9.0 Water Plan Alternatives

9.1 Goals and Objectives

The goals and objectives of the water plan are both unique and common for each of the watersheds studied. Following are the water plan's goals and objectives as defined by the scope of work for the study:

1. Identifications of existing and future water demands
2. Identification of water supplies for the Basin
3. Determination of needs to be met by considered alternatives
4. Development of implementable alternatives to meet water needs, including conservation measures.

The objective of the plan is to develop a comprehensive, regional decision-planning tool that can be used by water planners to effectively plan for projects to meet future water needs.

The following subsections will describe the goals and objectives of the watersheds that were identified by the draft Water Budget, dated September 2002.

9.1.1. **Socio-economic Goals**

The Planning Committee clearly stated that economic growth in the Region is a goal for all the watersheds. Limiting growth to conserve water resources was specifically rejected as a tool for managing water demands in the Region. The Planning Committee recognizes the sociological impacts of growth and accepts those consequences as part of the future for the San Juan Hydrologic Unit.

9.1.2. **Animas Watershed**

The Water Budget identified shortages associated with the 90th percentile drought conditions (9 of 10 years there will be more water available than the 90th percentile year). It was determined that all municipal, industrial and agricultural demands in the Animas Watershed in 2044 would be met with the 90th percentile surface water supplies. However, the surplus is only 3,071 acre-feet in the 90th percentile August month[1].

During extreme drought conditions, worse than the 90th percentile, there will be shortages of 1,000 acre-feet during the summer months (July, August, and September).

Based on this analysis, the water plan goal for the Animas Watershed is to develop a drought contingency plan that will provide 1,000 acre-feet during the summer months. Solutions need to recognize that under most conditions this water is not required to meet demands because this water is needed only in extreme drought conditions. Therefore, the best alternatives need to have low capital costs to justify their implementation.

9.1.3. **Blanco Watershed**

The future (2044) demands are only 602 acre-feet for the entire watershed[2]. Surface supplies are distant from demands and do not represent a reliable source for the demands.

[1] Water Demands Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. IV, Table 106
[2] Water Demands Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. IV, Table 39

Groundwater development is the most reasonable water source to meet demands. There are no shortages because groundwater is sufficient, 14,800 acre-feet[3], to meet future demands.

9.1.4. Chaco Watershed

Surface supplies are not reliable for the watershed. Chaco Watershed's future demand can and should be met from groundwater supplies. The Chaco Watershed groundwater has sufficient supply (36,884 acre-feet[4]) to meet the 2044 non-reservation demands of 2,494 acre-feet per year[5].

9.1.5. La Plata Watershed

The municipal demands for the La Plata Watershed are met from the Animas River. It is assumed that future municipal growth in the watershed will occur in areas outside the valley fill and the agricultural demands will be preserved through 2044.

Agricultural shortages in the watershed are severe. In the 90th percentile months of June through September, shortages represent approximately 50 percent of the demand. Consequently, this watershed experiences more shortages than any of the other watersheds. On the other hand, agricultural shortages are less critical than municipal shortages.

Also, there is insufficient surface water supply in the 90th percentile months prior to the critical summer months to store enough water to meet all the shortages. Only 2,900 acre-feet is available to be stored to meet the 5,600 acre-feet shortage.

Shortages can be only partially met with storage. Eliminating all shortages would require importation.

9.1.6. Middle San Juan Watershed

Single month shortages are as great as 28,244 acre-feet[6] in the Middle San Juan Watershed. However, all of this shortage is attributable to increased NIIP diversions upstream of the watershed. It is expected that this increase will be met with releases from Navajo Reservoir greater than historical releases. With incremental NIIP demands met from Navajo Reservoir, shortages become a 13,313 acre-feet surplus. Consequently, there are no anticipated shortages in the Middle San Juan Watershed.

9.1.7. Upper San Juan Watershed

The maximum single month shortage on the Upper San Juan Watershed is 48,246 acre-feet[7]. This shortage is attributable to increased NIIP diversions upstream of the watershed. It is expected that this increase will be met with releases from Navajo Reservoir greater than historical releases. With incremental NIIP demands (50,988 acre-feet) met from Navajo Reservoir, shortages become a 3,743 acre-feet surplus. However, this surplus is relatively small in comparison to the total demands met (58,289 acre-feet per year). Consequently, shortages could occur in drought periods worse than the 90th percentile months. Drought contingency options should be considered for the Upper San Juan Watershed.

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[3] Water Supply Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. III, Table 1.2-1
[4] Water Supply Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. III, Table 1.2-1
[5] Water Demands Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. IV, Table 46
[6] Water Demands Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. IV, Table 15.
[7] Water Budget, San Juan Hydrologic Unit Regional Water Plan, Vol. IV, Table 19.

9.1.8. **Upper San Juan above Navajo Dam Watershed**

The demands for the watershed can all be met with 90th percentile water supplies. With the supply at over 50,000 acre-feet per year[8] and total demands less than 8,000 acre-feet, there are no expected shortages in the Upper San Juan above Navajo Dam Watershed.

9.2. Alternative Development

This section describes the alternatives identified and evaluated. The alternatives should not be compared against each other directly because they meet vastly different goals. Some alternatives meet only extreme drought conditions for critical municipal needs. Others meet frequent shortages but for less critical agricultural needs. All cost estimates are based on reconnaissance level designs which do not require field investigations. Cost benefit ratios are presented for irrigation needs but not for critical municipal demands. This is because economic values of meeting municipal demands during extreme drought conditions are not easily determined.

9.3. Planning Committee Selected Alternatives

The Planning Committee was given the task to identify alternatives to be evaluated that would meet the goals. The Planning Committee identified the alternatives specific to the each watershed and alternatives that would have general application to the entire basin. The Planning Committee identified alternatives specifically for the Animas, La Plata and Middle San Juan Watersheds. There are no alternatives identified specifically for other watersheds. After two study sessions, the committee prioritized the alternatives for additional engineering investigations. None of the identified alternatives were eliminated. All were considered and evaluated. However, only the highest priority alternatives were developed further with reconnaissance level engineering and cost estimates. Following is a listing of the alternatives identified and their initial Planning Commission priorities for engineering evaluation.

[8] Water Supply Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. III. Table 2-39.

Table 9.1

Alternatives Priorities

12/12/2002

Alternative	Watershed Animas	LaPlata	Upper SJ	Basin-wide
Storage in NM	1			
Shallow groundwater by river	2			
Crop Leasing/Options	3			
Small reservoir storage		1		
Navajo Dam operation improvement			1	
Enlarge Farmington Lake *	11			
General				
Navajo Nation Water Rights Settlement				1
Conservation - indoor use				1
Conservation - outdoor use				1
Global Municipal				2
Agricultural Improvement				3
Groundwater exchange -NIIP/Nav-Gallup				4
Alternatives Not Identified for Engineering Reconnaissance Study				
Remove non-native species				5
Cloud seeding				6
Increase ALP storage	7			
Store stormwater runoff				8
Gallegos wash storage			9	
Treat saline water	10			
Challenge ESA				5
Blend Groundwater				6

* Initially low priority later identified for cost estimate study

9.4. Animas Watershed

The Planning Committee identified the following alternatives specific to the Animas Watershed. The Committee prioritized the alternatives for additional engineering investigations. Following are the alternatives that are specific to the Animas Watershed in the order of their prioritization for engineering study:

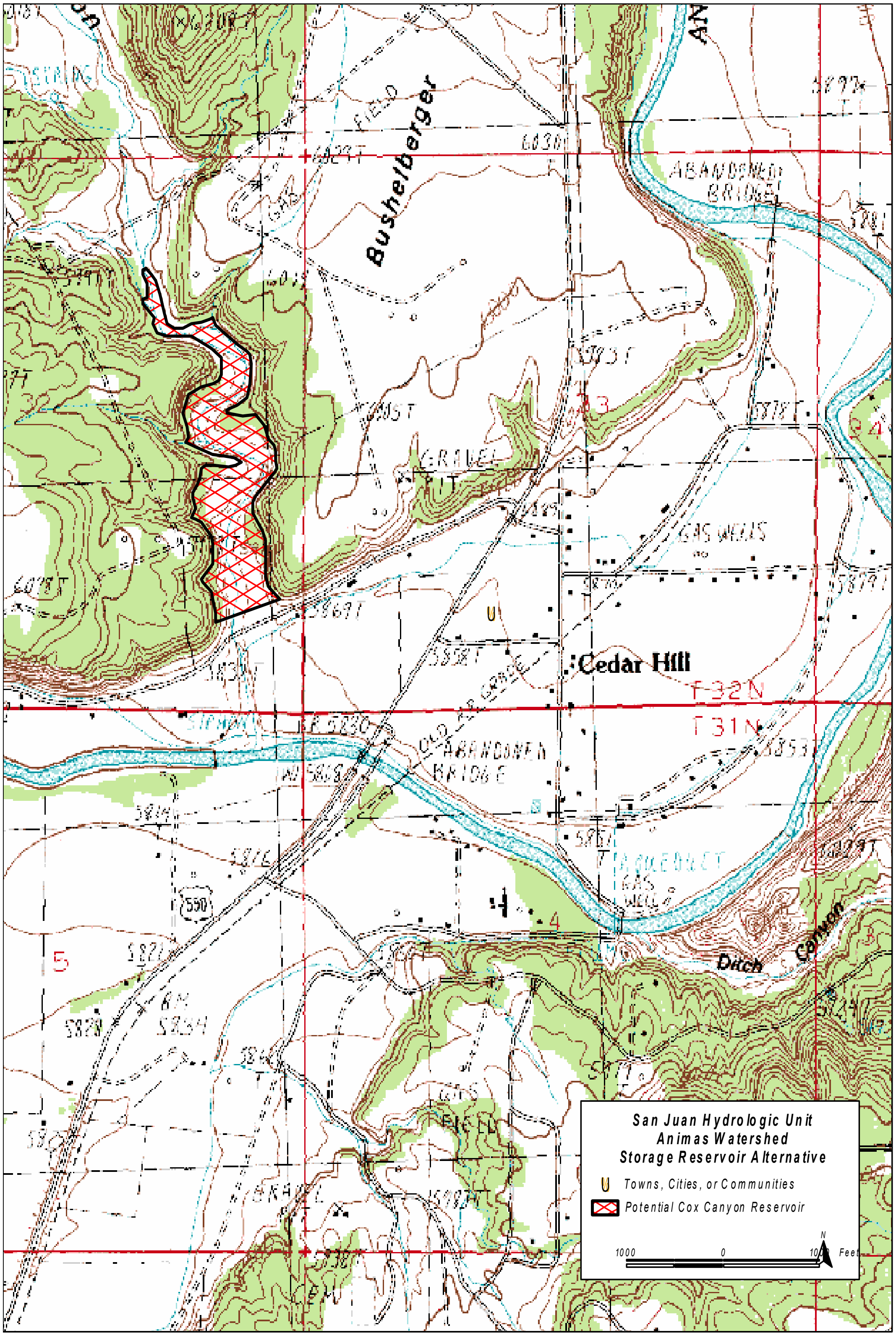
1. Additional storage in New Mexico
2. Development of shallow groundwater to improve surface water diversion capabilities
3. Crop leasing during droughts
4. Groundwater exchange with NIIP or Navajo-Gallup facilities
5. Removal of non-native species from riparian areas
6. Cloud seeding
7. Increase Animas-La Plata Project (ALP) storage
8. Storage of stormwater
9. Storage in Gallegos Wash
10. Treatment of saline waters to drinking water quality
11. Enlargement of Farmington Lake

9.4.1. Additional Storage in New Mexico

9.4.1.1. Description

As a representative alternative for additional storage, a site located in Cox Canyon near the state line with Colorado was evaluated. The site is shown on Figure 9-1. The project would require pumping water to an off-site reservoir and releasing water back to the Animas River to meet demands.

Figure 9-1


Bushelberger
ABANDONED BRIDGE
GRAVEL PIT
GAS WELLS
Cedar Hill
T32N
T31N
ABANDONED BRIDGE
AQUEDUCT
Ditch
Canyon
550
San Juan Hydrologic Unit
Animas Watershed
Storage Reservoir Alternative
Towns, Cities, or Communities
Potential Cox Canyon Reservoir
1000
0
Feet

9.4.1.2. **Assumptions**

Following are the alternative assumptions:

1. The reservoir would store 1,300 acre-feet and yield 1,000 acre-feet at Aztec.
2. At this site, a dam 600 feet long and 40 feet high would be required.
3. The reconnaissance level cost estimate is based on a 24-feet top width, 2:1 side slopes and 6-feet deep foundation excavation
4. A 10 cfs pump station on the Animas River is required to fill the reservoir during the two months of the spring prior to commencement of shortages.
5. Releases from the dam to the Animas River require no constructed facilities.

