APPENDIX A

Technical Memorandum
(Final Draft – March 16, 2001)

FINAL DRAFT

TECHNICAL MEMORANDUM

THE NAVAJO-GALLUP WATER SUPPLY PROJECT

The Navajo Nation Department of Water Resources

The City of Gallup

The Northwest New Mexico Council of Governments

The U.S. Bureau of Reclamation

March 16, 2001

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Navajo-Gallup Water Supply Project

EXECUTIVE SUMMARY

The Project has evolved over four decades as a major infrastructure initiative to identify and secure a long-term water supply for the parched lands of the eastern portions of the Navajo Reservation and the City of Gallup. Planning has progressed under guidance of a local steering committee, and in collaboration with Reclamation and the BIA. Project participants anticipate agreement between local, tribal and federal agencies on the technical, biological, financial and other parameters of the Project. This agreement will clear the way for Congress to authorize the construction the Project. This technical memorandum is focused on the region's municipal water needs. It is not intended to quantify the water claims of any of the parties.

I. Objectives

The objective of this technical memorandum is to consolidate the information needed by the Navajo Nation and the City of Gallup to formalize their commitments to the Project, and to present this Project in the context of regional water development. Based on these objectives:

- The participants will finalize the project definition for a project that will provide a long-term water supply to the service area and will adequately define the options for the key project features and the operation of those features, to comply with the Endangered Species Act and the National Environmental Protection Act.

- A "Final Plan Report" will be developed by Reclamation during Fiscal Years 2000 and 2001 that will adequately describe the Project as part of the submission to Congress for authorization in Fiscal Year 2002.

- This technical memorandum will become the primary reference document for the Environmental Impact Statement which was initiated in March 2000.

- This technical memorandum will also be the foundation for agreements between the participants, as requested by the New Mexico Congressional Delegation, regarding various aspects of the Project.

II. Service Area

This Project is designed to provide a forty-year water supply to the Navajo Nation and the City of Gallup. The Project will deliver water to more than 20 Navajo public water supply systems in New Mexico and Arizona, and the Navajo Agricultural Products Industry (NAPI). For planning purposes, the study area is the New Mexico portion of the Navajo Nation, the Window Rock area within Arizona, and the City of Gallup, New Mexico. Within the State of New Mexico, the study area is encompassed by the State's Water Planning Regions 2 and 6 (Table 5.1 includes a complete list of the Chapters within the Project service area). Along with greater economic opportunity in the Gallup area, the Project will improve the municipal water supply to Navajo economic development growth centers in Window Rock, Tohatchi, Crownpoint and Shiprock.

Navajo-Gallup Water Supply Project

By the year 2040 the projected municipal demand in the service area (including NAPI) is approximately 52,000 acre-feet per year. This projection does not include any major industrial uses. The Project's annual diversion from the San Juan River will be approximately 36,600 acre-feet and its annual depletion will be 34,700 acre-feet. In addition to the San Juan River depletion, the Navajo Nation will supply an additional 3,200 acre-feet of groundwater annually and the City of Gallup will supply an additional 1,400 acre-feet of groundwater. The Animas La Plata Project will divert an additional 4,680 acre-feet to the Shiprock area. The San Juan River depletions for each basin are shown in Table E.S. 1.

III. Project Configurations

Because the location of the proposed points of diversion have critical hydrologic implications for the endangered species in the San Juan River (which have yet to be fully evaluated), this technical memorandum presents two distinct alternatives. The first alternative diverts water directly out of the San Juan River below the confluence of the La Plata and San Juan Rivers. This configuration is referred to as the San Juan River Diversion Alternative. For the San Juan River Alternative, the pipeline begins either the Hogback Diversion or PNM Diversion which are downstream of the La Plata River confluence and it proceeds along Highway N36 to Highway 666, and south to Yah-ta-hey, Window Rock and the Gallup Area. This configuration is very similar to the "San Juan Alignment" described in the 1984 Environmental Statement.

The second alternative utilizes the Navajo Indian Irrigation Project (NIIP) Main Canal to divert water from Navajo Reservoir. This configuration is referred to as the NIIP Alternative. For the NIIP Alternative, the pipeline begins at the proposed Moncisco Reservoir at NIIP and proceeds south to the existing El Paso Natural Gas pipeline corridor. The pipeline route follows the gas line corridor to the vicinity of Twin Lakes. The pipeline then turns south to Yah-ta-hey, Window Roc, and the Gallup Area. It is similar to the "Cottonwood Alignment" described in the 1984 Environmental Statement. Analyses of the no-action and non-structural alternatives are beyond the scope of this document.

From Yah-ta-hey both alternatives connect to a lateral to Window Rock and to the water distribution system for the Gallup Area. Spurs from the Window Rock Lateral will serve communities along Highway 264. Navajo residents in the Gallup area and the surrounding Chapters will receive Project water conveyed through the City of Gallup's distribution system. Four spurs will connect to the main pipeline to service the Chapters between NIIP and Gallup. Storage tanks and water treatment are included in the Project.

Table E.S. 1
Projected Navajo Gallup Water Supply Project San Juan River Depletions (including NAPI) in the Project Service Area by Basin
(Acre-feet)

Decade	New Mexico Upper Colorado Basin	New Mexico Lower Colorado Basin	New Mexico Rio Grande Basin	Arizona Lower Colorado Basin	Project Total
2000	5,242	2,352	336	1,652	9,582
2010	5,202	10,503	470	2,469	18,644
2020	6,996	11,360	638	3,493	22,487
2030	9,722	12,479	850	4,783	27,834
2040	13,229	13,934	1,119	6,411	34,693
2050	17,820	15,907	1,451	8,404	43,583
2060	23,686	18,429	1,875	10,950	54,939

IV. Project Cost

Cost summaries were prepared for the NIIP and the San Juan River Alternatives. As presented in this technical memorandum, both alternatives serve the same area. The total Project cost for the San Juan River Alternative is $368 million and the total Project cost for the NIIP Alternative is $390 million. These estimates include the Gallup Regional System and delivery to the Shiprock Subarea. The cost of power transmission lines is assumed to be incorporated in the unit price of the power. The separate allocated costs for the Navajo Nation and City of Gallup are based on each ones share of the annual capacity of each component or pipe segment. The total project and programmatic costs, and the allocated costs, are shown in Tables E.S. 2 and E.S. 3.

The NDWR investigated the mutual benefits due to the shared economy of scale of a joint Navajo /City of Gallup Project. The NDWR estimates that a stand-alone Gallup only system would cost approximately $107 million. A stand-alone Navajo project using the San Juan River Alternative would cost $324 million and a stand-alone NIIP Alternative would cost $354 million. By partnering with the Navajo Nation, the City's share of the resulting project is approximately $60 million. By partnering with the City, the Navajo Nation's share of the resulting project is $310 million for the San Juan Alternative and $326 for the NIIP Alternative. The operation and maintenance costs presented in Tables 8.16 and 8.17 show similar benefits with partnering.

Navajo-Gallup Water Supply Project

The water delivery costs have been divided between programmatic and Project costs. A number of federal and state programs may be able to assist with water development in the region. For instance, the IHS has P.L. 86-121 authorization to construct domestic water systems on the Navajo Nation. The IHS annual budget is approximately $25 million per year. The EPA, USDA, HUD and other federal agencies also assist with water development. The Project will provide a core system around which programmatic funding can build on.

Table E.S. 2
Navajo-Gallup Water Supply Project Capital Costs
(Millions of Dollars)

Component	Project Cost	Programmatic Cost	Total Cost
1A. 36,700 af NIIP Alternative			
8,800 af Moncisco Reservoir	$59.72	$0.00	$59.72
65 CFS Treatment Plant	$78.21	$0.00	$78.21
Conveyance to Yah-ta-hey	$129.58	$0.00	$129.58
Project Laterals	$122.60	$27.30	$149.90
Power Lines, SCADA etc.	$5.10	$0.00	$5.10
1B. 36,700 af San Juan River Alternative			
Diversion Structure	$3.14	$0.00	$3.14
Water Treatment Plant	$70.81	$0.00	$70.81
Regulating Reservoir	$15.07	$0.00	$15.07
Conveyance to Yah-ta-hey	$161.47	$0.00	$161.47
Project Laterals	$117.44	$30.30	$147.74
Power lines, SCADA, etc.	$5.10	$0.00	$5.10
2. Groundwater Component	$0.00	$73.00	$73.00
3. Wastewater treatment	$0.00	$113.00	$113.00
4. Value of Water Rights	$0.00	$90.00	$90.00
5. Value of Rights-of-way	$0.00	$24.80	$24.80
Total NIIP Alternative	$395.21	$328.10	$723.31
Total SJR Alternative	$373.03	$331.10	$704.13

Table E.S. 3
Navajo-Gallup Water Supply Project Summary of Allocated Capital Costs

Scenario	Water Supply (Acre Feet)		Capital Cost (Millions of Dollars)		
	Navajo Nation	City of Gallup	Navajo Nation	City of Gallup	Total
SJR Alternative					
	29,067	0	$324	$0	$324
	29,067	7,500	$310	$58	$368
NIIP Alternative					
	29,067	0	$354	$0	$354
	29,067	7,500	$326	$64	$390

Note: Tabulated costs exclude transmission lines and groundwater components.

V. Unit Cost of Project Water

The unit costs of the Project water including several important noncapital costs are presented in Table 9.3. Based on the data presented in Table 9.3 the total unit cost of the Project water is approximately $4.81 per thousand gallons. Included in this estimated rate is the full cost of amortizing the capital investment and the value of the water rights. This estimate also includes the cost of using the NIIP, improving the local systems and the retail expense of the water utilities. The estimated rate is approximately $2 per thousand gallons more than NTUA and the City of Gallup are currently charging for water. For a family of four, using 160 gallons per capita per day, the monthly water bill would be $94 per month.

Table E.S. 4
Estimated Average Unit Cost of Navajo-Gallup Water Supply Project Water Based on 36,700 acre-feet of Diversion

Cost Component	Estimated 2000 Cost (Dollars/AF)	Estimated Cost (Dollars/1000 gal)
1.Amortized $370 Million Capital Cost (7% and 40 Years)	$756	$2.34
2. CRSP fee	$60	$0.18
3. Amortized Water Rights ($3,000/af, 7% and 40 years)	$191	$0.59
4. NIIP Cost of Services ($50 to $300 per acre-foot)	$50	$0.16
5. City of Gallup improvements	$36	$0.11
6. City of Gallup retail cost	$195	$0.60
7. Project Operation and Maintenance	$272	$0.83
Total Unit Cost	$1,560	$4.81

Note:

During the first decade of operation the Project operation and maintenance expense will be approximately $1.30 per thousand gallons for the Navajo Nation and $1.02 dollars per thousand gallons for the City of Gallup.

VII. Action Plan

To expedite the Project, the Navajo Nation, the City of Gallup and Reclamation have developed a plan of approach. This approach includes a time line for NEPA Compliance, preparing the Planning Report/EIS, Construction Authorization, and Starting Construction. In addition, the planning report and the Environmental Impact Statement will be compiled into a single document. This schedule anticipates Congressional authorization for design and construction by October 2002 and a Record of Decision on the EIS by February 2003.

Navajo-Gallup Water Supply Project

1.0 OBJECTIVES

Recognizing their severe water supply problems the Navajo Nation and the City of Gallup signed a Memorandum of Agreement (see Appendix B) on April 17, 1998 to proceed with the planning and development of the Navajo-Gallup Water Supply Project (Project). The Navajo Nation and the City of Gallup are working as partners, with the Bureau of Reclamation (Reclamation) and the Bureau of Indian Affairs (BIA) to plan, implement environmental compliance, secure water supplies, obtain Congressional authorization, and construct a domestic water supply system. This Project will serve the residents of the Navajo Nation and the City of Gallup.

The objective of this technical memorandum is to consolidate the information needed by the Navajo Nation and the City of Gallup to formalize their commitments to the Project, and to present this Project in the context of regional water development. Based on these objectives:

- The participants will finalize the project definition for a project that will provide a long-term water supply to the service area and will adequately define the options for the key project features and the operation of those features, to comply with the Endangered Species Act and the National Environmental Protection Act.

- A "Final Plan Report" will be developed by Reclamation during Fiscal Years 2000 and 2001 that will adequately describe the Project as part of the submission to Congress for authorization in Fiscal Year 2002.

- This technical memorandum will become the primary reference document for the Environmental Impact Statement which was initiated in March 2000.

- This technical memorandum will also be the foundation for agreements between the participants, as requested by the New Mexico Congressional Delegation, regarding various aspects of the Project.

This technical memorandum draws on Reclamation studies of the Project conducted from the 1970's through the 1990's, primarily the Draft Environmental Statement prepared by Reclamation in January 1984. It also draws on additional work by the Navajo Nation Department of Water Resources (NDWR), the Northwest New Mexico Council of Governments, and the City of Gallup. The participation of the NDWR was funded in part by Reclamation through the Navajo Nation/Reclamation Cooperative Agreement No. 5-FC-40-17490.

2.0 INTRODUCTION

The Project has evolved over four decades as a major infrastructure initiative to identify and secure a long-term water supply for the parched lands of the eastern portions of the Navajo Reservation and the City of Gallup. Planning has progressed under guidance of a local steering committee, and in collaboration with Reclamation and the BIA. Project participants anticipate agreement between local, tribal and federal agencies on the technical, biological, financial and other parameters of the Project. This agreement will clear the way for Congress to authorize the construction the Project. This technical memorandum is focused on the region's municipal water needs. It is not intended to quantify the water claims of any of the parties.

To improve the health and standard of living of those residing in Navajo Nation communities and to serve the future demographic and economic growth of both the City of Gallup and the Navajo Nation, a long-term, high quality, domestic water supply is needed. This technical memorandum presents Project alternatives to move the Navajo-Gallup Water Supply Project from open-ended planning to construction authorization.

This Project is designed to provide a forty-year water supply to the Navajo Nation and the City of Gallup. The Project will deliver water to more than 20 Navajo public water supply systems in New Mexico and Arizona, and the Navajo Agricultural Products Industry (NAPI). For planning purposes, the study area is the New Mexico portion of the Navajo Nation, the Window Rock area within Arizona, and the City of Gallup, New Mexico. Within the State of New Mexico, the study area is encompassed by the State's Water Planning Regions 2 and 6 (Table 5.1 includes a complete list of the Chapters within the Project service area). Along with greater economic opportunity in the Gallup area, the Project will improve the municipal water supply to Navajo economic development growth centers in Window Rock, Tohatchi, Crownpoint and Shiprock.

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Because the location of the proposed points of diversion have critical hydrologic implications for the endangered species in the San Juan River (which have yet to be fully evaluated), this technical memorandum presents two distinct alternatives. The first alternative, which is shown in Figure 2.1, diverts water directly out of the San Juan River below the confluence of the La Plata and San Juan Rivers. This configuration is referred to as the San Juan River Diversion Alternative. This configuration is very similar to the "San Juan Alignment" described in the 1984 Environmental Statement. The second alternative, which is shown in Figure 2.2, utilizes the Navajo Indian Irrigation Project (NIIP) Main Canal to divert water from Navajo Reservoir. This configuration is referred to as the NIIP Alternative. It is similar to the "Cottonwood Alignment" described in the

1984 Environmental Statement. Analyses of the no-action and non-structural alternatives are beyond the scope of this document.

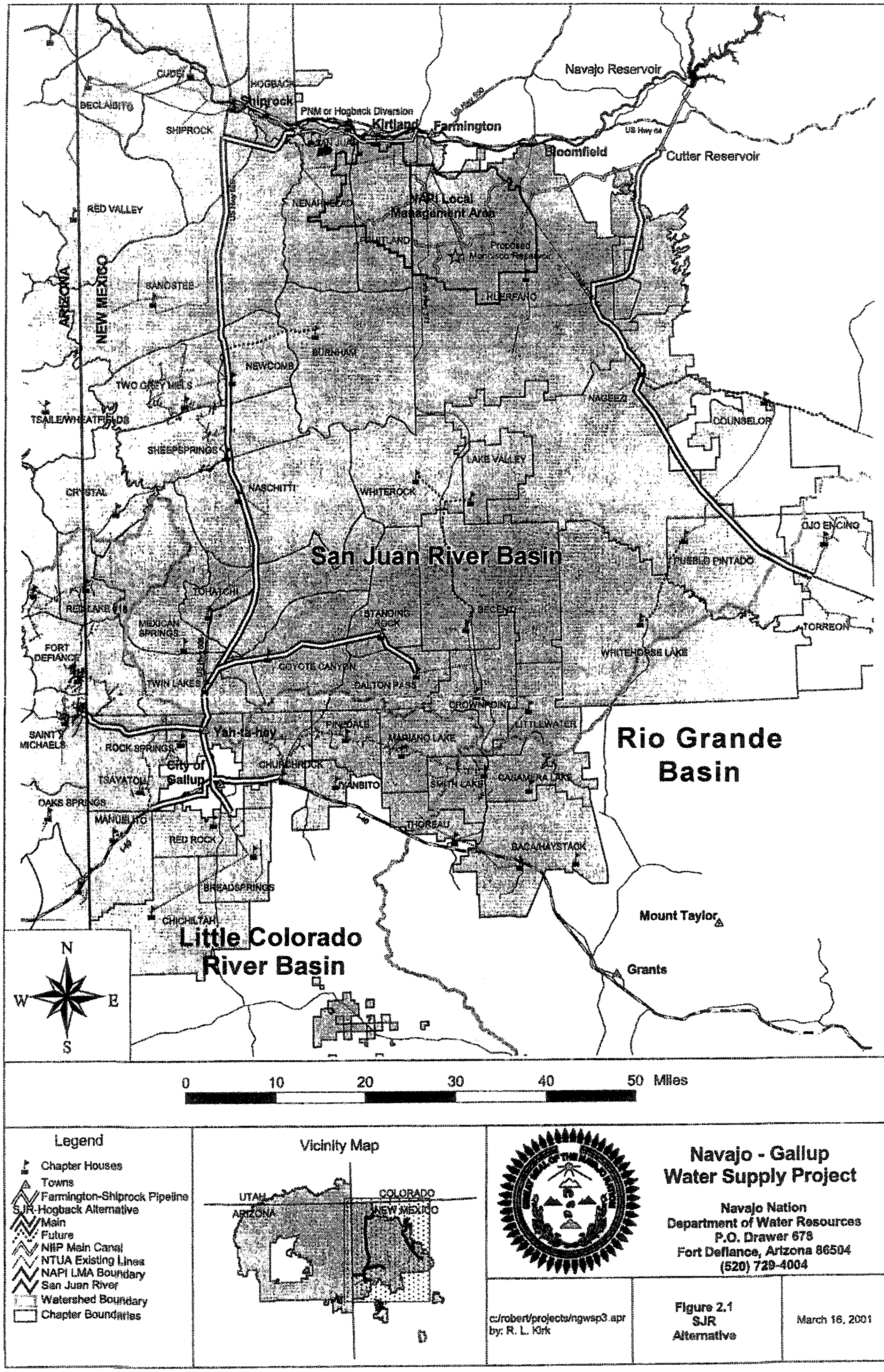
Section 3 of this technical memorandum presents a comprehensive Project history. The history includes a literature review and descriptions of the Project alternatives that have been previously evaluated. Section 4 presents the projected water demand and Section5 presents the current water production in the region. Current water sources will be unable to meet the future demand. Section6 presents water conservation options and Section 7 presents potential surface water supply options for the Project. Section 8 presents two Project alternatives (the San Juan River Diversion Alternative and the NIIP Alternative). Section 9 presents the unit cost of the Project water. And, Section 10 presents a plan of approach and time-line.

2.1 The Navajo Nation Background

The Navajo Reservation was established in 1868, and expanded through a series of executive orders, public land orders, and congressional statutes, to become the largest Indian reservation in the United States. Larger than the State of West Virginia, the Navajo Nation coves an area of approximately 27,000 square miles including portions of Arizona, New Mexico and Utah. The Navajo Nation is divided into 110 chapters, which are areas of local government. According to the 1990 Census the on-reservation Navajo population was 155,876 (Rodgers 1993).

Even after more than 100 years of federal trusteeship, the Navajo Nation faces serious economic and social challenges. In 1997 the Navajo Division of Economic Development observed that the Navajo 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 $5,600 while the average per capita income for the State of Arizona was approximately $22,000. More than 50 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. This poverty rate is one of the worst in the United States, even among American Indians. The Navajo unemployment rate on the Reservation is 58 percent, while the unemployment rate for the U.S. is approximately 5 percent. These disparities show no sign of narrowing. Even while the regional economy has boomed, these gaps in income, unemployment, and poverty have widened.

The Navajo Nation also faces serious water resource problems. Many homes lack indoor plumbing. More than 50 percent of Navajo homes lack complete kitchens and more than 40 percent of Navajo households rely solely on water hauling to meet daily water needs. Data from the Navajo Tribal Utility Authority (NTUA) and others demonstrate that Navajo's use far less water per capita yet pay among the highest water rates in the region. The low per capita water use is part of a larger pattern of a low economic standard of living.


Navajo Reservoir
CUDEI
HOGBACK
BECLABITO
Shiprock
PNM or Hogback Diversion
Kirtland
Farmington
US Hwy 550
US Hwy 64
SHIPROCK
Bloomfield
Cutter Reservoir
NAPI Local Management Area
RED VALLEY
US Hwy 666
Proposed Monolisco Reservoir
ARIZONA
NEW MEXICO
SANOSTEE
HUERFANO
BURNHAM
NEWCOMB
TWO GREY HILLS
NAGEEZI
TSAILE/WHEATFIELDS
COUNSELOR
SHEEPSPRINGS
LAKE VALLEY
CRYSTAL
NASCHITTI
WHITEROCK
OJO ENCINO
San Juan River Basin
PUEBLO PINTADO
TOHATCHI
RED LAKE
STANDING ROCK
BECENTI
MEXICAN SPRINGS
TORREON
FORT DEFIANCE
WHITEHORSE LAKE
COYOTE CANYON
TWIN LAKES
DALTON PASS
CROWNPOINT
SAINT MICHAELS
Yah-ta-hey
LITTLEWATER
FINEDALE
MARIANO LAKE
Rio Grande Basin
ROCK SPRINGS
City of Gallup
CHURCHROCK
TSAYATOH
IYANBITO
SMITH LAKE
CASAMERA LAKE
OAKS SPRINGS
MANUELITO
RED ROCK
THOREAU
I-40
BACA/HAYSTACK
BREADSPRINGS
Mount Taylor
CHICHILTAH
Little Colorado River Basin
Grants
N
W
E
S
0
10
20
30
40
50 Miles
Legend
Chapter Houses
Towns
Farmington-Shiprock Pipeline
SJR-Hogback Alternative
Main
Future
NIIP Main Canal
NTUA Existing Lines
NAPI LMA Boundary
San Juan River
Watershed Boundary
Chapter Boundaries
Vicinity Map
UTAH
COLORADO
ARIZONA
NEW MEXICO
Navajo - Gallup Water Supply Project
Navajo Nation
Department of Water Resources
P.O. Drawer 678
Fort Defiance, Arizona 86504
(520) 729-4004
c:/robert/projects/ngwsp3.apr
by: R. L. Kirk
Figure 2.1
SJR
Alternative
March 16, 2001

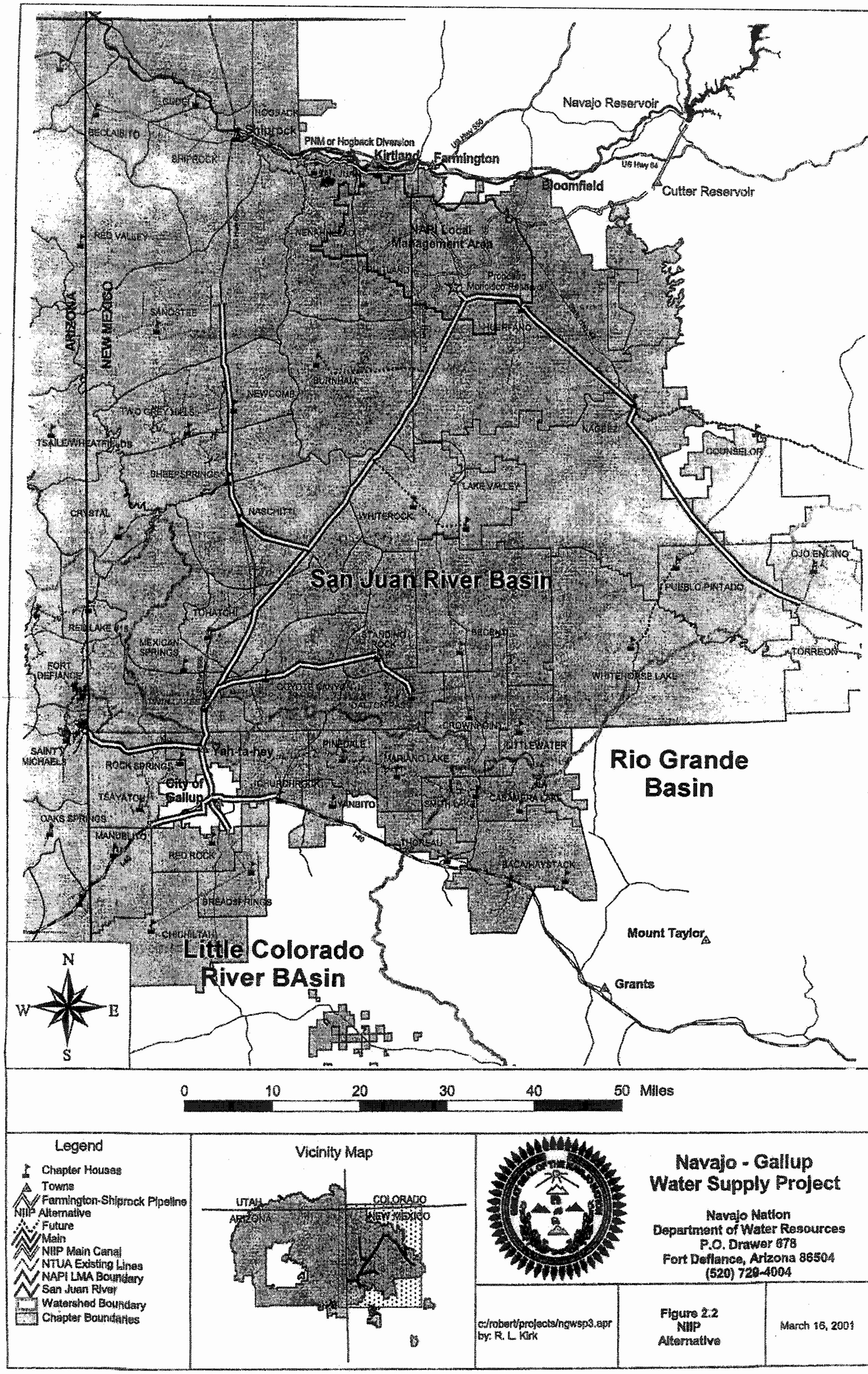


Figure 2.2
NIIP
Alternative

Navajo-Gallup Water Supply Project

Safe drinking water is a precondition for health promotion and disease prevention. The lack of clean safe water results in a higher incidence of disease, poor health, and inadequate fire protection. In 1996, President Clinton noted that "the number one health problem in the developing world is the absence of clean, safe water." Children living in homes without access to safe, affordable, and dependable drinking water are especially vulnerable. Without access to safe drinking water, people are forced through a revolving door of expensive medical treatment and unhealthy conditions. In a report to Congress by the Comptroller General, it was noted that families living in homes with satisfactory environmental conditions placed one fourth of the demands on Indian Health Service (IHS) primary health care delivery systems than families living in homes with unsatisfactory conditions. Biological contaminants such as coli form bacteria, giardia, and *crypto-sporidium* can only be controlled by proper water source protection, treatment, and distribution systems.

These grim statistics adversely impact the survival of the Navajo Nation. According to the Division of Community Development, due to the stagnation of development in Navajo country, the Navajo Nation is losing population to off-reservation communities, the Four Corners Area, and the remaining 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 47 states grew by 71 percent, while the on-reservation population grew by only 22 percent. Without reducing the out-migration, by 2012 more than half of the Navajo people may be living off of the Navajo Reservation (Rodgers, 1993).

The lack of infrastructure, the lack of economic development and the sustained poverty are closely connected. Throughout the arid southwest, and especially on the Navajo Nation, a reliable water supply is essential for stimulating and sustaining economic development. The Navajo Nation has identified economic development growth centers throughout the Reservation. These economic development centers represent large population bases that have the potential to benefit from an economy of scale in infrastructure development. Accordingly the Navajo Nation will focus resources in these locations to stimulate economic growth.

Creating an adequate water infrastructure does not guarantee sustained economic growth, nor a narrowing of the disparities between the Navajo people and the rest of the United States. It is however, a necessary prerequisite. If an improved water infrastructure could create even modest improvements, the benefits will be compounded. For instance, the Navajo Nation captures less than 8 percent of the $660 million annual tourism revenue in the Four Corners Area. If an enhanced tourist infrastructure increased that percentage to 12 percent, the Navajo Nation's economy would benefit from an additional $26 million annually. If an improved water infrastructure can close the income gap between the Navajo and the U.S. average by just one percent, the direct benefits will be worth tens of millions of dollars annually. Without this Project the Navajo economy will continue to stagnate.

2.2 The City of Gallup Background

The City of Gallup was established in the 1880's as a small company headquarters for the Atchison, Topeka and Santa Fe Railroad. Initially the town's economy was supported by coal mining in the region. The City of Gallup became a regional trade center for the surrounding area, including the Navajo Nation which borders most of the City's geographic boundary. Today, the City's population exceeds 23,000 and it continues to serve as an economic center for more than 100,000 people. The City relies solely on a groundwater supply that is being progressively mined with little recharge into the source aquifers. Current hydrologic projections by the City predict severe shortages in the groundwater supply within 10 years. This projected shortfall will have severe economic and social impacts on the City of Gallup and the surrounding Navajo Chapters.

The Navajo land near the City of Gallup has been explicitly included in this Project service area.. This area includes the Chapters of Bread Springs, Chichiltah, Church Rock, Iyanbito, Manuelito, Pinedale, Red Rock, Rock Springs, and Tsayatoh. Project water will be conveyed through the municipal system of the City of Gallup to the surrounding NTUA systems and, under some circumstances, to individual water users.

2.3 The Navajo Agricultural Products Industry

The Navajo Agricultural Products Industry (NAPI) is a tribal enterprise, which was created in 1970 to develop, farm, and operate the Navajo Indian Irrigation Project (NIIP) lands, and operate and maintain the NIIP water delivery system. NAPI currently produces a variety of crops including corn, potatoes, alfalfa, pinto beans, and others. Its crops are marketed throughout the United States, Mexico, and other international markets under the "Navajo Pride" trademark. NAPI provides approximately 250 permanent jobs and up to 800 seasonal jobs during peak seasons. Subcontractors, joint venture partners, and independent truckers employ additional workers. In 1999, NAPI farmed 64,000 of the 110,630 acres to be developed. NAPI channels $55 million annually into the Navajo Nation's economy.

Both Project alternatives will provide additional industrial water for the NAPI. The Project alternative that utilizes the NIIP Canals would be closely integrated with NIIP canal operation. The conveyance of municipal water may provide significant benefits to both NIIP and the Project. The thoughtful sequencing of construction, operation and maintenance, and financing could benefit NAPI and the Project. However, hydrologic constraints created by the Endangered Species Act may preclude the use of the NIIP canals for the Project.

3.0 PROJECT HISTORY

Regional water plans over the past 40 years have repeatedly identified the need for additional rural, municipal, and industrial water supplies for the eastern portion of the Navajo Nation and the City of Gallup. The history of the Project is presented in the following sections.

1958 - Congressional hearings on the Navajo Indian Irrigation Project

In 1958 the New Mexico State Engineer testified during Congressional hearings for the proposed Navajo Indian Irrigation Project that NIIP would be part of the regional water infrastructure intended to provide water from Navajo Reservoir to Navajo communities in northwest New Mexico and to the City of Gallup (Hearings before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs, S.3648, July 9 and 10, 1958). This position was reaffirmed in House Report #685, July 10, 1961 which stated that NIIP is adapted to serve municipal and industrial water users as well as its primary purpose of irrigation.

1960 - Preliminary Report on the Domestic Water Supplies for the Navajo Tribe

In 1960 Banner and Associates prepared a report entitled *Preliminary Report n Domestic Water Supplies for the Navajo Tribe, Newcomb-Window Rock Area, Supplement to Proposed Water Supply to the Town of Gallup, New Mexico.* Banner and Associates proposed a 20-inch diameter pipeline to deliver five million gallons a day to the City of Gallup, and 1.5 million gallons a day to the BIA schools along the pipeline route and the Navajo population in the Window Rock area. The proposed configuration would convey water from the NIIP canals, to an 8,800 acre-foot storage reservoir located in Newcomb, and then follow Highway 666 to the City of Gallup with a spur to the Window Rock area.

1962 - Authorization of the Navajo Indian Irrigation Project

The Navajo Indian Irrigation Project was authorized by Public Law 87-483 (June 13, 1962), amended by Public Law 91-416 (September 23, 1970). These laws authorized the Secretary of the Interior to construct, operate, and maintain NIIP for the principal purpose of furnishing irrigation water to approximately 110,630 acres of land. In developing NIIP, the Secretary of the Interior is authorized to "provide capacity for municipal and industrial supplies or miscellaneous purposes over and above the diversion requirements for irrigation." Public Law 87-483 also authorized the construction of the San Juan-Chama Diversion Project. The San Juan-Chama Project was complet́ed during the 1960's and it is supplying water for municipal, recreation and irrigation uses for a population of 500,000 in the Rio Grande Corridor. Public Law 87-483 also stipulated that no long-term contracts for San Juan River water, other than the Navajo Indian Irrigation Project and the San Juan-Chama

Project, will be granted until a Hydrologic Determination by the Secretary of the Interior shows that there is sufficient water to fulfill the contract.

1967 - Temporary water allocation from Navajo Reservoir

In June 1967, the City of Gallup through Resolution 24-51 formally requested that the New Mexico Interstate Stream Commission (ISC) support the 15,000 acre-feet per year allocation of Upper Colorado River water for Gallup. Upon review, the ISC recommended temporarily reserving 7,500 acre-feet of water from Navajo Reservoir for the City of Gallup. Based on the 1967 Hydrologic Determination, the Secretary of the Interior approved a temporary allocation for the State of New Mexico for 100,000 acre-feet from Navajo Reservoir through the year 2005 (Assistant Secretary of the Interior, Report No. 1106, 90th Congress, 2d Session, February 27, 1968 - S.J. Res. 123). This reservation was made for planning purposes and was not a Secretarial contract for water delivery.

Because the 7,500 acre-feet temporary reservation for the City of Gallup is part of the 100,000 acre-foot allocation for New Mexico, any water use contract beyond the year 2005 must be supported by a hydrologic determination by the Secretary of the Interior and approved by Congress. However, in a letter dated December 13, 1973 from the State Engineer of New Mexico to Reclamation's Regional Director of the Southwest Region, he states that "It is New Mexico's position that under the correct interpretation of the compact's provisions, the full 100,000 acre-feet of consumptive use from Navajo Reservoir contracts would be available in perpetuity."

