,000	$39,375
Power/[2]	$690,383	$14,000	$704,383	$442,689
Subtotal	$753,383	$14,000	$767,383	$482,064
Total Annual Budget	$1,438,263	$849,780	$2,288,043	$1,628,338

Notes: [1]/Transition costs for first 10 years only. [2]/ Common Facilities power costs includes pumping, lighting and other electrical uses. Distribution power does not include any pumping.

Fixed costs are similar to those for the Common Facilities and light and heavy equipment would also be required for Distribution System O&M. Fixed costs are shown in Table 6-1 and a list of equipment and estimated costs are presented in Table 6-2.

6.1. Fifty-year Analysis of Operation, Maintenance and Replacement Costs

A cost analysis of OM&R costs through year 2062 has been prepared for the Regional Water System. The fifty-year period is used because it is equivalent to the 50-year life of project used for projecting construction costs and sufficiently long enough for full demands to be reached and a normal annual operating program to be analyzed for several years. The analysis estimates the total cost (in 2006 dollars) to operate and maintain the Regional Water System and replace key components at scheduled intervals. Because a Pueblo Only system is not a viable alternative, all costs are estimated for the Combined System. A discussion then follows regarding allocation of costs to the Pueblo Only system and one method to parse out the federal share of those OM&R costs for the Pueblos. The assumptions required for such an analysis are described in the following sections.

6.1.1. System Demands

For this analysis system demands are projected to increase over time consistent with the demand schedule presented in Table 2-3 and the timeline for settlement compliance presented in Table 4-1. The respective "initial demands" shown in Table 2-3 are assumed to be realized as the projects shown in Table 4-1 are completed and the respective service areas brought on-line. Based on this schedule, approximately 59% of the 4000 AFY would be delivered in 2018 the first full year that all Distribution Systems are in full service.

In the analysis, the post construction demands shown in Table 2-3 would be increased incrementally over the 25 years following completion of construction (i.e., 1/25th of the remainder [i.e., 41% of 4000 AFY] would be added each successive year). Based on this approach, the first year for delivery of 100% of demands would be 2042.

The annual costs for power and water treatment chemicals (variable costs) have been "ramped up" based on the demand scenario described above. Power is assumed to cost $0.0085 per kilowatt-hour but a demand charge is not assessed.

The fixed costs, associated with both the RWA and consolidated distribution organization, have been "ramped up" based on the construction schedule. RWA fixed costs start at 60% of the annual budget in 2012 and are increased each year thereafter by 10% of the total fixed costs until full costs are reached in 2016. Distribution System costs start at 35% of the total in 2012 and are increased each year thereafter by 15% of the total annual budget until full costs are reached in year 2017.

6.1.2. Transition Costs

The Regional Water System will be considerably different than the existing systems for the individual Pueblos. In transitioning from the current systems to the new system with consolidated management and operation, the Pueblos will incur some additional costs. These costs are associated with addressing both practical and cultural concerns at each of the Pueblos which could involve time from leadership, existing management, facility operators or cultural committees at the Pueblos to help educate the new RWA employees. Some public involvement activities and visits with individual customers may also be required during the transition period. It is reasonable to assume the transition costs will be incurred during construction and the first few years of operations. For this analysis, such costs are assumed for ten years from the start of construction period in 2012 at $50,000 for each Pueblo per year plus fringe.

6.1.3. Inflation and Interest

All costs in the life cycle analysis are presented in 2006 dollars (as are construction costs). The calculation of future and present values is dependent on inflation and interest rates. The life cycle analysis uses an inflation factor of 4.75% (to calculate future values) and an interest or discount rate of 5.125% (to calculate present values) which was the Water Resource Development Act discount rate for fiscal year 2006. The 4.75% factor for inflation is representative of recent trends in cost increases in the construction and water service industries.