9.4.1.3. **Cost Estimate**

The total cost of this alternative is $1.8 million. A detailed cost estimate is provided in Appendix E, Volume II, San Juan Hydrologic Unit Regional Water Plan. The annualized cost of 1,000 acre-feet of water is $157,000 per year or $1,570 per acre-foot using the following assumptions.

- 40 year period
- 8 percent interest on investment
- 100 acre-feet per year yield (1,000 acre-feet every 10 years)

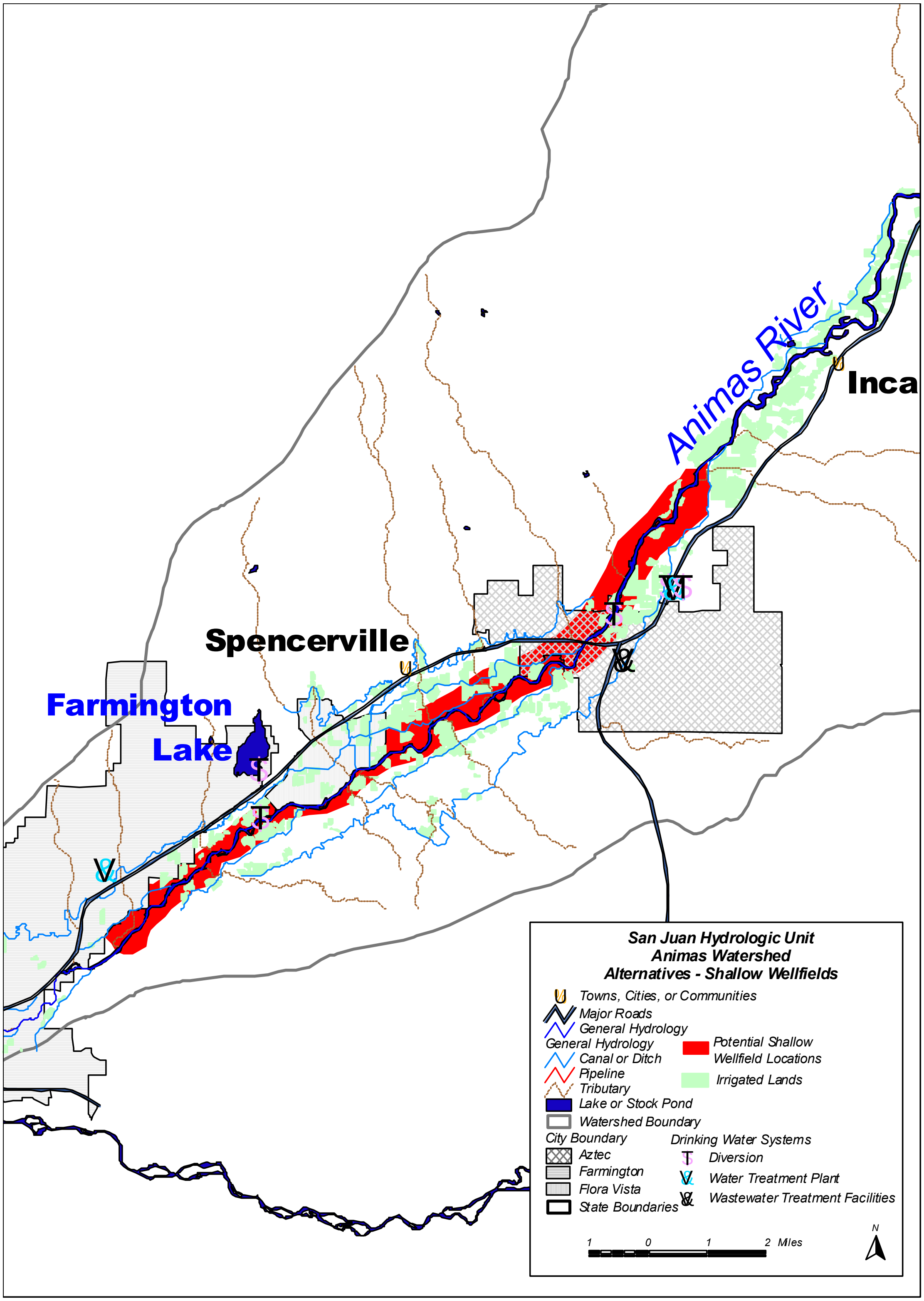
Additional costs associated with NEPA and ESA compliance is not included in this reconnaissance level estimate.

9.4.2. **Development of Shallow Groundwater**

9.4.2.1. **Description**

The shallow ground water along the Animas River is interconnected with the surface water. During extreme drought conditions, the surface water supply in the Animas River will not be adequate to meet the diversion requirements for the year 2044 based on the demands identified in the Water Demand Assessment Report, Vol. IV of the Regional Water Plan. Figure 9-2 shows the approximate area for development of shallow groundwater. This alternative improves the capability of the municipal water users to divert water but does not develop a new water supply.

Figure 9-2



Animas River
Inca
Spencerville
Farmington
Lake
San Juan Hydrologic Unit
Animas Watershed
Alternatives - Shallow Wellfields
Towns, Cities, or Communities
Major Roads
General Hydrology
General Hydrology
Canal or Ditch
Pipeline
Tributary
Lake or Stock Pond
Watershed Boundary
Potential Shallow Wellfield Locations
Irrigated Lands
City Boundary
Aztec
Farmington
Flora Vista
State Boundaries
Drinking Water Systems
Diversion
Water Treatment Plant
Wastewater Treatment Facilities
1 0 1 2 Miles
N

9.4.2.2. **Assumptions**

- Water supply of 1,000 acre-feet of water is available from subsurface flows in the shallow aquifer under the worst month of record.
- Shallow groundwater wells are less than 100 ft deep.
- All agricultural water is diverted upstream of well field. This is because the well field has the potential of interfering with surface water diversions.
- Wells are required to meet total municipal demand because of the surface water / groundwater interaction and the reportedly high transmissivities that may interfere with existing municipal diversions.
- Agricultural well construction is acceptable well design. This is lower standard than for municipal potable water wells.
- Completed wells will be capable of producing 1500 gpm
- Wells are located no closer than 1,000 feet to each other
- An average of one-quarter mile of pipeline required per well to convey groundwater to existing canals to deliver water to water treatment facilities.

9.4.2.3. **Calculations**

The following table describes the calculations and assumptions used to quantify the shortage and number of wells associated with this alternative:

Table 9-1

Well Capacity Requirements		
Total shortages (Jun – Aug)	3,606	acre-feet
Shortages to be met by Ridges Basin Reservoir	2,622	acre-feet
Remaining Shortages	984	acre-feet
Maximum Municipal Diversion Requirements (July)		
Animas Watershed	3,540	acre-feet
La Plata Watershed	454	acre-feet
Farmington – Shiprock Pipeline	800	acre-feet
Total Municipal Diversions	4,794	acre-feet /month
	35,000	gpm
	1,500	gpm/well
	24	wells

The above table assumes that as pumping of the shallow aquifer occurs during a drought period, the wells will cause increased river bed losses. This could potentially result in the communities needing to divert all of its surface water from the shallow wells. It is recognized that this is a very conservative assumption but demonstrates the complications associated with shallow groundwater withdrawals. The evaluation of this alternative in Section 10 describes in more detail the issues associated with this alternative.

9.4.2.4. Cost Estimate

The following table describes the costs associated with this alternative.

Table 9-2

Well Field Costs Estimate			
Wells			
Item	**Cost / Unit**	**Total Units**	**Total**
Well	$50,000	24	$1,200,000
Well house	$70,000	24	$1,680,000
		Total Well Costs	$2,880,000
Transmission Pipelines			
Item	Cost / Unit	Total Units	Total
10-inch D.I. pipeline	$14.00 / ft	31,700 ft	$443,800
Installation	$10.00 / ft	31,700 ft	$317,000
		Total Pipeline Costs	$760,800
		Project Subtotal Costs	$3,640,800
		Contingency (25%)	$910,200
		Total Project Cost	$4,551,000
		Cost per acre-ft	
		Shortages (984 ac-ft)	$4,625
		Total pumped (4,794 ac-ft)	$ 949

Additional costs associated with NEPA and ESA compliance is not included in this reconnaissance level estimate.

9.4.3 Crop Leasing

9.4.3.1. Description

The purpose of this alternative would be to contract with agricultural producer(s) prior to a drought in order to purchase water by replacing the revenue generated by his crop during that drought period. The mechanism would be an annual option payment to the irrigator that would obligate him to accept the execution of the option. For this analysis, it is assumed that the option would be executed only once in ten years.

9.4.3.2. Cost Estimate

Costs were initially developed for a one-year impact to the crops. Irrigators on the Planning Committee revised the costs to 3-years of impact because it takes that many years to re-establish a stand of alfalfa. The following table shows the water savings (as diversions) and costs to replace lost crops. It is the assumption that the option to lease would only be executed during the late summer. In a drought on the Animas River, shortages occur only during the months of July, August and September. This represents approximately 60 percent of the annual water savings (5 AF per acre annual diversion duty for alfalfa).

Table 9-3 Crop Revenue Replacement Costs

Crop	Water Savings (af)	Production (tons/acre)	Value ($/ton)	Revenue per Acre	Years of Lost Crop	Value of Crop	Seeding Cost	3 Months Cost
Alfalfa	5	5.5	$120	$660	3	1,980	$150	$810 (Note 1)

Note 1: Cost based on 60% of Annual Water Savings

It is also assumed that an annual option payment of $220 per acre would also be required. This annual option payment increases the cost per acre-foot of water to $1,470. These costs were developed with input from agricultural producers on the Planning Committee.

9.4.4. **Enlargement of Farmington Lake**

Based on information provided to the Planning Committee by Paul Martin, Farmington City Engineer, Farmington Lake could not be enlarged by increasing the dam height. The only way to increase its capacity would be to excavate the banks of the reservoir. Recognizing the difficulty, expense and potential for increased seepage losses, the Planning Committee decided to include this alternative. Initially, this was a low priority alternative but was elevated to engineering evaluation status by the Committee at a later date. At $4 per cubic yard, the cost to excavate 1,000 acre-feet would be $6.5 million. This does not consider the possible need for lining to mitigate increased seepage or the cost associated with excavation above the water surface to provide freeboard or to slope away from the edge of the water.

Using a rate of 8 percent, 40 year period and 100 acre-feet per year, the annualized cost of this alternative is $541,000 or $5,400 per acre-feet (1,000 acre feet once in 10 years).

Additional costs associated with NEPA and ESA compliance is not included in this reconnaissance level estimate.

9.4.5. **Other Animas Watershed Alternatives Considered**

There are several other alternatives that were considered for the Animas Watershed that were not selected for reconnaissance level engineering study. These alternatives were considered a less viable than the alternatives selected for additional investigations. Following is a list and description of these alternatives:

<u>Remove Non-Native Species from Riparian Areas</u> - This would require vegetation eradication along canals, drainages and rivers in order to reduce consumption of water. The program would be extensive and require continuous vegetation removal to ensure that the non-native species did not re-establish.

<u>Cloud Seeding</u> - This would require seeding in the areas in Colorado that provide most of the snow pack and subsequent runoff for both Colorado and New Mexico.

<u>Increase ALP Storage</u> - This alternative would require either enlargement of Ridges Basin Reservoir or acquisition of previously allocated storage.

Storage of Storm-Water - This alternative would require multiple storage facilities in arroyos to capture stormwater runoff. It also would include an extensive water collection pipe network to collect and treat the runoff.

Storage Facility in Gallegos Wash - This is similar to the Cox Canyon alternative to develop an off-stream reservoir.

Treat Saline Water to Potable Quality - Saline groundwater would be developed and treated by reverse osmosis.

Challenge Endangered Species Act (ESA) - This alternative assumes that water supply would be increased if the ESA were repealed.

Blend Groundwater - Saline groundwater would be blended with higher quality surface water to extend the volume of the water supply.

9.5. Blanco Canyon Watershed

The Blanco Canyon Watershed is unique among the San Juan Hydrologic Unit watersheds. There is minimal agricultural water use, with a relatively small population. However, there are significant soil erosion problems in the watershed associated with steep grades, minimal vegetation and infrequent high runoff events. Consequently, the communities have supported on-going efforts to control erosion with the installation of drop structures throughout the watershed.

Although these erosion control efforts do not constitute water demands as defined by the Regional Water Plan, they will improve the water quality of downstream supplies and improve the riparian habitat of the channels treated. These erosion control efforts are not classified as an alternative for the Regional Plan but are considered important water quality improvements.

9.6. La Plata Watershed

The La Plata Watershed has the most severe water shortage of all the studied watersheds. These shortages are all associated with agricultural irrigation shortages. However, there are concerns that the Upper La Plata area cannot be adequately served by future municipal deliveries from Farmington (Animas Watershed). The two alternatives that were identified by the Planning Committed are:

- Small reservoir storage (by individuals or ditch companies)
- Delivery of water from Ridges Basin Reservoir to the Upper La Plata for municipal uses (La Plata Pipeline) through the La Plata Conservancy District in Colorado.

