RECLAMATION

Managing Water in the West

Design, Estimating, and Construction Review

Pojoaque Basin Regional Water System

Upper-Colorado Region, New Mexico

(Sensitive—for official use only)

U.S. Department of the Interior
Bureau of Reclamation
Technical Resources
Design, Estimating, and Construction Office
Denver, Colorado

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MISSION STATEMENTS

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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

Design, Estimating, and Construction Review
Pojoaque Basin Regional Water System

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Acknowledgements

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I. Introduction

The purpose of this Design, Estimating, and Construction (DEC) Review by Bureau of Reclamation (Reclamation) is to provide an independent technical review to assess whether products related to design, cost estimating, and construction are technically sound and provide a credible basis for decision making. This includes determining if cost estimates for a project are appropriate for their intended purpose, identifying potential fatal flaws in the designs or estimates and determining whether major risk and uncertainties have been fully addressed in the cost estimates.

A request for a DEC review of the Pojoaque Basin Regional Water System was received from Reclamation's Office of Native American and International Affairs September 2009. A Team was formed and adapted the DEC review process to address the unique aspects of infrastructure proposed for inclusion in a pending Indian water rights settlement.

The DEC Review Team (Team) consisted of the following members:

- Robert H. Davis, P.E., Team Leader and Water Conveyance Team Member, Reclamation DEC Office, Denver, Colorado
- Mr. Robert H. Welsh, P.E., Construction Team Member, Consultant, Retired Reclamation, Bend, Oregon
- Craig A. Grush, P.E., Cost Estimates Team Member, Reclamation, Technical Service Center, Denver, Colorado
- Frank B. Leitz P.E., Water Treatment Team Member, Reclamation, Technical Service Center, Denver, Colorado

As the initial step of the DEC review, the following project documents were provided to the Team for review.

- *Pojoaque Regional Water System Engineering Report* (HKM Engineering, September 2008)
- *Aamodt Settlement Study Report* (Aamodt Technical Committee/Aamodt Settlement Negotiation Team, May 2004)

Definitions

Appraisal Investigation means an analysis of water supply problems, needs, and opportunities in the planning area, primarily using existing data. An appraisal investigation includes a preliminary assessment of alternatives to address the identified water supply problems and needs. The purpose of an appraisal investigation is to determine if there is at least one viable alternative that warrants a more detailed investigation through a feasibility study.

Feasibility Study means an analysis of the technical and economic feasibility of the proposed project based on detailed investigation requiring the acquisition of primary data, the impact of the proposed project on the environment in compliance with the National Environmental Policy Act and other applicable environmental laws. A feasibility study provides the basis for making recommendations to Congress about whether a proposed project should be authorized for construction.

Disclaimer

The professional opinions of the independent technical review team expressed in this report are not intended to endorse or express support for the authorization or funding of the proposed project or any associated studies. Also, this report does not commit the Bureau of Reclamation to provide funding or additional technical support to implement the findings or recommendations contained within.

II. Project Background

The information contained in this section is excerpted from the Pojoaque Regional Water System Engineering Report (HKM Engineering, September 2008), Aamodt Settlement Study Report (Aamodt, May 2004).

Background

The Pojoaque Basin Regional Water System or Regional Water System (RWS) has been proposed for inclusion in the settlement of the water rights claims of the Pueblos of Nambe, Pojoaque, San Ildefonso, and Tesuque. This settlement is currently pending before Congress in the Aamodt Litigation Settlement Act.

Study Area

The study area for the RWS is located north of Santa Fe, New Mexico, between Nambe Pueblo to the east, San Ildefonso Pueblo to the west, Pojoaque Pueblo to the north, and Bishop's Lodge to the south (see Figure 1). The study area includes four Pueblos: San Ildefonso, Pojoaque, Nambe, and Tesuque and the communities of El Rancho, Jacona, Nambe Village, Cuyamungue, Tesuque Village, Rio En Medio, Chupadero, Vista Redonda, and Los Caminitos. Also included in the

study area are Rancho Encantado, Bishop's Lodge, and the Santa Fe Opera which are three existing businesses with significant water use and each is a party to the Aamodt Water Rights Case.

Figure 1 - Location Map

Project Details

The RWS would deliver 2500 acre-feet per year (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. Only non-Indian county residents are serviced in the area south of the southern boundary of the Tesuque Indian Reservation in an area referred to as the "Bishop's Lodge Extension". The following major component parts have been integrated into the RWS.