6.1.4. Cost Allocation between the Combined System and the Pueblo Only System

As mentioned earlier, a Pueblo Only system is not a viable alternative and OM&R costs for such a system have not been analyzed. Therefore, the costs of the viable alternative (i.e., the Regional Water System) must be allocated between the Pueblos and County to determine the OM&R costs associated with water deliveries to the Pueblos. For purposes of this analysis, the OM&R costs for the Common Facilities (or "backbone facilities") have been allocated based on the respective capacity in the facilities. The Pueblos are allocated 2500 AFY of 4000 AFY or 62.5% of the system capacity and the County is allocated 1500 AFY of 4000 AFY or 37.5% of the system capacity. OM&R costs for the common faculties are allocated at the same percentages.

In this analysis, the OM&R costs for the Distribution Systems have been allocated based on the number of entities involved. The Pueblos make up four of the five governments comprising the RWA and have therefore been allocated 80% of the Distribution System costs. The remaining 20% of Distribution System OM&R costs are allocated to Santa Fe County.

6.1.5. Hybrid Wells

A detailed plan for the operation of the hybrid wells has not been developed. However as part of prudent conjunctive management to ensure a firm and reliable source of supply, it is planned to initiate the aquifer storage component of the aquifer storage and recovery (ASR) program early in the life of the project. For the cost analysis, it is assumed that 3,000 AFY of water will be stored in the aquifer between 2018 (first year after completion of construction) and 2042 (when full demands are delivered). The cost of storing the water has been estimated by multiplying the variable cost rate (dollars per thousand gallons for pumping and treatment chemicals) to the volume of water stored. It is assumed there are no additional fixed costs associated with storing the water. The cost for this storage is shown separately in Table 6-3.

In regard to the recovery component of the ASR program the hybrid wells are planned to deliver up to 50% of the average day demand. For the cost analysis it is assumed that one hybrid well will pump for 120 days out of the year beginning in year 2018. In regard to the variable costs, only those cost associated with pumping the water are included in the analysis. The variable costs associated with water treatment plant chemicals are not applicable because the well water would enter the system from the water storage tank closest to the well. The replacement costs associated with the hybrid wells are discussed in the following section.

6.1.6. Replacement Costs

Replacement costs have been estimated based on a portion of the system components original cost and a specified replacement interval. Table 6-2 shows the replacement items, cost and replacement interval. It should be noted that the useful lives of system pipelines are assumed to be greater than fifty years and therefore costs for the replacement of pipelines are not included in the analysis.

Table 6- 2
Replacement Items, Cost Basis and Replacement Interval

Component	Base Construction Cost	Unlisted Items or Replacement Factor		Mobilization, Taxes, Bonds, Insurance, TERO Fee	Contingency	Non-Contract Costs	Total Cost/Or Replacement Cost	Replacement Costs	
		%	Cost	17.5%	20.0%	31.0%		Useful Life (yrs)	# of Replace-ments Required
Intake & Raw Water Pump Station									
Site Work & Structures	$772,340	15%	$115,851	$155,433	$208,725	$388,228	$1,640,578	50	0
Pumps, Equipment & Electrical	$397,025	15%	$59,554	$79,901	$107,296	$199,571	$843,347	20	2
Subtotal	**$1,169,365**	**---**	**$175,405**	**$235,335**	**$316,021**	**$587,799**	**$2,483,924**	---	---
Water Treatment Plant									
Site Work & Structures	$3,356,050		$0	$587,309	$788,672	$1,466,929	$6,198,960	50	0
Pretreatment Pumps & Equipment	$482,500		$0	$84,438	$113,388	$210,901	$891,226	20	2
Membrane Treatment	$3,915,000		$0	$685,125	$920,025	$1,711,247	$7,231,397	20	2
Disinfection Equipment	$574,200		$0	$100,485	$134,937	$250,983	$1,060,605	25	1
Backwash Pumps & Equipment	$100,050		$0	$17,509	$23,512	$43,732	$184,802	20	2
Sediment Sludge Removal	$507,500		$0	$88,813	$119,263	$221,828	$937,403	20	2
Process & Yard Piping	$1,878,825		$0	$328,794	$441,524	$821,234	$3,470,378	50	0
Electrical and Controls	$399,750		$0	$69,956	$93,941	$174,731	$738,378	25	1
Subtotal	**$11,213,875**	**---**	**$0**	**$1,962,428**	**$2,635,261**	**$4,901,585**	**$20,713,149**	---	---
Transmission System									
Pump Stations	$3,250,000	40%					$1,300,000	15	3
Pipelines	$27,597,000	0%					$0	50	0
Control Valves	$530,000	20%					$106,000	15	3
Reservoirs	$3,947,000	30%					$1,184,100	25	1
Hybrid Wells	$4,612,000	30%					$1,383,600	15	3
Minor Pipeline Items	$11,975,750	50%					$5,987,875	25	1
Subtotal	**$51,911,750**	**---**	**$0**	**$0**	**$0**	**$0**	**$9,961,575**	---	---