9.6.1. Small Reservoir Storage

9.6.1.1. Description

The 90th percentile shortage on the La Plata Watershed is 5,700 acre-feet per year. The water available for storage during the January to June period of the drought years is only 2,700 acre feet. Consequently, if all the available water were stored, it would not be sufficient to meet all shortages.

This alternative assumes that small (10 acre-feet) reservoirs would be constructed on farms or near diversions from the La Plata River. It would require 270 reservoirs to store the entire 2,700 acre-feet of available water. The reservoirs would be low profile facilities requiring no embankments, only excavation to provide storage.

9.6.1.2. Cost Estimate and Benefit

A detailed reconnaissance cost estimate for a single storage reservoir is contained in Appendix E, Volume II, San Juan Hydrologic Unit Regional Water Plan. With 25 percent contingencies, a single 10 acre-foot reservoir would cost approximately $107,000. 270 reservoirs would cost $28.9 million.

Assuming that storage would allow irrigators to keep crops growing through the shortage period and that only 1 acre-foot per acre shortage could maintain a crop through the shortage, the benefit would be approximately $440 per acre. This represents 2/3 of the total annual alfalfa crop value. 2,700 acres times $440 results in an annual benefit of $1.2 million. This means that it would take 24 years at zero percent interest to reach a 1:1 cost to benefit ratio.

Additional costs associated with NEPA and ESA compliance is not included in this reconnaissance level estimate.

9.6.2. La Plata Pipeline

9.6.2.1. Description

This alternative is intended to meet the municipal needs in the upper La Plata Watershed instead of bringing more Animas Watershed water (Farmington water treatment plant) into the La Plata Watershed. It also reduces the need to concentrate urban growth in the lower La Plata Watershed where municipal water is more easily supplied.

Water would be treated by a treatment plant near Ridges Basin Reservoir and water delivered to the La Plata Water Conservancy District in Colorado. Upper La Plata would receive water through the district's system. Studies are being conducted by the district and U.S. Bureau of Reclamation to determine the feasibility of this alternative.

9.7. Middle San Juan Watershed

There are no shortages in the Middle San Juan Watershed for the 90th percentile water supply and assuming that future NIIP increases will be supplied from Navajo Reservoir storage. However, the Planning Committed included an alternative to encourage improvements to the operations of Navajo Reservoir. Reclamation is developing a hydrologic model of the San Juan basin and is continuously developing new operating criteria to meet instream flow recommendations and projected future demands on the reservoir.

9.8. Basin-Wide General Alternatives

The Planning Committee developed several alternatives that would serve multiple watersheds or would be universally applicable to all or multiple watersheds. Following is a listing of the Basin-wide General Alternatives:

1. Encourage settlement of the Navajo Nations' water rights
2. Conservation – indoor and outdoor municipal uses
3. Global municipal and irrigation pipeline from Navajo Reservoir

4. Agricultural improvements – on-farm and canal improvements
5. Groundwater exchange to NIIP and/or Navajo-Gallup Pipeline
6. Water Banking
    a. Acquire right to store existing direct flow rights in Navajo Reservoir
    b. Leasing of crops
7. Additional funding for the Office of the State Engineer

9.8.1. Navajo Nation Water Rights Settlement

The Planning Committee recognizes that the Navajo Nation water rights settlement is critical to the water resources of the entire San Juan Hydrologic Unit. The Regional Water Plan hereby states the Committee's encouragement of the State of New Mexico and the Navajo Nation to continue their efforts to settle the Nation's water rights.

9.8.2. General Discussion of Conservation Measures

The Planning Committee recognizes that conservation needs to be a key component of the Regional Water Plan. National average demand for municipal water is 179 gpcd in 1995.[9] The Upper Colorado region averages 257 gpcd. The San Juan Hydrologic Unit usage is between 50 gpcd in some of the rural areas and 305 gpcd in Farmington[10] (Volume IV, Water Demands Assessment Report). Consequently, this Regional Plan recognized anticipated increased per capital usage in rural areas and recommends conservation in urbanized areas.

Conservation efforts can be classified as those that 1) reduce consumptive use and diversions requirements and 2) those that reduce diversions requirements only. An example of a conservation measure that reduces consumptive use is xeriscaping where high consumption plants are replaced with plants that require less consumptive use. An example of a conservation measure that reduces diversion but not consumption is low-flow toilets. Neither low-flow or high-flow toilets consume water; however the high-flow toilets require greater diversions, water treatment and wastewater treatment than the low-flow toilet. Section 9.7.3 contains conservation efforts identified by the Planning Committee as conservation measures that are recommended.

In general, water conservation can be focused on two major uses of water within the San Juan Hydrologic Unit. The two uses are categorized broadly as 1) agricultural irrigation and 2) municipal and industrial (M&I) uses. There have been numerous studies and case histories that are well documented in the literature that discuss many aspects of implementing water conservation programs that have been developed at the national, state and local levels. This section of the Plan is not designed to be an exhaustive discussion of all methods and approaches in implementing effective water conservation strategies, rather, a discussion on what water users in the region may reasonably be able to implement, in a general context, to improve water use efficiencies to incrementally reduce certain demands in the two major use categories. Those water users that need further information regarding their particular needs are encouraged to contact the appropriate federal and state agencies that have specialized

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[9] http://water.usgs.gov/watuse/pdf1995/pdf/public.pdf
[10] Water Demands Assessment Report, San Juan Hydrologic Unit Regional Water Plan, Vol. IV, Table 18.

programs and assistance for irrigators and communities wishing to implement a water conservation program.

Over the last decade, there has been extensive discussions regarding how competing uses of water in the southwest and New Mexico are on a collision course that may lead to serious “water wars” never before seen. Concerns about the health of flowing rivers and species that live in and by western rivers have added additional conflicts, taking the form of expensive litigation and court decrees that are difficult and costly to implement. Much has been made of the potential for water conservation programs to be a mechanism to resolve or minimize these conflicts. But in many cases, careful analyses of the net effects of implementing water conservation programs on the scale necessary to free up sufficient water supplies to resolve serious conflicts has exposed that conservation in and of itself is not the answer. Generally speaking, water conservation can and should be considered under a comprehensive package of water supply management goals and alternatives.

Under the regional water planning agenda, water conservation must be considered as a viable part of the region’s supply. It does appear that water conservation programs and requirements are increasingly being legislated to assure that water managers and users have fully considered and implemented water conservation programs prior to new transfers being pursued. On the one hand, it is important for regulators responsible for protecting the state’s water resources to prevent wasteful practices but on the other hand, those advocating stringent rules and regulations that implement mandatory water conservation programs must be careful not to count on conservation as a means to meet new appropriations or environmental in-stream flow targets. Extreme conservations measures must be reserved for times of drought and not serve entirely to meet new demands. This will only serve to exacerbate the condition of over appropriations now experienced in every basin in New Mexico even the San Juan.

9.8.2.1. **Irrigation**

Over a century of extensive alterations of the west and New Mexico’s river systems for developing the agricultural economy has resulted in new ecological balances that, if altered again by implementing water conservation goals often results in unintended consequences. Implementing higher irrigation efficiencies such as canal lining may create a net reduction in senior user diversion demands but may also result in a net reduction in existing wetland habitats that have evolved from irrigation operations. In addition, irrigation efficiencies may also reduce groundwater percolation altering other systems in a current state of equilibrium and perhaps increasing salinity and other minerals in agricultural runoff. In New Mexico water law, water savings by senior diverters will have the effect of decreasing shortages to junior appropriators that may not be the intended purpose of the program.

The current ratio in New Mexico for water use approximately 80% agriculture and 20% M&I**.** It is assumed by many that increasing urban needs will flow from retirement of agricultural uses over time under the economic theory of free market pricing through supply and demand. Left to this “invisible hand” without consideration of impacts upon the rural and ecological environment of the lost crop lands and water operations associated with that loss, may not necessarily be in the best interest of the community or the region. To some extent, well planned agricultural water conservation programs may be an alternative to taking lands out of production. Regional planning can promote the dialogue between urban and rural communities to determine the best course of action in preserving the character and environment of the region.

As urbanization of areas previously under agriculture occurs, senior rights revert to new appropriators such as municipalities and industrial users through a process of transfers. This is not an orderly process and generally there is minimal consideration of the net effects on the agricultural water environment. Return flows that were associated with these lands cease as the "consumptive use" portion of the water right is transferred eliminating the off and on farm portion of the use that is non-consumptive from the irrigation system. Careful analyses of the net effects on the stream flows and the impacts to junior diverters requires extensive resources of the state and water users concerned with the impacts. Therefore, it is important to implement policies assuring that these new transfers are and will be used responsibly to protect the public welfare. Water conservation requirements on the receiving entity may be one measure of assuring responsible use of the resource.

There are three components to agricultural water use, the crop requirement referred to as the evapo-transpiration (ET) required for the crop to grow to maturity for harvest, the on-farm delivery requirement to get the water to the crop from the farmers' head gate, and the off-farm conveyance requirement that is needed to deliver water to the farmer's head gate from the diversion point from a river or dam. Each component has a certain water demand that varies with location, soil types, drainage, channel conditions, etc. When discussing water conservation opportunities within a given irrigation system the focus is on two of the three components, the off and on-farm delivery efficiencies. Crop ET sometimes referred to also as the consumptive use portion of the water right is generally a fixed number for a particular crop so except for altering the genetics of the crop itself or retiring of the acreage under cultivation, there is not much opportunity for reducing the demand of this component. As stated earlier, several agencies at the federal and state level have studied these issues extensively and have programs that most farmers are aware of and have used to improve their crop yields and increase their water efficiencies (in theory reducing costs and increasing profits). Following are general guidelines that can be investigated as possible sources of conserved water.

1) On-farm efficiency improvements – Crop types, soils and topography are the three main factors in determining the desired water delivery systems. Farms that have historically used flood irrigation systems, which constitutes a large percentage of approaches in the Basin, may be able to better control the diversion and application rates by leveling their land if the topography will allow, using alternative methods of application such as a center pivot or wheel lines. Siphon tubes on lined ditches have been implemented in areas where row crops are grown leading to higher efficiencies. Head gate measurement is key to providing the farmer and the irrigation district with the knowledge needed to better manage water and hence costs of the farm. The net savings opportunities come from reduction of water lost to deep percolation from unlined ditches, tail water runoff from unleveled fields, and additional evaporation from standing water in the fields. Implementing these types of on-farm improvement have increase crop delivery efficiencies from 50 to 200% in given circumstances reducing the on-farm demand from a large percentage of the crop ET rate down to a much smaller

percentage, again depending on circumstances. The down side is that these are costly measures and may not be economical for the Basin given the current cropping patterns and other factors.

2) Off-farm efficiency improvement – Irrigation system improvements may be the biggest bang for the buck in looking at deriving a net water savings by reducing total irrigation demands. Most irrigation delivery entities are run by a board with certain authorities depending upon their charter. Most collect assessments to perform annual operation and maintenance required of the diversion point(s), the delivery canals, the waste ways, access roads, and other features associated with the facilities. The general economic conditions of the membership is the limiting factor in the level of assessment capacity and hence, the level of management conducted on facilities. Federally constructed facilities usually have higher O&M requirements than non-federal facilities. Several opportunities are available for increasing operational efficiencies: Diversion point, lateral and head gate metering is a necessity in providing the entity with valuable operational data. Daily ditch rider management that assures only the diversions required are taken and that waste ways are regulated accordingly. De-vegetation of main canals, laterals, and waste ways reduces phreatephyte ET. Canal and lateral lining can significantly reduce seepage rates and increase delivery efficiencies. Piping water where feasible will reduce transport evaporation. Again, all these improvements have varying degrees of added expense to the operating entity and the agriculture economy. The agricultural economy, particularly feed crops, will likely not support the higher cost options without funding from outside sources.

Given the nature of the agricultural systems in the San Juan basin, the priorities for improving water efficiencies should be focused in a manner that allows for the irrigation entities to use grant funds and other resources to move toward a best management practice approach in an affordable manner. In this way, irrigation entities can move toward management of their systems that will help them achieve diversion goals that will be consistent with state administration and give them the data needed to more effectively deliver water to their customers. The following priorities are recommended in implementing BMP's and water conservation initiatives.

1) <u>Water Measurement</u> - NMISC is entering into agreements with all major water diverters on the Animas and San Juan to install diversion point measuring systems that will be satellite monitored for management purposes. In addition, entities should consider getting major laterals and waste ways metered (and possibly semi-automated). Implementing programs to assist farmers to meter turnouts is also recommended. Several programs are available to assist districts and farmers to meter systems. Knowing specific water use and managing accordingly can increase overall efficiencies with a relatively small investment.

2) <u>Active Management</u> - All irrigation companies would benefit by increasing management activities associated with monitoring water deliveries, reducing vegetation within canals, laterals, and waste ways, and working on scheduling and rotation programs with the farmers to minimize diversions.