1971 - Congressional authorization for feasibility studies

Congress specifically authorized Reclamation to complete feasibility studies for the "Gallup Project" (now called the Navajo-Gallup Water Supply Project) to transport San Juan River water to the City of Gallup (PL. 92-199, December 15, 1971). In 1972 the reconnaissance report concluded that: (1) water to meet the City's needs was available from Navajo Reservoir, (2) there was a potential to develop groundwater supplies within import distance of Gallup, and (3) feasibility investigations should be undertaken to develop plans for providing water to the City of Gallup and that those studies should consider providing water to Navajo communities along the supply routes.

1976 - The Turney Report assessing the Navajo Nation's water needs

In 1975 the Navajo Tribal Utility Authority (NTUA) requested that the investigation be expanded to include municipal/domestic water supplies for various Navajo communities in the eastern part of the Navajo Reservation. A memorandum of understanding between the Bureau of Reclamation and NTUA to include Navajo Nation communities was executed August 12, 1975. As part of the agreement, NTUA retained the engineering firm of William F. Turney & Associates to prepare the report *U.S. Bureau of Reclamation - Navajo Tribal Utility Authority Water Study P.L. 92-1999*

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(Turney,1976). Turney and Associates assessed the Navajo Nation water needs that could by addressed by the Project. Turney and Associates projected the population and water demand through the year 2025 and evaluated 25 community water systems. Many of those systems had water quality and water supply problems. Turney and Associates identified the Dakota-Morrison-Cow Springs aquifer as having the best potential in the southwest portion of the study area. These formations, however would only be able to supply one third to one half of the water demand in the Tohatchi-Gallup Area by the year 2025. The Navajo Nation fully supported the findings of Turney's report and Reclamation adopted the findings as a basis for the 1984 project plan formulation.

1984 - Compliance with the National Environmental Protection Act

During the late 1970's and early 1980's investigations were conducted to develop and evaluate alternatives to meet the Project's purposes. To comply with the National Environmental Protection Act (NEPA) the fish, wildlife, and habitat resources of the Project area were assessed and the impacts of the alternatives were analyzed. Alternatives were evaluated which would divert 25,800 to 48,500 acre-feet of water per year. Meeting the Project's purposes through increased groundwater withdrawals, surface water from the Chaco Wash and the Rio Puerco, and weather modification were determined to be infeasible. These investigations culminated with the *Gallup-Navajo Indian Water Supply Project, New Mexico-Arizona-Utah, Part I, Planning Report, Part II, Draft Environmental Statement* (Reclamation, 1984). This report confirmed the City of Gallup and the Navajo Nation's need for a water supply, and it determined that the San Juan River was the only source of water capable of meeting the Project demand. The following alternatives were evaluated in that report:

- No-Action Plan - This plan was based on the premise that there would be no federal action taken to meet current and future water needs of the Project area. This plan did not satisfy the purpose and need of the Project.

- Non-structural Plan (Water Conservation) - It was determined that water conservation could not meet the needs of the Navajo communities. While conservation measures may help the City of Gallup meet short term needs, it was not a viable solution to meet long-term needs and did not address deteriorating water quality.

- Shiprock Diversion Plan - The features of this plan included a diversion structure on the San Juan River near Shiprock, pipelines, pumping plants, and related facilities necessary for water delivery, and specific environmental features pertinent to reaches of the river influenced by the plan. This plan was not viable due to the poorer quality of the San Juan River at this diversion point and the additional 350-foot lift. No cost estimates were prepared for this alternative.

- San Juan Alignment Plan - The features of this plan included a diversion structure on the San Juan River upstream from the Animas River in Farmington, 180.5 miles of pipeline, 14 pumping plants and related facilities. A treatment plant near the diversion would be constructed separately. The route of the pipeline was along Highway 666 from Shiprock to Gallup and to Window Rock. This configuration would serve Burnham, Coyote Canyon, Standing Rock, Crownpoint, St. Michaels, Fort Defiance, Sanostee, Two Grey Hills, Toadlena, Mexican Springs, and 23 other Navajo communities.

This plan was evaluated for demands from 25,200 to 45,600 acre-feet per year. The estimated capital cost, excluding water treatment, was between $199 and $263 million in 1980 dollars. Using Reclamation's steel price index, the cost in 2000 dollars would be between $330 and $437 million. The estimated annual operation and maintenance was between $2.6 and $3.7 million in 1980 dollars. Using Reclamation's composite index, the cost in 2000 dollars would be between $4.1 and $5.8 million. The unit cost of the water including repayment of the capital, and operation and maintenance cost was between $1.87 and $2.59 per thousand gallons in 1980 dollars. Using Reclamation's steel price index, the unit cost in 2000 dollars would be between $3.06 and $4.28 per thousand gallons.

- Cottonwood Alignment Plan - This plan proposed to use the existing NIIP facilities to divert water from Navajo Reservoir and deliver it to a reservoir constructed in Cottonwood Canyon. Other features included a treatment plant (constructed by others) located near the dam, 180.6 miles of pipeline, 13 pumping plants and related facilities. The route of the pipeline went through Burnham along Highway 5 and then south along Highway 666 to Gallup.

  The plan was evaluated for demands from 25,200 to 45,600 acre-feet per year to serve 23 Navajo communities. The estimated capital cost, excluding water treatment, was between $210 and $266 million in 1980 dollars (or between $348 and $442 million in 2000 dollars). The estimated annual operation and maintenance cost was between $2.2 and $3.1 million in 1980 dollars (or between $3.5 and $4.9 million in 2000 dollars). The unit cost of the water including repayment of the capital, and operation and maintenance was between $1.83 and $2.68 per thousand gallons in 1980 dollars (or between $3.06 and $4.49 per thousand gallons in 2000 dollars).

- Four Corners Plan - This plan was considered the preferred alternative. It was essentially the same as the 1984 San Juan Alignment Plan except that it included construction of a water treatment plant for $23 million (or $37 million in 2000 dollars) and provided service to nine additional Navajo communities in Arizona and Utah. Features included 254.7 miles of pipeline and nine pumping plants.

  The plan provided a total water supply of 42,270 acre-feet per year with 29,300 acre-feet of delivery in New Mexico, 6,990 acre-feet in Arizona and 1,180 acre-feet in Utah. The proposed configuration would serve Upper Fruitland, Nenahnezad, Shiprock, Sanostee, Tocito, Burnham, Newcomb, Two Grew Hills, Toadlena, Sheep Springs, Naschitte, Tohatchi, Mexican springs, Twin Lakes, Yah-ta-hey, Gamerco, Gallup, Rattlesnake, Beclabito, Teec Nos Pos, White Mesa, Navajo, St. Michaels, Fort Defiance, Sawmill, Crystal, Coyote Canyon, Standing Rock and Crownpoint.

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The estimated cost in 1981 was $303 million (or $605 in 2000 dollars). The estimated annual operation and maintenance cost was $5.7 million in 1980 dollars (or $8.9 million in 2000 dollars). The unit cost of the water including repayment of the capital, and operation and maintenance was $3.24 per thousand gallons in 1980 dollars (or $5.41 per thousand gallons in 2000 dollars).

This 1984 planning report recommended the Four Corners Plan as the best alternative to meet the area's needs. It was noted that some of the proposed service area overlapped with that of the Animas-La Plata Project. And, if the Animas-La Plata Project was funded for construction, those communities could be dropped from the Navajo-Gallup Project. The report concluded that the Secretary of the Interior should seek congressional authorization to construct, operate, and maintain the Four Corners Plan.

During April of 1984, public meetings on the draft environmental statement were held in Gallup, Crownpoint, Shiprock, Farmington, and Window Rock. The City of Gallup indicated continued support for the recommended plan. However, the Navajo Nation, under new administration, indicated that prior to any further commitment to the Four Corners Plan, other alternatives serving water short communities along New Mexico Highway 371 needed to be evaluated. Reclamation discontinued work on the Planning Report and Draft Environmental Statement and published a notice of withdrawal of the Draft Environmental Statement in the Federal Register.

1986 - Reclamation's Gallup-Navajo Technical Report

Funding was written into the Energy and Water Development Appropriations Act for Fiscal Year 1986 to evaluate additional alternatives. Reclamation coordinated the definition of the Project's purpose with the Navajo Nation and the City of Gallup. The proposed concept would provide 7,500 acre-feet to the City of Gallup, 12,245 acre-feet to the Navajo Communities and 37,000 acre-feet for a proposed generating plant near Burnham, New Mexico. These alternatives were described by Reclamation in the *Gallup-Navajo Indian Water Supply Project, New Mexico-Arizona, Technical Report* (Reclamation,1986). The following alternatives were evaluated in that report:

- Direct San Juan River Pipeline - Two plans were evaluated (Alternatives A and C) which would divert water directly from the San Juan River. These plans were essentially the same as the San Juan Alignment Plan proposed in the 1984 Draft Environmental Statement. The nominal capacity of the pipeline would have been 7,500 acre-feet for the City of Gallup and 5,280 acre-feet for Window Rock, Fort Defiance and St. Michaels. Alternative A would divert water from the Fruitland Canal. Alternative C would require a new diversion dam on the San Juan River upstream of the Animas River confluence. Using an 8-year construction period and a 50-year repayment obligation at 8.5 percent, the total 1986 estimated costs, including indirect costs, was approximately $364 million for Alternative A and $363 million for Alternative C. These costs would be $512 and $511 million in 2000 dollars.

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- A pipeline from the Navajo Indian Irrigation Project - Three alternatives were put forth in the 1986 document which include a feeder canal to divert water from the NIIP main canal to the proposed Gallegos Reservoir. Alternatives B and E would convey water from Gallegos Reservoir water through the Burnham Lateral and then south along Highway 371 to Thoreau and along Interstate 40 to Gallup. Alternative D was similar to Alternative B, but would not require the use of the Burnham Lateral canal. Alternative E included the staged development of the pumping plants required for irrigation. The nominal capacity for all three alternatives would have been 7,500 acre-feet for the City of Gallup and 5,280 acre-feet for the Navajo communities from White Horse to Crownpoint to Church Rock. Based on an 8-year construction period and a 50-year repayment obligation at 8.5 percent, the 1986 estimated costs, including indirect costs, of Alternatives B, D, and E were $456 million, $381 million, and $369 million respectively. These costs would be $642, $537 and $519 million in 2000 dollars.

In the late 1980's the Project stalled in part due to the Navajo Nation's concerns over the failure to complete the Navajo Indian Irrigation Project, and the inadequacy of the Project's proposed service area. It also stalled due in part to Reclamation's concern over the long-term availability of water, lack of quantified water rights for the Project, difficulty in complying with the Endangered Species Act, and difficulty in financing the Project. Reclamation funding was suspended at that time.

1991 - The City of Gallup's Forty Year Water Supply Master Plan

In January of 1991 the City of Gallup prepared a forty-year water supply master plan (Shomaker 1991). The master plan projected that by the year 2030 the annual water demand in the Gallup area will be 7,632 acre-feet and that by the year 2010 the City will face peak water shortages of one million gallons per day. The City has already implemented periodic water rationing. As part of the master plan, the City evaluated additional water sources including "Alternative E" which is the alignment from NIIP to the City proposed in the 1986 Technical Report (Reclamation, 1986). The City also evaluated groundwater in the Bluewater area, the Ciniza Well Field, the Church Rock Mine area, the Yah-ta-hey Well Field, the Ramah Area Well Field, and the Danoff Well Field. The City also evaluated tertiary treatment and wastewater reuse, providing additional City storage and developing the surface water from the South Fork of the Rio Puerco. The City concluded that the Gallup-Navajo Project was the only project that offers a permanent supply and it should be pursued. This conclusion is supported by subsequent regional water plans prepared for the New Mexico Interstate Stream Commission. The short term alternatives identified by the Master Plan were to expand the Yah-ta-hey well field and to investigate groundwater in the Ciniza and Church Rock areas.

In December of 1991 the City investigated a stand alone water transmission line from NAPI to the City. The proposed project would convey 7,500 acre-feet of water. The proposed pipeline began at the southwest corner of NAPI, followed BIA Route 5 through Burnham, and south along Highway

666. The estimated cost in 1991 for the stand-alone pipeline was $61 million (or $74 million in 2000 dollars). This cost estimate did not include many of the indirect costs that would be incurred.

1993 - Reclamation appraisal level evaluation and cost estimate

Funding was written into the Energy and Water Development Appropriations Act for Fiscal Year 1993 for the Reclamation to evaluate the Project and provide cost estimates. The study culminated in the *San Juan River Gallup/Navajo Water Supply Project Engineering and Cost Estimates Technical Appraisal Report*, (Reclamation, 1993), which evaluated the following three alternatives:

- Alternative "A" - This plan was for a pipeline capable of conveying 10,860 acre-feet per year. The pipeline alignment would begin at the proposed Gallegos Reservoir, proceed south along Highway 371, west along Navajo Route 9 and South to Yah-ta-hey along Highway 666. This pipeline would deliver water to the City of Gallup at Yah-ta-hey and to unidentified Navajo communities along the route. The estimated 1993 construction cost was $67 million, the indirect cost was $20 million, and the operation and maintenance cost was $2.7 million (or $84 million, $24 million, and $3.3 million in 2000 dollars, respectively).

- Alternative "B" - This plan utilized the same pipeline route as Alternative A. This plan included 1,085 acre-feet for NAPI, 7,960 acre-feet for the City of Gallup, 9,412 acre-feet for Window Rock and 7,783 acre-feet for thirteen Navajo chapters. The estimated 1993 construction cost was $140 million, the indirect cost was $40 million, and the operation and maintenance cost (excluding the laterals) was $5.2 million (or $175 million, $50 million, and $6.3 million in 2000 dollars, respectively).

- Alternative "C" - This plan was developed in an effort to find a more cost effective alternative. The pipeline alignment would begin at the proposed Gallegos Reservoir and convey water to a point near Twin Lakes, and south along Highway 666 to Yah-ta-hey. This plan included 7,820 acre-feet for NAPI, 5,940 acre-feet for the City of Gallup, 8,600 acre-feet for Window Rock and 8,655 acre-feet for thirteen Navajo chapters. With this plan the main line is shorter than the other two alternatives. It requires fewer pumping stations and it eliminates the need to lift the large quantities of water needed to serve Window Rock and Gallup up to the Crownpoint elevation via the Highway 371 alignment. The estimated 1993 construction cost was $115 million, the indirect cost was $34 million and the operation and maintenance cost (including the laterals) was $4.7 million (or $143 million, $42 million, and $5.7 million in 2000 dollars, respectively). This alternative serves the same water-short communities that were to have been served by Alternative E described in the 1986 report. This analysis did not include the full costs of the proposed Gallegos Reservoir, water treatment, an adequate peaking capacity, or pipe installation.

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1996 - Reclamation evaluates the water supply and storage options

In the 1996 report *Water Supply and Storage Options Gallup Navajo Pipeline Project*, the Reclamation's Farmington Construction Office reviewed three water supply and storage options. This Reclamation investigation did not evaluate the conveyance system that would bring the water south to the Navajo Nation communities and the City of Gallup. This investigation included:

- Direct diversions from Navajo Reservoir - This option would deliver water from Navajo Reservoir through a pipeline to the proposed Gallegos Reservoir at NIIP. The total estimated cost of the pipeline, pumping plants, Gallegos Dam, power lines, utilities and mitigation was $107 million (or $118 million in 2000 dollars). This option minimizes the use of NIIP facilities.

- Direct diversions from the San Juan River - This option would divert 42 cubic feet per second (approximately 30,400 acre-feet per year) from the San Juan River near Farmington to the proposed Gallegos Reservoir. This option would require the construction of a diversion structure within the designated critical habitat of endangered fish species. The estimated cost of the pipeline and pumping plant was $34 million. The estimated cost of Gallegos Dam with 1,800 acre-feet of storage was $18 million. The total estimated cost including power lines, utilities and mitigation was $58 million (or $64 million in 2000 dollars). Energy for pumping water from the San Juan River to Gallegos Reservoir would cost $414,000 (or $459,000 in 2000 dollars) per year. This option also minimizes the use of NIIP facilities.

- Diversions from the NIIP Canal System - This option included several scenarios for conveying water through the NIIP canals. Reclamation investigated three sites for a proposed water storage reservoir: (1) Lower Cottonwood, (2) Upper Cottonwood, and (3) Moncisco Wash. Reclamation assessed three reservoir capacities (1,850, 8,800, and 11,000 acre-feet) at each site. Based on this analysis, the Moncisco site became the preferred alternative for the dam. Moncisco Reservoir is a modification of the previously proposed Gallegos Reservoir. With 8,800 acre-feet of storage, stabilized channels, utilities and mitigation, the field cost was $32.5 million (or $36.1 in 2000 dollars). Energy for pumping water from the NIIP canal to the reservoir would cost $160,000 (or $176,000 in 2000 dollars) per year.

Although the Reclamation analysis did not explicitly include the full cost of using the NIIP facilities, Reclamation concluded that conveying water through the NIIP facilities was slightly more economical than the San Juan Diversion option and far more economical than the Navajo Reservoir Diversion option. Furthermore, the collaboration between NIIP and the Project may increase the overall benefits of the already constructed NIIP facilities.

1998 - The Memorandum of Understanding between the City and the Navajo Nation

In April 1998 George Galanis, the Mayor of the City of Gallup and Thomas Atcitty, President of the Navajo Nation signed an agreement to cooperate on the planning for the Navajo-Gallup Water Supply Project. That document commits the City and the Navajo Nation to:

- A cooperative effort to proceed with planning and development;
- A project that works conjunctively with the Navajo Indian Irrigation Project;
- A project that will result in a fair and equitable distribution of project water between the City of Gallup and the Navajo communities;
- Cooperatively investigate all viable alternative project configurations;
- Support the commitment of the Bureau of Indian Affairs to engage in consultation with the USFWS as quickly as possible; and
- Work together to resolve issues affecting the implementation of the Project.

The Memorandum of Understanding continues to serve as the basis for the collaborative efforts of the Navajo Nation and the City of Gallup to develop the Project (See Appendix B).

1999 - Resolutions of the Upper Colorado River Commission

Recognizing the need to develop depletion schedules for long-range planing, the Upper Colorado River Commission periodically assesses the depletion projections for the Upper Colorado Basin states. Projections made in July 1994 had shown that New Mexico would exceed 669,000 acre-feet as soon as the year 2020. In December of 1999 the Upper Colorado River Commission passed a resolution not objecting to the use of the State's updated depletion schedules. According to the updated January 2000 depletion schedules, the State of New Mexico will not exceed 669,000 acre-feet of Upper Basin depletion until sometime between the years 2030 and 2040. Based on the January 2000 schedule, even though water allocated under the Upper Basin Compact to the State of New Mexico may not be available after the year 2040, it would be possible for the Project to develop a new water contract based on unused Upper Basin allocations at least through the year 2060.

Navajo-Gallup Water Supply Project

1990 to 1999 - Interdisciplinary technical reports

In a letter dated March 5, 1992 from Marshal Plummer, Vice President of the Navajo Nation to George Galanis, Mayor of the City of Gallup, Mr. Plummer indicated the Navajo Nation's support for a cooperative effort on this Project. As a result, a steering committee was created in June 1992 to oversee Project activities funded through annual congressional write-in funding and matching funds from the Project sponsors. The steering committee includes representatives from IHS, BIA, Reclamation, the City of Gallup, and the Navajo Nation. Additional technical investigations produced the following findings:

- Engineering - Reclamation provided additional review and constructablity surveys of the Project's regulating storage facilities. Technical analysis also refined estimates of Project demands, diversions and depletions. Based on this information, in 1998 a draft Project description was developed with adequate detail for engaging the USFWS in consultation pursuant to Section 7 of the Endangered Species Act.

- Cultural Resources - Extensive cultural resource studies were conducted for the El Paso Natural Gas and Transwestern Pipeline corridors which overlap some of the proposed Navajo-Gallup alignments. These reports include Winter (1991a), Winter (1991b), Kearns (1990), ENSR 1990, and FERC (1991). In 1993 staff from Reclamation, the Navajo Nation Archaeology Department and the Navajo Nation Historic Preservation Department provided information on cultural resources within the potential impact area. Based on these studies sites that are potentially within the area of direct impact of the Navajo-Gallup Project were identified. The scope of work and budget for a Phase II cultural resource survey was prepared.

- Biological Resources - Extensive biological resource studies were conducted for the El Paso Natural Gas and Transwestern Pipeline corridors which overlap some of the proposed Navajo-Gallup alignments. These reports include Cedar (1990), Mariah (1991), Ecosphere (1990), and ENSR (1990), and FERC (1991). In 1993 Reclamation and the Navajo Department of Fish and Wildlife identified the terrestrial biological issues and concerns associated with construction of the Navajo-Gallup Project. A comprehensive bibliography of biological resource information for the Project area was completed, and the scope of work for further investigations was prepared. In 1998 a field trip was made to the proposed reservoir sites to assess the presence of Willow Flycatcher habitats. A biological assessment for the threatened and endangered aquatic species in the San Juan River is underway.

- Ability to Pay - In 1993 Reclamation estimated the annualized construction costs over a forty-year life cycle for Alternative C as described in the 1993 *San Juan River Gallup/Navajo Water Supply Project Engineering and Cost Estimates Technical Appraisal Report*. These costs were calculated for a range of interest rates from 3 to 9.5 percent and a range of an outside subsidy from 10 to 75 percent. Based on that analysis, the annualized construction cost ranged from$1.6 million to $15.8 million. For an interest rate of 6.5 percent and a 10 percent subsidy the annualized construction cost was $10.1 million per year. The Reclamation analysis did not discount the interest rate due to inflation.

Based on average and maximum water bills, household incomes and tax burdens of 110 communities in New Mexico, Reclamation estimated the ability to pay for Gallup and the Reservation communities. The total annual ability to pay was estimated to be a little less than $2.2 million for the City of Gallup and approximately $1.0 million for the Reservation communities. This total amount was about one third of Reclamation's midrange estimate of the annualized construction cost. However, the Reclamation analysis did not fully take into account future population growth nor inflation.

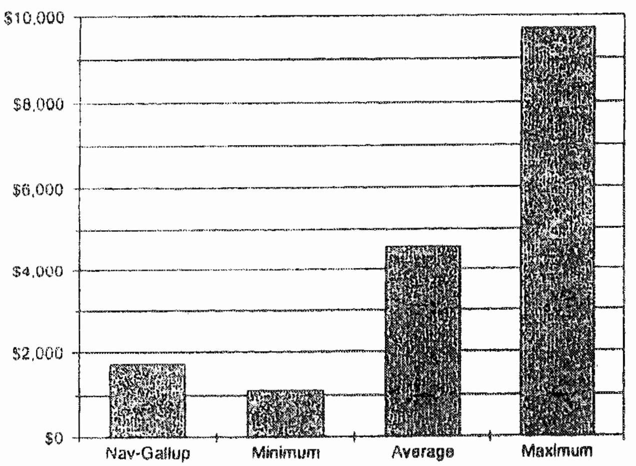
To determine if the communities had the willingness to pay for the construction and operation of the proposed facilities, in 1995 willingness to pay surveys were conducted for the Navajo communities and the City of Gallup. The communities in the service area share a widespread appreciation of the value and scarcity of water in the region. The surveys indicated that the water users were willing and able to pay a portion of the operating cost for the Project. According to the survey, in 1994 approximately 44 percent of the Navajo homes in the service area were without direct access to a public water supply system.

- Comparative Analysis - In 1999 the NDWR compared the Navajo-Gallup Water Supply Project with comparable municipal pipeline projects in the Western United States. This selection was originally compiled by MSE-HKM & Associates. The results of this comparison are shown in Figure 3.1. This list includes projects funded by the Garrison Reformulation Act including projects at Fort Berthold, Standing Rock and Fort Tolten, and the Southwestern Pipeline. It also includes the WEB Rural Water Development Project, the Lewis and Clark Rural Water System, the Mid-Dakota Rural Water System, the Mni Wiconi Project and the north-central Montana Project. The unit cost of the Navajo-Gallup Water Supply Project is approximately $11,000 per acre-foot of water (based on a Project cost of $350 million). This unit cost is less than 65 percent of the overall average unit cost of all of the projects evaluated. The unit cost of the Navajo-Gallup Water Supply Project is only $3,700 greater than the least expensive unit cost of the other nine projects reviewed. Additionally, the estimated operation and maintenance cost per acre-foot for the Navajo-Gallup Water Supply Project is only 78 percent of the overall average. These figures demonstrate that this Project compares very favorably with the other similar water supply projects.

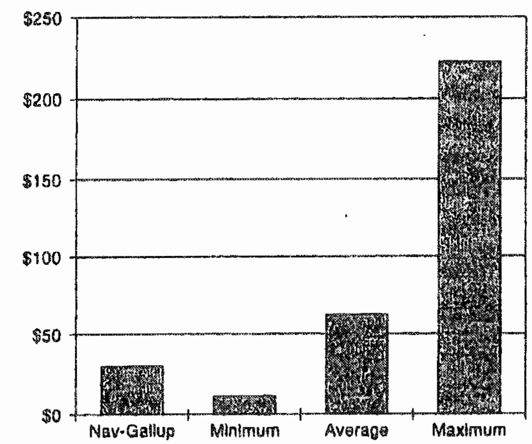
Figure 3.1 : Comparsions of Muncipal Water Projects

Projects	Total Capital $ Cost	Annual O&M	Annual Pumping Cost	G.P.D.	TCC/ Person	O&M/ Person	O&M/ 1000 Gal.	Pumping/ 1000GAL	TCC/ G.P.D.	Unit Cost/ Acre-Feet
ort Berthold	$95,746,810	$2,197,296	$409,965	299	$9,705	$223	$2.04	$0.38	$789	$28,970
;tanding Rock-Phase I	$11,069,217			391	$4,290					$8,386
ort Totten-Phase I	$6,226,625			141	$1,159					$7,334
:outhwest Pipeline	$200,220,240	$1,752,700	$1,489,300	302	$3,626	$32	$0.29	$0.24	$173	$10,712
VEB Rural Pipeline	$176,416,000	$938,000	$227,000	309	$7,787	$41	$0.37	$0.09	$149	$22,499
ewis & Clark	$330,993,000	$3,451,623	$1,816,409	56	$1,114	$12	$0.57	$0.30	$285	$17,897
lid-Dakota	$157,787,010	$1,803,176	$359,781	84	$3,094	$35	$0.55	$0.11	$215	$15,652
lni Wiconi	$318,521,610	$4,018,000	$1,707,000	215	$6,169	$78	$0.99	$0.42	$459	$25,535
lorth Central Montana	$207,883,520	$1,428,565	$349,047	230	$6,944	$48	$0.57	$0.14	$230	$26,945
lav-Gallup	$350,372,000	$5,038,489	$3,568,969	160	$1,735	$30	$0.59	$0.50	$356	$11,061
Minimum	$6,226,625	$938,000	$227,000	56	$1,114	$12	$0.29	$0.09	$149	$7,334
Average	$185,526,603	$2,579,481	$1,240,934	219	$4,562	$62	$0.75	$0.27	$332	$17,498
Maximum	$350,372,000	$5,038,489	$3,568,969	391	$9,705	$223	$2.04	$0.50	$789	$28,970

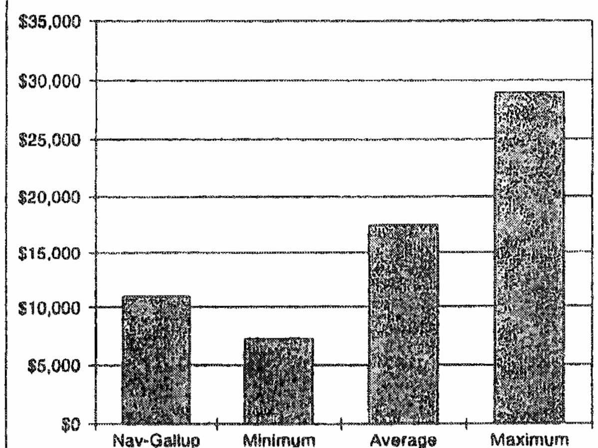
Total Capital Cost Per Person



Operation & Maint. Cost Per Person



Unit Cost Per Acre-Feet



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- Collection of NIIP Return Flows - An alternative water supply is to collect subsurface drainage water from NIIP irrigated lands. The potential advantage of sub-surface return flow is that it would be available all year reducing the need for Project storage at NIIP. Relief and interceptor drains would intercept groundwater helping to maintain the agricultural productivity at NIIP. Collector drains would collect the water from the relief and interceptor drains. Outlet drains would carry the collector drain water to a central location(s) for pumping into a forebay reservoir. A portion of the cost of the proposed collection systems may be incurred by NIIP to maintain commercial farming.

  A study is being conducted on NIIP to predict the groundwater buildup under current and future irrigation practices. The groundwater model is being updated as additional input data is available and as assumptions are refined. Using return flows would not reduce the overall combined depletions associated with NIIP and the Project. However, it could reduce NIIP discharges into the San Juan River that may affect native species.

  Recent studies of selenium levels in the San Juan River demonstrated that the environmental benefits of preventing these return flows from entering the San Juan River may be minimal. The relatively small volume of return flows, the high cost of the collection system, concerns regarding the expense of water treatment and the minimal environmental benefit have eliminated this option from further consideration as a water supply alternative.

- Groundwater Alternatives - In 1998 the NDWR prepared a summary of the current groundwater production for public water systems within the Navajo-Gallup Water Supply Project area. In some respects this report updates the 1976 report prepared by Turney & Associates. The NDWR identified and evaluated potential groundwater supply alternatives for each community within the Project area. The level of analysis is appropriate for planning purposes of the Navajo Chapters in the Project service area. For most of the communities evaluated, additional groundwater development is hindered by low yields, poor water quality, large depths to water and very low recharge rates. These conditions make the cost of drilling and pumping prohibitively expensive. Limited supplemental groundwater supplies were considered for several of the communities in the service area and they are included in the Project for development.

Navajo-Gallup Water Supply Project

1999 - San Juan River Recovery Implementation Program Flow Recommendations

In 1991 the USFWS designated much of the San Juan River as critical habitat for the Colorado pikeminnow (formerly known as the Colorado squawfish) and razorback sucker. This designation dramatically impacted the ability of water users to deplete additional water from the San Juan River.

In the early 1990's the USFWS issued a biological opinion that concluded that an additional depletion of 57,100 acre-feet of water out of the San Juan River for the Animas-La Plata Project and 120,000 acre-feet for NIIP would jeopardize the continuing existence of the endangered Colorado pikeminnow and razorback sucker. The USFWS reasonable and prudent alternative for the Animas-La Plata Project included a recovery program that was initiated in 1992. The program included a research period of approximately seven years and a recovery period of an additional seven years. The goals of the recovery program are to:

- Conserve populations of Colorado pikeminnow and razorback sucker in the basin consistent with the recovery goals established under the Endangered Species Act.

- Proceed with water development in the basin in compliance with federal and state laws, interstate compacts, supreme court decrees, and federal trust responsibilities to the Tribes.

In 1992 the recovery program established the total San Juan River baseline depletions for New Mexico at approximately 440,000 acre-feet.

One component of the USFWS's 1992 reasonable and prudent alternative for NIIP included participation in the recovery program. This decision by the USFWS enabled NIIP to initiate construction of Blocks 7 and 8. Additional features of the alternative included incorporating "conservation acreage" into NIIP's crop rotation, allocating NIIP project-wide water shortages, and transferring 16,400 acre-feet of baseline depletions from other Navajo irrigation projects in the Shiprock area. With these constraints the overall Navajo depletions from the San Juan River, and in the environmental baseline, did not increase.

Due to the recovery program the San Juan River and the operation of Navajo Dam have been the subject of intensive research. Between 1992 and 2000, NIIP invested approximately $14 million supporting the recovery effort. Based on that research, the flow requirements necessary to protect the endangered fish were assessed. The first phase of the flow recommendations were approved by the recovery program in May 1999 (Holden 1999). These recommendations have been provided to the USFWS for use in future Section 7 Consultations. The initial flow recommendations indicate that an additional 122,000 acre-foot annual withdrawal may be possible without jeopardizing the endangered fish. Through NIIP's 1999 consultation with the USFWS, this volume of depletion was added to the San Juan River environmental baseline. This additional depletion is barely sufficient to complete the construction of NIIP, and it does not enable NIIP to restore the 16,400 acre-foot baseline depletion to the Navajo irrigation projects in the Shiprock area. Additional features of the reasonable and prudent alternative include:

Navajo-Gallup Water Supply Project

- Re-operation of Navajo Dam to mimic a natural hydrograph and meet the flow recommendations for the San Juan River

- Construction of three rearing ponds to assist the augmentation program for razorback suckers and potentially Colorado pikeminnows

- Removal of the Cudei Diversion Dam to provide fish access to designated critical habitat

- Construction of fish passage at the Hogback Diversion Dam to provide fish access to designated critical habitat

- Improve irrigation efficiency to reduce irrigation return flows, improve water quality, and reduce impacts to river flows

- Continued funding of, and participation in, the San Juan River Recovery Implementation Program

Pending future research and recovery, the outcome of future Section 7 Consultations with the USFWS may enable additional depletions. Work is continuing to refine and optimize the required flow conditions for the fish while allowing water depletions for future development. Because the point of diversion for this Project has critical hydrologic implications, its location may be largely determined by the requirements of the endangered species in the San Juan River.

2000 - Investigation of the City of Gallup Transmission and Storage Facilities

The *City of Gallup Transmission and Storage Facilities* (December 2000) by DePauli Engineering and Surveying Company presented a preliminary design and cost estimate for distributing the Project water from the Yah-ta-hey Junction through the City of Gallup to the NTUA systems in Churchrock on the east, Manuelito and Spencer Valley on the west, and Redrock on the south. DePauli also investigated the required peaking factor for the City of Gallup. The total estimated cost for construction, engineering and contingencies for this regional project is $23.5 million (excluding costs associated with addressing NEPA, cultural resources and right-of-way).

2001 - A technical summary and plan of approach for the Project

This document is the *Navajo-Gallup Water Supply Project Technical Memorandum*. It presents a summary and analysis of the Navajo-Gallup Water Supply Project with reconnaissance level cost estimates. It includes Project alternatives which can meet the Project's purpose and need. And, it forms the basis of understanding between the Navajo Nation and the City of Gallup for establishing a partnership to construct the water system.

Navajo-Gallup Water Supply Project

More than twenty-five years of studies have reached essentially the same conclusions. The range of alternatives is very limited because the San Juan River is the only viable, long-term, source of water. Configurations have been developed which, at an appraisal level, appear to meet the Project's purpose in an economic manner. Further refinements and analysis to the Project plan such as the selection of reservoir sites, pipeline alignments, and other project facilities will require the collection and analysis of on-the-ground design data and information which will be generated through the NEPA compliance activities that started in March 2000. The draft planning report which is being prepared by Reclamation will be completed by December 2001. The Final Planning Report and EIS will be completed by January 2003.

4.0 WATER DEMAND IN THE PROJECT SERVICE AREA

The Project service area includes two Navajo Chapters in Arizona and 41 in New Mexico. It also includes NAPI, the City of Gallup, and Navajo land adjacent to the City of Gallup. To better characterize the water supply and demand of the region and the Project's service area, the communities have been grouped into twelve municipal subareas as shown in Figure 4.1. The subareas include: (1) City of Gallup, (2) Central Project Chapters, (3) Crownpoint, (4) Gallup Area (Navajo land adjacent to the City of Gallup), (5) Huerfano, (6) Rock Springs, (7) Route 666 Chapters, (8) San Juan River Chapters, (9) Torreon, (10) NAPI, (11) Window Rock, and (12) Thoreau-Smith Lake. A list of the municipal subareas and the communities within those areas served is shown in Table 4.1.

The water demand in the Project service area is based on three distinct components: (1) current population, (2) per capita water use, and (3) projected growth rates. The assumptions underlying those components are presented in this section.