Table 6-2 Replacement Items, Cost Basis and Replacement Interval Continued

Other Items									
Storage Building and Shop	$250,000	110%					$275,000	25	1
Excavator	$175,000	110%					$192,500	10	4
Dump Truck	$100,000	110%					$110,000	10	4
Trailer	$40,000	110%					$44,000	25	1
Vacuum Truck	$125,000	110%					$137,500	10	4
Skid-Steer Loader	$35,000	110%					$38,500	10	4
Car	$20,000	110%					$22,000	7	7
Service Trucks (2 @ $50,000)	100,000	110%					$110,000	7	7
Subtotal	**$845,000**	**---**	**$0**	**$0**	**$0**	**$0**	**$929,500**	---	---
Distribution System									
Building and Shop	$120,000	110%					$132,000	25	1
Backhoe	$75,000	110%					$82,500	10	4
Car	$20,000	110%					$22,000	7	7
Pickup (4 @ $30,000)	$120,000	110%					$132,000	7	7
Service Connection Meters	$791,000	100%					$791,000	20	2
Isolation Valves and Hydrants	$7,177,000	100%					$7,177,000	25	1
Subtotal	$8,303,000	**---**	$0	$0	$0	$0	$8,336,500	---	---
Total	**$73,442,990**	**---**	**$175,405**	**$2,197,763**	**$2,951,282**	**$5,489,384**	**$42,424,648**	**---**	---

6.1.7. OM&R Cost Analysis Summary

Using the assumptions described above, the analysis provides an estimate of the total cost (in 2006 dollars) to operate, maintain and replace the system through year 2062. The analysis also provides information on variable, fixed and replacement costs during the course of the fifty years. Table 6-3 presents the summary results of the OM&R cost analysis. Table 6-3 also shows the estimated project costs or construction costs which when added to the OM&R costs estimate becomes a life cycle cost estimate.

Table 6-3
Summary of OM&R Costs and Total 50-Year Life Cycle Costs

Item -------- System	Combined System	Pueblo Only
Operation and Maintenance Costs		
RWA Variable Costs	$30,574,000	$19,109,000
RWA Fixed Costs	$28,443,000	$17,777,000
Distribution Fixed Costs	$26,191,000	$20,953,000
Transition Costs		$2,623,000
Hybrid Well Aquifer Storage	$13,187,000	$8,242,000
Subtotal O&M	$98,395,000	$68,704,000
Replacement Costs		
Common Facilities	$29,862,000	$18,664,000
Distribution Systems	$9,106,000	$7,285,000
Subtotal Replacement	$38,968,000	$25,949,000
Total OM&R		
Total OM&R	$137,363,000	$94,653,000
Construction Related Costs		
Project Cost/[1]	$157,181,000	$106,384,000
50-year Life Cycle Cost		
Total	$294,544,000	$201,037,000
[1]/ Includes Hybrid Wells at 50% and does not include Bishop's Lodge Extension		

It may also be useful to examine how some of the cost components change over time and what the cost of various items per 1,000 gallons of water is. That material is presented in Appendix Table 1.