3) On-Farm Improvements - Irrigation companies can encourage members to look at a full range of on-farm improvements that may increase yields and reduce the net on-farm water losses.

4) Major System Improvements - As water needs for municipalities and environmental purposes increase, irrigation companies can investigate the possibilities of partnering with others in making significant (and costly) system-wide improvements. These would be subsidized projects in exchange for the water saved.

9.8.2.2. **Municipal and Industrial Conservation**

In general, the approach of the regional water planning process and specifically in this Plan, is to 1) identify areas that have the potential of reducing net demands through implementation of a water conservation program; 2) make recommendations as to how implementation of these programs may proceed; and 3) determine what benefits the communities and the region as a whole would derive from such programs.

The cost of acquiring new water rights and constructing new water development projects is escalating rapidly. Market prices for senior agricultural water rights have now exceeded $2,000 per acre-foot of the consumptive portion of the right. A drought of proportions not know in the last century has occurred during the past 5 years leading to shortages from Navajo Reservoir for the first time since the dam's construction. All of these issues are having the effect of tightening the water rights market likely leading to higher costs for municipalities and industrial users for future growth and economic expansion.

One component that is important to look at for planning purposes is what level of investment versus net water savings can a community or industrial user make in conserving water to meet future needs. In addition, it will be important to plan for the likely potential that future legislation at the federal and state levels may compel some level of water conservation on future water supply acquisitions as a condition of use. Although there is potential for moderate conservation to yield water for future needs in most communities, it is very important to provide some degree of flexibility in a community's water use strategy to reserve a significant portion of its water conservation potential for a drought reserve. This will minimize the potential for a community to over extend its water resources for new growth while exposing the entire community to water shortages or even outages during drought periods. A good rule of thumb for community water supply planning is to never drop below a 10% reserve of its annual average demand and to reserve at least half of the community's water conservation potential (the more painful actions) for weathering severe droughts.

Following are the major areas that communities can look at in developing and implementing a water conservation program.

1. Metering and Data - First and foremost, a community must have knowledge of its water use. Un-metered or under metered customers present enormous challenges in trying to implement an effective program. A quality meter reading program and water use/billing data base is also a key to establishing the baselines of customer water use that is critical in making decisions on what water conservation program will work in a community. There should also be differentiation between customer classes such as residential, small and large commercial, institutional, etc. This will provide

the appropriate data to structure rates that encourage water conservation while not penalizing those that have limited abilities to conserve. **It cannot be overemphasized that a poor metering and billing database is the weak link in implementing a quality water conservation program.**

2. Rates and Fees - With good data, communities can structure their fees and rates to induce moderate conservation goals, 5 to 15% of total demand, targeting the upper end of water use during peak months of production. This is normally the utilities' highest cost of production and if that can be curbed with rate incentives, the utility can generally balance new revenues and production costs savings to revenues lost through reduced demand. This rate structure is likely to encourage large water users to invest in permanent water saving devises through retrofitting existing systems and designing new systems to utilize best management practices (BMP's) in water conservation.
3. Education - The success of a good water conservation program for the long–term involves a commitment on the part of the utility to educate their customers and future customers as part of a recurring program. Bill stuffers, pamphlets, advertisements and workshops for existing customers are good investments, particularly if regional water issues are in the news. Programs targeting older elementary students and their parents in cooperation with the school systems have proven to be successful in recruiting wise users of water in the future. Setting up resources in the utility for specific water audits and recommendations for individual customers is a more costly step but one that serves the customers well.
4. Infrastructure - Implementing programs that mandate water saving devises in new construction is a low cost action that generally does not significantly increase the cost of new housing but can be sold to home buyers and financial institutions on the basis of reduced overall household operating expenses. Retrofitting existing facilities and homes is a more costly option and generally requires some form of subsidy from the utility to provide adequate incentives for homes and businesses to sign up. However, if the rate structure is very punitive on the higher end of typical water use, this may provide sufficient incentives for customers to invest in their own water management program. Again, water audits provided by the utility can help customers make informed decisions on this issue.
5. Turf Management - One of the high production costs for any water utility in the southwest is the peak summer demands associated with turf watering. Most turfs, even Kentucky bluegrass, are over watered or watered too frequently. City parks departments may want to invest in semi-automated systems that are tied to plant stress (soil moisture) for triggering sprinklers for large turf areas controlled by them. Programs to educate home owners on wasteful practices are encouraged and it may be appropriate to adopt regulations to encourage proper watering of turf areas.
6. City and County Building and Land Use Codes - Each individual entity or the collective entities within the planning region needs to review its regulations to see if existing codes inadvertently induce wasteful water use in building codes and land use ordinances. Incentives and directives are options to be included in regulations regarding new construction and remodeling. It is strongly recommended that communities that are vulnerable to water shortage due to drought or other problems need to develop a water emergency management plan that provides for particular

actions that limits water use relative to the level of emergency anticipated. Many communities have enacted water emergency ordinances that call for certain actions at varying stages of shortage severity. There are models available for those communities wishing to adopt drought contingency plans.

These are the major tools available to communities that believe it is important to implement a water conservation program and water emergency regulations. Before embarking on a particular program, it is important to determine what the community's conservation goals are and what purpose they are hoping to obtain through the program. That process requires an intimate engagement with the customers and community members so that there are "no surprises". A great water conservation program poorly communicated can lead to disastrous implementation and political fallout. It is wise to invest in a quality plan that is well communicated to the affected customers and the desired outcome must be well understood by the community and hopefully bought into by a majority of the constituents. A well thought out implementation plan designed specifically for the community is worth it weight in water so that reaching the desired level of water savings becomes a routine and relatively painless process for the customers. In this manner, most communities in the San Juan basin can save up to 5 – 20% of its existing demands through implementing a program over a reasonable time frame of 3 to 5 years. This will have the effect of giving the community a growth and drought reserve without the investment in expensive water rights or infrastructure at present. Added to the entire water supply portfolio, water conservation can be a legitimate approach to a moderate increase in available water supply but it important that a community does not come to rely solely on conservation to deal with its water supply issues. The sponge can only be wrung out so much until it begins to get painful for water customers and begins to put the entire community's water security in jeopardy.

9.8.3 **Conservation Measures Specific to SJHU**

9.8.3.1 **Reduction of Consumptive Use and Diversions Requirements**

<u>Limit Water Use on Mesa Areas</u> – Water used for outdoor use and indoor use to septic systems on the mesas does not return flows to the river systems for many years[11]. Consequently, irrigation of urbanized lands on the mesas and septic tank discharges on the mesas are essentially 100 percent consumptively used with respect to return flows to the hydrologic system. This conservation measure is to encourage municipalities to restrict or prohibit non-xeriscape landscaping on mesas and to require sewer collection and treatment for all new developments on the mesas.

<u>Xeriscaping for Non-Mesa Areas</u> – The Regional Plan encourages municipalities to promote xeriscaping by providing development incentives and water rate structuring to encourage xeriscaping. The cost of xeriscaping 1,000 square feet is approximately $1,670[12] and the water savings is approximately 0.034 acre-feet. Using a 20 year period, xeriscaping is very cost effective at only $202 per acre-foot. Assuming 7,000 square-feet landscaping per resident and 3.2 persons per resident, xeriscaping can result in a reduction in use of approximately 70 gpcd.

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[11] Draft Return Flow Credit Plan, March 1998, San Juan Water Commission
[12] "Residential End Uses of Water", AWWA Research Foundation, 1999

Procedures for enacting landscape ordinances can be found in New Mexico State Engineer Office , Technical Publication 48, "Water Conservation and Quantification of Water Demands in Subdivisions, A Guidance Manual for Public Officials and Developers" by Brian Wilson, dated February 1996.

9.8.3.2 **Reduction of Diversion Requirements Only**

Low Flow Toilets - Low-flow toilets conserve 10.5 gallons per capita day[13]. This equates to approximately 0.02 acre-foot per year per residential unit. At a cost of $150 per toilet and a 10 year life, low-flow toilets cost approximately $750 per acre-foot saved. It would require replacement of 50,000 standard toilets with low-flow toilets to reduce diversion demands by 1,000 acre-feet.

Low Flow Shower Heads - At a cost of $40 each, low-flow shower heads conserve 2.5 gallons per capita day. This is approximately 0.0048 acre-feet per year per residential unit. Assuming a 10-year life, this results in a cost of $828 per acre-foot. It would require replacement of 208,000 standard shower heads with low-flow heads to reduce diversion demands by 1,000 acre-feet.

Both of the above conservation measure are including in the International Plumbing Code (IPC), which is adopted by most incorporated communities[14]. Consequently, between now and the planning horizon 2044, all new plumbing fixtures will be classified as low-flow conservation fixtures. Therefore, these conservation measures require no effort other than on-going adoption of the IPC.

Improvement to Irrigation Canals - Improvement of irrigation canals to reduce seepage and operational waste would result in reduced diversion requirements. Furthermore, incidental consumptive use of plants supplied by seepage would be diminished. Improvements to canal systems in the San Juan Hydrologic Unit could reduce diversions and perhaps improve downstream water quality at the same time reducing return flows and groundwater recharge. The positive impacts may be negated by the loss of groundwater recharge, timing of return flows and environmental impacts associated with the loss of riparian areas near canals. Each canal would experience results different from every other canal within the basin. Because this Regional Plan is watershed based, no canal improvements were identified that would benefit a specific watershed. Nevertheless, canal improvements should be considered on a case by case basis to determine whether the benefits are greater than the negative impacts.

On-Farm Irrigation Efficiency Improvements - On-farm irrigation practices can be improved to reduce the amount of diversion requirement. However, plants will consume the same amount of water, regardless of the application method. Actually, some efficient irrigation practices will result in better crop growth, resulting in increased consumption. Sprinkler irrigation has a consumptive use, spray evaporation, not associated with flood irrigation. Following is a summary of irrigation efficiencies by application method[15]:

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[13] Residential End Uses of Water", AWWA Research Foundation, 1999

[14] International Plumbing Code, P604.3

[15] "Brian Wilson, State of New Mexico, A Short Course on Irrigation Efficiency

Table 9-4

Application Method	Efficiency Percentage
Flood	50
Sprinkler	65
Sprinkler (1/2 drop down heads)	80
Sprinkler (full drop down heads)	95

Improvement to on-farm irrigation practices reduces runoff and consequently improves downstream water quality. It can potentially reduce consumption by off-farm plants that benefit from this runoff. This Regional Plan did not identify any specific watersheds whose water supply would benefit from improvements to on-farm irrigation practices.

9.8.3.3 **Conservation Education in San Juan Hydrologic Unit – Water Fair Program**

The San Juan Water Commission annually sponsors a conservation education program called the "San Juan Basin Water Fair". One goal of the Water Fair program is to promote public awareness that each individual's daily water use, and the conservation practices each individual implements, makes a difference in the quality and quantity of water in the Basin. This educational program provides a forum to familiarize young and old alike, as to whom the water users are, and how different water uses impact the water supply in the San Juan Basin. By providing an interactive forum, the participants hear conservation ideas and see conservation techniques they can adopt into their daily routine. This new knowledge helps them realize that by incorporating even one conservation technique into their daily lives, they can play an essential role in protecting and increasing the Basin's limited water supply.

Water issues are inherently complex and obtaining the public support required to implement and sustain water conservation practices requires an extensive educational program. Even though early education influences the acceptability of water conservation practices, no formal curriculum on water conservation is currently required in New Mexico's schools. The Water Fair program helps bridge the gap between the lack of 'formalized' water conservation curriculum and the need for conservation education. Research indicates that fifth grade students are the optimum age-group to target for achieving long-term conservation goals and the school system provides the opportunity to present water conservation techniques and ideas to more than 1,500 individuals (students, teachers, and the general public.) Because public participation and the public's willingness to accept water management ideas are central to successful conservation implementation, the Water Fair's format is specifically designed to introduce new and unfamiliar water management tools to these young water users.

In a relaxed atmosphere exhibitors expose the participants to both theoretical and practical water conservation methods by using different forms of teaching stimuli, including print material, video, 'models', and experiments and demonstrations that require hands-on participation by the students. Interaction with water conservation specialists and the hands-on demonstrations and experiments acquaint young people, teachers, and the public with many different aspects of conserving water, which in turn, generates awareness of the crucial role that water management plays in the Basin. Annually presenting the Water Fair stresses the importance of water education and fosters the discussion of conservation issues within the educational system and throughout the community as a whole. By sharing the Water Fair experience with their family and friends, the estimated 1,500 student, teacher, and public participants convey the conservation message to an extended audience of 6,000 to 12,000 people throughout the Basin.

With every individual that incorporates water conservation into their daily routine as a contributor, the lasting legacy of educational programs like the Water Fair will be a water supply that supports and sustains a stable and reliable environment to live in.