4.1 Current population

The Navajo population statistics for this analysis are based on 1990 census data as reported in the *1990 Census - Population and Housing Characteristics of the Navajo Nation* (Rodgers 1993). The Project service area includes more than 66,000 people in New Mexico (including the City of Gallup) and more than 11,000 in Arizona. The population totals for each municipal subarea and basin are shown in Table 4.1. Population totals for the specific chapters in the Project service area are shown in Tables 4.2. Population totals for the Thoreau-Smith Lake Subarea, which is outside of the Project service area but within the study area, are shown in Table 4.3. The projected populations within the Upper Colorado River, Lower Colorado River, and Rio Grande Basins at ten year intervals are shown in Table 4.4. The population statistics presented in this technical memorandum do not take into account that the U.S. Census Bureau believes that the actual population of Navajos in 1990 was approximately 13.9 percent greater than the official count. After reviewing housing statistics, the McKinley County staff believe that the undercount in the study area may be even greater, but the County has not definitively quantified the undercount.

The current population of the City of Gallup is approximately 23,000. Statistics from the Northwestern New Mexico Council of Governments show that 30 percent of the City of Gallup population is Navajo. Growth trends indicate that Navajos may comprise approximately 50 percent of the Gallup population by the year 2040.

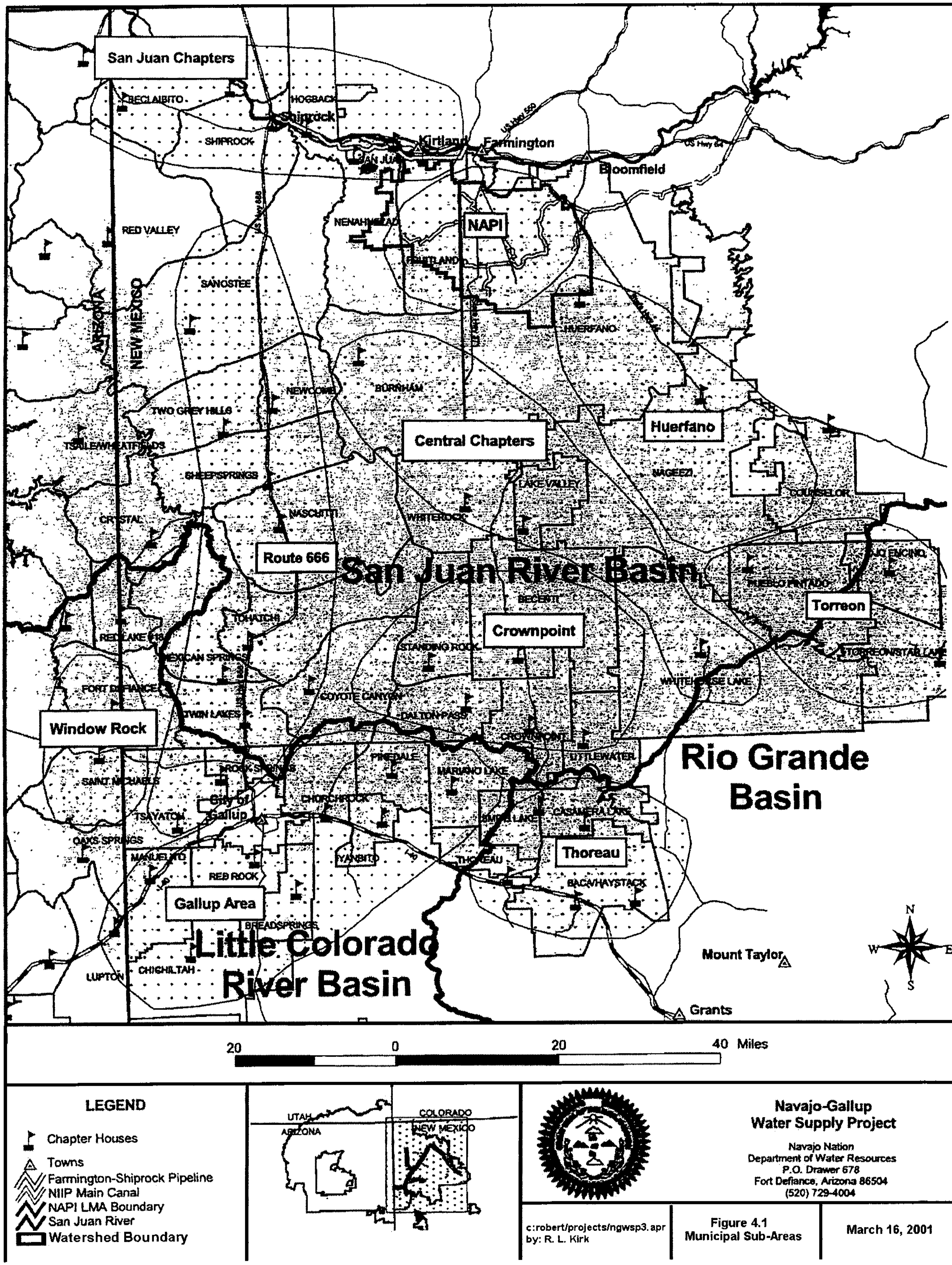


Figure 4.1
Municipal Sub-Areas

Table 4.1
Municipal Water Demand by Basin for the Navajo-Gallup Water Supply Project

Municipal Sub-Area	Basin of Use [2]	1990 Census Pop	2040 Pop [3]	2040 Demand [4] (Ac-ft/yr)	2040 G.W. Production & ALP [5] (Ac-ft/yr)	2040 SJR Diversion [6] (Ac-ft/yr)	2040 SJR Depletion [7] (Ac-ft/yr)
Central Area, NM	U.C.	1,493	5,082	911	77	834	834
City of Gallup, NM [8]	L.C.	19,154	47,197	8,459	1,439	7,500	7,500
Crownpoint, NM	U.C.	5,287	17,996	3,225	752	2,473	2,473
Gallup Area, NM	L.C.	7,904	26,903	4,822	506	4,316	4,316
Huerfano, NM	U.C.	1,492	5,078	910	46	864	864
NAPI Industrial, NM [9]	U.C.	n/a	n/a	7,274	0	700	700
Rock Springs, NM	L.C.	3,749	12,761	2,287	169	2,118	2,118
Route 666, NM	U.C.	10,099	34,374	6,161	795	5,366	5,366
San Juan River, NM [10]	U.C.	13,804	46,985	8,421	4,680	3,741	1,871
Torreon, NM [11]	U.C./ R.G.	3,797	12,924	2,316	77	2,240	2,240
NEW MEXICO UPPER COLORADO BASIN	U.C.	34,012	115,767	28,023	7,050	15,100	13,229
NEW MEXICO RIO GRANDE BASIN	R.G.	1,960	6,672	1,196	77	1,119	1,119
NEW MEXICO LOWER COLORADO BASIN	L.C.	30,807	86,861	15,568	2,114	13,934	13,934
TOTAL NEW MEXICO		66,779	209,300	44,788	9,241	30,153	28,282
TOTAL ARIZONA [11]	L.C.	11,767	40,052	7,179	767	6,411	6,411
PROJECT TOTAL		78,546	249,352	51,967	10,008	36,564	34,693

Notes:

1. Rounding error may cause subtotals to be off by 1
2. U.C.= Upper Colorado Basin, L.C.=Lower Colorado Basin, AND R.G.=Rio Grande Basin.
3. Annual growth for the City of Gallup is 1.82% and for Navajo Nation is 2.48%.
4. Per capita water demand is 160 gallons per person per day.
5. Estimated sustainable groundwater production.
6. Diversions = demand - groundwater use.
7. Depletions are based on zero return flow and use of sustainable groundwater.
8. The City of Gallup plans to recharge its aquifer and use groundwater for summer seasonal peaking.
9. NAPI depletions are 700 ac-ft/year including 400 ac-ft/year for the proposed french fry factory.
10. Approximately 4,680 acre-feet/yr of diversion and 2,340 acre-feet per year of depletion from the San Juan River Subarea's demand is met by the ALP Project and 1,871 acre-feet of depletion is met by the Navajo Gallup Water Supply Project. Assume 50 percent of the San Juan River municipal diversions return to the River.
11. Torreon includes use in the Rio Grande Basin. These depletions are counted toward New Mexico Upper Colorado River allocation.
12. Window Rock Subarea includes depletions which are counted toward the Arizona Lower Colorado allocation.

Table 4.2
Chapter Water Demand for the Navajo-Gallup Water Supply Project

Service Area	Chapter	1990 Population	2040 Population	2040 Demand (Ac-ft/yr)	2040 G.W. Production and ALP (Ac-ft/yr)	2040 SJR Depletion[1] (Ac-ft/yr)
City of Gallup, NM	City of Gallup	19,154	47,179	8,459	1,439	7,500
Central Area, NM	Burnham	246	837	150	0	150
	Lake Valley	436	1,484	266	46	220
	White Rock	201	684	123	See Lake Valley	123
	Whitehorse Lake	610	2,076	372	31	341
	SUBTOTAL	*1,493*	*5,082*	*911*	*77*	*834*
Crownpoint, NM	Becenti	193	657	118	See Crownpoint	118
	Coyote Canyon	1,234	4,200	753	61	692
	Crownpoint	2,658	9,047	1,622	614	1,008
	Dalton Pass	313	1,065	191	0	191
	Little Water	638	2,172	389	See Crownpoint	389
	Standing Rock	251	854	153	77	76
	SUBTOTAL	*5,287*	*17,996*	*3,225*	*752*	*2,473*
Gallup Area, NM	Bread Springs	1,219	4,149	744	77	667
	Chichiltah	1,555	5,293	949	See Bread Spr	949
	Church Rock	1,780	6,059	1,086	123	963
	Iyanbito	974	3,315	594	153	441
	Mariano Lake	726	2,471	443	92	351
	Pinedale	609	2,073	372	See Mariona Lk	372
	Red Rock	1,041	3,543	635	61	574
	SUBTOTAL	*7,904*	*26,903*	*4,822*	*506*	*4,316*
Huerfano, NM	Huerfano	511	1,739	312	31	281
	Nageezi	981	3,339	598	15	583
	SUBTOTAL	*1,492*	*5,078*	*910*	*46*	*864*
Rock Springs, NM	Manuelito	631	2,148	385	46	339
	Rock Springs	1,685	5,735	1,028	77	951
	Tsayatoh	1,433	4,878	874	46	828
	SUBTOTAL	*3,749*	*12,761*	*2,287*	*169*	*2,118*
Route 666, NM	Mexican Springs	711	2,420	434	See Tohatchi	434
	Naschitti	1,539	5,238	939	77	862
	Newcomb	651	2,216	397	12	385
	Sanostee	2,081	7,083	1,270	153	1,117
	Sheep Springs	660	2,246	403	15	388
	Tohatchi	1,607	5,470	980	307	673
	Twin Lakes	1,967	6,695	1,200	153	1,047
	Two Grey Hills	883	3,005	539	77	462
	SUBTOTAL	*10,099*	*34,374*	*6,161*	794	*5,367*
Torreon	Counselor	1,365	4,646	833	0	833
	Ojo Encino	596	2,029	364	15	349
	Pueblo Pintado	472	1,607	288	0	288
	Torreon	1,364	4,643	832	61	771
	SUBTOTAL	*3,797*	*12,924*	*2,316*	*76*	*2,240*
San Juan River[2]		13,804	46,985	8,421	2,340	1,871
NAPI Industrial[3]		n/a	n/a	7,274	0	700
TOTAL NEW MEXICO		*66,779*	*209,282*	*44,788*	*6,199*	*28,284*
Window Rock, AZ	Fort Defiance	6,187	21,059	3,774	767	3,007
	St. Michaels	5,580	18,993	3,404	See Fort Def	3,404
TOTAL ARIZONA		*11,767*	*40,052*	*7,179*	*767*	*6,412*
PROJECT TOTAL		*78,546*	*248,889*	*51,967*	*7,668*	*34,693*

Table 4.3
Water Demand for the remaining Chapters in the Study Area

Municipal Subarea	Chapters	1990 Population	2040 Population	2040 Demand (Ac-ft/yr)	2040 SJR Depletion (Ac-ft/yr)
Thoreau-Smith Lake[1]	Baca/Haystack	731	2,488	446	0
	Casamera Lake	568	1,933	347	0
	Smith Lake	515	1,753	314	0
	Thoreau	1,786	6,079	1,090	0
TOTAL		*3,600*	*12,253*	*2,196*	*0*

Note:

1. The Thoreau-Smith Lake Subarea is outside of the Project service area, but is within the Study Area. These Chapters do not receive San Juan River water.

Table 4.4
Projected Population in the Project Service Area by Basin

Decade	New Mexico Upper Colorado Basin	New Mexico Lower Colorado Basin	New Mexico Rio Grande Basin	Arizona Lower Colorado Basin	Project Total
2000	43,453	37,828	2,504	15,033	98,818
2010	55,516	46,494	3,199	19,206	124,416
2020	70,926	57,205	4,087	24,538	156,756
2030	90,614	70,454	5,222	31,349	197,639
2040	115,767	86,861	6,672	40,052	249,352
2050	147,904	107,200	8,523	51,170	314,796
2060	188,960	132,439	10,889	65,374	397,662

Note:

1. Annual growth for the City of Gallup is 1.82 percent and for Navajo Nation is 2.48 percent.

4.2 Projected growth rates

The City of Gallup has estimated that its annual growth rate over the next five decades will be between 1.32 and 2.36 percent per year. The City of Gallup's 1991 *Water-Supply Study and the Forty-year Water Supply Master Plan* (Shomaker 1991) utilized a 1.82 percent growth rate for projecting the City's water demand. This rate is based on a stable population base and assumes that the economy does not encourage people to move into, or out of, Gallup.

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 1950's the reported annual growth rate of the Navajo Nation's population was 3.57 percent, during the 1960's it was 1.45 percent, during the 1970's it was 1.76 percent and during the 1980's it was 4.48 percent. In 1990 the Navajo Division of Community Development determined that the average annual growth of the Navajo Nation is about 2.48 percent per year and the average Navajo family has 4.52 people (*1990 Census - Population and Housing Characteristics of the Navajo Nation,* Rodgers,1993).

Several other analyses of the population growth rate have been conducted. In a 1996 population study for the New Mexico Interstate Stream Commission, the University of New Mexico Bureau of Business and Economic Research (BBER) estimated that the 1990 growth rate for Native Americans in McKinley and Cibola Counties was 1.86 percent. The BBER study included members of the Navajo Nation, and the Pueblos of Acoma, Laguna and Zuni. This 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.

In 1984 Reclamation used a projected Project 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 (CSU) evaluated the changes in annual growth rates of the Navajo Nation. CSU concluded that a reasonable annual growth rate for planning purposes 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 reached the same conclusion (*Support Documentation for Current and Projected Population of the Little Colorado River and N-Aquifer Basins*, NEA, 1993b). The CSU and NEA estimates take into consideration in-migration, out-migration, fertility, and survival rates of the Navajo population. This growth rate has also been accepted by the multi-agency federal team involved in the Little Colorado River settlement negotiations. The NDWR recommends using a 2.48 percent annual growth rate for projecting Navajo water demand through the year 2040. Based on a 2.48 percent annual growth rate for the Navajo Nation and 1.82 percent growth rate for the City of Gallup, by 2040 the service area will include more than 200,000 people in New Mexico and more than 40,000 in Arizona. By the year 2060, the service area will include more than 300,000 in New Mexico and 60,000 in Arizona. The projected populations for specific communities and basins are shown in Tables 4.1, 4.2, 4.3 and 4.4.

4.3 Average daily per capita water use

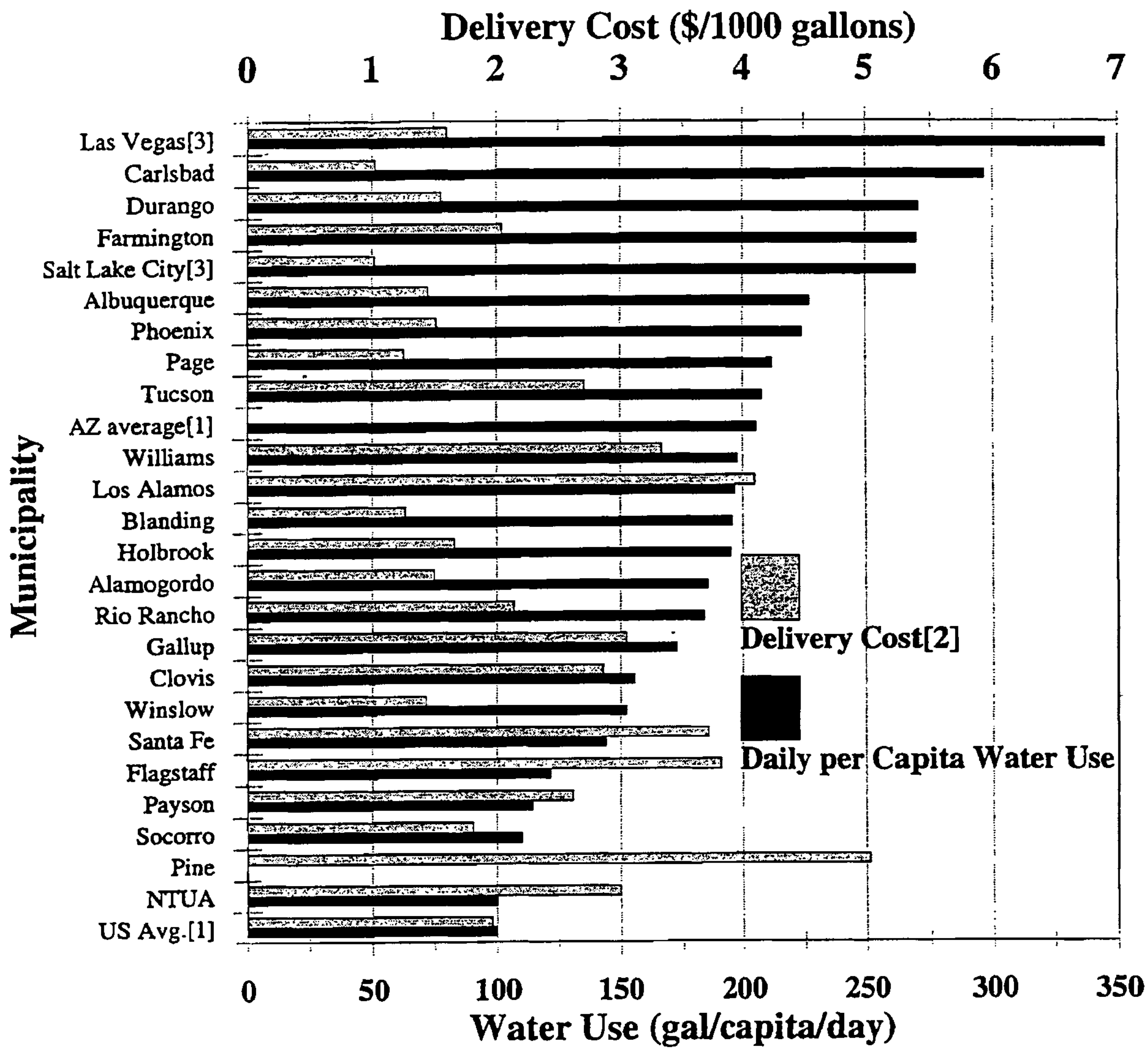
For the purposes of this technical memorandum, the per capita water use is the total community water use divided by the total population. Consequently, this definition includes some water use associated with commercial activity, schools, hospitals and other civic uses. These uses rarely exceed 500 acre-feet per individual user. This definition of per capita water use does not include specific large industrial allocations that may be needed for power plants or large factories.

According to the City of Gallup's 1991 Water Supply Master Plan, the City's average water consumption was 57 gallons per capita per day (gpcd) in 1950, 118 gpcd in 1970, and 160 gpcd in the late 1980's (Shomaker,1991). This 1991 water supply plan states that "since the historical trend of increasing consumption seems to have been arrested, since the future of mining and defense industries is uncertain, and since water conservation measures are expected to maintain or decrease current consumption, no increase in the gpcd was assumed." Consequently the City of Gallup uses 160 gpcd for current and future demand projections. The regional per capita water use comparisons shown in Figure 4.2 illustrate that the City's per capita water use is in the lower third and its water rates are in the top twenty percent.

Per capita water use on the Navajo Reservation varies depending on the accessibility of the water supply. The willingness to pay surveys conducted in 1994 report that 44 percent of the Navajo households in the service area are without direct access to a public water supply system and use very little water. In a 1982 water resource report *Navajo Water Resources Evaluation Volumes 1 - 8*, (Morrison Maierle Inc., 1982), the per capita water use for homes without running water is estimated to be 10 gallons per day. This same rate of water use is cited in *Estimated Use of Water in the United States* (Murray, Richard C., 1965). In 1993, NEA estimated that families which haul water for domestic purposes spend the equivalent of $22,000 per acre-foot compared with $600 per acre-foot for a typical suburban water user in the region (*Cost of Water Hauling, Relocation, and Water Mining and the Value of Family Garden Plots in the N-Aquifer Basin*, NEA, 1993a).

Billing data from NTUA indicates that the average water use on the NTUA systems is approximately 100 gallons per capita per day. According to data from other metered systems, water use on the non-NTUA systems ranges from 20 to 100 gallons per person per day. These low usage rates are often limited by system and supply constraints, not demand. Historic data for non-reservation communities in the region show that water use has increased over time and is currently approximately 160 gallons per capita per day. The increase in per capita water use is correlated with community growth, development and an improved standard of living. Therefore, a per capita water use of 160 gallons per capita per day is recommended for water resource planning on the Navajo Nation.

Figure 4.2
Southwestern Water Use and Water Rate Comparison



Notes:

1 U.S. average per capita use from APWA, Arizona average per capita use from USGS Circular 1200, U.S. average water use rate from Western States Water Circular #1283.

2 Average delivery cost is based on 18,700 gallons per month (25 cubic feet) for residential use. Seasonally variable rates were averaged over the entire year.

3 Salt Lake City and Las Vegas service areas extend beyond their city limits. Per capita water use is the reported value, and not a value calculated by NDWR.

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As shown in Figure 4.2, the recommended water use rate is well within the rates of other municipalities in the Southwest. This rate allows for increasing water use as the Navajo water systems are developed, and as the Navajo water users achieve parity with non-Indian water users in Arizona and New Mexico. The 160 gallon per capita per day rate has also been accepted by the multi-agency federal team overseeing the Little Colorado River settlement negotiations and it has been used for regional water plans in Arizona. This per capita water use is also cited in the City of Albuquerque's long-term water strategy (Brown, 1996).

The water demand projections using this rate per capita water use rate are shown in Tables 4.1, 4.2, and 4.3. The projected municipal demands (excluding NAPI) in the service area within the Upper Colorado River, Lower Colorado River, and Rio Grande Basins at ten year intervals are shown in Table 4.5. By the year 2040, the overall municipal water demand in the service area, excluding NAPI, is 44,700 acre-feet per year.

Table 4.5
Projected Municipal Demand (excluding NAPI) in the Project Service Area by Basin
(Acre-feet)

Decade	New Mexico Upper Colorado Basin	New Mexico Lower Colorado Basin	New Mexico Rio Grande Basin	Arizona Lower Colorado Basin	Project Total
2000	7,789	6,780	448	2,695	17,712
2010	9,951	8,333	573	3,442	22,299
2020	12,672	10,253	773	4,398	28,096
2030	16,241	12,628	936	5,619	35,424
2040	20,749	15,568	1,196	7,179	44,692
2050	26,509	19,214	1,528	9,171	56,422
2060	33,869	23,738	1,951	11,717	71,275

The 1998 groundwater production in the service area was approximately 6,800 acre-feet per year. Of that amount approximately 2,500 acre-feet was for the Navajo public water systems. These estimates are presented in greater detail in Chapter 5. In *Navajo Gallup Water Supply Evaluation of Groundwater and Conjunctive Use Alternatives* (NDWR, February 1998), the NDWR estimated the sustainable groundwater yield that might be available in 2040 for each municipal subarea. For instance, the Window Rock Subarea relies on the alluvial system for approximately 70 percent of its current water supply. NTUA should be able to maintain 760 acre-feet of water production during most years. The groundwater production in the Crownpoint Subarea is projected to double to approximately 750 acre-feet per year.

By the year 2040 groundwater production in the service area is estimated to be 4,600 acre-feet per year. Of that amount, 3,200 acre-feet per year will be for the Navajo Nation public water systems and 1,440 acre-feet will be for the City of Gallup for summer peaking demands. These estimates are presented in greater detail in Chapter 5. These assumptions are very similar to the conclusions reached by Turney and Associates in that water needs assessment (Turney, 1976). Without the Project severe municipal water shortages will ensue. Figure 4.3 shows the depletion schedule for the Project including groundwater withdrawals. Table 4.6 presents the projected San Juan River Project depletions by Basin. Detailed information on the Project depletions is shown in Appendix ___.

Figure 4.3
Projected Annual Depletions in the Navajo-Gallup Project Service Area

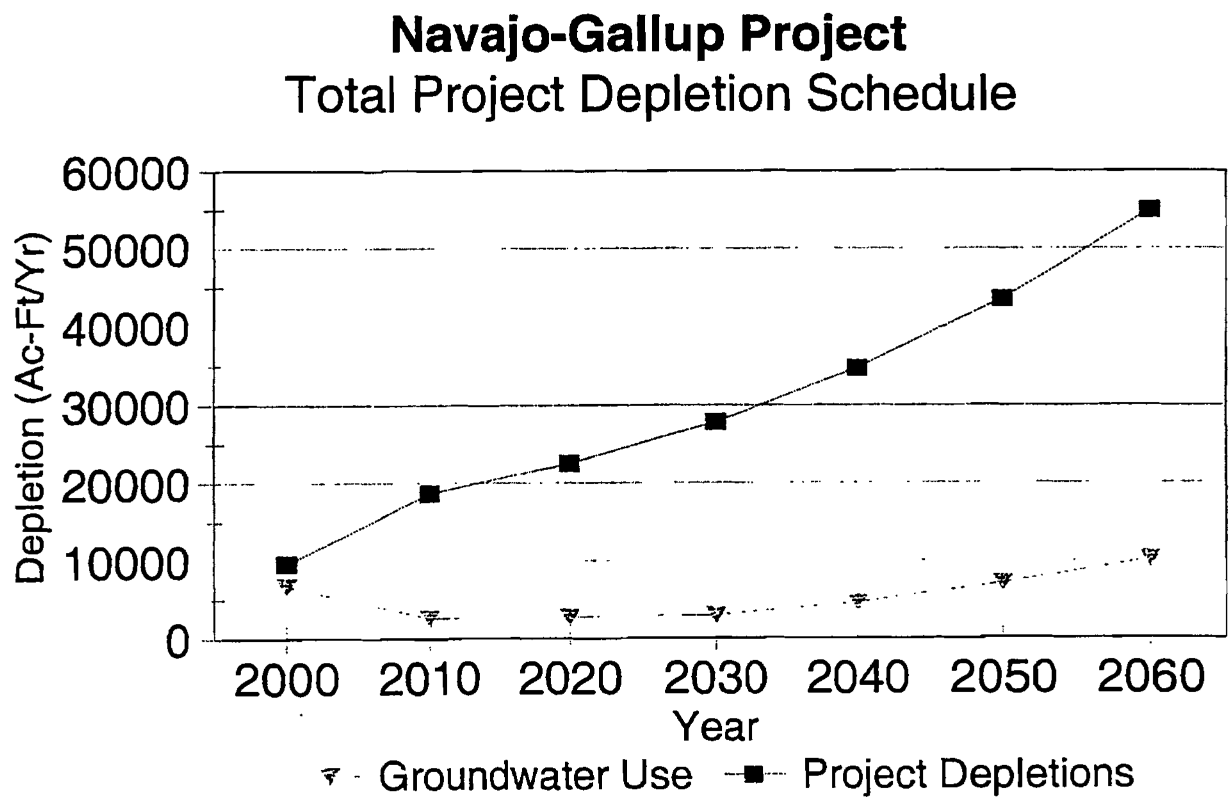


Table 4.6
Projected Navajo Gallup Water Supply Project San Juan River Depletions (including NAPI) in the Project Service Area by Basin
(Acre-feet)

Decade	New Mexico Upper Colorado Basin	New Mexico Lower Colorado Basin	New Mexico Rio Grande Basin	Arizona Lower Colorado Basin	Project Total
2000	5,242	2,352	336	1,652	9,582
2010	5,202	10,503	470	2,469	18,644
2020	6,996	11,360	638	3,493	22,487
2030	9,722	12,479	850	4,783	27,834
2040	13,229	13,934	1,119	6,411	34,693
2050	17,820	15,907	1,451	8,404	43,583
2060	23,686	18,429	1,875	10,950	54,939

4.4 Seasonal and daily peak per capita water use

Over the course of a day, week, month and year significant fluctuations occur in a municipal water system's demand. .To avoid rationing and customer disruptions, and to assist with fire protection, municipal water systems should have adequate production capacity to meet the estimated requirements during peak demand days. The NDWR reviewed several water use studies to determine the appropriate peaking factors for this Project.

The daily peaking factor is the peak daily water use divided by the average daily water use. Daily municipal peaking factors from comparable municipalities and projects are shown in Table 4.7. These daily peaking factors range from 1.70 to 2.50.

However, it may not be economical to design the main conveyance system of this project large enough to meet the daily peak demands. It may be more economical to design the main conveyance system to meet the seasonal demands, and to meet the daily peak water demands with local storage tanks. The daily average water demand for a municipal system during the maximum month is typically 1.2 times the daily average demand during the entire year. The daily average demand during the maximum week is typically 1.4 times the average daily demand during the year (Davis et.al., 1985).

Table 4.7
Daily Municipal Peaking Factors from Comparable Municipalities and Projects

Community	Daily Peaking Factor
Bloomfield	1.70
Shiprock (NTUA)	1.70
Gallup	1.80
Standing Rock and Fort Tolten	1.80
Mid-Dakota Rural System	2.10
Mni Wiconi and Fort Berthold	2.22
Farmington	2.40
Aztec	2.50

In 1993 Molzen-Corbin and Associates (MCA) prepared a report entitled *Navajo Tribal Utility Authority Shiprock Water Supply Study*. According to that study "At minimum, water systems should have enough capacity to meet sustained production needs during the peak 7-day period demand which is the greatest volume of water required over any seven-day period." MCA reviewed daily water production data between 1988 and 1992 for the NTUA's Shiprock system. The ratio between the peak seven day demand and the average daily demand is 1.28 which MCA rounded to 1.3. The greatest demand period for the City of Gallup occurs during the first half of July. The summer peaking factor for the City is 1.35 (DePauli, 2000). These peaking factor values are within the range of values cited by Davis.

At a minimum the Project should have enough capacity to meet sustained production for a seven-day period. In a letter dated August 28, 2000, from David Ruiz (City Manager) and Arvin Trujillo (Executive Director, Division of Natural Resources) to Rege Leach (Project Manager, Reclamation), the participants recommend that the Project be sized to handle a seasonal peaking factor of at least 1.3. Daily peak water demands of approximately 1.8 will be handled by local storage tanks. The peaking factor used in this technical memorandum is 1.3.

4.5 NAPI's water demand for future projects

In a June 30, 1993 letter from Tsosie Lewis, General Manager of NAPI, to Peterson Zah, President of the Navajo Nation, the General Manager described the positive benefits of the Project for NIIP including: (1) additional support for the construction of additional water storage, (2) a much needed supply of treated water that would be required for future agricultural processing projects, and (3) additional opportunity for NAPI to diversify its business activities which will increase profits and employment. In that letter, NAPI describes a variety of future projects that will be possible when NIIP is completed. These projects, listed in Table 4.8, may require a total of 7,274 acre-feet of treated water and 3,420 acre-feet of untreated water. The untreated water demands for NAPI have not been included in the demand tabulations.

All of these projects have been further evaluated. The project that has reached the most advanced state of planning is the potato chip and frozen french-fry factory. As recently proposed, this project will be a joint venture partnership with R.D. Offutt and Son, Incorporated. The proposed factory venture would create 500 jobs and the growing venture would create 100 jobs. The factory will process 600 million pounds of potatoes into 300 million pounds of frozen potato product with annual sales of $100 million and $15 million in pretax profits. The factory venture will use between 2,000 and 4,000 acre-feet of water per year. Most of the effluent from the factory will be used to irrigate fields. Approximately 400 acre-feet of the factory's water supply will be depleted. The BIA successfully consulted with the USFWS on this depletion as required under Section 7 of the Endangered Species Act. In addition to this 400 acre-feet of depletion, an additional 300 acre-feet of depletion, for a total of 700 acre-feet, have been included in the Navajo-Gallup Project for NAPI to pursue additional industrial diversification.

Table 4.8
Future NAPI Processing Water Demand

Future Project	Treated Water (Acre-feet)	Untreated Water (Acre-feet)
1. Dairy Farm Operation	112	
2. Hog Farm Operation	10	
3. Poultry Operation	336	
4. Vegetable Canning Plant	1,120	
5. Milk Packaging	1,120	
6. Ethanol-Gasohol		1,120
7. Animal Slaughter Plant	1,120	
8. Meat Packaging	1,120	
9. Potato Chip & French Fry Plant	1,120	
10. Frozen Vegetable Plant	1,120	
11. Dehydrated Onions	20	
12. Compressed Hay Bales		
13. Nursery Stock and Products		1,200
14. Christmas Trees		1,000
15. Aquiculture		100
16. Carrot Fresh Pack	22	
17. Truck Stop	22	
18. Farmer Market	5	
TOTAL	7,274	3,420

Source: Letter dated June 30, 1993 from Tsosie Lewis, General Manager of NAPI to Peterson Zah, President of the Navajo Nation.

5.0 WATER PRODUCTION IN THE SERVICE AREA

The objective of this section is to quantify the existing water production in the region. Outside of the San Juan River Chapters, the Navajo communities in the region and the City of Gallup rely almost entirely on groundwater for their water supply. The public water systems in the Project service area derive water from a variety of groundwater sources ranging from shallow, unconfined aquifers to deep, confined aquifers. The major aquifers are: (1) Permian and Triassic formations of the Coconino Aquifer system which include the De Chelly Sandstone and Shinarump Member of the Chinle Formation on the Defiance Plateau in Arizona, (2) Permian Glorietta and San Andreas Limestone in New Mexico, (3) Mesozoic sandstone formations which include the Morrison Formation and the Dakota Sandstone, (4) Cretaceous Gallup Sandstone, (5) the Tertiary Ojo Alamo Sandstone, and (6) alluvial deposits in the major drainages.