6.2. *Federal Share of Pueblo OM&R Costs*

Information from the OM&R cost analysis can be used to calculate one approach to the appropriate federal share of the OM&R costs. Many assumptions can be made and approaches taken to determine the appropriate level of federal funding for federal contribution for OM&R. Based on input from the interested parties and for purposes of this analysis the following assumptions are used:

1) the transition costs for assisting the Pueblos in transitioning from their current separate systems to the new consolidated operations of the RWA are a federal responsibility;
2) after completion of construction, the United States is responsible for payment of costs associated with unused capacity in the Pueblo Only component of the system
3) the United States is responsible for replacement costs during construction and until full demands are delivered;
4) the United States is responsible for the Pueblo's share of aquifer storage costs; and
5) the United States is responsible for O&M costs during construction;

The federal share of the OM&R costs for the Pueblo Only system have been estimated based on the OM&R cost analysis, and the assumptions stated above, total $37,608,000 for items one through four and $5,238,000 for item 5. An itemization is provided in Table 6-4. Detailed data for O&M costs during construction, costs associated with unused capacity in the Pueblo Only component of the system, and the Pueblo share of the replacement costs during construction and until full demands are delivered are set forth fully in Appendix Table 1. Table 6-3 describes the aquifer storage costs and the transition costs assigned to the federal share in this estimate.

Table 6-4 Federal Share of Pueblo Only System OM&R Costs

Transition Staff	$2,623,000
Excess Capacity Costs Prior to Full Demands	$5,640,000
Replacement Cost Until Full Demands Delivered	$21,103,000
Hybrid Well Aquifer Storage	$8,242,000
Total	$37,608,000
Estimated O&M Costs During Construction	$5,238,000

7. Conclusions

This Engineering Report used previously developed and new information in conjunction with relevant standards and professional experience to analyze the Regional Water System component of the Aamodt Settlement.

At October 2006 cost levels, a Regional Water System capable of providing a reliable firm supply of 4000 AFY to the Pueblos and County could be constructed for about $157,200,000. The cost of constructing the Pueblo Only system was estimated to serve as the basis for the federal share of the capital cost of the Regional Water System. That cost is estimated to be about $106,400,000 ($October 2006).

The cost estimates include unlisted items and a 20% contingency for unanticipated conditions. The contingency does not address the affect of inflation on future project costs. An indexing factor would need to be applied to adjust the October 2006 to future conditions.

This Report provides an estimate of the probable cost of building the water system that is envisioned in the Settlement Agreement as of October, 2006. It is not a final design and should not be used for such. Nevertheless, the procedures that were used provide a reliable estimate because of the inclusion of contingencies and other factors to ensure that the project can be constructed at the estimated cost. The estimate does not account for unforeseeable changes in circumstances. It also depends on effective and efficient construction management and the timely provision of funding to allow construction to proceed on the schedule included in the estimate.

The operation, maintenance and replacement costs associated with the operation of the Regional Water System are more difficult to estimate for because of the various assumptions that must be made regarding future conditions. Based on the assumptions used, the total OM&R cost for the system over the 50-year life cycle analysis would be $137,363,000 for a Combined System and $94,653,000for a Pueblo Only System. The federal share of that amount is estimated to be about $5,238,000 for O&M during construction and about $37,608,000 for other aspects of OM&R until full demands and capacity are realized.

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9 Appendix

- Table 1 OM&R Costs by Year.