9.8.4. **Global Municipal Delivery from Navajo Reservoir** (Navajo-Farmington Pipeline)

9.8.4.1. **Description**

Several members of the Planning Committee identified an alternative that would deliver high quality water from Navajo Reservoir to all the irrigators and municipal wholesalers between Navajo Dam and Farmington. The intent would be to provide for all the demands for the Upper San Juan Watershed and municipal demands in the Animas and La Plata Watersheds. Following is a summary of the cumulative peak month demands for this alternative.

Table 9-5

Peak 2044 Diversions (AF)	**July**
Upper San Juan Industrial	375
Upper San Juan Municipal	686
Animas M&I	3547
La Plata M&I	350
AF/month	4958

This peak demand equates to a flow of 80 cfs from Navajo Dam to Bloomfield and 58 cfs from Bloomfield to Farmington. These flow rates require a 42-inch diameter and a 36-inch diameter pipeline respectively, assuming a maximum velocity of 8 feet per second.

The elevation difference between Navajo Dam and Farmington is approximately 750 feet, which is excessive for operations and pipeline design. Consequently, this alignment would require two pressure reducing stations, likely sleeve-valve flow control structures.

9.8.4.2 **Cost Estimate**

Following is a reconnaissance level cost estimate for the Navajo-Farmington Pipeline. The estimate is based on open ground construction and does not include costs for asphalt replacement, plant restoration or utility conflicts resolution.

Table 9-6

Reconnaissance Estimate Navajo-Farmington Pipeline					
				Prepared by	Rick Cox J-02
Item	**Quantity**	**Unit**	**Materials Unit Cost**	**Installation and Labor Cost**	**Total Cost**
Pipeline					
42-inch RCCP Pipeline	132,000	l.f.	$ 75.00	$ 30.00	$ 13,860,000
36-inch RCCP Pipleline	62,304	l.f.	$ 55.00	$ 20.00	$ 4,672,800
Valves and fittings (10% of pipe cost)					$ 1,853,280
Sleeve Valves Stations	2	ls			$ 500,000
				Subtotal	$ 20,886,080
				Engineering, Admin (20%)	$ 4,177,000
				Contigencies (25%)	$ 6,266,000
				Total	**$ 31,329,000**

Additional costs associated with NEPA and ESA compliance is not included in this reconnaissance level estimate.

9.8.5. Agricultural Improvements – On-Farm and Canal Improvements

Refer to Section 9.8.2.1 and Section 9.8.3.2 for discussion

9.8.6. Groundwater Exchange with NIIP and/or Navajo-Gallup Pipeline

9.8.6.1. Description

Based on the geologic information reviewed for the Water Supply Assessment Report, Vol. III, of the Regional Water Plan, Blanco Canyon has a 14,800 supply of high quality groundwater[16]. This provides an opportunity to develop this resource, deliver the supply to either NIIP facilities or the proposed Navajo-Gallup Pipeline in exchange for release of water to the San Juan River, where it would be diverted by either Bloomfield or Farmington for municipal uses.

The costs estimate for this alternative would be the same as for the development of shallow groundwater in the Animas Watershed. The only facilities would be non-potable grade wells and pump stations with short delivery lines. No new facilities would be required to deliver water from Navajo Reservoir.

9.8.7. Water Banking

Two water banking alternatives identified for the San Juan Hydrologic Unit are:

1. Storage of existing direct flow water rights in Navajo Reservoir
2. Temporary leasing of crops to obtain water for municipal purposes.

[16] Water Supply Assessment, San Juan Hydrologic Unit Regional Water Plan, Vol. III, Table 1.2-1

Storage of existing direct flow rights - This alternative would involve storage of existing direct flow water rights of the Middle and Upper San Juan Watershed in Navajo Reservoir on a space available basis. There are no costs associated with additional facilities; however, there would be reimbursable cost to Reclamation for the Navajo Reservoir facilities. These costs could be negotiated once approval to store was determined to be viable.

Crop Leasing - The purpose of this alternative would be to contract with agricultural producer(s) prior to a drought in order to purchase water by replacing the revenue generated by his crop during that drought period. The mechanism would be an annual option payment to the irrigator that would obligate him to accept the execution of the option. This alternative is applicable to any watershed that has both municipal demands and agricultural irrigation. A detailed analysis of crop leasing in the Animas Watershed is described in Section 9.4.3.

9.8.8. Additional Funding for the Office of the State Engineer

The New Mexico Constitution declares that all surface and ground water belongs to the public. On the other hand, administering and protecting water rights, and overseeing adjudications are the responsibility of the Office of the State Engineer. In the San Juan Basin Hydrologic Unit, the Office of the State Engineer has not had sufficient resources to adequately discharge his responsibilities. For years, the Office of the State Engineer has lacked the resources to properly administer and protect New Mexico’s water rights, and general stream adjudications in the San Juan Basin Hydrologic Unit and throughout the State have languished for decades. Even now, insufficient resources frustrate the efforts of the State Engineer and the Office of the State Engineer continues to operate inefficiently and is unable to address protests and requests for water transfers, in a timely manner. The Office of the State Engineer must have the resources to efficiently and effectively fulfill all the responsibilities of the Office of the State Engineer. This Region’s water users can no longer tolerate this situation and it is recommended that consideration be given to upgrading the current State Engineers office in Aztec to a District Office, with a Water Master, and a commensurate increase in manpower and funding.

9.9. Navajo Nation Water Plan Alternatives

The Navajo Nation Department of Natural Resources provided the information for Section 9.9

The Navajo Reservation was established in 1868, and has been expanded through a series of executive orders to become the largest Indian reservation in the United States. Within Region 2, this expansion began with the Navajo Treaty Reservation, which was established by Article 11 of the Treaty on June 1, 1868. It was expanded by the second addition to the Navajo Treat Reservation on the south and the east by executive orders of January 6, 1880, May 17, 1884 and April 24, 1886. A series of later executive orders from 1907 through 1912 added additional land around Crownpoint known as the “Checkerboard”. Since the 1960’s additional lands were acquired for the Navajo Indian Irrigation Project, and through small acquisitions and exchanges.

Larger than the state of West Virginia, the Navajo Nation encompasses more than 27,000 square miles including portions of Arizona, New Mexico, and Utah. According to the U.S. Census Bureau, in 2000 the on-reservation population was 183,000. Approximately one third of the Navajo Nation’s land base and population are within the State of New Mexico. The 2000 U.S. Census reported that approximately 300,000 people indicated that they had a Navajo background.

Even after more than 100 years of federal trusteeship, the Navajo Nation faces serious economic and social challenges. In 1999, the Navajo Division of Economic Development reported that the median family income was only $11,885 while the U.S. median family income was more than $30,000. The average per capita income for the Navajo Nation was less than $6,200 while the per capita income for the State of Arizona was approximately $25,000. More than 56 percent of the Navajo families on the reservation lived below the federal poverty levels, compared with less than 13 percent of the general U.S. population, making it among the most impoverished regions in the United States. The Navajo unemployment rate on the reservation is 54 percent, compared to an unemployment rate for the U.S. of approximately 5 percent. These disparities show no sign of narrowing, and while the surrounding regional economy has boomed, these gaps in income, unemployment, and poverty have widened. The Navajo Housing Authority estimated that the Navajo Nation has an immediate unmet need for more than 20,000 housing units.

The Navajo Nation faces serious water resource problems. Many homes lack indoor plumbing. More than 50 percent of Navajo homes lack complete kitchens and between 20 and 50 percent of Navajo households rely solely on water hauling to meet daily water needs. Safe drinking water is a precondition for health promotion and disease prevention. The Navajo Tribal Utility Authority (NTUA) water users use far less water per capita than the other water users in the Region, yet pay among the highest water rates.

These grim statistics threaten the survival of the Navajo Nation. According to the Division of Community Development, due to the stagnation of economic development in Navajo country, the Navajo Nation is losing population to off-reservation communities, the Four Corners Area, and the other 46 states. Between 1980 and 1990 the Navajo off-reservation population in New Mexico, Arizona, and Utah grew by 125 percent, the Navajo population in the other 46 states grew by 71 percent, while the on-reservation population grew by only 22 percent. In 1996, the Navajo Nation Division of Community Development estimated that

without reducing the out-migration by 2012, more than half of the Navajo people might be living off of the Navajo reservation.

The Indian Health Service (IHS) is the pre-eminent domestic water development agency on the Navajo Nation. Public Law 86-121 authorizes IHS to provide essential water supply and storage facilities for communities and homes on the reservation. The IHS annually compiles the sanitation deficiency report of Sanitation Deficiency System (SDS) list for the Navajo Nation. The SDS ranks proposed water projects on very specific and objective criteria including health impact, water system deficiency, first water service, capital cost, operation and maintenance costs, and other contributions. The most important SDS criterion is the unit cost per house. Due to funding limits, it is not possible for the IHS to provide water from a public water system to every household on the reservation. To be feasible, homes must be served at a cost of less than $40,000 for the water supply and sewer service.

In 2001, the IHS identified $294 million in water system deficiencies, $78 million in sewer deficiencies, and $10.5 million in solid waste deficiencies. Approximately 40 percent of these deficiencies are in Region 2. However, the annual IHS budget for addressing sanitation deficiencies is only $13 million per year. The IHS also spent $10 million on water systems for new or nearly new homes. The IHS also leveraged an additional $7 million from other programs to supplement its construction program. Due to lack of funding, the HIS has a ten to twenty-year backlog of projects to meet existing demands.

For municipal water demand planning the NDWR recommends using the U.S. Census Bureau population count adjusted by an estimated undercount, a growth rate of 2.48 percent from the year 2000 through 2050, and a per capita municipal demand of 160 gallons per capita per day. Due to the difficulty in conducting an accurate census, determining the growth rate of the Navajo Nation is difficult. The Navajo Nation's reported annual increase in population changes dramatically from one census to the next. For instance, during the 1950s the reported annual growth rate was 3.57 percent, during the 1960s it was 1.45 percent, during the 1970s it was 1.76 percent, and during the 1980s it was 4.48 percent. (*1990 Census-Population and Housing Characteristics of the Navajo Nation*, Rodgers, 1993). In 1984, Reclamation used a projected population growth rate of 2.5 percent (*1984 Plan Formulation and Environmental Statement*, Reclamation, 1984). The Institute of Distribution and Development Studies at Colorado State University evaluated the changes in annual growth rates of the Navajo Nation and concluded that a reasonable growth rate for planning is 2.48 percent (*Employment and Incomes in the Navajo Nation: 1987 - 1988, Estimates and Historical Trends,* Eckert. et. al., 1989). In 1993, Northwest Economic Associates also developed a cohort model of the Navajo population and reached the same conclusion (*Support Documentation for Current and Projected Population of the Little Colorado River and N-Aquifer Basin*, NEA, 1993). Most recently, HDR Inc. reported that 2.48 percent was an appropriate midrange estimate for population projections (*Assessment of Western Navajo and Hopi Water Supply Needs, Alternatives and Impacts*, HDR, 2003). Part of the HDR justification for this growth rate was the possibility for significant in-migration due to the sizable population of Navajos living off of the Navajo Reservation, and the significant investment being made in housing, schools, roads, hospitals, utilities and other critical infrastructure.

A recent 1996 study by the University of New Mexico Bureau of Business and economic Research (BBER) estimated that the 1990 annual growth rate for Native Americans was 1.86 percent. That study combined members of the Navajo Nation, and the Pueblos of Acoma Laguna and Zuni. However, the BBER study did not adequately address how the current lack of critical infrastructure, including water facilities, is one of the greatest factors leading to stagnant economic growth and increased out-migration.

Per capita water use for Chapters depends on the accessibility of the water supply. An increase in per capita water use is correlated with community growth, development, and improved economic standards of living. Historic data for non-reservation communities in the region show that water use has increased over time and current average per capita use is at or exceeds 160 gallons per day. The 160 gallons per capita per day rate includes modest commercial and municipal demands comparable to cities such as Winslow, Arizona, or Gallup, New Mexico. By comparison, the nearby communities of Rio Rancho and Albuquerque use more than 200 gallons per capita per day (Brown et. al., 1996). Therefore, a municipal rate of 160 gallons per capita per day is used to determine the projected water demand.

As challenging as the current circumstances are, without dramatically increased water resource development, the future may be bleaker. Based on an annual growth rate of 2.48 percent and a per capita water demand of 160 gallons per capita per day, the total annual municipal water demand on the reservation will exceed 89,000 acre-feet by the year 2040. The water delivery systems will require a six-fold increase in capacity. Overcoming the legacy of economic neglect and the readily apparent deficits in the infrastructure will require a very aggressive water development program.

The lack of domestic and municipal water is the greatest water resource problem facing the Navajo Nation. The current demand for municipal water is not met by public water supply systems. No other region in the United States has such a large percentage of its population lacking in such a basic necessity as potable tap water. Access to adequate water is critical for economic growth and the survival of the Navajo culture. In response to this problem, the Navajo Department of Water Resources (NDWR) prepared the *Water Resources Development Strategy for the Navajo Nation* (Strategy Document, NDWR, 2000). A copy of the *Water Resources Development Strategy for the Navajo Nation* is located in **Volume II, Appendix A-5**. That document broadly describes the steps that the Navajo Nation can take to address municipal water development. These steps, and some of the specific projects, are described in the following sections.