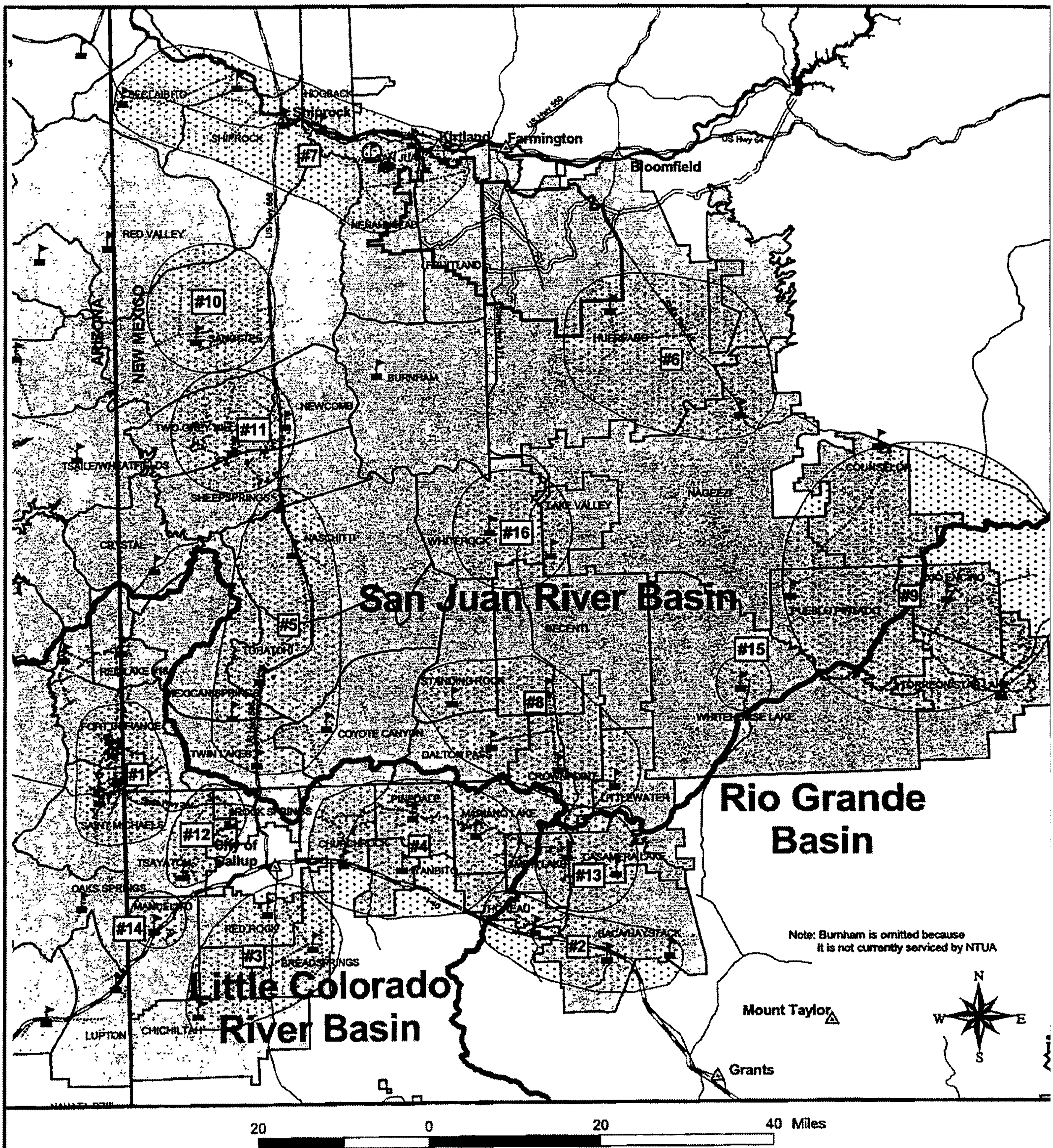
Alternatives to the proposed Project may include upgrading and extending existing water systems, and increasing groundwater withdrawals to meet part of the future demand. These alternatives have been investigated for each municipal subarea and they are described in Section 8.3. Most of the aquifers investigated are undesirable for additional long-term municipal development because of the harmful impacts of continued over-drafting on the groundwater. Continued over-drafting of the groundwater may:

- lower the water levels in wells and increase the pumping depths
- reduce the yield of the well fields
- reduce the quality of the water supply
- increase the capital and operating costs
- deplete the groundwater available for a drought reserve
- lower the water table in riparian areas
- cause land subsidence

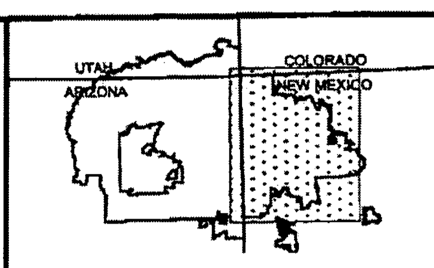
The water production in the region and the Project's service area, is grouped into twelve municipal subareas as shown in Figures 4.1 and 5.1. The subareas include: (1) City of Gallup, (2) Central Project Chapters, (3) Crownpoint, (4) Gallup Area (Navajo land adjacent to the City of Gallup), (5)Huerfano, (6) Rock Springs, (7) Route 666 Chapters, (8) San Juan River Chapters, (9) Torreon, (10) NAPI, (11) Window Rock, and (12) Thoreau-Smith Lake. The estimated water production in each subarea is presented in Table 5.1. The NTUA water supply priority of each subarea is shown in Figure 5.1. The Thoreau-Smith Lake Subarea is within the planning region, but it is not within the Project's proposed service area. Detailed well production information for each subarea is given in Appendix C. The estimated populations and water demands are shown in Table 4.1.

TABLE 5.1
Regional Municipal Water Production during 1998

MUNICIPAL SUBAREA	PRODUCTION (Acre-feet)	SOURCE AQUIFER
1. City of Gallup	4,335	Gallup Sandstone Dakota-Westwater
1. Central	27	Alluvium Picture Cliffs Menefee
2. Crownpoint	330	Westwater Morrison Menefee Gallup Sandstone Point Lookout
3. Gallup Area (Navajo land adjacent to Gallup)	258	Gallup Sandstone Dakota-Westwater
4. Huerfano	90	Alluvium Ojo Alamo
5. Rock Springs	58	Gallup Sandstone
6. Route 666	518	Alluvium Morrison Menefee Point Lookout Gallup Sandstone Mesa Verde Dakota
7. San Juan River	2,256	Surface Water
8. Torreon	113	Ojo Alamo
9. NAPI	N/A	Surface Water
10. Window Rock	1,043	Alluvium De Chelly Gallup Sandstone Shinarump
NAVAJO SUB-TOTAL	4,693	
1. Thoreau-Smith Lake	193	Glorieta
REGIONAL TOTAL	9,221	



LEGEND
- Chapter Houses
- Towns
- NIIP Main Canal
- NTUA Existing Lines
- NAPI LMA Boundary
- San Juan River
- Watershed Boundary



Navajo-Gallup Water Supply Project

Navajo Nation
Department of Water Resources
P.O. Drawer 678
Fort Defiance, Arizona 86504
(520) 729-4004

c:/robert/projects/ngwsp3.apr

Figure 5.1

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5.1 Groundwater production for the City of Gallup

City of Gallup records for 1997 report an average daily water production of 3.87 million gallons per day or 4,335 acre-feet for the year. The maximum daily use was 5.50 million gallons per day. According to the City of Gallup's *Well Production Planning Report* (Sterling & Mataya, and John W. Shomaker and Associates, Inc.,1998) the City derives its groundwater from two confined aquifers, the Gallup Sandstone and the Dakota-Westwater Canyon. The water table in the Gallup Sandstone Aquifer is between 900 and 2,000 feet deep and the aquifer is between 400 and 500 feet thick. The water table in the Dakota-Westwater Aquifer is between 1,900 and 3,000 feet deep and the aquifer is between 300 and 400 feet thick.

The City of Gallup operates two well fields: the Santa Fe Well Field and the Yah-ta-hey Well Field. Historic water table data provided by the City indicate that, from the early 1960's until the late 1990's, the static water level of the Santa Fe Well Field has declined between 340 and 350 feet. And, from the early 1970's until the late 1990's, the static water level of the Yah-ta-hey Well Field has declined between 700 and 835 feet. The City is anticipating a one million gallon per day shortage during peak periods as early as 2010. In 1991, the City's forty-year master water supply plan (Shomaker 1991) identified two short term alternatives including the expansion of the Yah-ta-hey Well Field to the north and developing water in the Ciniza area to the east. Neither alternative is sustainable. The City is also investigating the transfer of water rights from the Plains Escalante Generating Station.

In 1976 the U.S. Geological Survey completed groundwater investigations of the nearby Zuni Mountain and Malpais Region, and the Westwater Canyon Aquifer in the vicinity of Church Rock. The results indicated that the groundwater resources of those areas are inadequate to meet the municipal and industrial needs for the City of Gallup. These findings have been reiterated in numerous studies conducted since that time.

In 1998 the City collaborated with Reclamation and the Pueblos of Acoma and Laguna on an investigation of utilizing existing de-watering wells at the inactive Mount Taylor Mine located near San Mateo, New Mexico. In the March 1999 Technical Appraisal Reclamation estimates that a 4,000 acre-feet yield is possible for a 40-year period. The water source is approximately 70 miles from the City of Gallup and 43 miles from the Pueblo of Laguna. Based on delivering 2,000 acre-feet to the City of Gallup and 2,000 acre-feet to the Pueblos, the total project cost was estimated as $36 million and the annual operation as $2.2 million. This estimate was based on a peaking factor of 1.0 and no storage. Neither the allocation of the costs among the parties, nor the concerns of other interests in the region were addressed by that study. The Mount Taylor Project is not sustainable and does not meet the purpose and needs of the Navajo-Gallup Water Supply Project (Reclamation, 1999).

5.2 Groundwater production for the Navajo Nation

According to the Navajo Environmental Protection Agency, in 1996 there were more than 50 public water supply systems in the Project service area. The largest supplier of domestic and municipal water is NTUA which operates more than 30 water systems in the area. The NTUA systems in the service area are shown in Figures 2.1 and 2.2. The NDWR operates nine systems in the service area. According to data supplied by NTUA and estimates made by the NDWR, in 1998 the Navajo public water systems delivered 5,062 acre-feet in the region. This volume includes approximately 2,200 acre-feet of surface water delivered by the Shiprock NTUA system and 193 acre-feet (or 266?) delivered in the Thoreau-Smith Lake Subarea which is in the planning region, but outside the Project service area. This total also includes 1,043 acre-feet per year delivered by the NTUA system in Window Rock, Arizona.

Descriptions of the groundwater conditions in the municipal subareas are presented in the following section. The population data was provided by Navajo Division of Community Development in *1990 Census - Population and Housing Characteristics of the Navajo Nation* (Rodgers, 1993). Data on the number of service connections for the drinking water systems comes from *Navajo Nation Public Water Systems Inventory Listing May 6 1996* (Navajo EPA, 1996).

5.2.1 Central Project Chapters Subarea

The Central Subarea includes the Chapters of Burnham, Lake Valley, White Rock and Whitehorse Lake. Capacity is included in the main line for these Chapters. However, they may be served by groundwater until additional programmatic resources are available to connect them to the main line. The 1990 population of this subarea was 1,493 and the projected population by the year 2040 is 5,082. The annual water production in 1998 was 8,912,000 gallons (27 acre-feet). Essentially all of the municipal water is from two sources. One source is the Menefee Aquifer near White Horse with a maximum well yield of 16 gpm and well depths of approximately 1,400 feet. The other source is the alluvium aquifer near Lake Valley which has a maximum yield of 24 gpm and well depths of approximately 80 feet. NTUA staff report that a well near Whiterock with a depth of 4,620 feet was abandoned in part due to low yields. The low yields combined with the great depths make groundwater development in this subarea very difficult.

5.2.2 Crownpoint Subarea

The Crownpoint Subarea includes the Chapters of Becenti, Coyote Canyon, Crownpoint, Dalton Pass, Little Water, and Standing Rock. Crownpoint has been designated a primary growth center by the Navajo Division of Economic Development (NDED). The 1990 population of this area was 5,287 and the projected population by the year 2040 is 17,996. Its annual water production in 1998 was 107,416,000 gallons (330 acre-feet). Most of the groundwater in this area is from the Westwater and Morrison Aquifers. The maximum well yield in the area is 248 gpm. near Crownpoint from the Westwater Aquifer. Well depths in the area range from 2,400 to 2,700 feet deep.

Three water systems serve the Coyote Canyon Chapter. One is operated by NTUA and consists of two wells, a 64,000-gallon storage tank, and 114 service connections. The NDWR operates the Bass Lake system, which consists of a well, no storage tanks, and 11 service connections. The Coyote Canyon Chapter operates the Chapter House system, which has a well, an 8,000-gallon storage tank, and 20 service connections. One of the NTUA wells pumps from the Menefee Formation with a yield of about 30 gpm. The NDWR well is artesian and flows at about 60 gpm from the Dalton Sandstone. The Chapter well is completed in sandstones of the Mesa Verde Group and yields about 15 gpm.

5.2.3 Gallup Area

Navajo land adjacent to the City of Gallup has been explicitly included in this plan formulation. This area includes the Chapters of Bread Springs, Chichilta, Church Rock, Iyanbito, Mariano Lake, Pinedale, and Red Rock. The 1990 population of this area was 7,904 and the projected population by the year 2040 is 26,903. The annual water production was 84,078,900 gallons (258 acre-feet). The municipal water is from the Gallup Standstone, Glorietta, Dakota, Chinlee and Morrison Aquifers. Well logs for this subarea indicate that the maximum well yield is 180 gpm near Iyanbito and its depth is approximately 300 feet deep in the Glorietta Aquifer. The producing NTUA wells have depths that range from 1,100 to 1,800 feet. These are some of the same formations that the City of Gallup is withdrawing water from.

5.2.4 Huerfano Subarea

The Huerfano Subarea includes the Chapters of Huerfano and Nageezi. This subarea lies immediately south of the NIIP boundary. The 1990 population of this subarea was 1,492 and the projected population in the year 2040 is 5,078. Its annual water production in 1998 was 29,427,000 gallons (90 acre-feet). Essentially all of the municipal water is from the Ojo Alamo Aquifer. Well logs for this area indicate that the maximum well yield is 81 gpm near Huerfano and its depth is approximately 1,100 feet deep.

5.2.5 Rock Springs Subarea

The Rock Springs Subarea includes the Chapters of Manuelito, Rock Springs, and Tsayatoh. This subarea lies immediately south of the Highway 602 west of the City of Gallup. The 1990 population of this area was 3,749 and the projected population in the year 2040 is 12,761. Its annual water production in 1998 was 18,767,000 gallons (58 acre-feet). Essentially all of the municipal water is from the Gallup and Dakota Aquifers. These are some of the same formations that the City of Gallup is withdrawing water from. Well logs for this area indicate that the maximum well yield is 44 gpm near Tsayatoh and it is approximately 1,300 feet deep.

Rock Springs is served by the NTUA Rock Springs community system, which consists of one well which pumps water from the Gallup Sandstone aquifer with a yield of 20 gpm, a 107,000-gallon storage tank, and 43 service connections. This well is 1,760 feet deep.

Two water systems serve the Tsayatoh Chapter. The Spencer Valley/Defiance system is operated by NDWR and consists of a well which pumps from the Dakota Sandstone aquifer with a yield of about 27 gpm, a 27,000-gallon storage tank, and 21 service connections. The Tsayatoh community system is operated by NTUA and consists of one well which pumps from the Gallup Sandstone aquifer with a yield of about 44 gpm, a 150,000-gallon storage tank, and 67 service connections. Manuelito is served by an NDWR water system.

5.2.6 Route 666 Chapters

The Route 666 Chapters lie along Highway 666 between Shiprock and Yah-ta-hey. With either alignment alternative, these chapters and their public water systems are well positioned to take advantage of the Project water supply as soon as it is available. In addition, some of these chapters are able to take advantage of groundwater. The Route 666 Chapters include Mexican Springs, Naschitti, Newcomb, Sanostee, Sheep Springs, Tohatchi, Twin Lakes, and Two Grey Hills. Tohatchi has been designated by the NDED as a primary growth center. The 1990 population of this area was 10,099 and the projected population by the year 2040 is 34,374. In 1998 the annual water production was 168,723,000 gallons (518 acre-feet).

The communities along Highway 666 produce water from several of aquifers including alluvial sources, the Morrison, Menefee, Gallup Sandstone, and Dakota among others. The maximum well yield in this subarea area is 180 gpm from a well located near Twin Lakes which penetrates the Morrison Formation. This well is approximately 3,200 feet deep.

The Mexican Springs Chapter is served by three water systems, all operated by NTUA. The Tohatchi/Mexican Springs regional system consists of three wells, three storage tanks with a combined capacity of 1,400,000 gallons, and 472 service connections. Two wells pump from the Point Lookout Sandstone with yields ranging from about 30 to 150 gpm. These wells range from 345 feet to 800 feet in depth. The third well produces water from the Gallup Sandstone, Dakota Sandstone, and Morrison Aquifers. The Morrison Aquifer is the primary aquifer with a yield of more than 180 gpm. This well is 1,760 feet deep.

The Black Springs Wash/Deer Springs system consists of a well which pumps from the Crevasse Canyon Formation with a yield of about 15 gpm, an 11,500-gallon storage tank, 39 service connections, and is interconnected with the regional system. The Mexican Springs West Rural system consists of two wells, an 80,000-gallon storage tank, and 47 service connections. The wells pump from the Point Lookout Sandstone with yields of about 10 to 20 gpm.

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The Naschitti Chapter is served by two interconnected NTUA water systems. The Buffalo Springs system consists of one well which pumps water from the Gallup Sandstone aquifer with a yield of about 55 gpm, a 40,000-gallon storage tank, and 329 service connections. The Naschitti/Bisola system has two wells, three storage tanks with a combined capacity of 230,000 gallons, and 164 service connections. These wells pump from the Menefee and Point Lookout Sandstone aquifers with yields ranging from 70 to 115 gpm. These wells are approximately 1,400 feet deep.

Tohatchi Chapter is served by the Tohatchi/Mexican Springs regional system which also serves Mexican Springs. The Ramona Smith system consists of a single well which flows from a depth of 2,000 feet with a yield of 200 gpm, one storage tank, and 28 service connections.

Two water systems serve the Twin Lakes Chapter. One is the Tohatchi/Mexican Springs regional system. The other is operated by the NDWR, and consists of a single well which flows from the Gallup Sandstone aquifer at about two gpm, a 1,000-gallon storage tank, and has one service connection at the Chapter House.

NTUA operates five wells in the Sanostee Chapter which range in depth from 800 to 2,150 feet. Several of the wells were originally for oil exploration and converted for domestic water supply by NTUA. These wells withdraw water from the Dakota and Morrison Formations, and flowing artesian wells. Nominal well yields range from 30 to 60 gpm. All wells are equipped with submersible pumps. Recharge to the Dakota and Morrison Formations in the Sanostee Area is very limited.

5.2.7 San Juan River Subarea

NTUA's Shiprock District includes the Chapters of Beclaibito, Cudei, Hogback, Nenahnezad, San Juan, Sanostee, Shiprock, and Upper Fruitland. In 1990 the District's population was 15,581. NTUA provides water service to more than 10,000 people living in the Shiprock area and to commercial, industrial and institutional customers. According to NTUA records between 1988 and 1992 NTUA's average annual Shiprock water production was approximately 735,000,000 gallons (2,260 acre-feet). NTUA production records report that in 1997 Shiprock's annual water production was 535,976,000 gallons (1,645 acre-feet). The peak daily production in 1997 was 2,075,000 gallons. NTUA's entire Shiprock District supply is from the San Juan River.

For this analysis, the San Juan River municipal subarea includes the same chapters as NTUA's Shiprock District with one exception. Sanostee has been shifted to the Route 666 Subarea to better reflect the proposed pipeline configurations. The 1990 population of this subarea is 13,804 and the projected population by the year 2040 is 46,985. The NDWR projects the water demand of the Shiprock Subarea will be 8,421 acre-feet per year by 2040.

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NTUA diverts San Juan River water for the Shiprock area from three sources: (1) the Hogback Irrigation Project Canal, (2) water pumped directly from the San Juan River at the Highway 666 bridge in Shiprock, and (3) water purchased from the City of Farmington. In 1997 the City of Farmington provided 1,168 acre-feet or approximately 70 percent of the overall water supply. NTUA frequently shuts down its San Juan River diversion at Shiprock because poor water quality and high sediment loads create operation and maintenance problems, and significantly increase the cost of treatment. The proposed Animas-La Plata Project may enable NTUA to divert up to 4,600 acre-feet, and deplete 2,340 acre-feet, of Animas - La Plata Project water.

5.2.8 Torreon Subarea

The Torreon Subarea includes the Chapters of Counselor, Ojo Encino, Torreon, and Pueblo Pintado. The 1990 population of this area was 3,797 and the projected population by the year 2040 is 12,924. Its annual water production in 1998 was 36,783,000 gallons (113 acre-feet). Essentially all of the municipal water is from the Ojo Alamo Aquifer. Based on well logs for this area the maximum well yield is 70 gpm and it is approximately 1,100 feet deep.

5.2.9 NAPI

NAPI does not withdraw any groundwater for municipal or industrial purposes. However, NAPI currently receives approximately a small volume of per year of water for municipal and industrial purposes from NTUA. According to the information provide to the Navajo Nation Water Code in 1996 NAPI diverts 2,240 acre-feet for food processing and 55 acre-feet for local construction contractors (Department of Water Resources Management, *Water Use Fee Policy*, June 18, 1996).

5.2.10 Window Rock Subarea

The Window Rock Subarea includes the Fort Defiance and St. Michaels Chapters. Both of these communities have been designated by the NDED as economic development areas. Window Rock, Arizona is also the capital of the Navajo Nation. The NTUA system in Window Rock is the largest NTUA system on the Reservation. It has more than 2,800 connections. The 1990 census population of this subarea was 11,767 and the projected population by the year 2040 is 40,052. The annual water production in 1998 was 339,767,000 gallons (1,043 acre-feet).

Approximately 70 percent of the Window Rock water supply comes from the Black Creek Alluvium. These wells have yields up to 270 gpm and their depths range from 30 to 140 feet. However, this alluvial system is fully developed and very susceptible to droughts. To increase storage and recharge to the alluvial system during droughts, in 1984 the Indian Health Service built Blue Canyon Dam near Fort Defiance. Due to the limited surface water supply and seepage into the faults underlying the reservoir, this 1,900 acre-foot reservoir has only filled once since it was constructed. Although a portion of the seepage loss recharges the Black Creek Alluvium, Blue Canyon Dam provides little recharge during droughts.

The remaining 30 percent of the Window Rock water supply is derived from the Slick Rock Well field east of Window Rock and from wells in the De Chelly Sandstone in the St. Michael's area. These wells all exceed 800 feet in depth. The Slick Rock well field, which has a static water level 700 feet deep, derives its water from the Gallup Sandstone. NTUA reports that the static water level in the Slick Rock area has declined 250 feet.

5.2.11 Thoreau - Smith Lake Subarea

The Thoreau - Smith Lake Subarea includes the Chapters of Baca/Haystack, Casamera Lake, Smith Lake and Thoreau. This subarea is not part of the Project's service area. This subarea has been included in this analysis because it currently exports groundwater to Chapters that are part of the service area. After the Project is completed, these exports will be reduced or eliminated. These Chapters are primarily located in the Rio San Jose watershed which is tributary to the Rio Grande. The 1990 population of this area was 3,600 and the projected population by the year 2040 is 12,253. Its annual water production in 1998 was 86,193,000 gallons (193 acre-feet). Much of this water is conveyed to the Church Rock Area from the Glorietta, Dakota and Morrison formations. Based on well logs for Thoreau the maximum well yield is 30 gpm and it is approximately 1,700 feet deep. For Smith Lake the maximum well yield is 110 gpm and it is approximately 2,000 feet deep. Modeling of the Plains Electric Generating Station indicated that 8,000 acre-feet per year withdrawals would result in a water level decline of 40 feet in the Thoreau area.

6.0 NON-STRUCTURAL ALTERNATIVES

The Rock Mountain Institute has defined water conservation as increasing the efficiency of water use without diminishing the quality of services. In some cases conservation may allow communities to downsize, defer, or avoid new water infrastructure. Water conservation may represent a non-structural alternative for meeting the Project's purpose and need. At the very least water conservation can reduce water consumption and the Project's operation costs. Due to the Project's expense and environmental considerations, the communities in the service area will need to make every reasonable effort to maximize the current water supplies. The objective of this section is to evaluate the potential application of a water conservation program.

6.1 Water Conservation

Like any water supply alternative, water conservation needs to be evaluated based on its potential yield and its potential costs. These issues were addressed in water conservation plans prepared for the City of Albuquerque (Brown et. al 1996), the Santa Ynez Water Conservation District (Stetson Engineers, 1992) and the City of Gallup Forty Year Water Plan (Shomaker 1991). For the Santa Ynez Water Conservation District, Stetson Engineers evaluated the reported costs of reducing water use with three approaches to water conservation: (1) public education, (2) incentive programs, and (3) regulations.

6.1.1 Public education programs

The goal of public education programs is to increase water user awareness of habits that waste water and to promote understanding in the community on water conservation topics. Public information programs are relatively inexpensive. The California Department of Water Resources (CDWR) estimated that a community will typically reduce water use by 4 to 5 percent if public information is the only conservation program offered by a water agency. However, those savings largely depend on the number of water users already practicing water conservation measures. The CDWR estimated that additional reductions in water use in a community that already has a high level of community awareness, like the City of Gallup, are closer to one percent at a unit cost of approximately $300 per acre-foot. In the *1984 Plan Formulation and Environmental Statement*, Reclamation expressed concerns over the long-term effectiveness of voluntary programs.

6.1.2 Incentive programs

A more aggressive approach to water conservation is to financially reward water conservation and penalize wastefulness. These incentives may include increasing the unit cost of the water or implementing a seasonal fee structure to further encourage conservation during peak demands periods. For residential users the response to conservation incentives tends to vary with household income. For commercial users the response to water conservation incentives depends on the relative cost of water compared to the total operating costs. Stetson Engineers estimated that the cost of an education program combined with an incentive program targeting a 15 percent reduction has a unit cost of $990 per acre-foot. However, in a community like Gallup that has already adopted above average water rates and a seasonal rate structure, the resulting unit costs needed to reduce water use an additional 15 percent will be higher. The City's water plan cites the following studies:

- A study by the Colorado Water Resources Research Institute indicates that increasing water rates from $0.43 to $0.86 per thousand gallons (a 100 percent increase) reduced consumption by 25 percent.

- A study of water rates in the City of Santa Fe demonstrates that increasing water rates from $1.60 to $4.06 per thousand gallons (a 151 percent increase) reduced consumption by 39 percent.

- A study by the Texas Department of Water Resources indicates that a 10 percent increase in water rates results in a 3 percent reduction in municipal water use.

- A study by the California Department of Water Resources indicates that a 10 percent increase in water prices, reduces inside residential use by 2.6 percent and outside residential use by about 4 percent.

Most water utilities generate much of their revenue through the per-unit charge for water. Consequently, increasing the unit costs may encourage water conservation and, at the same time, increase the revenue needed to repay construction obligations and to pay for system operation, maintenance and repair. If the water rate accurately reflects the cost of the service and the value of water, then economically reasonable conservation incentives benefit both the utility and its customers. However, if the unit cost of the water becomes too high, and if the water use declines too much, the utility's revenue declines. The water rate structure must provide a stable income for the utility while conveying an accurate value for delivery of the water. A well designed conservation program will achieve this balance over time and will still provide enough price elasticity so that short term use reduction is still possible to address emergencies and droughts (Brown, et al, 1996).

As shown in Figure 4.2, the overall per capita water use rates in the service area are already among the lowest in the region. Per capita water use in Farmington and Albuquerque is 250 gallons per capita per day. By comparison, the per capita water use rate in Gallup is less than 170 gallons per capita per day. Navajo water users use far less. Significant, cost-effective, water conservation opportunities may not be available due to the relatively high water rates and low use.

The operation and maintenance expensive of the Project water may be greater than the current water rates. This higher rate may result in water users utilizing the over drafted groundwater before turning to the more costly pipeline supplies. Some type of pumping restrictions in the Gallup area may be required.

6.1.3 Regulatory programs

The CDWR suggested that the only way to achieve a 30 percent reduction in water use is through a program combining public education, incentives and regulations. Based on the Stetson study the unit cost for this type of program is $1,600 per acre-foot. Once again, for a community with very little outdoor water use, the unit costs will be much higher. And, according to Reclamation mandatory programs are less acceptable to the public.

The City of Gallup has recently raised water rates which should encourage water conservation. According to the City of Gallup's Forty Year Water-Supply Master Water Plan the City has instituted water conservation regulations which:

- Prohibit any person from allowing potable water to flow from his property onto any street.
- Prohibit the watering of streets with potable water.
- Restrict potable water usage by any person to 500 gallons per capita per day for soil compaction, street and driveway construction, or any other construction except where special permission has been granted.
- Prohibit the use of City fire hydrants or connections except by members of the City Water or Fire Departments.
- Prohibit leaky pipes, taps and appliances.
- Set minimum water-use standards for new plumbing.

The City is also pursuing:

- A public information program to promote water conservation.
- Xeriscaping of City parks and facilities.
- Restricting turf areas in new landscaping.
- Tiered water charges.
- Restricting lawn watering.

Due to the low per capita water use rates, in the *1984 Plan Formulation and Environmental Statement,* Reclamation concluded that a water conservation plan would not work for the Navajo communities in the study area. While conservation measures may help the City of Gallup meet short-term needs, it was not a viable solution to meet long-term needs, and water conservation will not address the problem of declining water quality. As a non-structural alternative, water conservation did not meet the Project's purpose and need.

6.2 Water Reuse

Although current safe drinking act regulations limit water reuse applications, water reuse can significantly increase a community's usable water supply. Under certain circumstances reclaimed water can be used on outdoor landscaping and athletic facilities. The City of Gallup has implemented several innovative water reuse projects to irrigate its golf course and athletic fields.

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On the Navajo Nation, irrigated landscaping is very limited and most wastewater ends up in sewage lagoons or evaporation ponds. The Navajo Nation and Reclamation have contracted with Westlands Resources to investigate water reuse opportunities. Appraisal level studies have been conducted in Tuba City and Ganado. The Nation Park Service has received a grant from the Arizona Water Protection Fund to use NTUA effluent in Ganado for a riparian restoration project.

Out of necessity within the next couple of decades "toilet to tap" water reuse systems will become commonplace across the West. At the current time there are no direct effluent-to-drinking water systems in use in Arizona or New Mexico. To make the concept socially acceptable some type of disconnect between the effluent and drinking water may be needed. For instance, if the treated effluent can be recharged in the ground, treatment costs may be reduced and the concept becomes more acceptable to the water users. Treated effluent may be more accepted for industrial uses than residential uses. The reuse system may include normal oxidation, micro filtration, activated carbon and disinfection.

Cost estimates by Westland Resources Inc. indicate that the capital cost of a toilet-to-tap system for a community like Gallup is $16 per gallon. Meeting the current peak demand of 5.5 million gallons per day will require a system with a capital cost of approximately $90 million. If the wastewater is available, the cost of a system designed to meet the average 2040 demand will cost $165 million. The estimated operation and maintenance cost is between $600 and $1,000 per acre-foot. Additional distribution systems will also be required. Even if this approach could assure a water supply, these unit costs far exceed the estimated cost of meeting the City of Gallup's demand with the Project.

6.3 Conjunctive use of groundwater and aquifer storage

Groundwater may be used conjunctively with the surface water supply to enhance the overall water supply available for the Project. Three approaches for conjunctive use have been considered: (1) utilizing wells during the summer when the water demand is at its peak, (2) supplementing the Project's surface water supply with groundwater during critical years on the San Juan River, and (3) aquifer storage and recovery. These approaches are described in greater detail in the following sections.

6.3.1 Utilize wells for peak summer demand

During the first few years of Project operation, the Project will have adequate capacity to greatly reduce groundwater withdrawals. Eventually, however, the City of Gallup and NTUA will need to utilize their wells for short periods during the summer when the water demand is at its peak. By the year 2040 the City's system will need to produce approximately 1,400 are-feet of groundwater, primarily during the summer months. The aquifers will be able to recharge during the remainder of the year. Although the City of Gallup's well fields may be able to supplement the total projected peak demands for a short period of time, it is unlikely that they will be able to replace the total projected summer demand.

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The estimated recharge to the source aquifers is very low, far less than current withdrawals. As the water demand increases over the next 20 years, without the Project, the demand to recharge ratios will become far less favorable. In conclusion, during the early life of the Project, the 1.3 peaking capacity in the system will greatly reduce, or eliminate, the City's dependence on groundwater. By the year 2040, groundwater will be needed to help meet the summer peak demands.

6.3.2 Supplemental groundwater during critical years

Theoretically, groundwater could supplement or replace the Project's surface water supply during critical years on the San Juan River. These critical years would depend on the flow recommendations adopted by the San Juan River Recovery Implementation Program to assist the recovery of the endangered species in the San Juan River (Holden 1999). These flow recommendations are intended to mimic the natural hydrograph of the San Juan River. These recommended flows require releases from Navajo Reservoir with the appropriate duration and frequency. However, based on the historic flow data, the critical period during which the recommended flows would have been most difficult to achieve lasted for seven years. Consequently, the USFWS may expect a commitment of seven acre-feet of groundwater to off set an acre-foot of proposed surface water depletion. This option is not practical for these groundwater aquifers.

6.3.3 Aquifer storage and recovery

In a January 26, 2000 letter to the City, John Shomaker and Associates, Inc., presented a technical review of aquifer storage. Based on that review, it may be possible to store and recover Project water. Eventually, it may also be economically possible to store and recover treated wastewater. Conceptually, production wells in the Yah-ta-hey and Santa Fe well fields would be used as injection wells during periods when water is available in excess of the City's demand. This water would then be available during periods when surface water is not available in adequate amounts. During the first years of the Project the City may only be able to utilize approximately 4,500 acre-feet per year out of the total Project allocation of 7,500 acre-feet. The difference may be available for recharge. This approach has been successful in other communities. The City of Santa Fe is recharging water and is proposing to expand its program with Title XVI funds. Typically the storage and recovery cycle is seasonal. With a seasonal cycle the stored water does not have enough time to move far from the recovery well, and the groundwater head does not have enough time to dissipate to pre-storage levels before the water is recovered.

Shomaker notes that the source aquifers for the City of Gallup are confined, and that they have very low hydraulic conductivities and storage coefficients. Because of the low conductivity, groundwater movement is relatively slow. For these reasons, the injected water would stay within reach of a recovery well for a longer than typical period, and the rise in water levels would take a long time to dissipate. Therefore, a longer recovery period might be feasible. Injecting Project water may restore part of the large decline in water levels in the wells and extend the life of the fields beyond the limits predicted by the City. The cost of storing this water would be partly offset by a reduction in the pumping lifts. Shomaker speculates that the water levels are so deep that water may be injected successfully by gravity flow, requiring no pumping. Aquifer storage is especially sensitive to the quality and chemical characteristics of the water. Shomaker concludes that the concept is worth considering. But, a complex analysis is needed before the feasibility of the concept can be determined.

7.0 SURFACE WATER SUPPLY OPTIONS

With more than 40 percent of the Navajo population lacking domestic water, and static water levels in the City of Gallup's well fields declining by hundreds of feet, the need for the Navajo-Gallup Water Supply Project is clear. Numerous investigations have found that additional groundwater sources are inadequate, and that they can only temporarily delay water supply shortfalls. This conclusion was presented in the 1976 Turney report which was the basis for the 1984 Plan Formulation and Environmental Statement. The objective of this section is to present the advantages and disadvantages of various surface water sources for the Project. While the following discussion adheres to the context of the 1922 Colorado River Compact and the 1948 Upper Colorado River Basin Compact, it should be noted that the Navajo Nation firmly believes the allocations in these compacts do not limit the Navajo Nation's claim to water within the Colorado River system.