Surface Water Diversion
A surface water diversion including an intake, raw water pump station and pipeline would be located on the east bank of the Rio Grande north of Otowi Bridge. The intake would draw water directly from the river channel through a series of fine screens near the channel bank. A pump station would be required at the intake site to lift raw water to the nearby treatment plant. The pump station would generally consist of wet well and vertical turbine pumps and also include sand separators.

Water Treatment Plant
The water treatment plant would be located on lands belonging to the San Ildefonso Pueblo on the south side of New Mexico (NM) Highway 502 near the lower entrance to the San Ildefonso Pueblo. Water from the Rio Grande would be diverted for treatment.

Transmission System
Major components of the RWS transmission system include pump stations, storage tanks, and the pipelines connecting the stations and tanks. The transmission mains would 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. The transmission system would also include hybrid wells and pressure reducing and flow control valves.

Supervisory Control and Data Acquisition (SCADA) System
The SCADA system would be used to operate the RWS and would include sensors, programmable logic controllers, remote telemetry units, and a master control center. The central control facility would be located in the office at the water treatment plant.

Distribution Systems
The distribution systems would consist of a network of 6-inch through 12-inch diameter pipelines, pressure relief valves (PRVs), service connections and appurtenant items. The vast majority of the pipelines would be 6-inches and 8-inches in diameter but large pipelines would be needed in some areas.

Hybrid Wells
Hybrid wells would be utilized as a supplementary and backup system in times when surface water diversion or treatment is not available. 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.

Pojoaque River Barrier Dam
An existing barrier dam would be extended from the north edge of the existing dam across the Pojoaque River to the north bank.

Rio Tesuque Channel Modifications and Alluvial Recharge
The 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.

III. Findings and Observations

On Friday, November 6, 2009, the Team presented their draft findings and recommendations to Reclamation personnel from the Upper Colorado Regional Office, Albuquerque Area Office, Native American Affairs Office, Senior Advisor, DEC; and other project stakeholders including personnel from the Federal Negotiation Team and representatives from the Pueblos.

Design

The following is a general discussion of the findings of the Team as they relate to the design elements presented.

The design team's efforts should be commended, but it is the finding of the Team that additional effort would be required to generate a complete Feasibility level design for the proposed project. In expressing this key finding, the DEC Team fully appreciates that the implementation of any additional efforts to enhance the level of the existing study would be evaluated in the broader context of Departmental policy and the established settlement negotiation process.

River Intake and Raw Water Pump Station

The Team finds the design and location of the river diversion intake structure may pose risks that could impact the successful completion or viability of the project. It is not clear the structure, as designed, would be fish friendly by providing a way out (bypass) for fish that get through the trashrack. The proposed drum screen

may not be an acceptable device for keeping fish out of the suction line for the raw water pumps or keep them from being impacted on the screen due to the suction.

It was not clear to the Team that the design elevation of the structure, which is proposed to be 1.5 ft below the estimated historical low water elevation, is adequate for the design flow and the low water level could be subject to negative impacts should the river degrade in this reach after construction.

At the time of this review, subsurface information at the intake site was not made available. The Team was unable to evaluate the type of foundation required for the intake structure or if the costs assumed were reasonable. It can therefore be assumed that the design team would also have the same difficulty in designing the foundation.

In order to get to Feasibility level, the Team finds that subsurface explorations should be conducted for the river diversion intake structure and the raw water pump station in order to design the foundations, a shoring system for the excavation of the raw water pump station and to determine groundwater conditions and unwatering/dewatering requirements.

The Team finds that this structure could be brought up to Feasibility level by re-evaluating the type and design of the river diversion intake structure. After consultation with the appropriate fish and wildlife agency, there may be a need for a fish bypass and the type of protective screen that is acceptable to prevent fish from getting into the suction line or impacted on the screen installed. As part of this re-evaluation, the elevations required to assure operation at very low river flows and the stability of the stream bed with respect to aggradations or degradations should be confirmed. The Team feels it would be beneficial to consult with New Mexico Department of Transportation (NMDOT) to see what subsurface conditions they encountered when constructing the Highway 502 Bridge and if they have experienced any scour problems at the center pier.