9.9.1. Establishing a Water Resource Development Task Force, Which Will Coordinate Technical and Fiscal Resources of the Navajo Nation and Federal Agencies

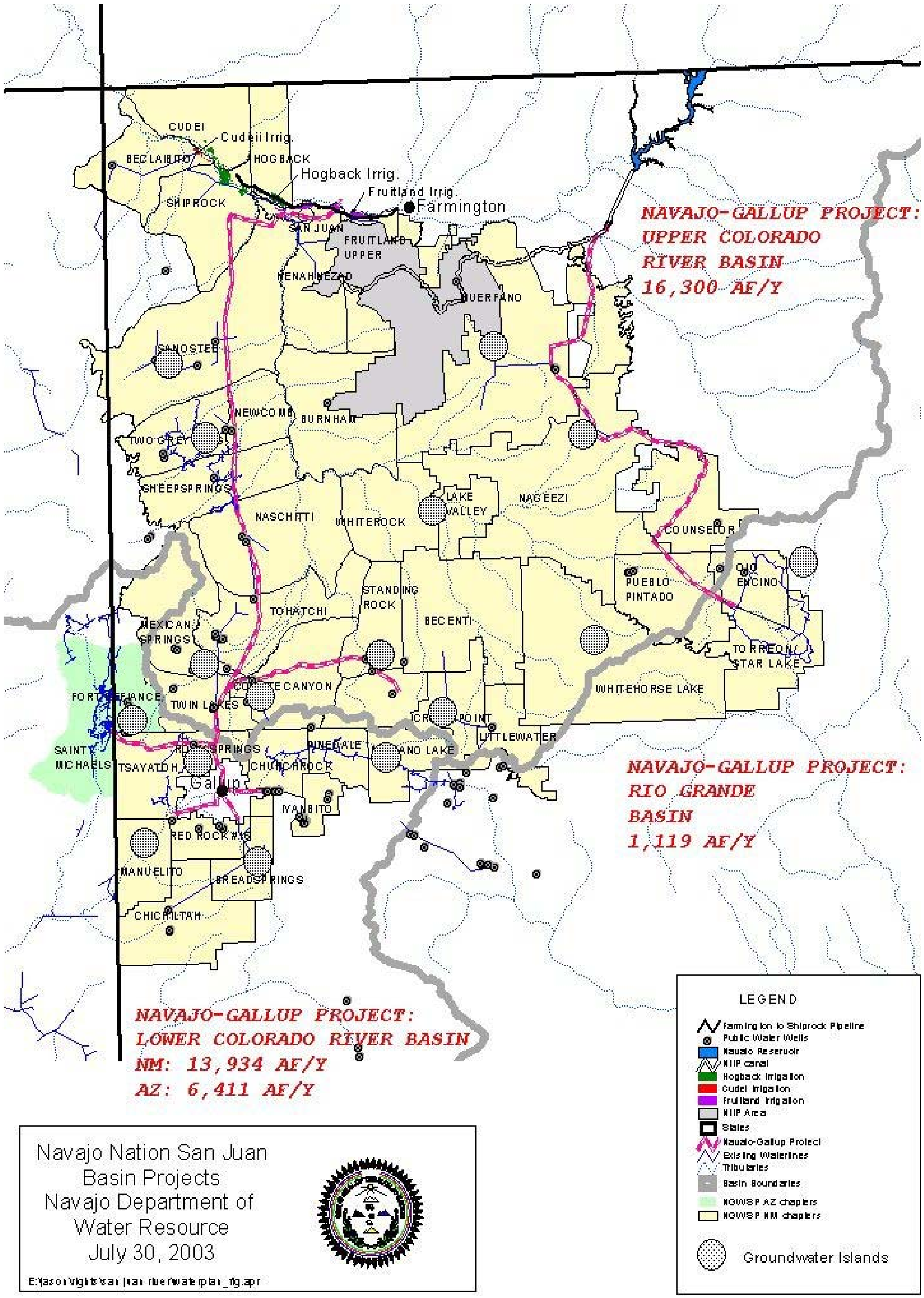
The Navajo Nation will work to ensure that its divisions work together under a single plan, and dedicate staff and resources toward its implementation. However, due to the magnitude and complexity of the deficiencies, to make significant inroads, the Navajo Nation must rely on the budgets and expertise of several Federal agencies. A water resource development task force will coordinate technical and fiscal resources of the Navajo Nation and Federal agencies. This will reduce agency redundancy and enable the agencies to utilize their combined resources more effectively.

9.9.2. Preparing a Reservation-Wide Needs Assessment and Prioritizing Water Projects

The Navajo Nation must systematically identify the full scope and needs of water development. The Navajo Nation is preparing a reservation-wide assessment of the local needs by assessing the water resource deficiencies throughout the reservation and establishing federal/tribal coalitions that can effectively construct the infrastructure identified in the needs assessments. The reservation will be assessed regionally by breaking the studies into manageable parts. The regions will be based on the service areas of the major water supply projects and on jurisdictional boundaries.

9.9.3. Developing Regional Water Supply Projects

The cornerstones of the Navajo water development strategy are several large, regional water supply projects that will provide new and reliable water for domestic and municipal use. Two of these projects, including the Navajo-Gallup Water Supply Project and the Farmington to Shiprock Pipeline, are in Region 2.


NAVAJO-GALLUP PROJECT:
UPPER COLORADO
RIVER BASIN
16,300 AF/Y
NAVAJO-GALLUP PROJECT:
RIO GRANDE
BASIN
1,119 AF/Y
NAVAJO-GALLUP PROJECT:
LOWER COLORADO RIVER BASIN
NM: 13,934 AF/Y
AZ: 6,411 AF/Y
CUDEI
Cudeii Irrig.
BECLABITO
HOGBACK
Hogback Irrig.
Fruitland Irrig.
SHIPROCK
Farmington
SAN JUAN
FRUITLAND
UPPER
NENAHNEZAD
HUERFANO
SANOSTEE
NEWCOMB
BURNHAM
TWO GREY
SHEEPSPRINGS
NASCHITTI
WHITEROCK
LAKE
VALLEY
NAGEEZI
COUNSELOR
PUEBLO
PINTADO
OJO
ENCINO
TORREON/
STAR LAKE
STANDING
ROCK
TOHATCHI
BECENTI
MEXICAN
SPRINGS
COYOTE CANYON
TWIN LAKES
FORT DEFIANCE
WHITEHORSE LAKE
LITTLEWATER
PINEDALE
CHURCHROCK
SAINT
MICHAELS
TSAYATOH
Gallup
IYANBITO
RED ROCK
MANUELITO
BREADSPRINGS
CHICHILTAH
LEGEND
Farmington to Shiprock Pipeline
Public Water Wells
Navajo Reservoir
NIIP canal
Hogback Irrigation
Cudei Irrigation
Fruitland Irrigation
NIIP Area
States
Navajo-Gallup Project
Existing Waterlines
Tributaries
Basin Boundaries
NGWSP AZ chapters
NGWSP NM chapters
Groundwater Islands
Navajo Nation San Juan
Basin Projects
Navajo Department of
Water Resource
July 30, 2003

9.9.3.1 Farmington to Shiprock Pipeline

The Shiprock Area is one of the fastest growing areas on the Navajo Reservation. By 2040 the population may approach 50,000. The Farmington to Shiprock Pipeline, also referred as the Navajo Municipal Pipeline, will supply water to meet most of the 2020 municipal water demands of seven Navajo Chapters along the San Juan River including Beclabito, Cudei, Hogback, Nenahnezad, San Juan, Shiprock, and Upper Fruitland. The 2020 municipal water demand is expected to exceed 5,100 acre-feet per year. The projected municipal water demands for these Chapters in 2040 are shown in Table 9.1. This pipeline was authorized for construction by the Colorado Ute Settlement Act amendments of 2000 (Public Law 106-554). The Navajo Department of Water Resources has not proposed any municipal groundwater development projects for these Chapters.

9.9.3.1.1 Description

This Farmington to Shiprock Pipeline is described in the *Animas La Plata Project Draft Supplemental Environmental Impact Statement* dated June 2000. The pipeline will divert up to 4,680 acre-feet of Animas La Plata Project water per year for the Navajo Tribal Utility Authority (NTUA) municipal public water system that provides water to the Upper Fruitland, Nenahnezad, San Juan, Hogback, Shiprock, Cudei, and Beclabito Chapters. This pipeline will be 29 miles long with a total storage capacity of 7.0 million gallons. The project water will potentially be conveyed through the City of Farmington's municipal system at a peak flow rate of 8.1 million gallons per day (or 12.6 cubic feet per second). In April 1999, Reclamation estimated that the cost would be approximately $24 million. The Bureau of Reclamation began field investigations in April 2003 and it is scheduled to be completed in 2006.

Table 9.1: Chapters Served by the Farmington-Shiprock Water Supply Project

Chapter	1990 Population	2040 Population	2040 San Juan Water Demand (AF/year)	Navajo-Gallup San Juan River Diversion	ALP San Juan River Diversion (AF/year)
Beclabito	388	1,321	237	118	119
Cudei	495	1,685	302	151	151
Hogback	740	2,519	451	226	225
Nenahnezad	1,253	4,265	764	382	382
San Juan	540	1,838	329	164	165
Shiprock	8,100	27,570	4,942	2002	2,940
Upper Fruitland	2,288	7,788	1,396	698	698
Total	13,804	46,985	8,421	3,741	4,680

9.9.3.1.2 Cost Estimate and Benefit

The primary benefit of the Farmington to Shiprock Pipeline will be 4,680 acre-feet of municipal water for the Shiprock Area. In the April 1999 Supplemental EIS, Reclamation estimated the cost of the pipeline to be $24 million.

9.9.3.2 **Navajo-Gallup Water Supply Project**

Regional water plans over the past 40 years have repeatedly identified the need for additional domestic, municipal and industrial water for the eastern portion of the Navajo Nation. In 1971, Congress authorized Reclamation to complete feasibility studies for the "Gallup Project." In 1975, the Navajo Tribal Utility Authority requested that the investigation be expanded to include municipal water supplies for Navajo communities in the eastern part of the Navajo Reservation. During the late 1970s and 1980s, investigations were conducted to develop and evaluate alternatives to meet these needs. In 1984, Reclamation completed a draft Environmental Impact Statement. In the late 1980s, the Project stalled in part due to the Navajo Nation's concerns over the failure to complete the Navajo Indian Irrigation Project, and limitations to the Project's proposed service area. It also stalled in part due to Reclamation's concern over the long-term availability of water, the lack of quantified water rights for the project, difficulty in complying with the Endangered Species Act, and difficulty in financing the Project.

To meet the area's pressing need for domestic and municipal water, Project planning activities were reinitiated during the 1990's. A series of interdisciplinary technical reports was completed addressing engineering, cultural resources, biological resources, and the ability of the participants to pay for the project. These reports culminated in a NDWR March 2001 *Final Draft, Technical Memorandum, Navajo Gallup Water Supply Project* that consolidated the information needed by the Navajo Nation to present the Navajo Gallup Water Supply Project (Project) in the context of regional water development. A copy of the March 16, 2001 *Final Draft, Technical Memorandum, Navajo Gallup Water Supply Project* is located in **Volume II, Appendix A-6**.

To better characterize the water supply and demand of the region and of the Project's service area, the City of Gallup and the Navajo chapters were grouped into twelve municipal sub-areas. The sub-areas include: (1) The City of Gallup, (2) Central Project Chapters, (3) Crownpoint Area, (4) Gallup Area Navajos (Navajo land adjacent to the City of Gallup), (5) Huerfano Area, (6) Rock Springs Area, (7) Route 666 (now 491) Chapters, (8) San Juan River Chapters, (9) Torreon Area, (10) NAPI, (11) Window Rock, and (12) Thoreau-Smith Lake. Each subarea has a common public water supply system and water supply option. For each subarea both San Juan River surface water and local conjunctive ground water were considered.

Within the State of New Mexico, the Project service area is primarily encompassed by the State Water Planning Regions 2 and 6. The Central Project Chapters (Burnham, Lake Valley, White Rock and Whitehorse Lake), Crownpoint Area (Becenti, Coyote Canyon, Crownpoint, Dalton Pass, Little Water, and Standing Rock), Huerfano Area (Huerfano and Nageezi), Route 491 (666) Chapters (Mexican Springs, Naschitti, Newcomb, Sanostee, Sheep Springs, Tohatchi, Twin Lakes, and Two Grey Hills), San Juan River Chapters (Upper Fruitland, Nenahnezad, San Juan, Hogback, Shiprock, Cudei, and Beclabito), Torreon Area (Counselor, Ojo Encino, Pueblo Pintado, and Torreon), and NAPI are in Region 2. The City of Gallup, Gallup Area Navajos (Bread Springs, Chichiltah, Church Rock, Iyanbito, Mariano Lake, Pinedale, and Red Rock), Rock Springs Area (Manuelito, Rock Springs, and

Tsayatoh), and Thoreau-Smith Lake Area are in Region 6. Window Rock, the capital of the Navajo Nation, which is in Arizona, is not in a State of New Mexico planning region. The Navajo Department of Water Resources is completing chapter water plans for the Chapters within Regions 2 and 6.