Cost Item----------Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Percent of Demands	7.37%	34.09%	46.10%	52.14%	52.79%	56.22%	58.99%	60.70%	62.40%	64.11%	65.82%	67.53%	69.24%	70.95%	72.66%	74.37%	76.08%	77.78%
Annual Gallons (k~1,000s)	96,045	444,245	600,746	679,518	688,009	732,709	768,725	790,995	813,266	835,537	857,808	880,079	902,350	924,621	946,891	969,162	991,433	1,013,704
Variable Costs																		
Electrical Power	$20,628	$129,368	$216,500	$244,015	$263,942	$290,804	$445,287	$452,671	$459,997	$467,265	$474,475	$481,628	$488,724	$495,763	$502,746	$509,672	$516,543	$523,358
Chemicals	$4,544	$20,945	$28,223	$31,809	$32,092	$34,055	$35,601	$36,502	$37,396	$38,283	$39,163	$40,037	$40,903	$41,764	$42,617	$43,464	$44,304	$45,137
Total Variable Costs	$25,172	$150,313	$244,722	$275,824	$296,034	$324,859	$480,888	$489,173	$497,393	$505,548	$513,639	$521,665	$529,627	$537,526	$545,362	$553,136	$560,846	$568,495
Fixed Costs																		
RWA/2	$401,330	$466,548	$531,296	$595,576	$659,390	$657,038	$654,694	$652,359	$650,032	$647,713	$645,402	$643,100	$640,806	$638,520	$636,243	$633,973	$631,711	$629,458
Distribution/3	$147,254	$234,765	$321,651	$407,913	$493,557	$578,583	$576,520	$574,463	$572,414	$570,372	$568,337	$566,310	$564,290	$562,277	$560,271	$558,272	$556,281	$554,297
Transition Staff/4	$242,739	$241,873	$241,010	$240,151	$239,294	$238,440	$237,590	$236,742	$235,898	$235,056	$234,218							
Total Fixed	$548,584	$701,313	$852,947	$1,003,489	$1,152,947	$1,235,621	$1,231,214	$1,226,822	$1,222,446	$1,218,085	$1,213,740	$1,209,410	$1,205,096	$1,200,797	$1,196,514	$1,192,245	$1,187,993	$1,183,755
Aquifer Storage/1							$611,523	$604,544	$597,869	$591,474	$585,338	$579,441	$573,766	$568,297	$563,020	$557,923	$552,993	$548,220
Cost Per 1,000 Gallons																		
$/kgal Power	$0.21	$0.29	$0.36	$0.36	$0.38	$0.40	$0.58	$0.57	$0.57	$0.56	$0.55	$0.55	$0.54	$0.54	$0.53	$0.53	$0.52	$0.52
$/kgal Total Variable	$0.26	$0.34	$0.41	$0.41	$0.43	$0.44	$0.63	$0.62	$0.61	$0.61	$0.60	$0.59	$0.59	$0.58	$0.58	$0.57	$0.57	$0.56
$/kgal Fixed	$5.71	$1.58	$1.42	$1.48	$1.68	$1.69	$1.60	$1.55	$1.50	$1.46	$1.41	$1.37	$1.34	$1.30	$1.26	$1.23	$1.20	$1.17
Total O&M$/kgal	$5.97	$1.92	$1.83	$1.88	$2.11	$2.13	$2.23	$2.17	$2.11	$2.06	$2.01	$1.97	$1.92	$1.88	$1.84	$1.80	$1.76	$1.73

Pueblo Cost Summary	Construction Period						Transition to Full Demands											
Summary by Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Pueblo Deliveries (kgal)	84,075	324,150	449,341	528,114	535,923	549,505	559,906	570,307	580,708	591,109	601,511	611,912	622,313	632,714	643,115	653,517	663,918	674,319
Total Pueblo Delivery Cost	$502,247	$621,401	$821,026	$994,267	$1,128,681	$1,170,304	$1,247,021	$1,237,231	$1,228,041	$1,219,402	$1,211,269	$1,203,603	$1,196,366	$1,189,528	$1,183,058	$1,176,929	$1,171,118	$1,165,602
Federal Share	$502,247	$621,401	$821,026	$994,267	$1,128,681	$1,170,304	$476,927	$452,830	$429,335	$406,390	$383,951	$361,979	$340,437	$319,292	$298,516	$278,082	$257,965	$238,143
			Subtotal - Federal Share During Construction			$5,237,926												

Notes on above:

1/ Aquifer storage a costs are based on the assumption that 3,000 AFY would be injected through the hybrid wells prior to full demands being reached in 2042. Injection would start in 2018 and end in 2041. Costs are calculated by multiplying the total v

2/ RWA fixed costs start at 60% in first year and increase by 10% a year untill 100% of fixed costs are incurred in 2016 and thereafter.

3/ Distribtuion system fixed costs start at 25% and increase by 15% until 100% of fixed costs are incurred in 2017 and thereafter.

4/ Transition costs are estimated at $50,000 plus fringe @24% per year for each Pueblo.