Environmental and Cultural Resource Studies

Water development projects of this nature would most certainly involve environmental and cultural resource considerations and mitigation (i.e., legislated federal and state environmental and cultural resource considerations). The Team encourages that consideration be given to these requirements and their impacts on the project (both scope and schedule) and costs. Typical studies (such as environmental impact statements and other National Environmental Policy Act (NEPA) compliance studies, Section 106 of the National Historic Preservation Act compliance studies, and Air Quality and Stormwater requirements) required

on projects of this nature can be very time consuming – and as such, should be identified and planned for.

Pipe Line Construction

It is the finding of the Team that the typical pipeline earthwork cross section applied to a pipeline diameter by the design team may not be appropriate for the present level of design. The design team has made the assumption that typical trench section excavation would be an average depth of 4 feet of cover (5 feet at drainage crossings) would be adequate to estimate all pipe excavation for a particular pipe size. The Team has concerns with this assumption.

During the site visit, the Team observed many locations where private adobe fence lines come up to the edge of the narrow winding roadway where the proposed pipeline would be placed. These roadways lack shoulder space to divert traffic to the side while construction efforts are being made to place the pipeline. To place this section of pipeline it may be necessary to close the roadway during construction efforts and place the pipeline utilizing a shield or other such placement techniques that would protect and support the surrounding private property. Set-down space for materials and equipment would be required as the pipeline is constructed through these tight spaces. Items such as care and diversion of traffic and extra haul to and from contractor use areas would greatly increase the cost and lower the production rates assumed.

Additionally, river crossings and areas in sections of high groundwater levels may require dewatering/unwatering efforts to facilitate construction. The pipeline may also require ballast or low strength concrete backfill to protect from floatation or scourer erosion.

The Team has found that protective measures for pipeline sewer crossings were not accounted for in the design or cost estimate.

These items should be identified and considered in the production and cost per foot for the sections of pipeline.

Hybrid or Injection Wells

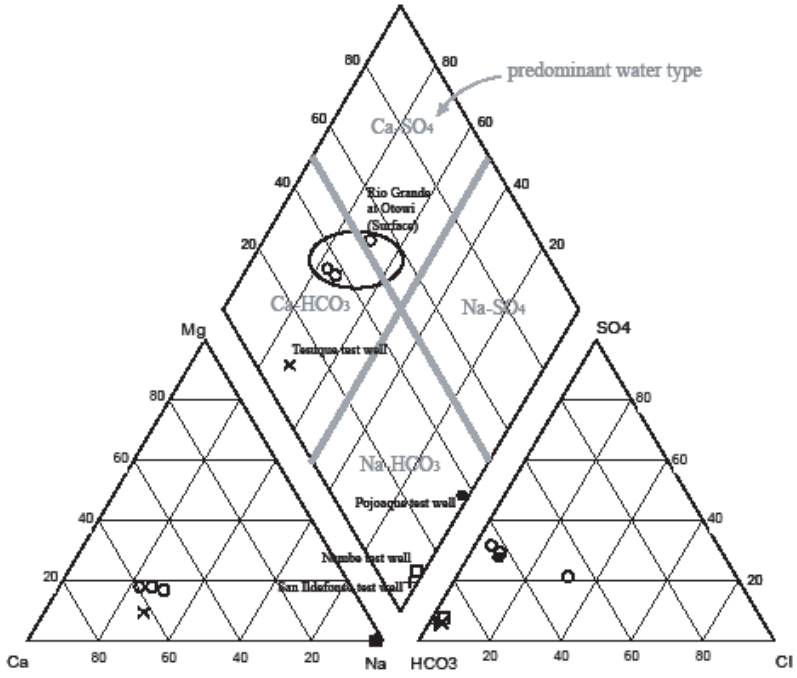
The design team has proposed to utilize hybrid wells to ensure that a redundant supplemental water supply is available. The Team recognizes the need to have a redundant water supply to supplement times when surface water is not available due to high turbidity or other factors that affect intake or water treatment. It is the understanding of the Team that these wells are to be developed as part of an aquifer storage and recovery (ASR) project. In the *Pojoaque Regional Water System Engineering Report*, (HKM Engineering 2008, p.37) the design team has presented the understanding that:

> "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 proposal to inject treated water for recovery at a later date has yet to be determined as a viable solution. The Team was not able to find a study that verifies the injection process will solve the supplemental water issue. The Team has concern that injecting excess water from the surface water source may create more problems than it would solve. The following is an excerpt from the *Aamodt Settlement Study Report, Appendix 18, Final Report for Task 3 Deep Well / Well Field Investigation and Integration* prepared for Northern Pueblos Tributary Water Rights Association (Leder 2003, p. 26, 60, 61):

> "Aquifer Storage and Recovery (ASR) involves the diversion of excess surface flow (or other waters) to specified wells for injection to an underground aquifer, thus storing the water for recovery at a later time. Several important factors must be taken into consideration. The geochemical compatibility of the injected water with both the receiving water and the aquifer material must be considered. If the chemistry among these three components is not compatible, it is possible that minerals in the aquifer could dissolve, or minerals dissolved in the injected water could precipitate and plug pore-spaces, thus reducing the effectiveness of the aquifer to store and transmit water. Other considerations that must also be assessed include the potential loss of injected water to other users and to streams, the physical ability of the aquifer to receive injected water, and the potential costs of injecting and recovering the water at a later time. The quality of injected water is also a major concern."

> "It is assumed that the deep well fields will be used to supplement a collector well drawing from the alluvium of the Rio Grande, just north of the Otowi Bridge. When water is available, it would be treated and injected into the aquifer through dedicated injection wells."



*Note: The Rio Grande at Otowi was chosen because it is the sample site closest to where a surface-water diversion will take place. Relationship indicates that Rio Grande water is more compatible with ground water from the Tesuque test well than with the ground water in the other test well locations. Water-quality data for the Rio Grande is from Boyle Engineering, 1997. The three samples represent average, minimum, and maximum values. Data are from a limited number of samples collected over a 6-year period.

Figure 8. Piper diagram representing waters from four pueblo test wells and samples from the Rio Grande at Otowi Bridge, to compare surface water and ground waters.

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"Figure 8 on page 26 is a Piper diagram of the primary cations and anions (positively and negatively charged ions) in water in the Rio Grande at Otowi Bridge and for each of the four pueblo test wells. As discussed previously the test wells of Pojoaque, Nambe, and San Ildefonso Pueblos produce a sodium bicarbonate type water, and the Tesuque test well is a calcium bicarbonate type water. The Rio Grande sample is predominately a calcium bicarbonate type water, making it more compatible with ground water from the Tesuque test well than with the other three. If Rio Grande water was injected into the Pojoaque, Nambe, or San Ildefonso test wells,

> ion exchange could occur between the calcium-rich river water and formation water, potentially resulting in the flocculation of clays, which could become unstable and plug aquifer porosity."
>
> "Geochemical compatibility between ground water from the Tesuque test well and the Rio Grande can also be evaluated by examining pH. The pH of a solution plays a significant role in controlling mineral solubility. In most cases, when mixing two sources of water, a similar pH is desired. The river water has a field pH of 7.7, while water from the Tesuque test well has a pH of 7.4. Water from both the Nambe and Pojoaque test wells has pH values equal to or greater than 9. The San Ildefonso test well produced water with a pH of 7.9."
>
> "The preliminary review of the available geochemical data suggests some of the possible problems with the proposed ASR program. To fully understand the consequences of this ASR project, more detailed chemistry would need to be considered, including the presence of iron, manganese, and other constituents. The presence of organics in the river water would also need to be considered."

It is understood that the design team recognizes that considerable planning and design work is needed, and a final decision needs to be made regarding whether ASR injection wells are to be included in the overall project. It is the Team's opinion that further investigation and study to prove the viability of this ASR project's ability to provide a safe and verifiable water source is required before this plan can be applied to this project as a supplemental water supply.

The Team feels that until further investigation verifying ASR as a viable supplemental source of water for this project is available that it not be considered in a Feasibility level design, and that another verifiable supplemental water source be provided for in the cost estimate at this time.

Water Treatment

The design team echoes the Reclamation report of 2003 (p.4), Appendix 15 of Pojoaque Regional Water System Engineering Report, in suggesting a year's pilot testing. The Team agrees with this concept. The testing should be of a year's duration to cover the seasonal variation of the river water (including composition, temperature, and flow) during one year, which can be assumed to be characteristic if not typical. The pilot system to be tested should use intake, pre-sedimentation and enhanced coagulation systems that model those planned to be installed to ensure that the full scale plant will be accurately simulated. Equipment from three or more different manufacturers can be tested, side by side. This will permit determination of which equipment is most appropriate. The focus of the pilot

testing should be simplicity of operation and high reliability of equipment rather than cost. The addition of chlorine and ammonia to the product water should be included to demonstrate what kind of and what quantity of disinfection byproducts (DBPs) will be produced, to ensure that the product water will meet drinking water standards.