National Environmental Policy Act (NEPA) compliance work is well underway. During 2001, Reclamation conducted public scoping meetings in Farmington, Shiprock, Crownpoint and Gallup. Based on public input at those meetings the Project's purpose and scope was defined. The Navajo Nation requires a supplemental water supply to augment the groundwater and to promote economic development. The City of Gallup, an important regional economic center to the surrounding Navajo and Zuni reservations, anticipates a one million gallon per day water supply deficit during its peak summer demand period by the year 2010. This project will to provide a forty-year potable water supply to more than 20 Navajo public water supply systems, the City of Gallup, processing water for the Navajo Agricultural Products Industry in New Mexico, and Window Rock, Arizona. As part of the scoping process, service to the southern portion of the Jicarilla Apache Nation has also been included. In April 2002, Reclamation completed the appraisal level planning report entitled *Navajo Gallup Water Supply Project Appraisal Level Designs and Cost Estimates*. The surface water components of the project have an estimated cost of $441 million. A copy of the *Navajo Gallup Water Supply Project Appraisal Level Designs and Cost Estimates* is located in **Volume II, Appendix A-7**.

The Project will divert approximately 37,700 acre-feet and deplete approximately 35,800 acre-feet of San Juan River Water. Based on the preferred alternative, the Project will divert 15,100 acre-feet water and deplete 13,229 acre-feet of San Juan River water for use within the Upper Colorado River Basin on the Navajo Nation within Region 2. The Project also includes 1,200 acre-feet of depletion that will be used within the Upper Basin by the Jicarilla Apache Nation at the Teepee Junction. The Project includes 13,934 acre-feet of depletion that will be used within the Lower Colorado River Basin in New Mexico. This value includes 7,500 acre-feet of depletion that will be used by the City of Gallup, and 6,434 acre-feet that will be used by Navajo chapters. The Project also includes 1,119 acre-feet of depletion that will be used in the Torreon Area within the Rio Grande Basin. Finally, the Project includes 6,411 acre-feet of water that will be used with the Lower Colorado River Basin in Window Rock, Arizona.

Reclamation investigated 12 configurations to meet the Project's purpose. On March 25, 2002, the Resources Committee of the Navajo Nation Council endorsed the San Juan River "PNM" Alternative, which was selected by the Project participants as the preferred alternative. According to Reclamation, Reclamation anticipates that the Environmental Impact Statement and the Record of Decision should be completed in early 2004.

In addition to the San Juan River depletions, the Project includes a conjunctive groundwater component. In 1998, groundwater production in the Navajo Gallup Water Supply Project service area was approximately 6,800 acre-feet per year. Of that amount, approximately 2,500 acre-feet were for the Navajo public water systems. The groundwater component will increase annual groundwater production to 3,200 acre-feet. This rate is considered sustainable by the Navajo Department of Water Resources (*Navajo-Gallup Water Supply Project Evaluation of Groundwater and Conjunctive Use Alternatives*, January 8, 1998).

Table 9.2 lists the groundwater production, San Juan River diversion, and San Juan River depletions associated with this Project. In May 2003, Reclamation initiated appraisal level studies of these conjunctive groundwater components. The first study will focus on the Dalton Pass, Crownpoint and Becenti NTUA public water system. The second study will focus on the Chapters from Huerfano to Torreon and the third study will focus on the Smith Lake Area. Table 9.2 also presents some non-Project water demands including the ALP San Juan River diversions and the potential demand of a power plant proposed by the Dine Power Authority.

Table 9.2 Municipal Water Demand by Basin for the Navajo-Gallup Water Supply Project

Municipal Subarea	Basin of Use	1990 Census Pop.	2040 Pop.	2040 Demand (AF/yr)	ALP Diversion (AF/yr)	2040 G.W. Production (AF/yr)	2040 SJR Diversion (AF/yr)	2040 SJR Depletion (AF/yr)
Central Area	UC	1,493	5,082	911		77	834	834
City of Gallup	LC	19,154	47,197	8,459		1,439	7,500	7,500
Crownpoint	UC	5,287	17,996	3,225		752	2,473	2,473
Gallup area	LC	7,904	26,903	4,822		506	4,316	4,316
Huerfano	UC	1,492	5,078	910		46	864	864
NAPI	UC			7,274			700	700
Rock Springs	LC	3,749	12,761	2,287		169	2,118	2,118
Route 491	UC	10,099	34,374	6,161		795	5,366	5,366
San Juan River	UC	13,804	46,985	8,421	4,680		3,741	1,871
Torreon	UC/RG	3,797	12,924	2,316		77	2,240	2,240
Jicarilla	UC			1,200			1,200	1,200
N.M. Upper Colorado	UC	34,012	115,767	28,023		7,050	16,300	14,429
N.M. Rio Grande	RG	1,960	6,672	1,196		77	1,119	1,119
N. M. Lower Colorado	LC	30,807	86,861	15,568		2,114	13,934	13,934
N.M. Total		66,779	209,300	44,788		9,241	30,153	28,282
Ariz. Total	LC	11,767	40,052	7,179		767	6,411	6,411
Municipal Project Total		78,546	249,352	51,967	4,680	5,328	37,764	35,893
DPA Power Generation				25,000				

9.9.3.2.1 Description

The Navajo-Gallup Water Supply Project will deliver San Juan River water to the forty-three Navajo Nation Chapters, the southern portion of the Jicarilla Apache Nation, and the City of Gallup, New Mexico. This Project description is from the technical memorandum prepared by the participants entitled *Final Draft, Technical Memorandum, Navajo-Gallup Water Supply Project* dated March 16, 2001 (**Volume II, Appendix A-6**), and the Reclamation appraisal level planning report entitled *Appraisal Level Designs and Cost Estimates* dated April 2002 (**Volume II, Appendix A-7**). The Project depletions for each Chapter and subarea are shown in Table 9.2.

The preferred Project configuration is the product of approximately 40 years of progressively refined analysis. The San Juan River "PNM" Alternative includes the San Juan River Lateral and the Cutter Lateral. The major features of the Project include:

- San Juan Lateral and the Cutter Lateral
- Spurs to Window Rock, the Gallup Area, and Dalton Pass
- Storage tanks to serve the NTUA systems in each municipal subarea
- The Gallup/Rural Navajo Regional System
- Conjunctive groundwater components
- Water treatment
- Wastewater treatment

The Project will connect to existing and future NTUA, City of Gallup, and Jicarilla Apache public water systems. The conjunctive ground water components will connect separately into the existing public water systems.

The San Juan River Lateral will divert approximately 85 percent of the Project's water supply directly from the San Juan River below the confluences with the Animals and the La Plata Rivers at the Public Service Company of New Mexico's San Juan Generating Station diversion. The annual demand of the San Juan Lateral will be 20,600 acre-feet in 2020 and 33,000 acre-feet in 2040. The peak demand will be 23.9 MGD (or 36.9 cfs) in 2020 and 38.2 MGD (or 59.2 cfs) in 2040.

The San Juan River Lateral begins at the Public Service Company of New Mexico San Juan Generating Station diversion near Kirtland, New Mexico. The intake and water treatment plant will be on the north side of the San Juan River to reduce impacts on the recently completed fish bypass. This point of diversion enables the Project water to remain in the San Juan River to below the confluences of the Animas and La Plata Rivers. This point of diversion increases the hydrologic flexibility of the project's diversion reducing potential impacts on the endangered fish. This point may be able to take advantage of an existing diversion weir. And it ensures that flows released from Navajo Reservoir are in the river as far down stream as practical creating a number of benefits along the river channel. In addition, this point of diversion is upstream of the Chaco Wash, which contributes heavy sediment loads that make water treatment difficult.

The San Juan Lateral will proceed west along the Navajo Route N36 to U.S. Highway 491 (formerly Highway 666) serving the San Juan River Chapters. The route then proceeds south along Highway 491 toward the City of Gallup serving the Route 491 Chapters along the way. This lateral will have a spur at the junction of Highway 491 and Navajo Route N9 (the Coyote Canyon Junction) which will convey water east to Dalton Pass and the Crownpoint public water system. This lateral will have another spur at the junction of State Highway 264 and Highway 491 (the Yah-ta-hey Junction) that will convey water west to the Rock Springs and Window Rock public water systems. From Yah-ta-hey the Gallup Regional System will convey water through the City of Gallup and to the surrounding NTUA public water system that serve the Chapters of Churchrock, Breadsprings, Red Rock, Manuelito and Tsayatoh.

The Cutter Lateral diverts the balance of the Project water from the Cutter Reservoir in Largo Canyon. Cutter Reservoir is an existing component of the Navajo Indian Irrigation Project. The annual demand of the Cutter Lateral will be 3,000 acre-feet in 2020 and 4,760 acre-feet in 2040. The peak demand of this lateral will be 3.7 MGD (or 5.78 cfs) in 2020 and 5.4 MGD (or 8.3 cfs) in 2040.

The Cutter Lateral begins at the Cutter Reservoir. This lateral will proceed south toward U.S. Highway 550 (State Highway 44) where it will connect with the Huerfano and Nageezi NTUA public water systems. The route follows State Highway 44 for approximately 30 miles to Navajo Route 46. At this junction the Jicarilla Apache Nation will be able to convey water to the Teepee Junction. The route follows Navajo Route 46 south toward Navajo Route 9 serving the Counselor NTUA public water system. From Counselor the route proceeds south to Ojo Encino where it will provide water for the NTUA public water system serving Ojo Encino, Pueblo Pintado, White Horse Lake, and Torreon.

The Central Project Subarea includes the chapters of Burnham, Lake Valley, White Rock and White Horse Lake. The projected annual municipal demand for the area in the year 2040 is 911 acre-feet, of which 77 acre-feet will be met with groundwater. Burnham can be served directly from the San Juan Lateral. Lake Valley and White Horse can be served from the Crownpoint Spur. This subarea is in Region 2.

The Crownpoint Subarea includes the chapters of Becenti, Coyote Canyon, Crownpoint Dalton Pass, Little Water and Standing Rock. The annual projected municipal demand for this subarea in the year 2040 is 3,225 acre-feet, of which 752 acre-feet will be met with groundwater. This subarea will be served by the Crownpoint Spur from the Coyote Canyon Junction. This subarea is in Region 2.

The Huerfano Subarea includes the chapters of Huerfano and Nageezi. The annual projected municipal demand for the Huerfano Subarea in 2040 is 910 acre-feet, of which 46 acre-feet will be met with groundwater. This subarea will be served from the Cutter Lateral. This subarea is in Region 2.

Route 491 (666) Subarea includes the chapters of Mexican Springs, Naschiti, Newcomb, Sanostee, Sheep Springs, Tohatchi, Twin Lakes, and Two Grey Hills. These chapters are located along Highway 491. These public water systems are well situated to take advantage of the Project water as soon as it is available. The annual projected municipal water demand for this subarea in the year 2040 is 6,161 acre-feet, of which 795 acre-feet may come from ground water. This subarea is in Region 2.

The San Juan River Subarea includes the Navajo chapters along the San Juan River. The annual projected municipal water demand by the year 2040 is 8,421 acre-feet per year. The Farmington to Shiprock Pipeline will provide 4,680 acre-feet of that demand, and the Navajo Gallup Water Supply Project will meet the balance of the demand. This subarea is in Region 2.

The Torreon Subarea includes the chapters of Counselor, Ojo Encino, Torreon, and Pueblo Pintado. The annual projected municipal demand of the Torreon Subarea in the year 2040 is 2,317 acre-feet, with groundwater meeting 77 acre-feet of this demand. This area will be served from the Cutter Lateral. This subarea is in Region 2.

NAPI has reported plans to develop agricultural processing projects with a total treated water demand of 7,274 acre-feet. The BIA recently consulted with the USFWS on a french-fry processing venture that will require NAPI to deplete 400 acre-feet of water per year. The Navajo Gallup Project depletions include 700 acre-feet of depletion for food processing opportunities such as vegetable canning. This volume includes 400 acre-feet of depletion for a proposed french-fry venture The NAPI potable water demand may be served either from a tap at the junction of the pipeline with Highway 64, or possibly from the Cutter Lateral. NAPI is in Region 2.

The Gallup Area Navajos include the chapters of Breadsprings, Chichilta, Church Rock Iyanbito Marion Lake Pinedale and Red Rock. The projected municipal demand in the year 2040 is 4,822 acre-feet, of which 506 acre-feet will be met with ground water. These chapters will be served from the Gallup Region System. This subarea is in Region 6.