Replacement Costs Through Delivery of Full Demands										
Frequency	7 years	10 years	14 years	15 years	20 years	21 years	25 years	28 years	30 years	
Starting Year 2012	2019	2022	2026	2027	2032	2033	2037	2040	2042	Total
RWA	$126,008	$451,908	$120,288	$2,587,917	$8,851,358	$114,828	$8,315,770	$109,615	$2,803,892	$23,481,585
Distribution	$147,009	$77,915	$140,336		$794,402	$133,966	$6,542,544	$127,884	$69,496	$8,033,553

Summary	
RWA	$23,481,585
Distribution	$8,033,553
Federal Share	
RWA @ 62.5%	$14,675,991
Distribution @ 80%	$6,426,843
Total	$21,102,833

Appendix - Table 1 OM&R Costs by Year.

Cost Item----------Year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Percent of Demands	79.49%	81.20%	82.91%	84.62%	86.33%	88.04%	89.75%	91.46%	93.16%	94.87%	96.58%	98.29%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Annual Gallons (k~1,000s)	1,035,975	1,058,246	1,080,517	1,102,787	1,125,058	1,147,329	1,169,600	1,191,871	1,214,142	1,236,413	1,258,683	1,280,954	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225
Variable Costs																			
Electrical Power	$530,118	$536,823	$543,473	$550,069	$556,612	$563,100	$569,535	$575,917	$582,247	$588,524	$594,748	$600,921	$607,042	$604,877	$602,719	$600,569	$598,427	$596,292	$594,165
Chemicals	$45,965	$46,785	$47,599	$48,407	$49,209	$50,004	$50,792	$51,575	$52,351	$53,121	$53,885	$54,643	$55,395	$55,197	$55,000	$54,804	$54,609	$54,414	$54,220
Total Variable Costs	$576,082	$583,608	$591,073	$598,477	$605,820	$613,104	$620,328	$627,492	$634,598	$641,645	$648,634	$655,564	$662,437	$660,074	$657,719	$655,373	$653,035	$650,706	$648,385
Fixed Costs																			
RWA/2	$627,213	$624,975	$622,746	$620,524	$618,311	$616,105	$613,908	$611,718	$609,535	$607,361	$605,195	$603,036	$600,885	$598,741	$596,605	$594,477	$592,357	$590,243	$588,138
Distribution/3	$552,319	$550,349	$548,386	$546,430	$544,481	$542,538	$540,603	$538,675	$536,753	$534,838	$532,930	$531,029	$529,135	$527,248	$525,367	$523,493	$521,625	$519,765	$517,910
Transition Staff/4																			
Total Fixed	$1,179,532	$1,175,324	$1,171,132	$1,166,954	$1,162,791	$1,158,644	$1,154,510	$1,150,392	$1,146,288	$1,142,199	$1,138,125	$1,134,065	$1,130,020	$1,125,989	$1,121,972	$1,117,970	$1,113,982	$1,110,008	$1,106,048
Aquifer Storage/1	$543,593	$539,105	$534,747	$530,511	$526,390	$522,378	$518,469	$514,657	$510,938	$507,306	$503,758	$500,288							
Cost Per 1,000 Gallons																			
$/kgal Power	$0.51	$0.51	$0.50	$0.50	$0.49	$0.49	$0.49	$0.48	$0.48	$0.48	$0.47	$0.47	$0.47	$0.46	$0.46	$0.46	$0.46	$0.46	$0.46
$/kgal Total Variable	$0.56	$0.55	$0.55	$0.54	$0.54	$0.53	$0.53	$0.53	$0.52	$0.52	$0.52	$0.51	$0.51	$0.51	$0.50	$0.50	$0.50	$0.50	$0.50
$/kgal Fixed	$1.14	$1.11	$1.08	$1.06	$1.03	$1.01	$0.99	$0.97	$0.94	$0.92	$0.90	$0.89	$0.87	$0.86	$0.86	$0.86	$0.85	$0.85	$0.85
Total O&M$/kgal	$1.69	$1.66	$1.63	$1.60	$1.57	$1.54	$1.52	$1.49	$1.47	$1.44	$1.42	$1.40	$1.38	$1.37	$1.37	$1.36	$1.36	$1.35	$1.35