The chemical analysis of the river water does not include calcium and magnesium, which prevents determination of an ion balance in the water, the scaling tendency of the water, or the sodium adsorption ratio. The scaling tendency indicates the probability of forming (or removing) a calcium carbonate layer of the downstream pipeline distribution system. It also indicates the compatibility with other waters which the product water may be mixed.

Consideration should also be given to understanding effects of mixing pumped groundwater with treated river water. Chemical analysis of proposed well field groundwater sources will provide invaluable information for understanding and predicting potential adverse conditions.

The bromide concentration in the water is not specified. Experience with seawater desalination plants has shown that the presence of even modest concentrations of bromide in the feed water can significantly promote the formation of DBPs.

It is not clear what the Total Organic Carbon (TOC) consists of. The TOC of the river water is high enough that one must worry about formation of DBPs. Some of the organic carbon will be removed during the coagulation process, but not all.

It is not clear what residence time would exist between the addition of chlorine and the addition of ammonia to convert the chlorine to monochloramine. One of the advantages of using chloramines for disinfection is the lowered tendency to form DBPs. However, if the period of time that the water is exposed to chlorine is too long, this advantage is dissipated.

Reference is made to the hazards of use of chlorine gas as disinfectant. The use of calcium hypochlorite should be considered.

Land and Land Rights

By law, Reclamation must have rights and interests in the lands their facilities are constructed on, whether it be fee title, permanent easement or temporary easement. Typically, pipelines are constructed within a permanent easement. Often times it is necessary to acquire a temporary easement outside of the permanent easement for use for during construction. The permanent easement is an encumbrance on the lands, which means the owner is restricted on what he can do on the permanent easement. For example, the owner could not erect a

structure over the pipeline or do anything which would prevent the operation and maintenance of the line. Typically, tank sites are held in fee title and the complications presented by tribal ownership should be taken into consideration.

Right-of-Way through Pueblo and private land will require entering into agreements, which will be costly in terms of time and money. Since the land rights must be acquired before the award of contract, this item will affect schedules. Estimate of lands and Right-of-Way costs should be made as accurately as possible and included in a Feasibility level cost estimate.

Project Management

It is the Team's opinion that as the project progresses, the formation of a formal Project Management Team (PMT) would benefit the project. The PMT would consist of members representing the key stakeholders including, but not necessarily limited to the Northern Pueblo Tributary Water Rights Association and their representatives, Bureau of Indian Affairs, Reclamation, and Fish and Wildlife Service. The PMT should include an experienced design engineer that would provide ongoing technical advice on the design and construction aspects of the project. The PMT would meet periodically to make decisions regarding the feasibility study process, monitor progress and budget of the study, recommend implementation of environmental and cultural resource studies, and make adjustments to the process to ensure a successful and complete study.

Estimating

During the project briefing as conducted at Reclamation's Albuquerque Area Office on Monday November 2, 2009, it was noted that the current estimate level is Appraisal and the price level is October 2006. Appraisal cost estimates are not normally suitable for requesting project authorization or construction fund appropriations from the Congress. The Team considers the estimate to be at only an Appraisal level for the following reasons:

- The majority of the estimate cost items are lump sum in nature.
- Prices have been developed utilizing historical data via cost curves and/or bid tabs/abstracts.
- Prices are the same for like cost items without taking into account the differing site conditions that exist (e.g., same diameter pipe having the same unit price whether the pipe is in a rural, unobstructed area versus within city limits where the pipeline runs occur in narrow, populated areas).
- Major cost items are lumped into the unlisted items (e.g., traffic control, pipeline crossings, dewatering/unwatering, pipeline fittings, relocation of existing utilities, and water treatment pilot testing, etc.).

Estimates should be re-priced and not indexed when those estimates are greater than 5 years old. Indexing data older than 5 years may lead to erroneous results.