Sources of surface water that were considered for the Project demand within New Mexico include: (1) acquisition of private water rights or options, (2) a San Juan River contract for water with the Department of the Interior, (3) a San Juan River contract for water from the Jicarilla Apache Nation (Apache Nation), (4) Navajo Indian Irrigation Project water, and (5) Navajo Nation non-NIIP water. Approximately 25 percent of the Project's water demand is in the Lower Colorado River Basin within the State of Arizona. For addressing the Arizona demands the Navajo Nation is investigating Central Arizona Project water and other main-stem Colorado River water. These water supply options are discussed in greater detail below, followed by a conclusion.

7.1 Acquisition of private water rights or water options

One option for providing a permanent water supply for the Project is to purchase private water rights or water options from water users within the San Juan River Basin. One advantage of acquiring private water rights is that these existing depletions have been included in past Section 7 Consultations with the USFWS and will most likely be included in future consultations. Through these consultations the USFWS determines which additional depletions can occur in the San Juan River basin without causing jeopardy to the endangered fish. Identifying water within the baseline reduces, but does not necessarily eliminate, the complications associated with compliance with the Endangered Species Act. Another advantage of acquiring private water rights is that these water rights are within the State of New Mexico's Upper Colorado River Basin compact allocation.

Although private water rights may have a senior priority date, they may not have a full water supply every year. Furthermore, these water rights do not come with a storage right behind Navajo Dam. They would not be subject to the Colorado River Storage Project Act (CRSPA) fee which is approximately $60 per acre-foot. However, if this water is conveyed through the NIIP facilities it would be subject to an administration fee for the use of Navajo Reservoir as a point of the diversion. The administration fee is less than the CRSPA fee.

The primary disadvantage to purchasing private water rights is that they are not cheap. Long-term water contracts in the Colorado River Basin frequently cost $2,000 to $5,000 per acre-foot. Recent small transactions in the Farmington area have been for approximately $1,500 per acre-foot. At that price, water for the City of Gallup's demand could cost between $11 and $20 million and water for the Navajo demands could cost in excess of $40 and $70 million.

Another disadvantage of purchasing water rights is that the depletions associated with these water rights will need to be transferred to the Project. It is very likely that these transfers will be protested by numerous parties within the Basin. The effect of the depletions that may be transferred will be closely scrutinized. If downstream depletions are to be transferred upstream to the Navajo Reservoir, a large number of water users may claim to be impacted. The Office of the State Engineer has a process for administrating transfers. However, these hearing processes may become complicated, protracted and expensive. A final disadvantage is that private water rights within the San Juan River Basin, even those purchased by the City of Gallup, may not necessarily be exempt from any ultimate federally reserved water rights claim exerted by the Navajo Nation.

Acquiring water options for San Juan River water would most likely be less expensive than purchasing water rights. These water options may take the form of forbearance agreements. Under these forbearance agreements current water users would agree that if there is a call on the river to meet either the flow recommendations or the compact requirements, then those water users would agree to discontinue their uses. These water options would not necessarily be exercised every year. Presumably the need to exercise an option would be based on the water supply forecast for the San Juan River and the flow recommendations in effect at that time. As a practical matter, it is unlikely that these options would be exercised at least until NIIP and the ALP projects begin to fully utilize their allocations.

7.2 A San Juan River water contract with the Department of the Interior

The City of Gallup has no water rights for San Juan River water, nor does it have any San Juan River water under contract. During the 1950's and 1960's the City of Gallup filed three notices of intent to divert water from the San Juan River. After the construction of Navajo Reservoir, the State Engineer indicated that the City would need a contract with the Secretary of the Interior for water. In 1966 a contract for 7,500 acre-feet of water was drafted and several meetings were held between Reclamation and the City of Gallup to work out the details. That contract was never finalized. In 1967 the ISC recommended, and the Secretary of the Interior granted, a temporary allocation for the City of Gallup of 7,500 acre-feet per year through the year 2005. In the 1988 Hydrologic Determination Reclamation identified 24,000 acre-feet of water in New Mexico and 7,000 acre-feet of water in Arizona that was temporarily available from the San Juan River for the Navajo-Gallup Water Supply Project through the year 2039. In a letter dated November 22, 2000 from Kelsey A. Begaye, President of the Navajo Nation and John Pena, Mayor of the City of Gallup to Eluid Martinez, Commissioner of Reclamation, the Project participants request separate water contracts from the Navajo Reservoir Water Supply. The Navajo contract would be for 29,300 acre-feet per year and the City of Gallup contract would be for 7,500 acre-feet per year.

Several important issues need to be addressed by the authorizing legislation before this water could be contracted by the Secretary. These issues are summarized in a letter dated June 30, 1994 from Rob Luethhouser, Reclamation to the Project participants and include:

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- The Navajo-Gallup Water Supply Project was never specifically authorized by Congress as part of the Colorado River Storage Project Act (CRSP). Consequently, the Project is limited to temporary water contracts from Navajo Reservoir.

- CRSP temporary water service contracts for municipal and industrial uses are authorized by Section 9(c)(2) of Reclamation Project Act of 1939. However, they are limited to a maximum term of 40 years. Contract renewal may be subject to the extent of other water developments in the San Juan River Basin. The long-term dependability of contract water needs to be evaluated.

- Before any temporary contract from Navajo Reservoir can be allowed to extend past the year 2039, the 1988 Hydrologic Determination must be officially updated and approved by the Secretary of the Interior, and transmitted to Congress.

- Due to specific language in the authorizing legislation of NIIP (Public Law 87-483), any additional 40-year contracts from Navajo Reservoir must be authorized by Congress. Congressional approval may take several years.

Other issues that need to be addressed before contracting new water from the San Juan River include:

- A new contract will require an examination of future depletions in the Upper Basin. The determination of when, and if, the Upper Basin exceeds its allocation depends in part on various interpretations of the river compacts. Based on Reclamation's 1967 Hydrologic Determination, an additional 100,000 acre-feet of water was temporarily allocated to the State of New Mexico through the year 2005. This 100,000 acre-foot block of temporarily allocated water includes 7,500 acre-feet for the City of Gallup. Based on the Department of the Interior's interpretation, 5.8 million acre-feet per year of Upper Basin depletion was set as an upper limit for planning purposes. According to Reclamation's 1988 Hydrologic Determination, New Mexico's Upper Basin water allocation of 669,000 acre-feet per year will be exceeded by 74,000 acre-feet by the year 2039. Consequently, Reclamation limits new contracts. The current Reclamation administrative policy limits new contracts to 25 years.

  The Upper Basin States do not agree with the Department of the Interior's interpretation that they are limited to 5.8 million acre-feet per year. Under the State's interpretation, the State of New Mexico is entitled to 727,000 acre-feet of depletion per year. In a letter dated December 13, 1973 from Steve Reynolds, the New Mexico State Engineer, to James A. Bradley, Regional Director, Southwest Region, Reclamation the State Engineer writes "It is New Mexico's position that under a correct interpretation of the compact's provisions, the full 100,000 acre-feet of consumptive use from Navajo Reservoir contracts would be available in perpetuity," and "New Mexico's view is that there is sufficient water available from the San Juan River Basin to Supply Gallup 7,500 acre-feet annually for at least 50 years."

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In December1999 the Upper Colorado River Commission updated the depletions presented in the previous determinations. Based on the updated tables, the State of New Mexico will not exceed 669,000 acre-feet of depletion until sometime between 2030 and 2040. And, it may be possible for the Project participants to develop new water contracts based in part on the Upper Basin's unused allocation through the year 2060.

- Even if a new contract is granted, these depletions have not been included in previous Section 7 Consultations with the USFWS. The San Juan River may not be able to accommodate additional depletions without jeopardizing the endangered fish.

- The overall impact of a new contract on Indian Trust Assets within the San Juan River Basin will need to be evaluated by the Department of the Interior. Four Indian tribes including the Southern Ute Indian Tribe, the Ute Mountain Ute Tribe, the Jicarilla Apache Nation, and the Navajo Nation, may have concerns regarding the potential impacts.

- The City of Gallup in New Mexico and Window Rock in Arizona are geographically located in the Little Colorado River Basin which is tributary to the Lower Colorado River Basin. The provisions of the 1948 Upper Colorado River Basin Compact need to be addressed to utilize an Upper Basin allocation of water in either the Gallup or Window Rock subareas.

7.3 Contract water from the Jicarilla Apache Nation

The recent Jicarilla Apache Nation settlement includes 25,500 acre-feet of depletion per year of the Navajo Reservoir supply that may be available for marketing within the State of New Mexico. The Apache Nation is pursuing a variety of development options for using its San Juan River Basin depletions including potential third party contracts and on-reservation water projects. Consequently, under certain circumstances, the Apache Nation may be amenable to providing some water for this Project.

The Apache Nation water has a quantified water right and shares priority with other Navajo Reservoir users. Unlike other Navajo Reservoir contracts with the Secretary, the Secretary has already determined that sufficient water is available to fulfill the Apache Nation's settlement. While third party contracts for Apache Nation water must be approved by the Secretary (through his designee with Reclamation), no further Congressional action is necessary for the use of Apache Nation water. In addition, these depletions will be recognized in future hydrologic determinations, while the Navajo-Gallup Project water may not.

If Apache Nation water was made available for this Project under terms favorable to the Apache Nation, they would have incentive to support the Project during Section 7 Consultation with the USFWS and during NEPA compliance. In addition, because the Apache Nation already has a contract with the Secretary, a subcontract with the Apache Nation eliminates the need for a new Secretarial water use contract out of Navajo Reservoir. This subcontract may require an annual construction payment currently set at $2.60 per acre-foot, and a payment for the proportionate share of the operation and maintenance of Navajo Dam.

However, a long-term Apache Nation water lease may not be cheap, and it may not be less expensive than leasing private water rights. In addition, the Apache Nation water has not been included in recent environmental baselines for previous consultations under Section 7 of the Endangered Species Act in the San Juan River Basin. Consequently, even with an Apache Nation subcontract, it may not be possible to meet the new San Juan River flow recommendations for the additional depletions needed for this Project.

The City of Gallup, as well as the Navajo Nation, need long-term, essentially permanent municipal water supplies. However, the Apache Nation may be more inclined to support a short-term contract. Any arrangement with the Apache Nation will need to consider an equitable renewal clause. Such a clause may be able to reference future water prices against some mutually agreed upon benchmarks. Even with these limitations, the Apache Nation water may provide a short-term "bridge," allowing the Project to proceed until broader water rights settlement issues for the Navajo Nation can be resolved, or additional depletions are made available through the Recovery Program.

7.4 Navajo Indian Irrigation Project water

The Navajo Indian Irrigation Project was authorized 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 irrigation water to approximately 110,630 acres of land. NIIP consists of the initial land development, water distribution system, water delivery, roads, and other infrastructure. In 1970 the Navajo Nation created the Navajo Agricultural Products Industry (NAPI) to run the agricultural business venture and take responsibility for operating the NIIP facilities. The boundaries of NIIP are shown in Figure 2.1.

NIIP is approximately 60 percent complete with 64,000 acres developed. In 1999, NIIP diverted 193,100 acre-feet of water from Navajo Reservoir and depleted 129,571 acre-feet of San Juan River water. Based on an average unit depletion of 2.44 acre-feet per acre, at full build-out, with all of the Project acreage irrigated, NIIP will deplete approximately 270,000 acre-feet per year of San Juan River water. Based on the current overall Project irrigation efficiency, NIIP would divert approximately 337,500 acre-feet of water (*Navajo Indian Irrigation Project Biological Assessment*, June 11, 1999, Keller Bliesner Engineering and Ecosystems Research Institute Inc.).

NIIP has successfully consulted with the USFWS on approximately 270,000 acre-feet of depletion which according to the USFWS can be depleted without jeopardizing the endangered fish. However, NIIP was only able to acquire the water it needs to complete Blocks 9, 10, and 11 by shifting more than 16,000 acre-feet of baseline depletions away from the Hogback and Fruitland irrigation projects. Even so, NIIP's depletions may include two types of water that may under certain circumstances be available for municipal use: unused NIIP water and forbearing the use of NIIP irrigation water. These options, which will need to overcome considerable legal and political hurdles, are described in the following sections.

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- Municipal use of unused NIIP Water

At current funding levels, it will take more than 18 years to complete NIIP. This completion date delays the time when NIIP can provide all of the benefits that are envisioned. A revised completion schedule to complete NIIP by the year 2009 has been proposed by Reclamation, NAPI and the BIA. The revised schedule assumes that the financial and environmental challenges can be addressed, enabling all 110,630 acres of land to be developed as soon as the year 2006. The drains, the system control and data acquisition facilities, and Gallegos Dam would be completed by the year 2009.

Consequently, there is a six to 18 year period during which unused NIIP water, which has undergone Section 7 Consultation, may be available. Sequencing the construction of NIIP with this Project may enable NIIP to realize some benefits from this water resource until it can be used for irrigation. However, several issues need to be addressed before this water can be used for municipal purposes.

The authorized purposes of the NIIP facilities include conveying water for municipal, domestic, and industrial uses, and for other beneficial purposes. The Secretary is authorized to provide capacity for municipal and industrial water supplies or miscellaneous purposes over and above the diversion requirements for irrigation of NIIP, but such additional capacity will not be constructed and no appropriation of funds for such construction will be made until contracts have been executed which provide satisfactory assurance of repayment of all costs properly allocated.

Even if the Navajo Nation is willing to convert unused NIIP water from irrigation uses to municipal uses, under the present contract the Secretary of the Interior is not authorized to deliver water for uses other than irrigation. NIIP's statutory authorization, and the Navajo Nation's contract with the Secretary of the Interior, allocate to NIIP an average annual diversion of 508,000 acre-feet of water per year from the San Juan River for the principal purpose of furnishing irrigation water to approximately 110,630 acres of land. It is presently unresolved whether (and how) NIIP irrigation water can be used for municipal and industrial purposes. Furthermore, the Secretary has no authority to contract for the delivery of any water from Navajo Reservoir which would impair the availability of water for the irrigation of 110,630 acres of Navajo Indian land.

In addition, if irrigation water is transferred away from any of the 110,630 acres, Navajo Dam and Reservoir may have separable costs allocated to NIIP which could become a repayment obligation. And, a portion of the NIIP capital costs associated with the idled acreage could also become a repayment obligation. Presumably these issues can be addressed through the Project's enabling legislation.

A more critical issue is that unused NIIP water is only temporarily available, perhaps for a six to 18 year period. The municipal demand, however, requires a nearly permanent supply. Committing this water temporarily to non-NIIP municipal water demand creates significant disincentives for the completion of NIIP, and it may eventually result in conflict between the irrigation and municipal uses. Even with these concerns, the unused NIIP water may be able to provide a short-term "bridge," allowing the Project to proceed until biological and water rights settlement issues can be resolved.

- A forbearance agreement for NIIP water

Another water supply option is for the Navajo Nation to enter into a forbearance agreement to provide water for municipal needs. Unlike the "unused" water described in the previous section, under a forbearance agreement NIIP would forbear the use of a specific volume of water that it could otherwise make use of for a designated period of time. This foregone use may come at the expense of not irrigating a specific number of acres. Based on an average depletion of 2.44 acre-feet per acre, the Gallup water supply would require idling or fallowing, approximately 3,000 acres and the Navajo demand would require approximately 10,000 acres.

Instead of idling acreage, it may be possible to change the proposed crop mix to include crops that require less water, or to under irrigate some of the irrigated crops in the current mix. However, these approaches have agronomic impacts on NIIP including lower revenue, fewer jobs, and greater risk of crop failure.

Another approach is to improve the overall irrigation efficiency at NIIP. Most, but not all, of the water diverted by NIIP is depleted directly by the crops. However, much of the reported irrigation inefficiency returns to the San Juan River (Keller-Bliesner, 1999). This portion of NIIP's diversion is not credited against NIIP's San Juan River depletions. However, some portion of the water diverted by NIIP is depleted by a variety of causes including evaporation in the canals and from the sprinklers. The State of New Mexico refers to these losses as incidental depletions. If improved irrigation technology can be deployed at NIIP, these incidental depletions may be reduced. Theoretically, reducing NIIP's overall depletions from 2.44 to 2.1 acre-feet per acre, or 11 percent, would result in a depletion saving that could provide water for the Navajo Gallup Project's entire municipal demand.

Some of this technology, such as improved sprinklers, is relatively straightforward. Other techniques, such as improving the match between water application and climate conditions, require extremely vigilant management. Still other techniques, such as adding amendments to the soil to reduce infiltration losses, are still experimental. All of these techniques hold promise for reducing NIIP's depletions. Due to the expense of moving water from Navajo Reservoir to the NIIP fields, reducing these depletions offers some economic benefit to NIIP. However, none of these methods are inexpensive, and they all have agronomic impact. And, under its current Biological Opinion, NIIP is already committed to improving its overall efficiency by 10 percent, from 55 percent to 65 percent. Even so, eventually, this approach may result in water that can be utilized for a long-term municipal water supply. However, the potential promise must be weighed against the unknown agronomic costs. The trade offs between increasing efficiency and impacting NIIP should be investigated by the Project participants.

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If NIIP water is converted from an irrigation to a municipal use, a repayment obligation may exist for costs against the Indian owned land that is idled. In addition there may be conflicts between state and federal law. From the State of New Mexico's perspective, agricultural water rights can only be transferred from irrigated land if the irrigated land is fallowed or dry farmed. These water rights only include the consumptive use of the crop, not the incidental losses. Since there is no inherent right to the incidental losses, reducing them does not "free up" water that can be transferred between water users. From the irrigators' perspective, the main incentives for conserving water in this manner are to lower pumping costs and to make more water available to the crops during times of shortage.

In conclusion, although NIIP has a relatively large amount of water that has undergone Section 7 Consultation and other environmental compliance, forbearance agreements for NIIP water will not be simple or inexpensive. These agreements would need to be developed around the current contractual constraints and without creating disincentives to the completion of NIIP. However, this option may provide a bridge until broader water issues are resolved.

7.5 Navajo non-NIIP water

One option to provide a water supply for the Navajo-Gallup Water Supply Project is for the Navajo Nation to assume the responsibility for guaranteeing depletions out of water supplies allocated to the Navajo Nation, either through existing statutes or an eventual settlement of the Navajo Nation's federally reserved water claims. Such an approach saves the City of Gallup from having to deal directly with the San Juan Basin interests, and provides the Navajo Nation the opportunity to redistribute its water resources consistent with its internal policies.

The primary disadvantage with this approach is that the Navajo Nation has very limited non-NIIP water in the San Juan River Basin that has a quantified water right and that could be leased to Gallup. For instance, as a result of its Section 7 Consultation with the USFWS, unused water from the Shiprock irrigation projects has already been temporarily utilized by NIIP to ensure that NIIP's construction can continue. When this depletion is restored to the Shiprock irrigation projects, it may under certain circumstances in the future, be available for the Navajo-Gallup Project. However, utilizing Navajo Nation water to meet non-Navajo municipal demands raises issues that will need to be addressed.

The Navajo Nation is concerned that using the non-NIIP water for the Navajo-Gallup Project may hinder other future Navajo water development. Even if Navajo non-NIIP water becomes available under favorable terms, it will not necessarily be less expensive than acquiring private water rights. Consequently, in the short-term, this non-NIIP water option may not meet the City of Gallup's need to secure a long-term water supply.

7.6 Central Arizona Project or other Main-stem Colorado River water

The 1988 Hydrologic Determination identified 7,000 acre-feet of water in the Upper Basin of Arizona for the Arizona portion of this Project. However, the most recent Reclamation Consumptive Use and Loss Report for that area does not identify depletions for this Project. Water allocated to the Lower Colorado River Basin may fit most readily into existing Compact allocations for use in Lower Basin areas like Window Rock, Arizona. For instance, the Navajo Nation is in the process of adjudicating its Little Colorado River water rights. Through that adjudication a modest amount of Central Arizona Project water may be available to address on-reservation needs in the Window Rock Subarea. However, many of the Central Arizona Water Conservancy District constituents are opposed to water leaving that district's service area. Other scenarios are to acquire non Central Arizona Project main-stem water or lower priority non-municipal water.

Procuring Central Arizona Project water or other main-stem Colorado River water may be expensive. It will also require an adequate accounting system to ensure that system gains and losses are accurately calculated, and that other issues such as lost power revenues and increased salinity are addressed. Reclamation has initiated work on an *Environmental Impact Statement on the Allocation of Water Supply and Expected Long-term Contract Execution for the CAP.* The results of that study may have a direct impact on this water supply option.

7.7 Conclusions

All of the water supply options pose difficult challenges. One option for a water supply is the outright acquisition of water rights within the environmental baseline from a willing seller. Unfortunately, this option is, in the short-term, the most expensive. Depending on the specific conditions, acquiring water options may be less expensive. The City of Gallup can approach either the Navajo Nation or the Jicarilla Apache Nation for a lease. However, the longer the lease, the more expensive the terms will become.

Even though the Navajo Nation has the paramount water right in the San Juan River Basin, that right has not been fully quantified. Consequently, the Navajo Nation shares some of the same water supply obstacles as the City of Gallup in meeting its long-term water supply needs. Until there is a fully quantified water right, the Navajo Nation can convert NIIP irrigation water to municipal use, acquire water from willing sellers or willing leasers, or join the City in pursuing a new Secretarial water contract. Such a contract could secure the Project water until the interpretation of the compacts and the Navajo Nation's water rights are resolved. With respect to compliance with the Endangered Species Act, it may be possible to work with various entities that have water in the currently described environmental baseline to ensure that specific depletions will be scheduled in a manner that provides an opportunity for this Project to deplete water during an interim period.

The City and the Navajo Nation have approached the Commissioner of Reclamation for two new water contracts. These Secretarial contracts will require the tacit support of the Indian tribes in the basin. For instance, the water that may be available for the City through their proposed contract may be water that would otherwise be included in a Navajo water rights settlement. Or, it may affect existing Navajo or Apache Secretarial contracts. Although a Secretarial contract does not provide a permanent guarantee of water, even under the most restrictive interpretation of the compacts, the full water supply should be available at least through the year 2060. According to the interpretation by the State of New Mexico, the supply should be available for a much longer period. A contract with the Secretary may also result in the smallest short-term financial burden to the City and the Navajo Nation.

8.0 NAVAJO-GALLUP PROJECT STRUCTURAL ALTERNATIVES

The principal objective of this technical memorandum is to describe Project configurations that may meet the Project's purpose and need, and that are acceptable to the participants. The configurations presented in this technical memorandum are the product of more than 40 years of progressively refined analysis. The location of the point of diversion has critical hydrologic implications for the endangered species in the San Juan River which have yet to be fully evaluated. Therefore, this technical memorandum presents two distinct configurations:

- The first alternative is the San Juan River Alternative. This alternative would divert water directly out of the San Juan River below the confluence of the La Plata and San Juan Rivers and then south along Highway 666 to Yah-ta-hey.

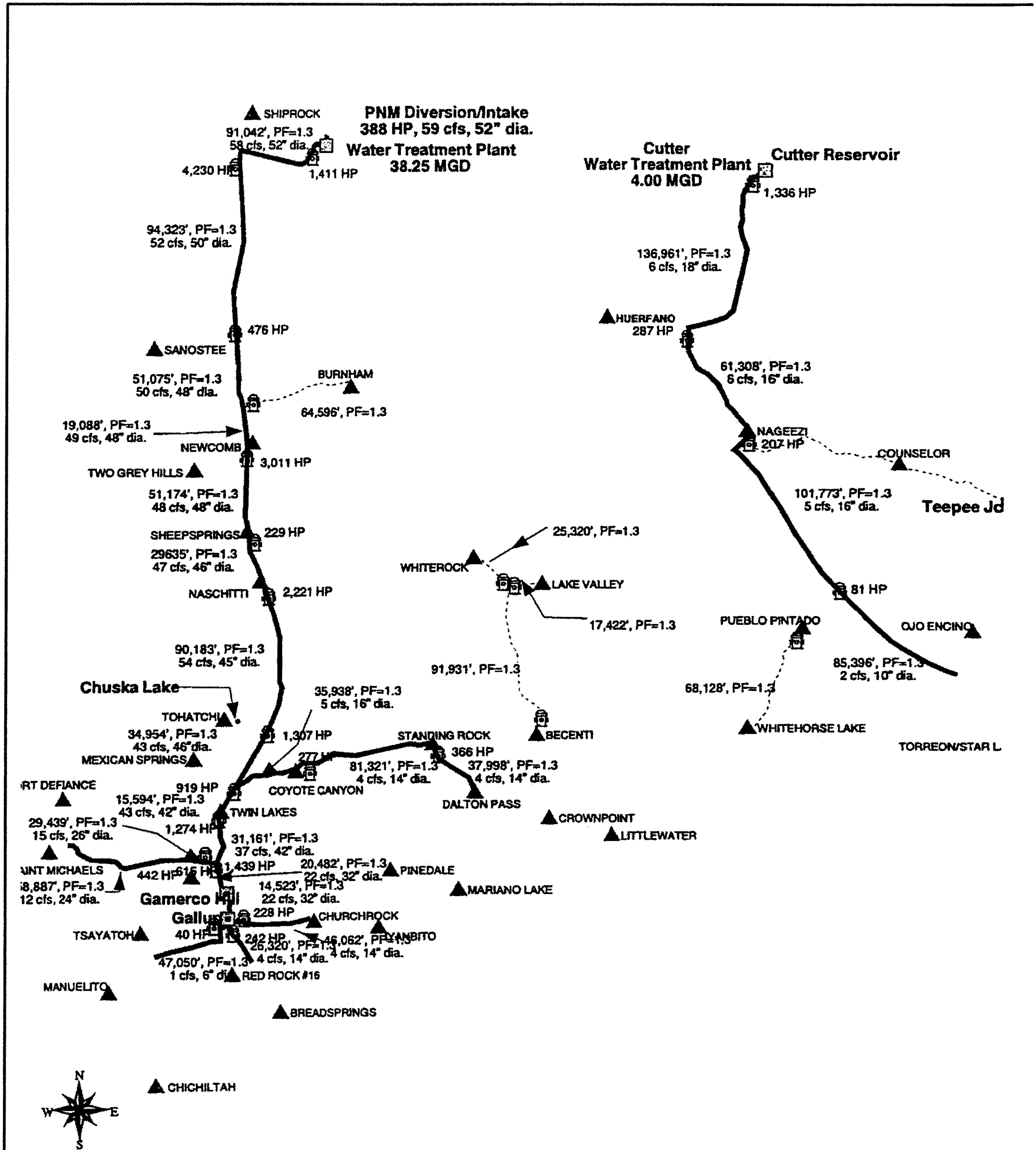
- The second alternative is the NIIP Alternative. This alternative would route water through the Navajo Indian Irrigation Project (NIIP) Main Gravity Canal to Moncisco Reservoir and then south along the Transwestern Pipeline corridor to Yah-ta-hey.

As proposed, both alternatives provide water to the same service area. These alternatives are shown in Figures 2.1, 2.2, 8.1 and 8.2. By the year 2040 the Project will divert 36,600 acre-feet and deplete 34,700 acre-feet from the San Juan River. The remaining municipal demand will be met with 4,680 acre-feet from the Animas La Plata Project, 3,200 acre-feet of groundwater production by the Navajo public water systems, and 1,400 acre-feet of groundwater production by the City of Gallup.

The NDWR investigated additional groundwater development for the Navajo communities in the Project area. One scenario is to provide the entire municipal demand with groundwater. In most cases this scenario is not viable at any cost because groundwater supplies are inadequate to provide a reliable, long-term water supply. The other preferred scenario is to develop a conjunctive water supply based on the sustainable yield of the groundwater. The conjunctive groundwater component reduces the cost of the surface water system and the required depletions from the San Juan River.

The major system elements are:

- The diversion from the San Juan River and conveyance along Highway 666 (The San Juan River Diversion Alternative)
- Routing water through the NIIP facilities and conveyance along the Transwestern Pipeline Corridor (The NIIP Alternative)
- Service to the municipal subareas
- Water treatment
- Wastewater treatment
- Terminus storage
- Project rights-of-way
- Other direct and indirect costs
- Operation and Maintenance



LEGEND

Required Pumping HP

Served Chapters

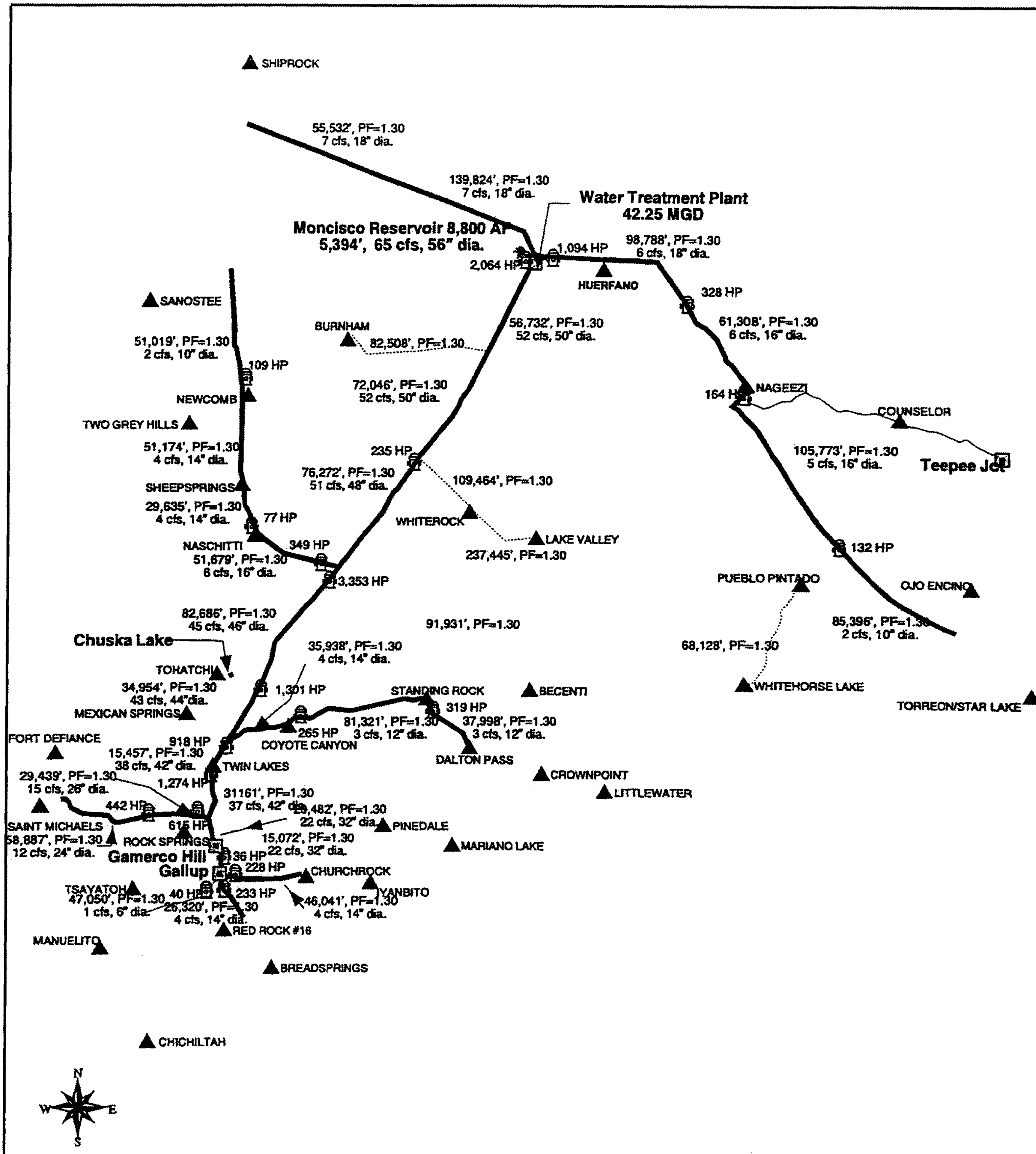
SJR Alternative

Figure 8.1
Navajo-Gallup Water Supply Projec
Project Configuration Map

Navajo Department of Water Resour

proj1.apr

March 15, 2001
by: Robert L. Kirk



LEGEND

- Required Pumping HP
- Moncisco.shp
- Served Chapters
- Programmatic Lines
- NIIP Alternative

Figure 8.2
Navajo-Gallup Water Supply Project
Project Configuration Map

Navajo Department of Water Resources

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8.1 The San Juan River Diversion Alternative

The San Juan Diversion would divert approximately 33,000 acre-feet per year directly from the San Juan River. The average diversion is 46 cubic feet per second and the peak diversion is 60 cubic feet per second. A treatment plant, settling basin, and regulating reservoir would be constructed near the point of diversion. Compared to the water in the NIIP canals, the water quality of the San Juan River is lower and it may require additional treatment. From the treatment plant, the pipeline alignment proceeds south along Highway 666 to Yah-ta-hey. At Yah-ta-hey one lateral follows Highway 64 east to Window Rock and another lateral goes south along Highway 666 to the City of Gallup and surrounding areas. Another lateral from Twin Lakes goes east along Indian Route 9 to Dalton Pass. Storage tanks and re-chlorination facilities are included in the Project. This alternative is shown in Figures 2.1 and 8.1.

To service the eastern portion of the Navajo Reservation, a separate pipeline, referred to as the Cutter Lateral, will be constructed. This diversion would divert approximately 3,500 acre-feet per year with an average diversion of 4.6 cubic feet per second and a peak diversion of six cubic feet per second. This pipeline will originate at a treatment plant to be constructed at Cutter Reservoir. The Cutter Lateral will convey water from the treatment plant south to Huerfano, follow Highway 44 to Nageezi and then south to Torreon. Cutter Reservoir is a part of the NIIP canal system and it receives water from Navajo Reservoir. The Cutter Lateral may also be able to convey water to the Jicarilla Apache Nation. This lateral is shown in Figures 2.1 and 8.1.

There may be greater hydrologic flexibility if the main point of diversion is located on the San Juan River below the confluence of the La Plata and San Juan Rivers than if it is located upstream at Navajo Reservoir. This flexibility may make it easier for the Project to be operated in a manner that will satisfy the San Juan River Recovery Implementation Program's flow recommendations.

For the cost estimates presented in this technical memorandum, it has been assumed that the San Juan River Diversion Alternative would use the existing San Juan Generating Station Diversion Structure. This structure is located on the San Juan River at river mile 166, downstream of the La Plata River confluence and upstream from the Chaco Wash. However, other diversion points such as at the Hogback Diversion Structure and a Ranney infiltration gallery will also be considered.

8.1.1 Potential San Juan River Points of Diversion

During the 1980's and 1990's several points of diversion were evaluated including: (1) direct diversions out of the San Juan River, (2) collection of NIIP subsurface drainage return flows, (3) a direct pipeline from Navajo Reservoir, (4) developing groundwater and (5) routing water through the NIIP Main Canal to Moncisco Reservoir. Diverting water directly from the San Juan River is evaluated in this section.

Reclamation investigated two new sites for the diversion structure: (1) upstream from the Fruitland Diversion Structure, and (2) a Ranney infiltration gallery. The impacts of the new diversion on the endangered fish species may be minimized if the Project utilizes an existing diversion structure. Five sites at existing diversions were also evaluated: (1) the diversion for the Fruitland Irrigation Project, (2) the NTUA intake in Shiprock, (3) the BHP diversion to Morgan Lake which provides cooling water to the Four Corners Power Plant, (4) the APS diversion to the San Juan Generating Station, and (5) the diversion for the Hogback Irrigation Project. The potential points of diversion are described in the following sections.

The locations of these diversions are shown in Figure 8.3 and they are described in greater detail in the following section. Other small diversions used by the Lower Valley Water Users Association and the Lee Acres Hammond Irrigation Project diversion may also need to be evaluated. All of the proposed diversion sites could be connected to the existing and proposed Farmington to Shiprock pipelines.