Pueblo Cost Summary	Transition to Full Demands																		
Summary by Year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Pueblo Deliveries (kgal)	684,720	695,121	705,522	715,924	726,325	736,726	747,127	757,528	767,930	778,331	788,732	799,133	809,534	809,534	809,534	809,534	809,534	809,534	809,534
Total Pueblo Delivery Cost	$1,160,361	$1,155,376	$1,150,630	$1,146,108	$1,141,796	$1,137,679	$1,133,747	$1,129,987	$1,126,389	$1,122,943	$1,119,641	$1,116,474	$1,113,434	$1,109,462	$1,105,505	$1,101,561	$1,097,632	$1,093,716	$1,089,815
Federal Share	$218,596	$199,305	$180,254	$161,426	$142,808	$124,386	$106,147	$88,082	$70,178	$52,427	$34,819	$17,346	$0						
Subtotal - Federal Share of Unused Pueblo Capacity Until Full Demands Reached												$5,639,620							

Appendix - Table 1 OM&R Costs by Year.

Cost Item----------Year	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	Total
Percent of Demands	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
Annual Gallons (k~1,000s)	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	1,303,225	55,205,149
Variable Costs															
Electrical Power	$592,045	$589,933	$587,829	$585,732	$583,643	$581,561	$579,486	$577,419	$575,359	$573,307	$571,262	$569,224	$567,193	$565,170	$26,078,727
Chemicals	$54,026	$53,834	$53,642	$53,450	$53,260	$53,070	$52,880	$52,692	$52,504	$52,316	$52,130	$51,944	$51,759	$51,574	$2,363,895
Total Variable Costs	$646,072	$643,767	$641,471	$639,182	$636,902	$634,630	$632,366	$630,111	$627,863	$625,623	$623,392	$621,168	$618,952	$616,744	$28,442,621
Fixed Costs															
RWA/2	$586,040	$583,949	$581,866	$579,791	$577,723	$575,662	$573,608	$571,562	$569,523	$567,492	$565,467	$563,450	$561,440	$559,437	$30,574,274
Distribution/3	$516,063	$514,222	$512,388	$510,560	$508,739	$506,924	$505,116	$503,314	$501,518	$499,729	$497,947	$496,171	$494,401	$492,637	$26,191,429
Transition Staff/4															$2,623,012
Total Fixed	$1,102,103	$1,098,172	$1,094,254	$1,090,351	$1,086,461	$1,082,586	$1,078,724	$1,074,876	$1,071,042	$1,067,221	$1,063,414	$1,059,621	$1,055,841	$1,052,074	$56,765,703
Aquifer Storage/1															$13,186,548
Cost Per 1,000 Gallons															
$/kgal Power	$0.45	$0.45	$0.45	$0.45	$0.45	$0.45	$0.44	$0.44	$0.44	$0.44	$0.44	$0.44	$0.44	$0.43	
$/kgal Total Variable	$0.50	$0.49	$0.49	$0.49	$0.49	$0.49	$0.49	$0.48	$0.48	$0.48	$0.48	$0.48	$0.47	$0.47	
$/kgal Fixed	$0.85	$0.84	$0.84	$0.84	$0.83	$0.83	$0.83	$0.82	$0.82	$0.82	$0.82	$0.81	$0.81	$0.81	
Total O&M$/kgal	$1.34	$1.34	$1.33	$1.33	$1.32	$1.32	$1.31	$1.31	$1.30	$1.30	$1.29	$1.29	$1.29	$1.28	
Pueblo Cost Summary															
Summary by Year	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	
Pueblo Deliveries (kgal)	809,534	809,534	809,534	809,534	809,534	809,534	809,534	809,534	809,534	809,534	809,534	809,534	809,534	809,534	35,779,798
Total Pueblo Delivery Cost	$1,085,927	$1,082,053	$1,078,193	$1,074,347	$1,070,515	$1,066,696	$1,062,891	$1,059,100	$1,055,322	$1,051,557	$1,047,806	$1,044,068	$1,040,344	$1,036,633	$55,874,800
Federal Share															$10,877,546