The Rock Springs Subarea includes the chapters of Manuelito, Rock Springs, and Tsayatoh. The annual projected municipal demand is 2,287 acre-feet, of which 169 acre-feet may be met with groundwater. Window Rock will be served from the Window Rock Spur, which starts at the Yah-ta-hey Junction. This subarea is in Region 6.

The Window Rock Subarea includes the chapters of Fort Defiance and Saint Michaels. The annual projected municipal demand for this subarea in the year 2040 is 7,179 acre-feet, of which 767 acre-feet may be from groundwater. Window Rock will be served from the Window Rock Spur, which starts at the Yah-ta-hey Junction. This subarea is in Arizona.

9.9.3.2.2 **Cost Estimate and Benefit**

The benefit to the participants is a renewable water supply that will satisfy much of the municipal water demand through 2040. The Project will encourage economic development and to reduce the percentage of the Navajo population that hauls water. The Jicarilla Apache Nation will also have the opportunity to development in the southern portion of their reservation at Tepee Junction.

In April 2002, Reclamation completed an appraisal level design and cost estimate of the surface water component of the Project. The estimated cost of the surface water components of the Project is $441 million. Of this total, the Navajo Nation's estimated allocated cost is approximately $344 million.

In March 2001, the Navajo Department of Water Resources estimated the conjunctive ground water component for the Navajo Nation Chapters is an additional $73 million. This reconnaissance level estimate is being refined by Reclamation.

9.9.4 **Developing and Rehabilitating Local Public Water Systems**

The six proposed large Navajo regional water supply projects, including the Farmington to Shiprock Pipeline and the Navajo Gallup Water Supply Project, will convey domestic, municipal and industrial water to approximately 67 of the 110 chapters on the reservation, and they will serve approximately 80 percent of the projected reservation wide population of 500,000 by the year 2040. By the year 2040 the Navajo population on the Navajo Reservation within Region 2 will be approximately 150,000. However, without additional local infrastructure, there will be inadequate conveyance and treatment capacity to deliver potable water from the regional systems to many of the local water users. Even with the regional systems and associated local distribution systems fully in place, a significant portion of the chapters will rely on alternative water supply facilities. Many of the smaller water systems require rehabilitation, and in many areas, new systems are needed. In areas where regional distribution systems are infeasible, community wells will be upgraded to improve access for water haulers. Rehabilitation and development of small, local, public water systems is also an important component of the Navajo Nation's water development strategy.

These improvements are essential for conveying water from the regional projects to homes and businesses. These improvements include: 1) improving Public Water Systems Connected with the Regional Projects, 2) improving public water systems not connected to the regional projects, and 3) improving water service to water users without direct access to public water systems.

9.9.4.1 **Improve Public Water Systems Connected with the Regional Projects**

Additional upgrades may be needed to ensure that the water from the Farmington to Shiprock and Navajo-Gallup Water Supply Projects reach the water users.

9.9.4.2 **Improve Public Water Systems Not Connected to the Regional Projects**

The regional water projects and the associated public water systems will reach 80 percent of the population and 60 percent of the chapters. Much of the remaining population is served by 90 small public water systems that need improvements. These small systems share similar obstacles. They are remote with very limited access. They require long distances between the water sources and places of use. And, the water sources are extremely limited. These factors result in very expensive water infrastructure. These problems are compounded by the fact that many of these small public water projects do not meet the minimum established criteria for incorporation into NTUA operation. NTUA will not accept a system that has fewer than three water meters per mile or systems requiring major repairs. Many of the public water systems not operated by NTUA depend on tribal subsidies. As the tribal general funds decline, the ability of the Tribal government to maintain these subsidies decreases.

Because these water systems often only serve a few dozen connections, improvement efforts do not fit into traditional construction authorization processes. Developing separate appraisal and feasibility level studies for each project and approaching Congress separately on behalf of each project would create unmanageable administrative and political obstacles. Furthermore, the remote locations make it expensive to repeatedly mobilize technical expertise. For this Strategy, the Navajo Nation may request that Congress grant an overarching or omnibus authority to prepare feasibility studies and to submit multiple projects for Congressional construction authorization.

9.9.4.3 Improving Water Service to Water Users Without Direct Access to Public Water Systems

Approximately 40 percent of the Navajo population hauls water to meet their daily household needs. They frequently drive long distances to the nearest public water source. The cost of hauling water in pickup trucks can exceed $16,000 per acre-foot compared to typical urban water rates, which are approximately $600 per acre-foot. This situation means that one of the poorest sectors of the New Mexico population has the most expensive water supply. Sanitation is also a concern for water haulers. If potable water sources are difficult to access, water haulers frequently get water from non-potable sources such as stock tanks. Occasionally, even if the water quality at the water point is adequate, unregulated taps can have unsanitary hoses and other conditions that render the water supply unsafe. Furthermore, households that rely on water hauling have less water available for personal hygiene, which can result in increased health related problems.

The regional water projects will provide indirect relief to the Navajo water haulers. For instance, the distance to reliable water taps will decrease for most Navajo water haulers. However, direct assistance to develop additional local potable water sources, possibly with solar pumps and cisterns, may be required. The Navajo Environmental Protection Agency is completing a joint study on this topic. The objective of the study is to define the nature and extent of the problem, and to pose solutions. The investigation is based on IHS data, literature reviews, interviews, and field trips. The solution strategies will be provided to appropriate individuals and agencies to determine which options have the greatest chance of success.

9.9.5 Completing the Navajo Indian Irrigation Project

The Navajo Indian Irrigation Project (NIIP) was jointly authorized with the San Juan Diversion in 1962 by Public Law 87-483. This public law authorized the Secretary of the Interior to construct, operate, and maintain NIIP for the principal purpose of furnishing 508,000 acre-feet of, irrigation water to approximately 110,630 acres of land. NIIP's principle features include the Main Canal which is 46.3 miles long and has an initial capacity of 1,800 cfs., the Gravity Main Canal which is 14.2 miles and has a capacity of which has an initial capacity of 1,285 cfs, the long Amarillo Canal which is 11.2 miles long and has an initial capacity of 385 cfs., the Cutter Reservoir, the Kutz Pumping Plant with a capacity of 128 cfs., the Gallegos Pumping Plant with a capacity of 880 cfs, the proposed Moncisco Pumping Plant with capacity of 400 cfs., and 340 miles of pipeline ranging in diameter for 6 to 84 inches.

NIIP consists of the initial land development, water distribution system, water delivery roads, and other infrastructure. The development of NIIP has been broken into 111 Blocks of approximately 10,000 acres each. Block 1 was first irrigated in 1976. Seven blocks have been completed and portions of Block 8 are now being irrigated.

The Department of the Interior has a 1956 State Water Use Permit for NIIP for the diversion of 640,000 acre-feet of water from Navajo Reservoir and the Navajo Nation has a 1970 Secretarial water contract to divert 508,000 acre-feet of water for agricultural use. For planning purposes, according the Department of the Interior's 1988 Hydrologic Determination, the NIIP will deplete 254,000 acre-feet on an annual basis. This value is based on an assumption than in any given year five percent of the NIIP farmland will be fallow. According to NIIP's recent 1999 Biological Opinion, with a unit depletion of 2.4

acre-feet per acre, when it is completed, NIIP will divert 360,000 acre-feet and, at equilibrium, deplete 270,000 acre-feet of San Juan River water per year. NIIP currently diverts approximately 200,000 acre-feet per year and depletes approximately 160,000 acre-feet per year.

In 2003, NAPI anticipated farming more than 65,000 acres and it generates an annual revenue between $30 and $40 million. NAPI employs almost 200 full time employees and several hundred temporary employees. Eventually, with vertical integration, NAPI may employ more than 1,000 full time employees. However, NIIP has not realized its full economic potential. After more than 40 years, the project is farming less than 60 percent of its authorized project land.

The Navajo Nation has made several specific suggestions to realize NIIP's potential including: increasing the annual construction funds to complete both the distribution systems and on-farm components in a shorter period of time, vertically integrating to increase tribal employment and other economic benefits, and adequately funding the operation and maintenance. The Navajo Nation, Reclamation, NAPI, and the BIA are developing a long-range plan for NIIP that may include the transfer of the facilities to the Navajo Nation.

9.9.6 Small Agricultural Irrigation Projects

As part of the regional needs assessments, the small irrigation projects are being assessed by Reclamation, the NRCS, and the Navajo Department of Water Resources. These assessments will evaluate those projects that have the best chance hydrologically, institutionally, and agronomically sustaining themselves. The NDWR is encouraging water users to organize water users associations through their local farm boards, accept additional responsibility for the operation and maintenance, and form partnerships with a broad array of institutions. These efforts may improve the chances of these irrigation projects succeeding. This approach is consistent with recent Navajo Nation Council directives intended to make decision-making more accountable to local needs and oversight.

Region 2 includes several irrigation projects along the San Juan River including Hogback, Fruitland, Cudei and Cambridge. These irrigation projects include approximately 12,000 acres of land that have been permitted by the Bureau of Indian Affairs. In 1999, the Shiprock Farmboard passed resolutions that helped to establish the San Juan River Dine Water Users Association. Investigations are underway to assess the rehabilitation needs of these irrigation projects. These improvements improve efficiency and conserve water.

Approximately 20 smaller Navajo irrigation projects are located along the tributaries to the San Juan River. The NDWR and the ISC are currently assessing the total acreage of these projects and their hydrologic impact to the San Juan River.

9.9.7 Water Conservation and Water Reuse

Navajo communities will need to make every reasonable effort to maximize the available water supply. Therefore, a commitment to water conservation and water reuse is needed. However, due to the already extremely low on-Reservation per capita water use rates,

Reclamation concluded that water conservation plans will not significantly enhance the water supply options for the Navajo water users.

The Navajo Nation and Reclamation are investigating water reuse opportunities. Under certain circumstance reclaimed water can be used on outdoor landscaping and athletic facilities. Appraisal level Navajo water use studies have been conducted in Tuba City and Ganado, Arizona. An analysis of opportunities for water conservation and reuse of wastewater will be a component of the reservation-wide needs assessment and appraisals.

9.9.8 Power Generation

The Navajo Nation hosts a variety of industrial and mining water users, all of which require a reliable water supply. Mining is the largest revenue producer on the reservation, often producing 75 percent of the total annual tribal general revenue. Regionally the largest industrial water users are coal mining, oil recovery, and power generation.

Six power generating stations operate in the vicinity or on the Navajo Reservation including the Cholla Generating Station, Four Corners Generating Station, Mohave Generating Station, Navajo Generating Station, Plains Electric Generating Station, and San Juan Generating Station. These generating stations, which are located in New Mexico and Arizona, have a combined installed capacity of 10,400 megawatts and an annual water demand of 113,000 acre-feet per year.

Two of these generating stations, the Four Corners Generating Station and the San Juan Generating Station are within Region 2, and Plains Electric (Tri State) is within Region 6. The Four Corners Generating Station is operated by Arizona Public Service. It has an installed capacity of 2,040 megawatts and it uses approximately 23,000 acre-feet per year. The San Juan Generating Station is operated by the Public Service Company of New Mexico. It has an installed capacity of 1,800 megawatts and it uses approximately 20,000 acre-feet per year.

Region 2 has hundreds of millions of tons of recoverable coal, much of it on the Navajo Reservation. This abundance of coal has led the Navajo Nation to explore numerous opportunities for additional mining and power generation. Currently, the Dine Power Authority is considering a 1,500 megawatt power plant, which would require 20,000 acre-feet of water. Additional water may be needed for mining approximately eight million tons of coal every year.

One potential source of water is groundwater. Several large aquifers underlie much of the Navajo Nation. For instance, the Westwater Aquifer underlies a large portion of the Eastern Navajo Agency and Regions 2 and 6. Adequate yields and water quality are feasible from the Westwater Aquifer near Burnham. However, the recharge rates are extremely low. The result of this pumping would be large cones of depression radiating out from any proposed well field. Technical investigations are required to determine if the impacts of this pumping are acceptable to the Navajo Nation and other affected parties.

The other potential water source is San Juan River surface water. Any surface water option will raises challenges. First, it is unlikely that the Secretary of the Interior would approve a new water contract from Navajo Reservoir if that contract impacts the Indian Trust Assets of either the Navajo Nation or the Jicarilla Apache Nation. And, a new contract would need to address compliance with the Endangered Species Act. Second, the Jicarilla Apache Nation recently decided to subcontract most of its Navajo Reservoir water supply to the Public Service Company of New Mexico for use at the San Juan Generating Station. Third, acquiring and consolidating a block of 20,000 acre-feet of water would require complex water transfers involving dozens, or possibly hundreds, of small water users in the Basin. Finally, the Navajo Nation's NIIP contract is explicitly for irrigated agriculture use, not industrial use. However, given the appropriate circumstances, the Navajo Nation could investigate the theoretical possibility of transferring water from an irrigation use to an industrial use.