- Potential Diversion Site #1: Upstream from the Fruitland Diversion Structure

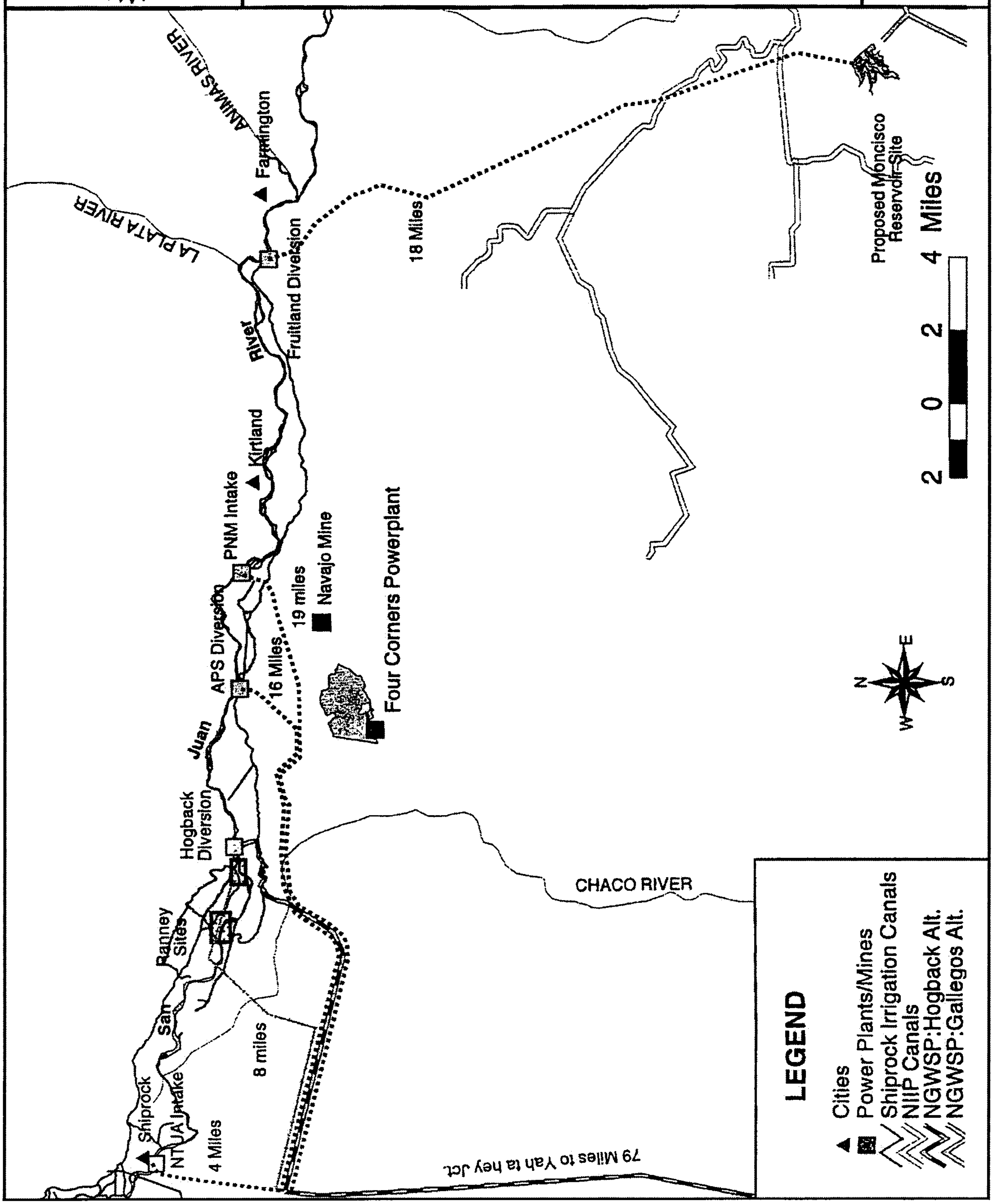
  Reclamation assessed direct diversions out of the San Juan River for the 1984 Environmental Statement, and again in 1996 (*Water Supply and Storage Options, Gallup Navajo Pipeline Project, Engineering and Cost Estimates, Appraisal Level Report*, 1996, Reclamation). Reclamation evaluated a pipeline, pumping plant, pipeline outlet structure, 1,800 acre-foot storage facility and appurtenant structures. The total estimated cost for construction including the pipeline and pumping plants, dam, power lines, and relocation of utilities and archeological mitigation is $58 million in 1996 dollars ($64 million in 2000 dollars). This estimate includes five percent for unlisted items and 20 percent for contingency. This configuration would require an 800-foot lift from the intake pipeline. With a power demand rate of $3.54/kw/month and an energy rate of $0.008 kWh, the annual power cost at full build out would be $414,000 or approximately $13.80 per acre-foot. The estimated field cost of the diversion structure is $2 million.

  In addition to the diversion facilities, a lined regulating pond with a capacity of approximately seven percent of the annual demand, or 1,500 acre-feet of the total annual diversion, may be required to provide water when the water quality of the river is low and the pumps must be shut down. This pond has an estimated field cost of $9.6 million.

  The point of diversion has critical hydrologic implications for the endangered species in the San Juan River. A diversion on the San Juan River upstream from the confluence of the La Plata and San Juan Rivers may be unable to accommodate with the current flow recommendations. For this reason, this site was not considered further.

Figure 8.3
Direct Diversions Options

nilpproj.apr
By: R.L. Kirk
March 15, 2001
Department of Water Resources



Navajo-Gallup Water Supply Project

- Potential Diversion Site #2: The Fruitland Diversion Structure

The Fruitland Irrigation Project includes approximately 350 farming plots totaling 3,830 assessed acres (*BIA 1993 Crop Utilization Survey*, BIA, 1993). The Fruitland Diversion Structure is located two miles west of Farmington, San Juan County, New Mexico, on the southern bank of the San Juan River at river mile 178.5 about 0.4 miles upstream from the confluence of the La Plata River. The diversion structure is located on land which was previously owned by the Navajo Mission and is now owned by the City of Farmington.

The Fruitland Diversion Structure is a quarry rock structure that is maintained on an as-needed basis. A sluiceway to the river adjacent to the canal can sluice up to 1,000 cfs back to the river through two 10 foot wide gates. During midsummer these gates are operated to allow a flow of 100 to 200 cfs through the sluiceway. The gates are opened wider during periods of higher flows and are left open during the winter. The capacity of the canal is approximately 165 cfs although 120 cfs is considered the likely maximum. This diversion does not operate during the winter months (BIO/WEST, 1996).

The Fruitland Diversion is very close to the upstream diversion site evaluated in the 1984 Environmental Statement, and it is very close to the site evaluated by Reclamation in 1996. Of the diversion sites considered, the Fruitland Diversion is the furthest upstream and it has the best water quality. Utilizing the existing Fruitland Diversion would require significant upgrades including fish screens and passages, better sediment control, and a more permanent weir. A nearby rock quarry has several excavated pits that have filled with water from the San Juan River. These ponds might provide regulating storage for the Project. However, they would need to be protected from potential flood damage during high flows.

The Fruitland Diversion is upstream from the confluence of the La Plata and San Juan Rivers. Consequently, its location does not have the hydrologic flexibility needed to accommodate the San Juan River Recovery Program Flow Recommendations. For this reason, it was not further evaluated.

- Potential Diversion Site #3: The Shiprock NTUA Diversion Structure

NTUA has an octagonal intake tower set in the river channel on the north side of the San Juan River near river mile 145. It is adjacent to the Highway 666 bridge. The NTUA facilities include a gravity line leading to a settling basin, pumps and a pipeline to the water treatment plant. The diversion diverts approximately 600 acre-feet per year. The original facilities have been modified twice to reduce the intake of river sand. These modifications include an infiltration gallery beneath the river bed and a venturi type sand separator. The sand separator is not able to extract sand fast enough which creates major problems. The operators have indicated that suspended solids originating largely from the Chaco Wash also create water treatment problems (Molzin-Corbin, 1993).

Reclamation ruled out a diversion structure for the Project at Shiprock because the extra 300 foot pumping lifts were excessive and the water quality was low. The Recovery Program reports that during 1999 turbidity of the San Juan River at Shiprock exceeded 4,000 NTU's for three six-day periods. Reclamation reports that the total dissolved solids (TDS) at Shiprock ranged from 149 mg/l to more than 2,000 mg/l during low flows. The median concentration was 488 mg/l which barely meets secondary safe drinking water standards. Projected flow reductions in the San Juan River by the year 2030 will cause those concentrations to increase. Reclamation recommended a more favorable site up stream closer to Farmington (Reclamation, 1984). The NTUA diversion is downstream from the Uranium Mine Tailing Reclamation Act site in Shiprock. A diversion downstream from this site may raise health and safety concerns in the future. For these reasons, this site was not further evaluated.

- Potential Diversion Site #4: The Four Corners Generation Station Diversion Structure

The Arizona Public Service Company (APS), which operates the Four Corners Power Plant, diverts water from the San Juan River near river mile 160. The intake structure is at the base of a cliff on the south side of the river. It was constructed during the late 1960's. Since then silt and landslides have shifted the river channel away from the intake making it more difficult to maintain an adequate water supply to the power plant. From the intake structure, two sets of two pumps convey 32,000 gpm approximately 2.5 miles from the river to Morgan Lake. Morgan Lake is used as a cooling pond for the power plant. Depending on the weather and power demands, during a typical year the pumps operate between 60 and 70 percent of the time.

Morgan Lake impounds 39,000 acre-feet. The water is used for condenser cooling, domestic use at the plant, boiler feed makeup, ash sluicing and scrubbers. Approximately 10,000 acre-feet of the Morgan Lake water returns to the San Juan River each year via the Chaco River.

One of the concerns with incorporating Morgan Lake into the Project is the poor quality of the water in the lake. The cooling process results in a build up of solids. While relatively low TDS water (415 ppm) is diverted from the river, the operation of the lake results in TDS concentrations between 900 and 1000 ppm. APS tries to keep the TDS between 700 and 800 ppm. The TDS of the water discharged to the Chaco Wash has been measured at 3,300 ppm. Data from 1975 indicate that the water in Morgan Lake is, on average, twice as hard as the water in the San Juan River near Shiprock (230 verses 452 ppm) and that it fails to meet a large number of secondary water treatment standards (*Four Corners Power Generating Plant and Coal Mine, Environmental Report*, March 1975, Westinghouse Environmental Systems Department).

Although these water quality issues are not necessarily fatal flaws, they would result in much more complex water treatment requirements. Theoretically, the Lake could be managed to maintain higher water quality. However, occasional contamination due to small amounts of turbine lubricating oil has occurred. The Lake Morgan water supply meets the water quality demands of the power plant. However, domestic systems have much more stringent water quality standards, including notification requirements if standards are violated. These safe drinking water standards make it much more difficult to use a cooling pond for a municipal domestic water supply. For these reasons, this site was not further evaluated.

- Potential Diversion Site #5: The Ranney Infiltration Gallery

The Ranney Method Western Cooperation (Ranney) conducted an initial assessment of the practicality of developing an infiltrated water supply using the San Juan River aquifer materials to pre-treat the supply. The Ranney staff conducted a site visit to the San Juan River. Theoretically, an infiltration gallery can be installed anywhere along the river. The San Juan River between Shiprock and Farmington was inspected to determine the most suitable sites. One criterion was to locate the infiltration galleries upstream from Uranium Mine Tailing Reclamation Act (UMTRA) site in Shiprock. Additional effort was made to identify sites that would minimize the potential environmental impacts. With these criteria three sites were field inspected.

Ranney reviewed information in their corporate files. Ranney installed a similar unit one mile west of Farmington, New Mexico for the Lower Valley Water Users Association (Brewer, 1977 and 1981). Reports indicate that the gallery yielded approximately 1.0 million gallons per day. But, the water from that gallery had a noticeable hydrogen sulfide odor and it was high in iron and manganese. That gallery has been abandoned. In 1973 Ranney investigated a site near the Hogback Diversion for the Fluer Corporation. For that investigation five test wells were installed. The Fluer investigation indicates that each gallery may yield 2.0 million gallons per day.

Ranney recommends 20 foot deep reinforced concrete caissons with inside diameters of nine feet and concrete top slabs. The caissons would be 500 feet apart. Each caisson would have three 500 foot long horizontal gallery lines installed beneath the streambed. Ranney estimates that individual units would yield approximately 1.5 million gallons per day and have an estimated cost between $900,000 and $1,100,000. This option would require approximately 22 caissons to meet the average annual demand of the Project at full build out and approximately 26 caissons to meet the 1.3 peaking requirement. The reconnaissance level cost for this diversion is $26 million. The cost for pumps, pump houses, access roads, and conveyance pipelines to the treatment facility would be additional.

This proposed configuration for three banks of caissons is down stream from the Hogback Diversion Structure. One bank of caissons would be located directly downstream from the Hogback Diversion Structure on the north side of the river between the river and the Hogback Canal. Another bank of caissons would be approximately two miles downstream from the Hogback Diversion Structure on the south side of the river. The third bank would be about four miles downstream from the Hogback Diversion Structure on the south side of the river. Compared to the San Juan Generating Station Diversion, this site eliminates approximately 36,000 feet, or seven miles, of 52 inch diameter pipe. It may also eliminate the need for a storage reservoir to supply water during times of high turbidity and it may result in lower water treatment costs. However, it will require a more extensive collection system. The banks of caissons could be phased as the Project demand increases over time. This option will be further investigated.

- Potential Diversion Site #6: The San Juan Generating Station Diversion Structure

The Public Service Company of New Mexico (PNM), which operates the San Juan Generating Station, diverts water from the San Juan River approximately 13 miles downstream from the City of Farmington near river mile 166. This diversion was constructed in 1972 and it diverts approximately 30 cubic feet per second or 24,000 acre-feet per year, of which 16,400 acre-feet is under a contract from the Secretary of the Interior. The San Juan Generating Station is a zero discharge facility. The PNM diversion is downstream from the La Plata River confluence and upstream from the Ojo Amarillo Wash confluence. This location may have slightly better water quality than the other downstream sites, but with respect to the endangered species, it has somewhat less hydrologic flexibility.

The water is diverted through a sluice way on the north side of the river to a pumping station. Three 800 horsepower pumps lift the water about 200 feet to a 2,700 acre-foot cooling and regulating pond about three miles away. When the river turbidity exceeds 5,000 NTU's the pumps are shut down and the plant draws on water stored in the pond. After 27 years of operation PNM has lost about 600 acre-feet, or 20 percent, of its capacity due to sediment and suspended solids. PNM and City of Farmington power facilities are located at the pump station. The weir is being modified with a manned fish bypass on the south side of the river to enable endangered species greater access to habitat upstream.

The PNM diversion could readily incorporate an additional sluiceway and pump station. For this Project the sedimentation sluiceway will need to be enlarged to maintain the appropriate velocities to ensure that the suspended solids in the water pumped by the PNM pumps does not increase. It may also be possible to utilize the existing PNM pond during times when the river water is turbid by releasing water down back down the existing pipeline. It also appears that the PNM site is large enough to accommodate the treatment facilities. The PNM Diversion has been used for the cost estimates presented in this technical memorandum. This site will be further evaluated.

- Potential Diversion Site #7: The Hogback Diversion Structure

The Hogback Irrigation Project includes 9,614 acres of irrigable land (BIA, 1962). The Hogback Diversion Structure is located at river mile 158.9 (BIO/WEST, 1996). It is downstream from the La Plata River and the Ojo Amarillo Wash confluences with the San Juan River, and upstream from the Chaco Wash confluence. It was constructed of alluvial fill materials pushed up from the river bed to form a berm across the channel and it is routinely damaged and reconstructed with major flow events. The size and configuration varied from year to year.

As a result of NIIP's Section 7 Consultation with the USFWS for NIIP, the BIA and Reclamation are rebuilding the diversion dam. The new sheet pile diversion will be completed in 2001, and the headworks will be completed in 2002. This upgrade will improve fish passage and improve the water control for the Shiprock irrigators. These upgrades will result in a much more sound structure that may be more suitable for a municipal project than the previous one.

The diversion structure forces water into a side channel where water either passes through radial gates into the canal or returns to the main river channel using a side channel sluiceway. The headgate is a remnant of an older quarry rock structure. Up to 1,700 cubic feet per second (cfs) of water can be diverted into the inlet bay where the majority of flow passes through a sluiceway back to the main channel. Radial gates in the control structure are used to regulate flow into the irrigation canal. Approximately 300 cfs of water typically passes into the irrigation canal. A second sluiceway, located approximately 1,500 feet farther down stream returns about 100 cfs back to the main river channel. Approximately 200 cfs continues down the canal for irrigation. NTUA has a 900 gallon per minute, or 2 cfs, gravity lateral which conveys water from the Hogback Canal to the NTUA Shiprock water treatment plant (Molzen-Corbin, 1993).

The Hogback Canal does not operate during the winter months, and it may have capacity constraints during the summer months. However, water is diverted through the headworks throughout the year. The canal headgates are on the north side of the San Juan River. Consequently, to reach the Project service area, either a new headgate would be needed on the south side, or the diverted water would need to be siphoned across the San Juan River. Compared to the San Juan Generating Station Diversion, this site eliminates approximately 36,000 feet, or seven miles, of 52 inch diameter pipe. Depending on the results of the analysis of the Ranney Infiltration Gallery and the PNM diversion, this site on may be further evaluated.

In conclusion, in 1996 Reclamation concluded that the capital cost of a direct diversion from the San Juan River may be more expensive than utilizing the NIIP facilities. However, that analysis did not include the full costs using the NIIP facilities. For this technical memorandum sites upstream from the La Plata River confluence were not further considered because their limited hydrologic flexibility will make it difficult to accommodate the flow recommendations. Sites downstream from the Chaco Wash and the Shiprock UMTRA site were eliminated due to water quality concerns. The Four Corners Diversion Site was eliminated due to hydraulic constraints and the incompatibility of combining a municipal water supply with the power plant's cooling pond water supply.

Three options may be further considered: (1) A Ranney infiltration gallery downstream from the Hogback Diversion, (2) PNM's San Juan Generating Station Diversion Structure and (3) possibly the Hogback Diversion Structure. For the cost estimates presented in this technical memorandum, the PNM San Juan Generating Station Diversion Structure is used. Reconnaissance evaluations indicate that the overall costs of any of these three options will be similar. More detailed analysis is required to determine a preferred alternative.

8.1.2 The Highway 666 Pipeline Corridor

During the 1980's and 1990's several possible main line alignments were evaluated. The alignment for the San Juan River Diversion Alternative generally follows the Highway 666 corridor and is similar to the "San Juan Alignment "described in the *1984 Environmental Statement and Planning Report*. This alignment was considered the preferred alternative in the 1984 report. Descriptions and cost estimates of the main pipeline and pumping stations from the Hogback Diversion Structure to Yah-ta-hey are presented in the following sections.

For the San Juan River Diversion Alternative, the main pipeline may originate near PNM's San Juan Generating Station Diversion Structure. This pipeline alignment proceeds west along Highway 36 to Highway 666 south of Shiprock. The pipeline route follows Highway 666 to Yah-ta-hey where it connects to laterals serving the Window Rock and Gallup areas. The use of the highway corridor will have to address the concerns of the State of New Mexico Highway Department. This route brings together transportation, power, and water corridors. With this alternative it may also be possible to take advantage of previous environmental compliance investigations conducted for the highway. This alignment is shown in Figures 2.1 and 8.1.

The main line has been sized to accommodate a seasonal peaking factor of 1.3. The diameter of the main line is estimated to be 52 inches at the first reach and it decreases incrementally to 34 inches near Yah-ta-hey. These diameter and lengths are shown in Table 8.1. The pipe material would likely be steel, polyvinyl chloride (PVC), or ductile iron. Steel has been used for this cost estimate. Appurtenant structures such as air valves, blowoffs, meter structures, and sectionalizing valves, will be specified during final design. The diameters, lengths and appraisal level field costs for the main line reaches are presented in Appendix D. The unit cost for the pipelines are based on cost estimates prepared by Reclamation for similar projects in northern Arizona (Reclamation, 2000).

Reclamation evaluated the geology on this pipeline corridor. Approximately 10.2 percent of the Highway 666 pipeline corridor is in possible bedrock. For the cost estimates presented in this technical memorandum, the pipeline corridor is based on 90 percent common excavation and 10 percent rock excavation.

At individual NTUA points of delivery, storage tanks of sufficient capacity are needed to supply water during peak use periods, during system repair, and for fire suppression. These tanks will either be located at high elevations or equipped with booster pumps to provide adequate system pressure. Regulating storage capacity has been included in the cost estimates. The IHS recommends approximately 2,000 gallons of system storage per household. Assuming 4.5 people per household, this standard is equivalent to a 4.4 day supply at 100 gallons per capita per day or a 2.7 day supply at 160 gallons per capita per day. Reclamation's Denver Technical Center recommends three days of storage capacity for a system with multiple water sources, and five days of supply for a system with a single source. These two criterion are very similar to the criterion recommend by Bosserman (et al). The NDWR recommends a local Project storage capacity adequate for five days of average demand.

The cost estimates for the storage tanks are based on Mean's Handbook for ground level tanks. At some sites, more expensive elevated tanks may be required, but that option was not considered in the cost estimate. With this criterion the Project main line will need 33 million gallons of storage at a cost of $8.7 million (or $13.6 million including indirect costs).

8.1.3 San Juan Alternative Pumping Requirements

Approximately 14 pumping plants are needed to lift the water to higher elevations and to supply energy to overcome friction resistance of water moving through the pipeline. The initial pumping plant would be located at the diversion structure on the San Juan River with booster pumping plants located on the main line and on the laterals. Each pumping plant would have multiple pumps with electric motors located indoors. Each pump would have an arrangement of valves and valve operators for startup control and isolation from the pipeline. The pumping plants would have flow meters for measurement of water distribution. The field cost of the pumping plants assumes 70 percent efficiency. Exact locations, sizes, and power requirements will be determined in the final design process. The main line will require a total horsepower of 17,000 and will cost of $10.5 million (or $16.4 million with indirect costs).

Table 8.1
The San Juan River Alternative Main Line Reach Diameters and Lengths

Reach	Length (Feet)	Diameter (Inch)
PNM Diversion to NAPI Junction	8,388	52
NAPI Junction to Highway 666 near Shiprock	91,042	52
Shiprock Junction to Sanostee	94,323	50
Sanostee to Burnham Junction	51,075	48
Burnham Junction to Newcomb Junction	19,088	48
Newcomb Junction to Sheep Springs	51,174	48
Sheep Springs to Naschitti	29,635	46
Naschitti to Tohatchi	90,183	46
Tohatchi to Coyote Canyon Junction	34,954	46
Coyote Canyon Junction to the Twin Lakes Junction	15,594	42
Twin Lakes Junction to the Ya-ta-hey Junction	31,161	42
Total	516,617	

8.2 The NIIP Alternative

Several NIIP points of diversion were evaluated including: (1) collection of NIIP subsurface drainage return flows, (2) a direct pipeline from Navajo Reservoir, and (3) conveying water through the NIIP Main Canal to Moncisco Reservoir. Due to the relatively small volume of NIIP return flows, the high cost of the collection system, concerns regarding the expense of water treatment, and the minimal environmental benefits, the sub-surface option was not further considered. Due to the high cost, a direct pipeline from Navajo Reservoir was not further considered. Conveying water through the NIIP facilities is evaluated in this section.

With the NIIP Alternative the Project would convey 36,700 acre-feet per year through the NIIP facilities. The average diversion is 50 cubic feet per second and the peak diversion is 65 cubic feet per second. Water from the Navajo Reservoir would be conveyed through the NIIP Main and Burnham Lateral Canals to the proposed Moncisco Reservoir. Winter operation of the NIIP canals may reduce the size of the required storage. A treatment plant and pumping station would be constructed near Moncisco Reservoir. The pipeline alignment proceeds south from the treatment plant to an existing natural gas line corridor used by the El Paso San Juan Triangle Mainline and by the Transwestern San Juan Lateral System. The main pipeline route follows the gas line corridor to Twin Lakes where it follows Highway 666 south to Yah-ta-hey. At Yah-ta-hey one lateral follows Highway 64 east to Window Rock and another lateral goes south along Highway 666 to the City of Gallup and surrounding areas. From the main line three laterals include: (1) a pipeline from Naschitti north along Highway 666 to Sanostee, (2) a pipeline from Twin Lakes east along Indian Route 9 to Dalton Pass, and (3) a pipeline from the treatment plant near Moncisco Reservoir along Highway 44 to Nageezi then south to Torreon. Storage tanks and re-chlorination facilities are included in the Project. This alternative is shown in Figures 2.2 and 8.2.

8.2.1 Conveying water through the NIIP Facilities

Conveying water through the NIIP facilities is evaluated in this section. With the NIIP Alternative, the water would be diverted from Navajo Reservoir through the NIIP Main Canal, the water would be lifted approximately 300 feet at Gallegos Pumping Plant into the Burnham Lateral Canal. A pipeline and a stabilized channel would deliver the water from the Burnham Lateral Canal to the proposed Moncisco Reservoir. (The 1996 *Water Supply and Storage Alternatives Gallup Navajo Pipeline Project* report by Reclamation refers to the proposed reservoir as Moncisco Reservoir.) The proposed Moncisco Reservoir would only inundate the Moncisco Wash arm of the facility proposed in the *1984 Plan Formulation and Environmental Study.*

Conveyance losses through the NIIP canal system will need to be addressed. Diversion and metered agricultural deliveries data over the period 1989 to 1993 indicate that the mean conveyance efficiency of the NIIP canal system is 90 percent. The worst case conveyance efficiency is approximately 87 percent. This efficiency will improve if NIIP is not required to deliver selenium dilution water. For this technical memorandum NIIP conveyance losses are assumed to be 10 percent.

Table 8.1
The San Juan River Alternative Main Line Reach Diameters and Lengths

Reach	Length (Feet)	Diameter (Inch)
PNM Diversion to NAPI Junction	8,388	52
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Burnham Junction to Newcomb Junction	19,088	48
Newcomb Junction to Sheep Springs	51,174	48
Sheep Springs to Naschitti	29,635	46
Naschitti to Tohatchi	90,183	46
Tohatchi to Coyote Canyon Junction	34,954	46
Coyote Canyon Junction to the Twin Lakes Junction	15,594	42
Twin Lakes Junction to the Ya-ta-hey Junction	31,161	42
Total	516,617	

8.2 The NIIP Alternative

Several NIIP points of diversion were evaluated including: (1) collection of NIIP subsurface drainage return flows, (2) a direct pipeline from Navajo Reservoir, and (3) conveying water through the NIIP Main Canal to Moncisco Reservoir. Due to the relatively small volume of NIIP return flows, the high cost of the collection system, concerns regarding the expense of water treatment, and the minimal environmental benefits, the sub-surface option was not further considered. Due to the high cost, a direct pipeline from Navajo Reservoir was not further considered. Conveying water through the NIIP facilities is evaluated in this section.

With the NIIP Alternative the Project would convey 36,700 acre-feet per year through the NIIP facilities. The average diversion is 50 cubic feet per second and the peak diversion is 65 cubic feet per second. Water from the Navajo Reservoir would be conveyed through the NIIP Main and Burnham Lateral Canals to the proposed Moncisco Reservoir. Winter operation of the NIIP canals may reduce the size of the required storage. A treatment plant and pumping station would be constructed near Moncisco Reservoir. The pipeline alignment proceeds south from the treatment plant to an existing natural gas line corridor used by the El Paso San Juan Triangle Mainline and by the Transwestern San Juan Lateral System. The main pipeline route follows the gas line corridor to Twin Lakes where it follows Highway 666 south to Yah-ta-hey. At Yah-ta-hey one lateral follows Highway 64 east to Window Rock and another lateral goes south along Highway 666 to the City of Gallup and surrounding areas. From the main line three laterals include: (1) a pipeline from Naschitti north along Highway 666 to Sanostee, (2) a pipeline from Twin Lakes east along Indian Route 9 to Dalton Pass, and (3) a pipeline from the treatment plant near Moncisco Reservoir along Highway 44 to Nageezi then south to Torreon. Storage tanks and re-chlorination facilities are included in the Project. This alternative is shown in Figures 2.2 and 8.2.

8.2.1 Conveying water through the NIIP Facilities

Conveying water through the NIIP facilities is evaluated in this section. With the NIIP Alternative, the water would be diverted from Navajo Reservoir through the NIIP Main Canal, the water would be lifted approximately 300 feet at Gallegos Pumping Plant into the Burnham Lateral Canal. A pipeline and a stabilized channel would deliver the water from the Burnham Lateral Canal to the proposed Moncisco Reservoir. (The 1996 *Water Supply and Storage Alternatives Gallup Navajo Pipeline Project* report by Reclamation refers to the proposed reservoir as Moncisco Reservoir.) The proposed Moncisco Reservoir would only inundate the Moncisco Wash arm of the facility proposed in the *1984 Plan Formulation and Environmental Study*.

Conveyance losses through the NIIP canal system will need to be addressed. Diversion and metered agricultural deliveries data over the period 1989 to 1993 indicate that the mean conveyance efficiency of the NIIP canal system is 90 percent. The worst case conveyance efficiency is approximately 87 percent. This efficiency will improve if NIIP is not required to deliver selenium dilution water. For this technical memorandum NIIP conveyance losses are assumed to be 10 percent.

Navajo-Gallup Water Supply Project

The ability to convey Project water through the NIIP canals depends on three constraints: (1) the available canal capacity during July, (2) the length of the canal operating seasons, and (3) the storage capacity of the proposed Moncisco Reservoir. Because each of these constraints affects the project configuration differently, each one is described in the following sections. A map of the NIIP canals and the related facilities is shown in Figure 8.4.

- Constraint #1: NIIP canal capacity available during July

  The capacity of the NIIP Gravity Main Canal is 1,285 cfs and the capacity of the Burnham Lateral is 880 cfs. The average municipal demand is approximately 50 cubic feet per second. The peak demand is 65 cubic feet per second. During most, but not all, of the year these facilities have more than adequate capacity to meet the demands of both NAPI's irrigated land and the Project's municipal requirements.

  One of the operating constraints for the Project may be the canal capacity required during the peak NAPI's irrigation demand in July. The irrigation demands for NAPI during a typical year for the Gravity Main Canal, the Burnham Lateral, and the Burnham Lateral West are shown in Table 8.2 (Reclamation, 1996). With an overall irrigation efficiency of 55 percent, NAPI's irrigation demand limits the canal capacity available for the Project during July. The municipal demand, however continues throughout the year. Insufficient midsummer capacity could be addressed if NAPI maintains higher irrigation efficiencies, stresses its irrigated crops or irrigates fewer acres. For instance, with an overall efficiency of 65 percent this limit is almost eliminated. These options may reduce NAPI's operational flexibility and increase NAPI's risks during unexpected weather events or canal breakdowns. Based on Reclamation's operation analysis, approximately 2,000 acre-feet of reservoir capacity is required to supply the municipal demand during July.

Figure 8.4 : Map of NIIP Facilities

Schematic of the NIIP Canals
and proposed NGWSP Facilities

niipproj.apr
By: R.L. Kirk
March 15, 2001
Department of Water
Resources

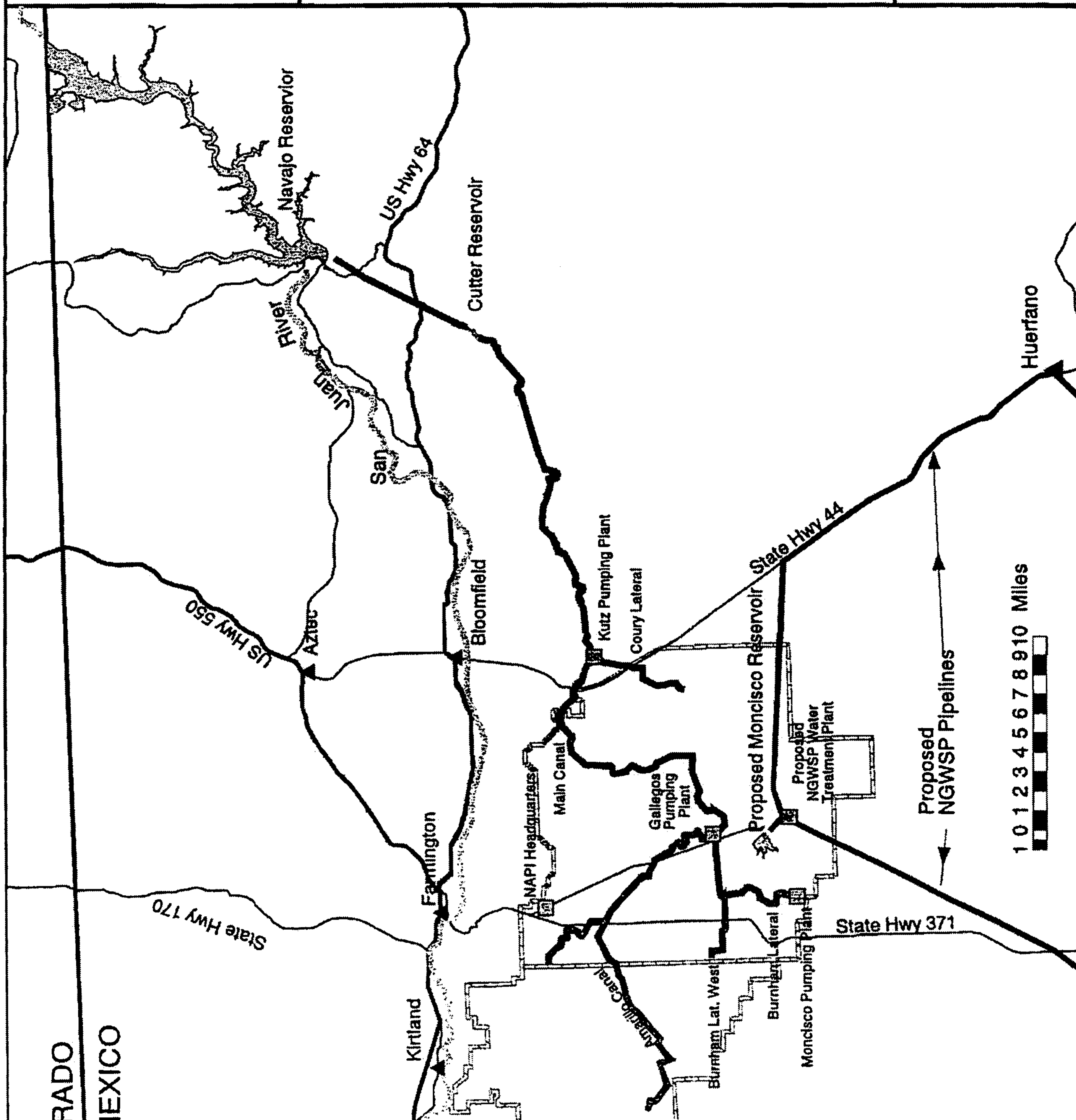


Table 8.2
NIIP Monthly Canal Capacities Available for the Navajo-Gallup Water Supply Project

Month	NAPI Demand as a Percent of the Peak Capacity[1] (Percent)	Gravity Main Canal Capacity Available for NGWSP[2] (cfs)	Burnham Lateral Capacity Available for NGWSP (cfs)	Burnham Lateral West Capacity Available for NGWSP (cfs)	Amarillo Canal Capacity Available for NGWSP (cfs)
January	0	1,285	880	320	190
February	0	1,285	880	320	190
March	0	1,285	880	320	190
April	25	964	660	240	143
May	55	578	396	144	86
June	75	321	220	80	48
July	100	0	0	0	0
August	82	231	158	58	34
September	50	643	440	160	95
October	17	1,067	730	266	158
November	0	1,285	880	320	190
December	0	1,285	880	320	190

[1] These percentages are the ratio of NAPI's peak monthly demand and that months average demand.