The DEC Team identified a number of cost elements that should be considered in a Feasibility level estimate. The following is a list (not all inclusive) the Team believes to be significant and should be identified in the cost estimate:

- The power requirements and associated costs of bringing power to the necessary sites (intake pumping plant, water treatment plant, booster pumping plants, etc.).
- Costs associated with creating access roads, road upgrades and road maintenance during construction.
- Create takeoff quantities further defining the lump sum items.
- Define the pipeline quantities by like areas and topography locations such that unit prices can be developed for these differing areas.
- Include itemization of pipeline fittings, various backfill requirements (concrete encasements vs. earth), excavation types (rock vs. common), trench side slopes and whether trench boxes or shoring is required, and pipeline crossing types (river, existing sewer lines, state highways, county roads, etc.).
- Define previously unlisted items (e.g., water treatment pilot testing, traffic control, relocation of existing utilities, dewatering/unwatering, cathodic protection systems, etc.).
- Detail estimating rather than unit pricing by historical data via cost curves and bid tabs/abstracts. Obtain material quotes, develop crews, and productions rates for major items of work.
- Determine the need for compliance with the Davis-Bacon Act and prevailing wage rates on this project (if applicable) and the potential impacts to labor costs.
- Consider the need for compliance with Air Emission Standards in the State of New Mexico (if applicable) and the potential impacts to construction costs on this project.
- Account for Tribal administrative costs, fees, and taxes that may be required for this project. In addition, consideration should be given to the procurement strategies anticipated for this project (if known) and adjust the cost estimates accordingly.
- Consider costs associated with breaking up this project into multiple contracts due to procurement requirements and/or limitation of funding.
- The Team feels the current schedule has not allowed enough time to obtain the necessary Right-of-Way and Land Rights. Construction schedule delays will increase the project costs.

Upon review of the cost estimate provided, the design team included percentages for unlisted items ranging from 0 percent to 25 percent depending on the feature,

"Contract Add-ons" (to account for mobilization, taxes, bonds and insurance, and Tribal Employment and Rights Ordinance) fee at 17.5 percent, Contingency at 20 percent, and Non-Contract Costs ranging from 29.5 percent to 31 percent.

The Team would set unlisted items (now called design contingencies) at no less than 10 percent, construction contingencies no less than 20 percent, and non-contract costs at 35 percent for a Feasibility level study. If non-contract costs are estimated lower then 35 percent, specific rationale addressing the following should be provided:

- Rights-of-way
- Relocation of property
- Engineering design
- Construction engineering and management
- Project management
- Surveying
- Cultural resource services
- Legal services
- Operation and maintenance during construction (if applicable)
- Legislated environmental requirements (NEPA, etc.)

This list is not all inclusive but includes most of the key factors to be considered in the development of non-contract cost.

Operations, Maintenance, and Replacement (OM&R)

The Team identified a number of cost elements that should be considered and included to take this to a Feasibility level estimate. The following is a list (not all inclusive) the Team believes to be significant and should be identified in the cost estimate:

- Replacement costs need to be itemized rather than calculated by a percentage of the construction cost.
- The type of raw water sediments (mineralogy) that exist in the Rio Grande River need to be identified. The information will aid in better defining the frequency of replacement for the Regional Water System's equipment (valves, pumps, etc.).
- Consult the Office of Management and Budget's Circular A-94 Appendix C to obtain the real interest rate percentages used in the life cycle cost calculations.
- Power costs need to be verified with Jemez Mountain Cooperative and PNM, the local electric utilities.
- Currently the estimate assumes demand increasing incrementally to 100 percent over 25 years following completion of construction. The Team

suggests further evaluation of this assumption. OM&R cost will increase if demand for this water occurs faster than currently predicted.
- The 20 year useful life of microfiltration membrane elements appears very high. The Team would suggest it should be more on the order of 5 years or less depending on the solids loading and the type of cleaning employed.