[2] Available canal capacities are the design capacity minus the NAPI irrigation demand. Canals are assumed to be operating at full capacity during the peak month to maintain NAPI's operational flexibility.

- Constraint #2: The length of the NIIP canal operating season

Municipal water supply projects require water throughout the year. In contrast, irrigation projects typically only operate during the irrigation season. The shorter the irrigation season lasts, the more storage will be required for the municipal project. The length of the canal operating season is the most critical constraint for determining the municipal storage requirement.

At NIIP the current irrigation season normally extends from April 1 to October 31. During the months that no irrigation occurs, November through March, NAPI conducts maintenance on the NIIP facilities. In addition to the storage required to provide water during the peak summer irrigation season, the Project requires storage while the canals are not in operation. Reclamation analyzed the Project's storage requirement based on three theoretical NIIP canal operating seasons: (1) the current canal operating season from April 1 to October 31, (2) an extended canal operating season from March 1 to October 31, and (3) all year operation of the canal system.

<u>The Current Canal Operating Season.</u> The current canal operating season begins in April and ends in October. This season provides NAPI with five full months during which the canals are not operated and annual maintenance can be conducted. With no water delivery during these winter months, Moncisco Reservoir needs approximately 11,000 acre-feet of active storage to supply the Navajo-Gallup Project.

<u>An Extended Canal Operating Season.</u> The current canal operating season could be extended by beginning water deliveries approximately one month earlier. The extended season would begin March 1 and end October 31. This season would provide NAPI with four months to conduct the annual maintenance. This extended canal operating season would avoid the likelihood of hard winter freezes which may severely damage the canal facilities. The earlier season reduces the required storage capacity at Moncisco Reservoir to approximately 8,800 acre-feet of active storage. The extended season might also provide NAPI with an opportunity to pre-irrigate some of its fields. Pre-irrigation stores water in the soil column reducing the peak irrigation diversion requirements and helps to circumvent canal capacity constraints during the summer months. Pre-irrigation may reduce pumping costs by taking advantage of off-season energy rates. Other local irrigation companies including the Farmers Mutual Ditch Company near Kirtland have extended delivery seasons to encourage pre-irrigation.

<u>All Year Canal Operation.</u> All year operation of NIIP canals and structures will impact NAPI's ability to conduct annual operation and maintenance. Specialized winter operation and preparation may increase NIIP's operation and maintenance expense, but it decreases the storage required to meet the municipal demands. Winter maintenance such as canal lining replacement, drain installation, crack sealing, and silt removal cannot be performed with water in the canal. Maintenance at canal check structures and turnout structures is more difficult if they are under

water. All year operation will also require that positive seals be installed at turnouts to pumping plants to keep water out of the pump sumps. The siphon blowoffs also need to be protected from freezing. In addition, winter operation affects the operation of the canal drains. Water under the canal lining combined with the freezing action of the soil can damage the canal linings. Currently the canal drains are open during the winter and closed during summer. This operation drains water under the lining during the winter and conserves water during the summer. There is also the potential for canal lining and other structures to be damaged due to ice dams.

For food processing NAPI may need to operate a portion of the Main Canal and the Gravity Main Canal downstream from Cutter Reservoir during most of the year. NAPI has proposed a factory that would produce frozen french fry potatoes. This factory would have an annual diversion requirement of approximately 3,000 acre-feet and deplete approximately 400 acre-feet. Cutter Reservoir has an active storage of 808 acre-feet and an inactive storage of 942 acre-feet. This reservoir has adequate capacity to meet the factory's water demand for several weeks. This storage will enable NAPI to shut down portions of the Main Canal for brief periods of time for annual maintenance. All year operation reduces, but does not eliminate the need for additional municipal storage.

- Constraint #3: Regulating storage at the proposed Moncisco Reservoir

Gallegos Reservoir was a feature of the original project specifications for the Navajo Indian Irrigation Project and was originally designed to provide 45,000 acre-feet of storage for surface irrigation. In 1973, NIIP was redesigned as an all-sprinkler system operation and Reclamation maintained that the sprinkler modifications eliminated the need for Gallegos Reservoir. Consequently, the 1976 Environmental Impact Statement (EIS) for NIIP is based on all-sprinkler operation that does not include Gallegos Reservoir. After a four-year consumptive use study was completed by Reclamation in 1983, Reclamation and the BIA determined that the storage capacity in Gallegos Reservoir was required, and it was added as a project feature of NIIP. Since Gallegos Reservoir was not included in the 1976 EIS, a supplemental EIS is required before it, or an alternative reservoir, can be constructed.

The proposed Moncisco Reservoir is smaller than the proposed Gallegos Reservoir. It will be located on the Moncisco Wash. It will supply water during periods when the NIIP facilities are not operating. If the NIIP canals do not operate during the five winter months, the Project will need 11,000 acre-feet of active storage capacity to deliver 34,000 acre-feet per year. If the canals do not operate for four months, the Project will only need 8,800 acre-feet of active storage capacity. Even if the NIIP canals operate all year, the Project will need at least 1,850 acre-feet of active storage capacity. The Project cost estimate for the NIIP Alternative presented in this Technical Memorandum is based on 8,800 acre-feet of storage.

Navajo-Gallup Water Supply Project

Two possible sites near NIIP have been identified for the proposed Moncisco Reservoir: the Cottonwood site located in Section 25, R15W, T27N, and the Moncisco site located in Section 18, R12W, T26N. The Moncisco site is within the boundary of the originally proposed Gallegos Reservoir. At either location the proposed dam would be a zoned earth core dam with a concrete spillway and outlet works consisting of an intake structure, outlet pipe with valves, and outlet structure. At either location, a dam approximately 80 to 100 feet high with a 350-surface acre reservoir is expected. Detailed geologic field investigations are still required. Both sites were visited during March of 1998 by Reclamation biologists. Based on those field trips, the proposed reservoir sites are extremely arid and support mixed desert plant communities with small, sparse willows in the bottom of the washes. Neither site has habitat suitable for the Southwestern willow flycatcher, an endangered species. Appraisal level studies identify the Moncisco site as the preferred site. The cost estimates of various capacities are shown in Table 8.3 and a schematic of the Moncisco site is shown in Figure 8.5. The cost estimates presented in this technical memorandum are based on Reclamation's high range cost estimate for 8,800 acre-foot capacity.

The construction of any reservoir will require withdrawing land. Reclamation staff have indicated that there may be some local opposition to withdrawing land for either the Moncisco or Cottonwood sites.

Table 8.3
Range of Estimated Cost for Project Storage Facilities at NIIP
(FY 2000 Dollars)

Capacity (Acre-feet)	Low Range (Million Dollars)	High Range (Million Dollars)
11,000	$38.6	$40.0
8,800	$33.0	$36.1
4,380	$22.5	$27.8

Navajo-Gallup Water Supply Project

To better characterize the three water delivery constraints at NIIP, the NDWR analyzed the operation of the NIIP facilities. The results of a representative scenario are shown in Figure 8.6. For this scenario, the NIIP canals begin operating in early March. During March, April and May the canals have adequate capacity to meet the irrigation and the municipal demand. Late in May and early June the diversions into Moncisco Reservoir are increased. The reservoir is partially filled as late as possible to minimize the duration that it is full and when evaporation and seepage losses are the greatest. Late in June and most of July the irrigation demand requires essentially all of the canal capacity. During this period the municipal demand is met by releases from the reservoir. Depending on the weather, a portion of the irrigation demand may also be met with reservoir releases. By late July the irrigation demand deceases and the canal capacity is again adequate. To keep evaporation and seepage losses to a minimum, the reservoir is filled as late as possible in the fall. The reservoir should be filled some time in early October to supply the municipal water demand during the winter months when the canals are shut down. From October to March the municipal demand is met by releases from the reservoir.

The evaporation and seepage losses from Moncisco Reservoir are impacted by the overall efficiency at NIIP. For this technical memorandum it is assumed that the evaporation loss is a depletion and that the seepage loss returns to the San Juan River. If NIIP's efficiency is 55 percent, there is a canal capacity constraint during July. Consequently, Moncisco Reservoir needs to be partly filled in June. The evaporation loss is approximately 540 acre-feet per year and the seepage loss is approximately 323 acre-feet per year. If NIIP's efficiency is 65 percent, there are no canal capacity constraints during July. Consequently Moncisco Reservoir only needs to be filled in September to provide water during the winter months. The evaporation loss is approximately 210 acre-feet per year and the seepage loss is approximately 130 acre-feet per year. NIIP's 1999 Biological Assessment indicates that NIIP's overall efficiency in the future will be close to 65 percent (Keller Bliesner, 1999). For the depletion estimates in this technical memorandum NIIP's overall irrigation efficiency is assumed to be 65 percent.

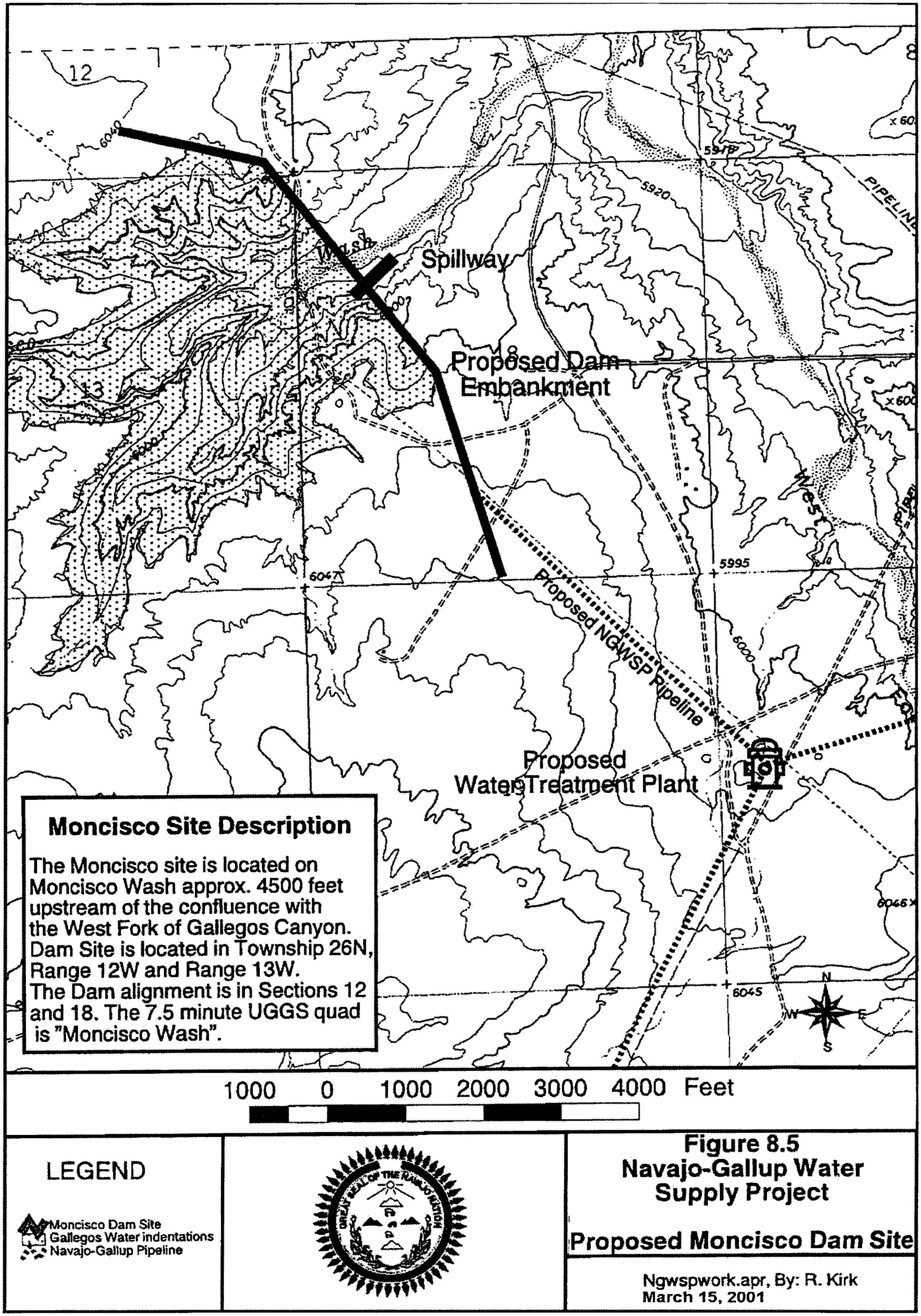
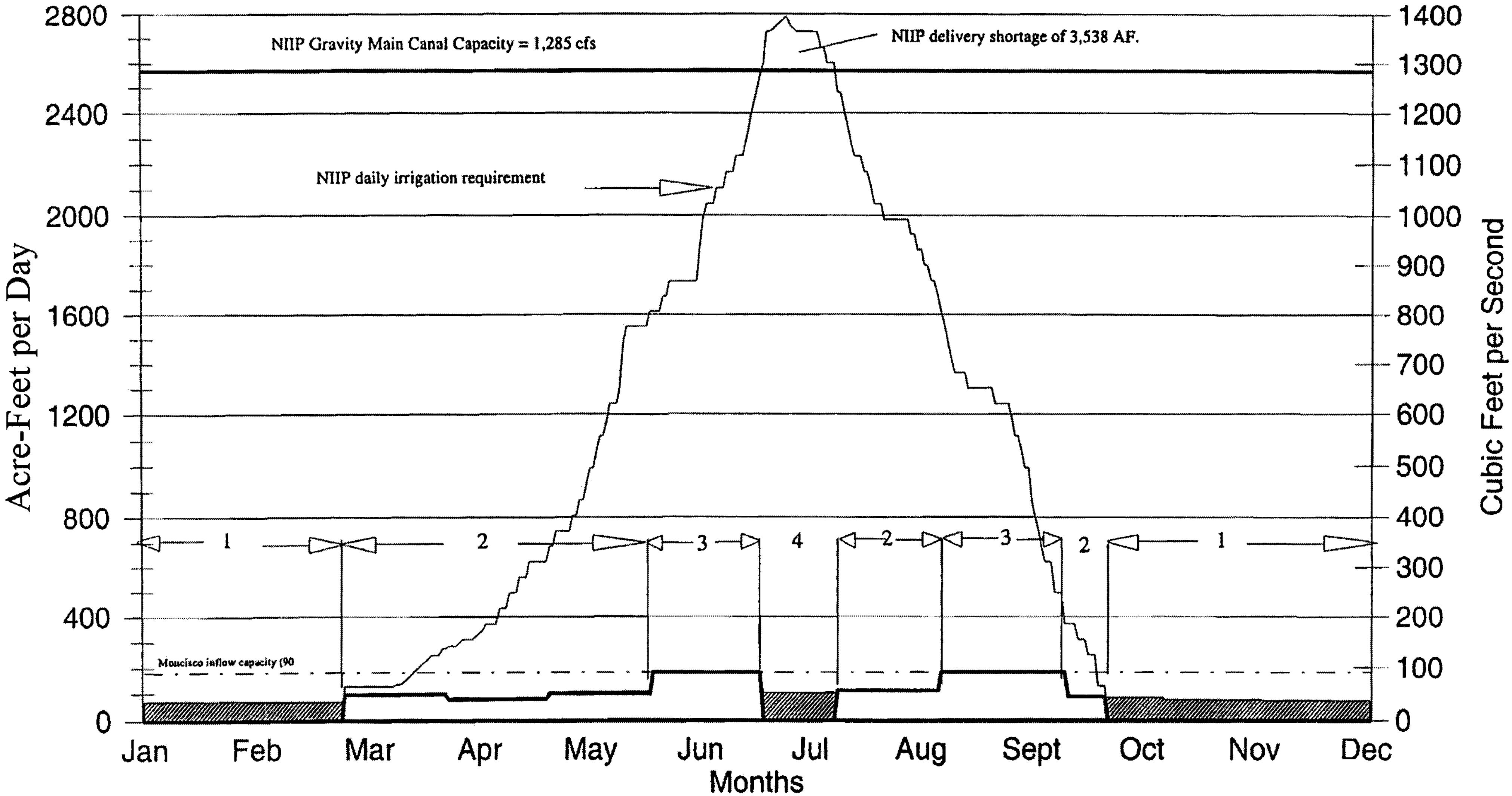


Figure 8.5
Navajo-Gallup Water Supply Project
Proposed Moncisco Dam Site

Figure 8.6: Navajo Indian Irrigation Project vs. Navajo-Gallup Water Supply Project Demand



1. NIIP canals closed for winter. NGWSP water delivery from Moncisco Reservoir.

2. Diversions from NIIP canals through Moncisco Reservoir to NGWSP Pipeline.

3. Moncisco Reservoir is filled. Late season fill minimizes reservoir losses. Reservoir only supplys water during summer and winter shortages.

4. Inadequate capacity for NGWSP and NIIP industrial water delivery. Diversions from Moncisco Reservoir are required during summer shortages.

Note:
* NIIP Irrigation delivery requirement is based on the 1994/95 operating season.
* Moncisco Reservoir has a 8,800 AF capacity.
* NIIP overall Efficiency is 55%

8.2.2 The Transwestern Pipeline Corridor

During the 1980's and 1990's several possible alignments for the main line were evaluated. The pipeline alignment for the NIIP Alternative generally follows the Transwestern Pipeline Corridor and is similar to "Alternative C" described in the *San Juan River Gallup/Navajo Water Supply Project Engineering and Cost Estimates Technical Appraisal Report*, November 1993. Of all the alignments between NIIP and Yah-ta-hey considered, this alignment is the shortest and requires the least amount of lift and fewest pumping stations to serve the Project area. The description and cost estimate of the main line from Moncisco Reservoir to Yah-ta-hey are presented in the following section.

For the NIIP Alternative, the main line originates near the pumping plant below the proposed Moncisco Reservoir. This pipeline alignment proceeds south to an existing natural gas line corridor used by the El Paso San Juan Triangle Mainline and by the Transwestern San Juan Lateral System. The pipeline route follows the gas line corridor to Twin Lakes where it turns south to Yah-ta-hey where it connects to water lines for the Window Rock and Gallup areas. Use of the gas line corridor will have to be negotiated with the respective pipeline representatives. However, a memorandum of understanding between the Navajo Nation and the companies regarding the pipeline right-of-ways should facilitate these discussions. This alignment is shown in Figures 2.2 and 8.2.

The main line has been sized to accommodate a peaking factor of 1.3. The diameter of the main line is estimated to be 52 inches at the beginning and 42 inches near Yah-ta-hey. The pipe material would likely be steel, polyvinyl chloride (PVC), or ductile iron. Appurtenant structures such as air valves, blowoffs, meter structures, and sectionalizing valves, will be specified during final design. The diameters, lengths and appraisal level field costs for the main line reaches are presented in Table 8.4. At individual points of delivery, storage tanks with a total capacity of 33 million gallons and a cost of $8.7 million (or $13.7 million including indirect costs) are included in the cost estimate.

Reclamation evaluated the geology on this pipeline corridor. Approximately 7.7 percent of the Highway 666 pipeline corridor is in possible bedrock. For the cost estimates presented in this technical memorandum, the pipeline corridor is based on 90 percent common excavation and 10 percent rock excavation.

8.2.3 Pumping Requirements

Approximately 14 pumping plants are needed to lift the water and to supply the energy to overcome the frictional resistance of water moving through the pipeline. The initial pumping plant would be located below the forebay of Moncisco Reservoir with booster pumping plants located on the main line and on the lateral pipelines. Six pumping plants are needed. The main line will require 10,000 horsepower at a cost of $6.1 million (or $9.7 million including indirect costs). The exact locations, sizes, and power requirements will be determined in the final design process (Reclamation 1993).

Table 8.4
The NIIP Alternative Main Line Reach Diameters and Lengths

Reach	Length (Feet)	Diameter (Inch)
Moncisco Water Treatment Plant to the Main Line (Huerfano Junction)	4,478	52
Main Line (Huerfano Junction) to the Burnham Junction	55,732	50
Burnham Junction to the Lake Valley Junction	72,046	50
Lake Valley Junction to the Naschitti Junction	76,272	48
Naschitti Junction to the Tohatchi Junction	82,686	46
Tohatchi Junction to the Coyote Canyon Junction	34,954	44
Coyote Canyon Junction to the Twin Lakes Junction	15,594	42
Twin Lakes Junction to the Ya-ta-hey Junction	31,161	42
Total	372,923	

8.3 Service to the Municipal Subareas

The objective of this section is to describe the alternatives for conveying water from the main line to each of the communities. One critical goal is to develop a Project that can be readily operated. NTUA raised several operational concerns. First, if a significant portion of the water in a proposed lateral or water tank is not used, the water stagnates. Under these circumstances it is difficult to maintain chlorine residuals and it can result in bacteria problems. Second, the pipelines and other facilities will be subjected to wear and tear as soon as they are installed. Even with a long life expectancy, the water purveyor needs to address maintenance as soon as a facility is built, whether or not the facility is used. Third, additional miles of long laterals which serve relatively small demands create a disproportionate operation and maintenance burden for the water purveyor and the water users. And, fourth, the water users must be able to afford the water. The proposed alternatives combine Project and programmatic components to balance the short-term and long-term demands of the service area in a cost-effective manner.

The laterals are designed with a peaking factor of 1.3 and a per capita water use of 160 gallons per person per day. The pipe diameters of the laterals range from 34 to 6 inches and the pipes would likely be steel, polyvinyl chloride (PVC), or ductile iron. Pipe diameters and lengths for the San Juan River and the NIIP Alternatives shown in Figures 8.1 and 8.2 and Tables 8.5, 8.6, 8.7 and 8.8. Depending on the Project alternative, the total estimated cost for the laterals is between $117 (for the San Juan Alternative) and $123 million (for the NIIP Alternative).

An additional objective of this section is to present surface and groundwater supply options for each municipal subarea. The Project, as proposed, will require additional conjunctive groundwater development. Groundwater development in this region is very difficult and costly. Further study will be required to determine if the conceptual groundwater components described in this memorandum are viable. As shown in Tables 8.7 and 8.8 the cost of the proposed groundwater component is approximately $73 million.

If the entire municipal demand in the service area could be met with groundwater, the capital cost of developing wells to meet those demands would exceed $500 million. For the reasons presented in Chapter 5, groundwater development does not provide a viable option at any cost because groundwater supplies are inadequate to provide a reliable, long-term water supply. However, for comparatives purposes, 100 percent groundwater scenarios are presented for every subarea along with the recommended conjunctive groundwater option. Regulating storage tanks have been included with the surface water components. Presumably the groundwater component and the regulating storage tanks can be phased over the next forty years.

To better characterize the water supply and demand of the region and the Project's service area, the communities have been grouped into twelve municipal subareas. The subareas include: (1) The City of Gallup, (2) Central Project, (3) Crownpoint, (4) Huerfano, (5) NAPI, (6) Navajo Land adjacent to the City of Gallup and the City of Gallup, (7) Rock Springs, (8) Route 666, (9) the San Juan River, (10) Thoreau-Smith Lake (which is within the planning region, but it is not within the Project's proposed service area), (11) Torreon, and (12) Window Rock. The service options for the subareas within the service area are described in the following section.

Table 8.5
The San Juan River Alternative Project Laterals - Lengths, Diameters and Cost including pumps, storage tanks and indirect costs

Lateral	Length (Feet)	Diameter (Inch)	Cost (Million Dollars)
Window Rock Lateral			$25.55
Yah-ta-hey to Rock Springs	29,439	26	
Rock Springs to St. Michaels	58,871	24	
Crownpoint Lateral			$18.94
Coyote Canyon Jct to Coyote Canyon	35,938	16	
Coyote Canyon to Standing Rock	81,321	14	
Standing Rock to Dalton Pass	37,998	14	
Cutter Reservoir - Torreon Lateral			$50.33
Cutter Reservoir to Huerfano	136,961	18	
Huerfano to Nageezi	61,308	18	
Nageezi to Counselor	105,773	16	
Counselor to Torreon	85,396	10	
Gallup Area Lateral			$22.62
Yah-ta-hey to Gamerco Hill	20,482	32	
Gamerco Hill to Gallup Junction	15,072	32	
Gallup Junction to Churchrock	46,041	14	
Gallup Junction to Red Rock	26,320	14	
Gallup Junction to Manuelito	47,050	14	
Total	787,970		$117.44

Table 8.6
The NIIP Alternative Project Laterals - Lengths, Diameters and Costs including pumps, storage tanks and indirect costs

Lateral	Length (Feet)	Diameter (Inch)	Cost (Million Dollars)
Window Rock Lateral		0	$25.55
Yah-ta-hey to Rock Springs	29,439	28	
Rock Springs to St. Michaels	58,871	24	
Crownpoint Lateral			$16.46
Coyote Canyon Jct - Coyote Cyn	35,938	14	
Coyote Canyon - Standing Rock	81,321	12	
Standing Rock to Dalton Pass	37,998	12	
Moncisco - Torreon Lateral			$37.91
Huerfano Junction to Huerfano	98,788	18	
Huerfano to Nageezi	61,308	16	
Nageezi to Counselor	105,773	16	
Counselor to Torreon	85,396	10	
Gallup Area Lateral			$22.62
Yah-tah-hey to Gamerco Hill	20,482	32	
Gamerco Hill to Gallup Junction	15,072	32	
Gallup Junction to Churchrock	46,041	14	
Gallup Junction to Red Rock	26,320	14	
Gallup Junction to Manuelito	47,050	14	
Sanostee Lateral			$20.06
Naschitti Jct to Naschitti	51,354	16	
Naschitti to Sheep Springs	29,459	14	
Sheep Springs to Newcomb	51,058	14	
Newcomb to Sanostee	51,019	10	
Shiprock Lateral			$19.59
Moncisco to Hogback	139,824	18	
Hogback to Shirpock	55,532	18	
Total	1,128,043		$122.60

TABLE 8.7
Recommended Municipal Conjunctive Groundwater Development

MUNICIPAL SUBAREA	1998 G.W. PRODUCTION (Acre-feet)	2040 DEMAND (Acre-feet)	PROPOSED 2040 G.W. PRODUCTION (Acre-feet)	PROPOSED CONJUNCTIVE GROUNDWATER COMPONENT
1. Central	27	911	77	Burnham: 1 well at 4,000 feet in the Gallup, Dakota or Morrison at 120 gpm ($4,000,000) Lake Valley: 2 wells at 100 feet the Chaco River Alluvium at 20 gpm ($200,000) White Rock: 1 well at 4,000 feet in the Morrison at 100 gpm ($4,000,000) Whitehorse Lake: 2 wells at 500 feet in the Menefee Formation at 20 gpm ($1,000,000)
2. Crownpoint	330	3,226	752	Coyote Canyon: 2 wells at 1,500 feet in the Dalton Sandstone at 60 gpm ($3,000,000) Crownpoint: 3 wells at 2,000 feet in the Westwater Sandstone at 100 gpm ($6,000,000) Dalton Pass: 2 wells at 2,000 feet in Gallup Sandstone at 20 gpm ($4,000,000) Standing Rock: 2 wells at 2,500 feet in the Westwater at 80 gpm ($5,000,000)
3. Huerfano	90	910	46	2 wells at 1,000 feet in the Ojo Alamo Sandstone at 60 gpm ($2,000,000)
4. Gallup Area	328	4,823	502	Breadsprings: 2 well at 2,000 feet in the Gallup Sandstone at 50 gpm ($4,000,000) Church Rock: 2 well at 2,000 feet in the Chinlee at 30 gpm ($4,000,000) Iyanbito: 2 well at 2,000 feet in the Glorietta at 125 gpm ($4,000,000) Red Rock: 2 well at 2,000 feet in the Gallup Sandstone at 50 gpm ($4,000,000)
5. Rock Springs	58	2,287	169	3 wells at 1,700 feet in the Gallup Sandstone at 40 gpm ($5,100,000)
6. Route 666	551	6,161	795	Naschitti: 2 wells at 1,500 feet in the Point Lookout Sandstone at 80 gpm ($3,000,000) Tohatchi: 3 wells at 1,500 feet in the Point Lookout Sandstone at 150 gpm ($4,500,000)
7. Torreon	113	2,316	77	6 wells at 1,500 feet in the Menefee/Point Lookout Sandstone at 20 gpm ($9,000,000)
9. Window Rock	1,043	7,179	767	6 wells at 750 feet in the Gallup/Dakota/Morrison at 60 gpm ($4,500,000) 6 wells at 300 feet in the C-Aquifer at 50 gpm and conveyance system ($1,800,000)
NAVAJO TOTAL	2,540	27,813	3,185	
GALLUP TOTAL	4,335	8,900	1,400	See City of Gallup's Well Production Planning Report and DePauli Report

Table 8.8
Groundwater Supply Options for the Project Service Area (excluding distribution systems)

Municipal Subarea	2040 Municipal Demand	100 Percent Groundwater Scenario	Recommended Conjunctive Groundwater Scenario
	(Acre-feet)	(Million Dollars)	(Million Dollars)
1. City of Gallup	8,459	n/a	n/a
1. Central	911	$16.5	$9.2
2. Crownpoint	3,225	$67.5	$18.0
3. Huerfano	910	$20.0	$2.0
4. Gallup (Navajo land adjacent to the City)	4,822	$107.0	$16.0
5. Rock Springs	2,287	$95.0	$5.0
6. Route 666	6,161	$52.0	$7.5
7. San Juan River	n/a	n/a	n/a
8. Torreon	2,316	$117.0	$9.0
9. NAPI	n/a	n/a	n/a
10. Window Rock	7,179	$59.0	$6.3
Navajo Nation Total	27,811	$534.0	$73.0

8.3.1 City of Gallup

In 1997 the City assessed its groundwater development options. That year the City produced 4,335 acre-feet of water. By the year 2040, the City's water demand will increase to approximately 8,500 acre-feet. According to the City's *Well Production Planning Report* (Sterling & Mataya, and John W. Shomaker and Associates, Inc, 1998) without a new water source the City anticipates a one million gallon per day shortage during peak periods as early as 2010. This section describes water services options with and without the Project.

- The No-Action Alternative with 100 percent groundwater

  According to the City's reports, the static water level of the Santa Fe Well Field has decline more than 340 feet since the 1960's and the Yah-ta-hey Well Field has declined more than 700 feet since the 1970's. The City's forty-year master plan identified two short-term alternatives including the expansion of the Yah-ta-hey Well Field to the north and developing water in the Ciniza area to the east. The City is also considering developing groundwater near Mount Taylor. None of these options will result in a sustainable, long-term water supply. None of these options meet the Project's purpose and need.

- The NIIP or San Juan River Project Alternative with the preferred conjunctive groundwater development

  With either Project alternative, the City of Gallup's groundwater withdrawals will be dramatically reduced. During the first few years, groundwater withdrawals can be completely eliminated, and the aquifer recharge can be maximized. By the year 2040 the City will again use groundwater during the summer. With the Project, the City estimates that by 2040 it will use approximately 1,440 acre-feet of groundwater per year. One result of the Project is that the City will not need new groundwater development. And, the associated groundwater operation and maintenance expenses will be greatly reduced.

  Depauli Engineering and Surveying Company presented a preliminary design and cost estimate for distributing the Project water from the Yah-ta-hey Junction through the City of Gallup to the NTUA systems in Churchrock on the east, Manuelito and Spencer Valley on the west, and Redrock on the south. The total estimated cost for construction, engineering and contingencies for the regional project is $23.5 million (excluding costs associated with addressing NEPA, cultural resources and rights-of-way).

8.3.2 Central Project Subarea

The Central Project Subarea includes the Chapters of Burnham, Lake Valley, White Rock, and Whitehorse Lake. The projected municipal demand for this area in the year 2040 is 911 acre-feet, of which 77 acre-feet will be met with groundwater. Two options have been considered for serving this subarea, with either alternative a lateral from the main line and conjunctive groundwater development.

- The San Juan River Alternative with a lateral from the main line

  To ensure that the long-term needs of this subarea are not ignored, capacity for these chapters has been included in the main line under the NIIP and San Juan River alternatives. With the San Juan River Alternative a 65,000 foot long programmatic lateral could be constructed from the Highway 666 corridor to Burnham. This lateral would cost $4.0 million. Lake Valley and White Horse Lake would be served from the Crownpoint Lateral. This 165,000 foot long programmatic lateral would cost $9.3 million.

- The NIIP Alternative with a lateral from main line

  With the NIIP Alternative a 82,500 foot long programmatic lateral from the Transwestern Pipeline corridor could be constructed to Burnham and a 83,000 foot long programmatic lateral could be constructed to Whiterock and Lake Valley. These laterals would cost $10.3 million. Depending on the alternative, Whitehorse Lake would be served from either from Crownpoint or Cutter Reservoir. These programmatic options are shown in Figures 8.1 and 8.2.

- Groundwater development

  A possible groundwater option for Burnham is to drill additional wells in the Pictured Cliffs Sandstone Aquifer. Assuming an average of 10 gpm could be attained, 12 wells at depths of about 700 feet would be required. Given the low yields, this alternative is not considered viable. Another alternative would be development of the Gallup, Dakota or Morrison aquifers. Assuming that a well in any of these aquifers could attain 120 gpm, at least one well would be required. This well would need to be between 3,500 and 5,000 feet deep at a cost of $3.5 to $5 million. This option may be viable, but the water quality is poor (specific conductance 2,000 to 5,000 microseimens per centimeter).

  An alternative for Lake Valley is to drill additional wells in the Chaco River alluvial aquifer. Assuming 20 gpm could be attained, two wells with depths of less than 100 feet would be required at a cost of about $200,000. Water quality in the alluvium is generally good (specific conductance about 1,000 microseimens per centimeter). Another alternative would be to complete wells in the Morrison aquifer at depths of more than 4,000 feet. Water quality would be marginal too poor.

An alternative for White Rock is to complete an additional 100 gpm well in the Morrison aquifer at a depth of more than 4,000 feet and a cost of $4 million. Water quality in the Morrison would be marginal too poor (specific conductance 2,000 to 5,000 microseimens).

An alternative for Whitehorse Lake is to complete two wells with a 20 gpm yield in the Menefee formation at a depth of more than 500 feet and a cost of $1 million. Water quality in the Menefee would be marginal too poor (specific conductance 2,000 to 5,000 microseimens). Meeting the total conjunctive groundwater demand will cost $9.2 million.

If the entire demand is to be met with groundwater, the cost of well development would be $16.5 million. These groundwater alternatives will need further study to determine if groundwater is viable. For instance, IHS recently spent one million dollars drilling a well in the Ojo Alamo formation near Whitehorse Lake that was unusable due to benzene. Groundwater can only be incorporated into a preferred alternative if the water supply can be sustained. However, it is unlikely that this groundwater could supply more than 10 percent of the total demand. These costs are shown in Table 8.8.

8.3.3 Crownpoint Subarea

The Crownpoint Subarea includes the chapters of Becenti, Coyote Canyon, Crownpoint, Dalton Pass, Little Water and Standing Rock. The projected municipal demand for the Crownpoint Subarea in the year 2040 is 3,225 acre-feet, of which 752 acre-feet will be met with groundwater. With either alternative two options have been considered for serving this subarea: a lateral from the main line and conjunctive groundwater development.