Construction

The team found the current design of the river diversion intake structure, suction line, sand separators, raw water pump house, and access road pose significant construction risks:

- The diversion intake structure will require construction of a cofferdam and dewatering/unwatering will have to be done. It is not clear what type of foundation will be required (i.e., spread footing, piles or other foundation treatment).
- The water intake at the river needs to be carefully designed. The smaller the quantity of suspended solids that is taken in, the easier the operation of the water treatment plant will be.
- The excavation for the pump house, as currently located, is deep and would undercut the embankment for the Highway 502 bridge approach without a vertical excavation. This will require permitting from NMDOT and shoring of the excavation slope adjacent to the highway.
- The raw water pump house access road from Highway 502, as depicted on the rendering, does not appear to intersect the Highway in an acceptable manner (i.e., at or near 90 degrees) and this intersection will also require permitting from NMDOT.
- A high pressure gas line has been recognized as a conflict by the design team. The relocation of this facility should be accomplished before award of the contract for the diversion intake structure and the raw water pump station. The cost of relocation should be reflected in the cost estimates as a line item.

The Team finds that the following steps should be taken to minimize the construction related risks of the river diversion intake structure and raw water pump house:

- Perform subsurface investigations and/or consult NMDOT on foundation, groundwater conditions to better understand foundation conditions and groundwater levels to be expected and adjust design accordingly.
- If the raw water pump house cannot be moved far enough away to keep the excavation from encroaching on NMDOT Right-of-Way and/or undercutting the highway embankment, design a shoring system to retain the embankment. In any event, this may require permitting by NMDOT and their approval of the plans.

- The access road for raw water pump house should be relocated to allow the intersection with Highway 502 to be at or near 90 degrees. This access will also have to be permitted by NMDOT.

IV. Conclusions and Recommendations

The Team acknowledges the considerable effort invested by the Northern Pueblo Tributary Water Rights Association and their representatives that has brought the project to its current level. The Team has identified some significant issues that need to be addressed for the study to be brought to a complete Feasibility level, which is the level of study necessary to establish a reasonable basis for the cost of the project. These issues have the potential to significantly increase the total estimated cost for this project.

The following recommendations are considered essential, if the present study is to be taken to the Feasibility level. The Team does not take a position as to whether a Feasibility level study must be done for the project. Rather, the issues identified by the Team herein make it clear that in the absence of a Feasibility level study, the risks of significant increases in the total estimated cost of the project are substantial.

Recommendation 1

Consideration should be given to legislated federal and state environmental and cultural resource requirements and their impacts on the project's scope, schedule, and costs. Studies (such as environmental impact statements and other NEPA compliance studies, Section 106 of the National Historic Preservation Act compliance studies, and Air Quality and Stormwater requirements) required on projects of this nature can be very time consuming – and as such, should be identified and planned for.

Recommendation 2

Consult with State and Federal Fish and Wildlife Services to better understand the requirements placed on the intake structure with respect to the need for a fish bypass and the type of screen that is acceptable to prevent fish from getting into the suction line or impacted on the screen.

Recommendation 3

Confirm the elevations of the intake structure required to assure operation at very low river flows and confirmation of the stability of the stream bed with respect to aggradations or degradations. The Team feels it would be beneficial to consult with NMDOT to see what subsurface conditions they encountered when constructing the Highway 502 Bridge and if they have experienced any scour problems at the center pier.

Recommendation 4

Perform subsurface explorations for the river diversion intake structure and the raw water pump station in order to design the foundations, shoring system for the excavation of the raw water pump station and to determine groundwater conditions and dewatering/unwatering requirements. Adjustments to quantity and cost estimates should be made as required.

Recommendation 5

Right-of-Way through the Pueblo lands and private lands will require entering into agreements, which will be costly in terms of time and money to draw up the agreements and acquire the land interests. Estimate of lands and Right-of-Way costs should be made as accurately as possible and included in a Feasibility level cost estimate.

Recommendation 6

Update the design team study to a Feasibility level by re-pricing the cost estimate (versus indexing the historical prices) such that site specific costs unique for this project may be captured. In addition, the Team identified a number of cost elements that were excluded from the cost estimate, some of which may be significant cost drivers and should be considered and captured.

Recommendation 7

The pilot testing of the proposed water treatment system should be performed as part of a Feasibility study. The pilot system should use an intake similar to that planned to be installed to ensure that the full scale plant will be accurately simulated for both intake conditions and water quality. The focus of the pilot testing should be simplicity of operation and high reliability of equipment.

Recommendation 8

Until further investigation verifying ASR as a viable supplemental source of water for this project is available, the ASR not be considered in a Feasibility design, and that another verifiable storage alternative be provided for in the cost estimate at this time.

V. References

Aamodt Technical Committee/Aamodt Settlement Negotiation Team. May 2004. *Aamodt Settlement Study Report*.

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