- The NIIP or San Juan River Project Alternative with a lateral from the main line and the preferred conjunctive groundwater development

  Both the San Juan River and the NIIP Project alternatives include capacity in the main line and a 118,000 foot long lateral from the main line near Coyote Canyon to the NTUA regional system near Dalton Pass. The estimated cost of this lateral is $17 million. The NTUA system will require additional programmatic upgrades costing an additional $17 million to convey this water. The Project lateral costs for both alternatives are shown in Tables 8.5 and 8.6.

- Groundwater development

  The 752 acre-foot conjunctive groundwater demand for Crownpoint, Becenti and Dalton Pass could be met by increasing groundwater withdrawals from the Westwater Canyon Sandstone Aquifer near Crownpoint and constructing a regional distribution system. The regional distribution system will distribute a combination of San Juan River water and groundwater. Further study is required to ensure that these groundwater withdrawals are sustainable. It is possible that the Westwater Canyon Aquifer is tributary to the San Juan River, and increased groundwater withdrawals may eventually result in depletion to the river.

For Coyote Canyon, additional wells could be drilled in the Menefee Formation or the Dalton Sandstone. This alternative could extend the regional system to meet the combined conjunctive demands of Tohatchi, Mexican Springs, Coyote Canyon, and Twin Lakes. Assuming an average of 60 gpm could be attained, 2 wells at depths of about 1,500 feet and a cost of $3 million are required.

A groundwater option for Crownpoint is to drill additional wells in the Westwater Canyon aquifer. Assuming an average of 100 gpm could be attained, 3 wells at depths of about 2,000 feet at a cost of $6 million is required.

A groundwater option for Dalton Pass is to drill additional wells in the Gallup Sandstone. Assuming an average of 20 gpm could be attained, 2 wells at depths of about 2,000 feet at a cost of $4 million is required.

A groundwater option for Standing Rock is to drill additional wells in the Westwater Canyon aquifer. Assuming an average of 80 gpm could be attained, 2 wells at depths of about 2,500 feet at a cost of $5 million is required. Meeting the total conjunctive groundwater demand will cost $18 million.

Consideration was given to meeting the entire subarea demand with groundwater. The cost of well development to meet the entire demand would be $67.5 million, However, it is unlikely that this groundwater could supply more than 25 percent of the total demand. These costs are shown in Table 8.8.

8.3.4 Gallup Area (Navajo Land Adjacent to the City of Gallup)

The Gallup Subarea includes the chapters of Breadsprings, Chichilta, Church Rock, Iyanbito, Mariano Lake, Pinedale, and Red Rock. In addition to 7,500 acre-feet for the City, the projected municipal demand in the year 2040 is 4,823 acre-feet, of which 721 acre-feet will be met with groundwater. Two options have been considered for serving this subarea: a regional City of Gallup distribution system from the main line at Yah-ta-hey and groundwater development.

Previous investigations of this Project resulted in appraisal level designs and cost estimates for the conveyance system as far south as Yah-ta-hey. However, considerable attention needs to be given to the infrastructure south of Yah-ta-hey. The Gallup Subarea distribution system has been explicitly included in this plan formulation.

Navajo-Gallup Water Supply Project

Due to water supply shortages, the City of Gallup has a city ordinance that prevents the deliver of municipal water to the surrounding Navajo trust land. In a letter date March 16, 1998, the Public Works Director for the City of Gallup indicated that the municipal code could be changed once the Project's water becomes available. The City of Gallup, the Indian Health Service and the NDWR are working to remove the administrative and technical obstacles. The trust land raises two delivery opportunities. The first opportunity is delivery to individual Navajo home sites close to the City's current distribution system. If additional water becomes available, these individuals will be able to connect with the City's system in a revenue-neutral manner. This additional system flexibility will provide benefits to the individuals served and for the City's water planning. The second opportunity is to convey water through the City's municipal system to the NTUA public water systems in Bread Springs, Chichiltah, Church Rock, Iyanbito, Pinedale, and Red Rock.

- Regional Gallup Distribution System from Gamerco Hill

  Both Project alternatives include capacity in the main line for the City of Gallup's demands and for the demands for the trust land adjacent to the City. A lateral from the main line near Gamerco Hill would connect to a Regional City distribution system. A 22-cfs pipeline with an initial diameter of 32 inches will convey 12,300 acre-feet of treated water from Yah-ta-hey south toward the City. From the pumping station local laterals will convey water south toward Red Rock, east toward Church Rock, and west toward Manuelito. The NDWR estimated cost of this lateral is $23 million.

  Depauli Engineering followed up the NDWR cost estimate with a more refined estimate for this regional system. The Depauli estimated cost of this regional City distribution system is $23.5 million (excluding costs associated with addressing NEPA, cultural resources and rights-of-way). The Depauli estimate included additional storage tanks and other specific appurtenants. A schematic of this system is presented in Figures 2.1, 2.2, 8.1 and 8.2.

- Groundwater development

  Even with the Project's surface water supply, approximately 721 acre-feet of demand will be met with conjunctive groundwater use by Bread Springs, Chichiltah, Church Rock, Iyanbito, Pinedale, and Red Rock. The NDWR considers this rate of groundwater withdrawal sustainable. This conjunctive component can be met by increasing groundwater withdrawals from the Gallup sandstone, the Glorietta and the Chinle formations. The short-term needs of Church Rock and Iyanbito may be met with groundwater conveyed from the east. However, the Manuelito, Red Rock and Bread Springs Chapters have very limited groundwater development opportunities.

Navajo-Gallup Water Supply Project

A groundwater option for Breadsprings is to drill additional wells in the Gallup Sandstone. Assuming an average of 50 gpm could be attained, 2 wells at depths of about 2,000 feet at a cost of $4 million is required.

A groundwater option for Church Rock is to drill additional wells in the Chinle Aquifer. Assuming an average of 30 gpm could be attained, 2 wells at depths of about 2,000 feet at a cost of $4 million is required.

A groundwater option for Iyanbito is to drill additional wells in the Glorietta Sandstone. Assuming an average of 125 gpm could be attained, 2 wells at depths of about 2,000 feet at a cost of $4 million is required.

A groundwater option for Red Rock is to drill additional wells in the Chinlee aquifer. Assuming an average of 50 gpm could be attained, 2 wells at depths of about 2,000 feet at a cost of $4 million is required. Meeting the total conjunctive groundwater demand will cost $16 million.

Consideration was given to meeting the entire subarea demand with groundwater. The cost of well development to meet the entire demand would be $107 million. However, it is unlikely that this groundwater could supply more than 15 percent of the total demand. These costs are shown in Table 8.8.

8.3.5 Huerfano Subarea

The Huerfano Subarea includes the chapters of Huerfano and Nageezi. The projected municipal demand for the Huerfano Subarea in the year 2040 is 910 acre-feet. Conjunctive groundwater development could supply 92 acre-feet of this demand. Under the NIIP Alternative the remaining 828 acre-feet of demand can be served by a lateral from Moncisco Reservoir. Under the San Juan River Alternative it can be served with a lateral from Cutter Reservoir.

- The San Juan River Alternative with a lateral from Cutter Reservoir

  Under the San Juan River Alternative a lateral from Cutter Reservoir to the NTUA systems at Huerfano, Nageezi and Torreon would be constructed. The estimated cost of this lateral is $50.3 million. This lateral can be readily extended to the TeePee Junction in order to serve the Jicarilla Apache Nation.

  A variation of this alternative is to convey the water for this subarea through the NIIP main canal to the Kutz pumping plant and then on through the Coury Lateral. This variation may enable the delivery of water to this subarea with a minimum of new construction. However, this option may compromise the ability to provide water to some of NIIP's fields.

- The NIIP Alternative with a lateral from Moncisco Dam

  Under the NIIP Alternative a lateral from Moncisco Reservoir to the NTUA systems at Huerfano, Nageezi and Torreon would be constructed. The estimated cost of this lateral is $37.9 million. A schematic of this lateral is shown at Figure 8.2 on page 62.

- Groundwater development

  The 92 acre-foot conjunctive groundwater demand for Huerfano and Nageezi could be met by increasing groundwater withdrawals from the Ojo Alamo Sandstone and connecting the wells to a regional distribution system. Assuming an average of 60 gpm could be attained, 2 wells at depths of about 1,000 feet at a cost of $2 million is required.

  Consideration was given to meeting the entire subarea demand with groundwater. The cost of well development to meet the entire demand would be $20 million; however, it is unlikely that this groundwater could supply more than 20 percent of the total demand. It is also likely that the Ojo Alamo aquifer is tributary to the San Juan River. Therefore, increased groundwater withdrawals may eventually result in depletions to the river. These costs are shown in Table 8.8.

8.3.6 Rock Springs Subarea

The Rock Springs Subarea includes the chapters of Manuelito, Rock Springs and Tsayatoh. The projected municipal demand for the Rock Springs Subarea in the year 2040 is 2,287 acre-feet, of which 123 acre-feet would be met with conjunctive groundwater. Two options have been considered for serving these demands: with either alternative a lateral can be constructed from the main line and developing additional groundwater.

- The NIIP or San Juan River Project Alternative with a lateral from the main line and the preferred conjunctive groundwater development

  Both Project alternatives include capacity in the main line and the Window Rock Lateral for this subarea. This lateral will connect with the NTUA systems at Rock Springs and Tsayatoh. Manuelito would be served from the Gallup regional system.

- Groundwater development

Navajo-Gallup Water Supply Project

One possible alternative for Rock Springs would be to drill additional wells in the Gallup Sandstone aquifer. Assuming 40 gpm could be attained for each well, three such wells at depths of more than 1,700 feet would be required at a cost of $5.1 million. A regional system could distribute this water to the other chapters.

Consideration was given to meeting the entire subarea demand with groundwater. Meeting the entire demand will require 32 wells in the Gallup Sandstone aquifer at 40 gpm each, or 16 wells in the Morrison aquifer at 80 gpm each, at a cost of $95 million. However, it is unlikely that this groundwater could supply more than 18 percent of the total demand. These costs are shown in Table 8.8.

8.3.7 Route 666 Subarea

The Route 666 Subarea includes the chapters of Mexican Springs, Naschitti, Newcomb, Sanostee, Sheep Springs, Tohatchi, Twin Lakes and Two Grey Hills. These chapters are located along Highway 666. Under either alignment alternative, the public water systems in these communities are well situated to take advantage of the Project water as soon as it is available. The projected municipal demand for the Route 666 Subarea in the year 2040 is 6,161 acre-feet, of which 882 acre-feet could come from groundwater. Two options have been considered for serving these chapters: with either alternative, the subarea can be served from the main line and developing additional groundwater.

- The NIIP or San Juan River Project Alternative with a lateral from the main line and the preferred conjunctive groundwater development

  Both Project alternatives include capacity in the main line for these chapters. These chapters are well positioned to take advantage of the main line without any additional Project laterals. The NTUA systems in the area will need to be upgraded.

- Groundwater development

  An extended regional system could be developed to meet the combined demands of Tohatchi, Mexican Springs, Coyote Canyon, and Twin Lakes. To meet the conjunctive groundwater of the regional system, this extended regional system would require three wells with depths of 1,500 feet in the Point Lookout Sandstone aquifer, or 1,500 to 2,000 feet deep in the Morrison aquifer, at 150 gpm each. Water quality in both the Point Lookout and the Morrison would be good (specific conductance less than 1,000 microseimens per centimeter (Stone and others, 1983)). These wells would cost $4.5 million.

  An alternative for Naschitti would be to drill additional wells in the Point Lookout Sandstone aquifer. Assuming an average of 80 gpm could be attained, two wells at depths of more than 1,500 feet would be required. These wells would cost $3.0 million. Meeting the total conjunctive groundwater demand will cost $7.5 million.

Consideration was given to meeting the entire subarea demand with groundwater. Meeting the entire demand will cost of $52 million. However, it is unlikely that this groundwater could supply more than 15 percent of the total demand. These costs are shown in Table 8.8.

8.3.8 San Juan River Subarea

The projected municipal water demand in the San Juan River Subarea by the year 2040 is 8,421 acre-feet per year. The Animas-La Plata Project Supplemental EIS describes three alternatives for delivering approximately 4,680 acre-feet of diversion, or 2,340 acre-feet of depletion, to the Shiprock Area. These alternatives are also described in the NDWR technical memorandum *An Appraisal Level Study of the Proposed Farmington to Shiprock Municipal Pipeline.* The Animas-La Plata Project water supply is only adequate for 55 percent of the Shiprock Subarea's 2040 water demand. This Project includes an additional 3,740 acre-feet of diversion, or 1,870 acre-feet of depletion, to meet the balance of the subarea's municipal demand. Delivery options were considered for both the NIIP Alternative and the San Juan River Alternative. Groundwater is not available in this subarea.

- Serving the San Juan River Subarea with the San Juan River Alternative

  One option is to convey the Project's 3,740 acre-feet of water diversion for this subarea through an enhanced Animas-La Plata Navajo Municipal Pipeline. However, the City of Farmington will have water treatment and conveyance constraints. If Farmington is constrained, this option could include a separate diversion structure which would join the Animas-La Plata Navajo midway between Farmington and Shiprock. The NDWR has estimated that adding this capacity to the Animas-La Plata Navajo pipeline will cost approximately $10 million.

  With the San Juan River Alternative a blind tap can be installed at the Junction of Highway 666 and Highway 34. The NDWR has estimated that adding this capacity to the San Juan River Alternative main line from the from the PNM Diversion to the highway junction will add approximately $ 8.7 million to the Project. For the San Juan River Alternative, this option is the most cost effective and it has been used for the cost estimates in this technical memorandum.

- Serving the San Juan River Subarea with the NIIP Alternative

  It is possible to convey the Project's 3,740 acre-feet of water diversion through an enhanced Animas-La Plata Navajo Municipal Pipeline. The NDWR has estimated that adding this capacity to the Animas-La Plata Navajo pipeline will cost approximately $10 million. For the NIIP Alternative, this option is the most cost effective.

With either alternative it is possible to convey the Project water through a separate stand-alone pipeline. The NDWR estimated that the cost of a stand-alone pipeline from the PNM Diversion to Shiprock would be $20 million.

It is also possible to convey the treated Project water from the proposed Moncisco Reservoir to the Shiprock Junction at Highway 666. The advantage to this option is that is may be able to take advantage of the proposed treatment plant at NAPI. The NDWR estimated that the cost of this option would add $19.6 million. This option has been used for the cost estimates in this technical memorandum.

It is also possible to convey the treated Project water from the proposed Moncisco Reservoir through the main conveyance line to Sanostee. From Sanostee a lateral would convey the water to Shiprock. The NDWR estimated that the cost of this option would be $27.6 million.

8.3.9 Torreon Subarea

The Torreon Subarea includes the chapters of Counselor, Ojo Encino, Torreon and Pueblo Pintado. The projected municipal demand for the Torreon Subarea in the year 2040 is 2,317 acre-feet. Conjunctive groundwater development could supply 177 acre-feet of this demand. The remaining demand can be served by a lateral from the NIIP Main Line or the San Juan River Cutter Lateral.

- The San Juan River Alternative with a lateral from the Cutter Lateral

  Along with serving the Huerfano subarea, with the San Juan River Alternative the Cutter Lateral will also serve the Torreon Subarea. The estimated cost of this lateral is $50.3 million.

- The NIIP Alternative with a lateral from Huerfano

  Under the NIIP Alternative, this subarea will be served from the Huerfano-Torreon Lateral. The estimated cost of this lateral is $37.9 million.

- Conjunctive groundwater development

Navajo-Gallup Water Supply Project

An extended regional system could be developed to meet the combined demands of Counselor, Ojo Encino, Pueblo Pintado, and Torreon. To meet the conjunctive groundwater of the regional system, this extended regional system would require six wells with depths of 1,500 feet in the Menefee or Point Lookout Sandstone aquifer and a yield of 20 gpm. Water quality in both the Point Lookout and the Morrison would be good (specific conductance less than 1,000 µS/cm; Stone and others, 1983). Meeting the conjunctive groundwater demand will cost $9.0 million.

Consideration was given to meeting the entire subarea demand with groundwater. Meeting the entire demand will cost of $117 million. However, it is unlikely that this groundwater could supply more than 10 percent of the total demand. These costs are shown in Table 8.8.

8.3.10 NAPI Subarea

NAPI has plans to develop agricultural processing projects with a total treated water demand of 7,274 acre-feet. The BIA has recently consulted with the USFWS on a french fry processing venture that will require NAPI to deplete 400 acre-feet per year. NAPI is developing a two million gallon per day water treatment plant to provide potable water for the potato processing venture. Both Project alternatives include 300 acre-feet of depletion, in addition to the 400 acre-feet, for food processing opportunities such as vegetable canning. With the NIIP Alternative NAPI will be served from the water treatment plant at the proposed Moncisco Reservoir. With the San Juan River Alternative NAPI will be served from a tap at the junction of the pipeline with Highway 64. No groundwater component is proposed. With either alternative, the cost of water treatment capacity has been included in the cost estimates.

8.3.11 Window Rock Subarea

The Widow Rock Subarea includes the chapters of Fort Defiance and Saint Michaels. The projected municipal demand for this Subarea in the year 2040 is 7,179 acre-feet, of which 767 acre-feet will be groundwater. Two options have been considered for serving these demands including: with either alternative, a lateral from the main line, and groundwater development.

- The NIIP or San Juan River Project Alternative with a lateral from the main line and the preferred conjunctive groundwater development

  With either the NIIP or the San Juan River Alternatives, a lateral from the main line near Yah-ta-hey connects to the existing NTUA system serving the Window Rock Subarea. The estimated cost of this lateral is $25.6 million. The NTUA system will require additional programmatic upgrades to convey this water. This later will also have capacity to serve the Rock Springs Subarea. A schematic of this lateral is shown at Figures 8.1 and 8.2.

- Groundwater development near Ganado

  The Navajo Nation has considered developing a well field in the Coconino Aquifer near Ganado 30 miles away to augment the Window Rock water supplies. However, the static water level is approximately 200 feet below the surface. From Ganado the water would have to be lifted another 1,400 feet to cross the 7,800 foot pass between Ganado and Window Rock. Based on reconnaissance level estimates, the 26-mile Ganado-Window Rock pipeline would cost approximately $50 million. Importing this water from the Ganado Area to the Window Rock area would strain the limited water supply for the NTUA regional system in Ganado which is Projected to exceed its sustainable supply over the next 40-year planning horizon. The Ganado-Window Rock Project does not meet the purpose and need of the Navajo-Gallup Water Supply Project.

- Groundwater development in the Window Rock Area

  An extended regional system could be developed to meet the combined conjunctive groundwater demands of Fort Defiance and St. Michaels. To meet the conjunctive groundwater of the regional system would require six wells with depths of 750 feet in the Gallup, Dakota or Morrison formations with a yield of 60 gpm and a cost of $4.5 million, and six wells with depths of 750 feet in the C-aquifer with a yield of 50 gpm and a cost of $1.8 million. Water quality in both would be good (specific conductance less than 1,000 µS/cm; Stone and others, 1983). Meeting the conjunctive groundwater demand will cost $6.3 million.

  Consideration was given to meeting the entire subarea demand with groundwater. Meeting the entire demand will cost of $59 million. However, it is unlikely that this groundwater could supply more than 10 percent of the total demand. These costs are shown in Table 8.8.

8.3.12 Thoreau-Smith Lake Subarea

The Thoreau-Smith Lake Subarea includes the chapters of Baca/Haystack, Casamera Lake, Smith Lake and Thoreau. This subarea is in the planning region, but it is not within the proposed Project service area. The projected municipal demand for the Thoreau Subarea by the year 2040 is 2,196 acre-feet. These chapters are primarily located in the Rio San Jose watershed which is tributary to the Rio Grande. Presently, a significant portion of the water withdrawn by NTUA in this area is conveyed to the Navajo Chapters of Pinedale, Iyanbito, and Church Rock. With the Project, the Thoreau Subarea will benefit because these exports will be greatly reduced. This subarea is also well positioned to take advantage of groundwater in the Mount Taylor Area. The preferred alternative for this subarea is additional groundwater development.

8.4 Power transmission lines, SCADA systems, and cathodic protection

Power lines must be built to furnish the electric power to run the motors and controls of the pumping plants. Electrical connections at existing facilities of the NTUA, Continental Divide Electric Cooperative (CDEC) and Jemez Mountain Electric Cooperative (JMEC) would be required. Power lines of the Navajo Indian Irrigation Project and the City of Farmington may also be an option to provide power. The power lines would be constructed on wood pole structures with overhead conductors. The closest existing 115, 69, or 34.5 kV power line in the vicinity of each pumping plant would be tapped to provide the power to the large horsepower motors. The small horsepower motor of the Huerfano/Nageezi lift pumping plant could be served from a 13.8 Kv power line. Connecting to the larger Kv power lines will require more expensive transformers. The locations and voltages of the transmission lines will be determined after final pumping plant locations are determined. Reclamation's Farmington Construction Office estimated that the power transmission system will cost $3,000,000. This cost could be incorporated into the annual power costs.

A project with over 200 miles of pipelines and tying into over 30 public water systems will need a Supervisory Control and Data Acquisition (SCADA) system to control and monitor the pumping stations, storage and regulating tanks, and the distribution points. The Master control station will cost $318,000, 10 remote stations will cost $232,000 and the installed cable will cost $1.79 per foot (Reclamation, 2000). The total estimated cost for the SCADA system is $1.2 million. Cathodic protection based on stations 1,000 feet apart will cost $0.58 per foot (Reclamation, 2000). The estimated cost of the cathodic protection system is $900,000.

8.5 Water treatment

Reclamation evaluated water treatment options for this Project. Surface water for public drinking systems requires compliance with the Environmental Protection Agency's Surface Water Treatment Rule (SWTR). This rule is part of the National Primary Drinking Water Regulations for public water systems using surface water sources or groundwater under the direct influence of surface water. Each Project alternative was evaluated separately.

NIIP water is characterized by low sulfate concentrations, low total dissolved solids (TDS) concentrations and turbidities less than 100 NTU. Table 8.9 lists potential treatment systems and estimated construction cost for treating NIIP water. Figures 8.7, 8.8 and 8.9 provide preliminary site layouts for a 30 million gallon per day treatment system.

Table 8.9
Treatment Alternatives for the Navajo Indian Irrigation Project Water

Alternative	Generated Waste Streams	Estimated Construction Cost per MGD Capacity
Microfiltration (CMF-S)	Backwash water conveyed to evaporation ponds.	$1,030,000 to $1,240,000
Conventional	Chemical sludge, dried and transported to landfill. Filter backwash water conveyed to evaporation ponds	$900,000 to $1,000,000
Diatomaceous Earth	Spent DE material to Landfill	$770,000 to $973,000

Note: Construction cost is only for treatment system and building. The estimate does not include intake structure, lined evaporation ponds or treated water conveyance system.

Table 8.10 lists treatment alternatives and estimated construction costs for treating water from the San Juan River. To meet the SWTR requirements using these systems, the diversion of water should occur upstream from the Hogback Diversion. Due to high turbidities in the San Juan River during the spring runoff and summer rain storms, a settling pond will be required to decrease the turbidity of the San Juan River water to 500 NTU. Water in the San Juan River upstream from the Hogback Diversion is characterized by sulfate concentrations of less than 200 mg/L and TDS concentrations less than 300 mg/L. To assist in the removal of turbidity in the settling pond, a polymer injection system is required at the pumping plant intake. Figures 8.9 and 8.10 provide preliminary site layouts for a 30 MGD treatment system for each alternative.

Table 8.10
Treatment alternatives and costs for treatment of San Juan River Water at or upstream of the Hogback Diversion

Alternative	Generated Waste Streams	Estimated Construction Cost per MGD Capacity
Pre-settling followed by Microfiltration (CMF-S)	Backwash water routed back to settling pond.	$1,030,000 to $1,240,000
Pre-settling followed by Conventional Treatment	Chemical sludge dried and transported to landfill. Filter backwash water routed back to settling pond.	$900,000 to $1,000,000

Note: Construction cost for treatment system and building only. Estimates do not include river intake, sediment channel, settling pond or treated water conveyance system.

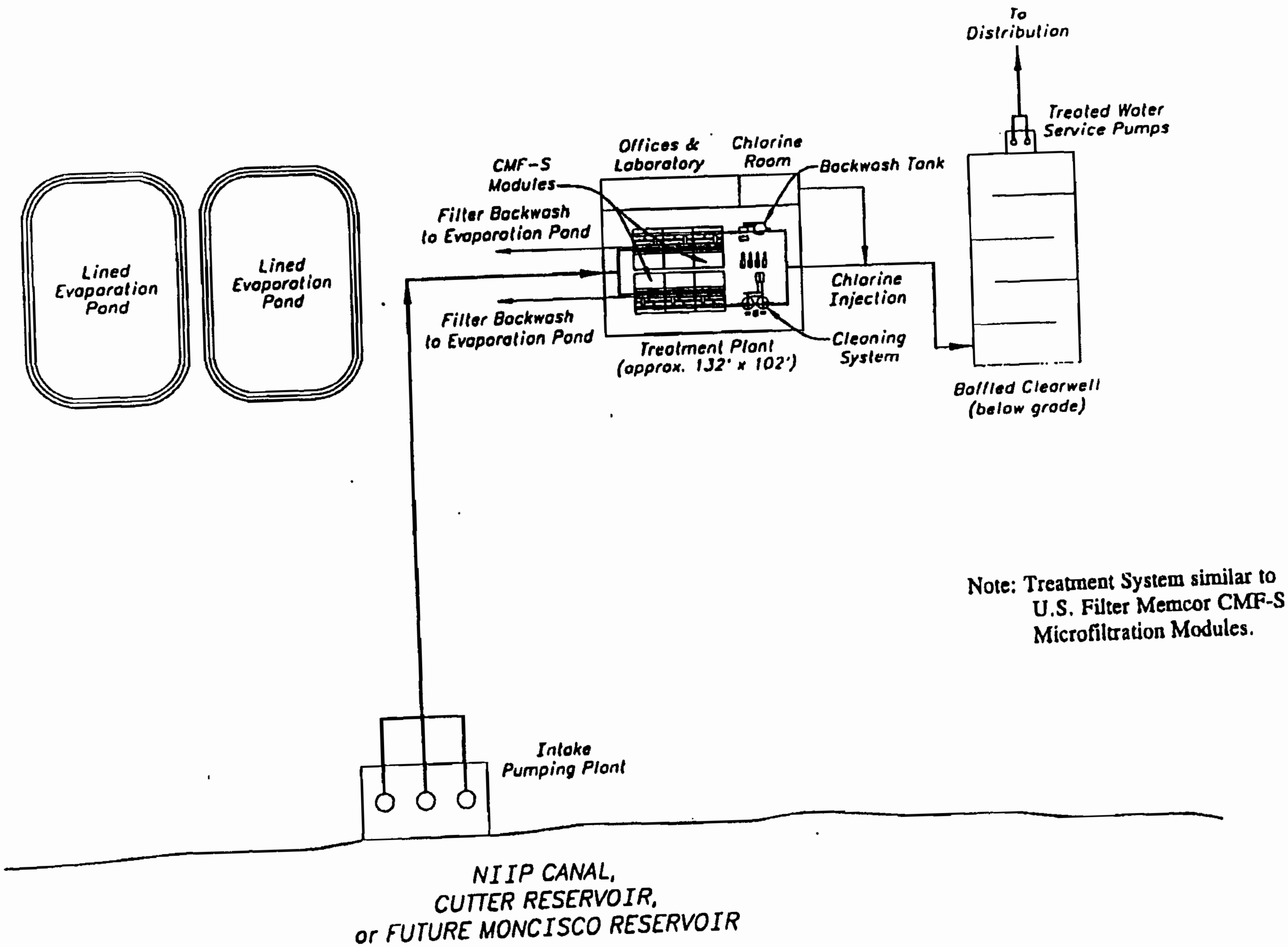
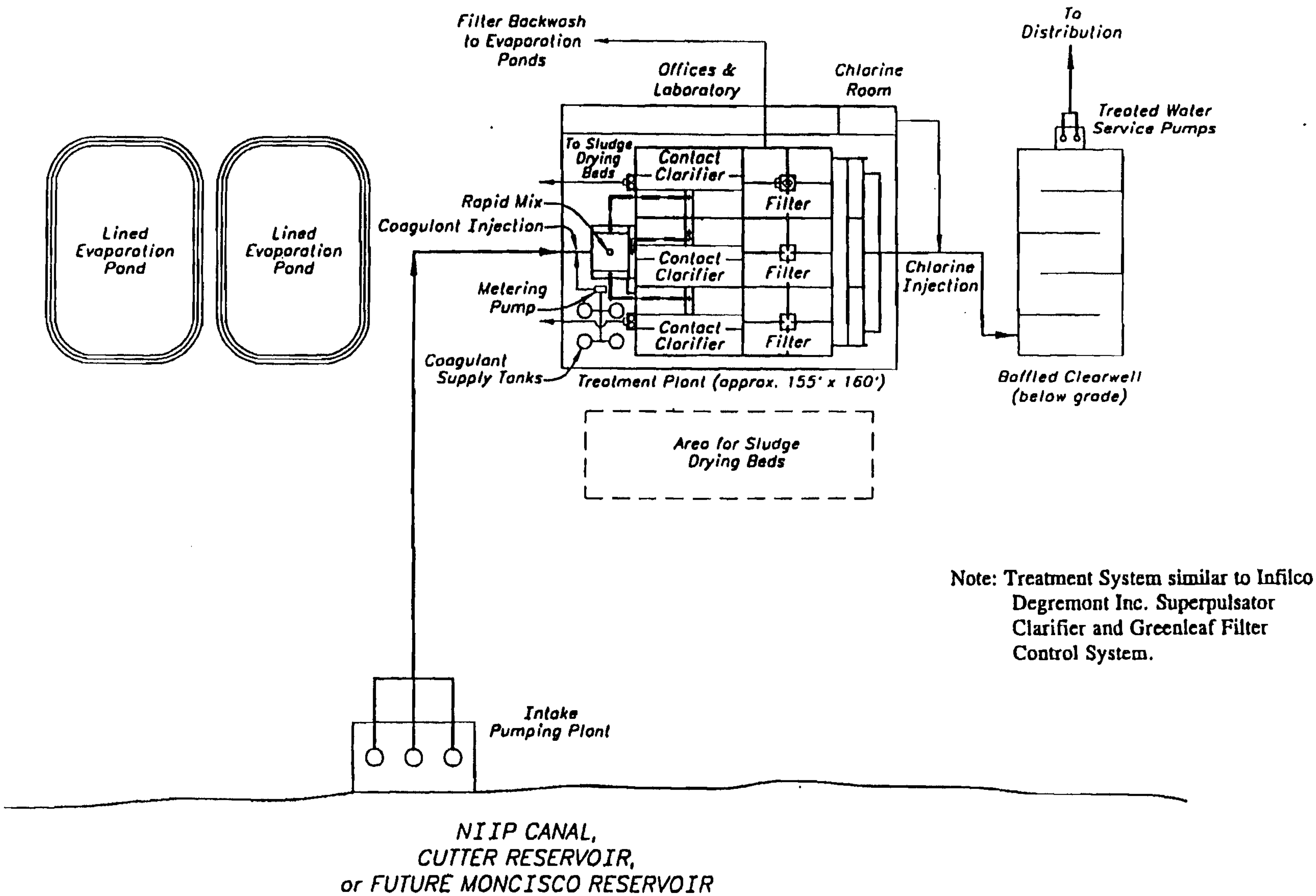
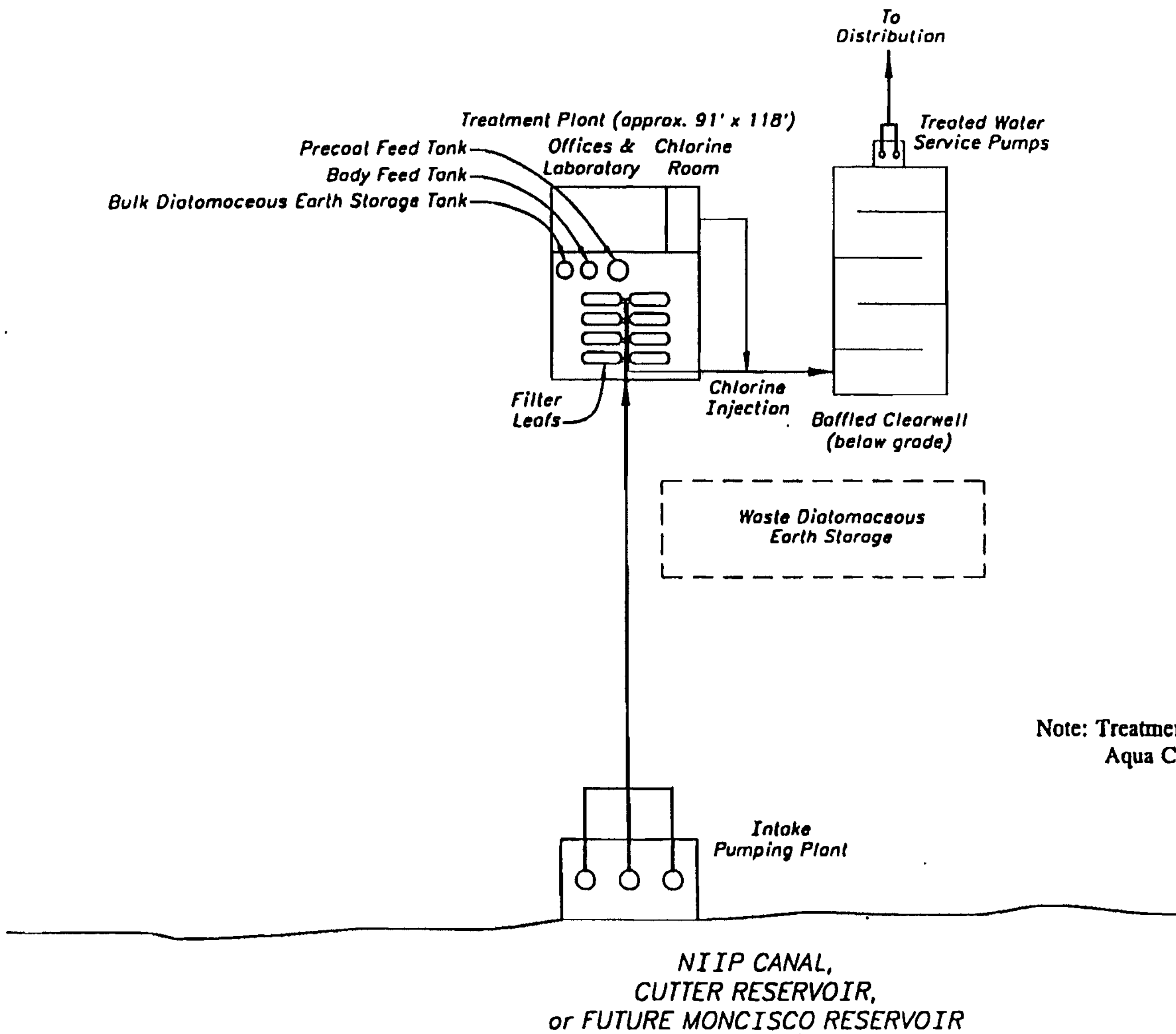


Figure 1 - 30 MGD Microfiltration Treatment System, Treating Navajo Indian Irrigation Project (NIIP) Water



Note: Treatment System similar to Infilco Degremont Inc. Superpulsator Clarifier and Greenleaf Filter Control System.

Figure 2 - 30 MGD Conventional Treatment Plant, Treating Navajo Indian Irrigation Project (NIIP) Water

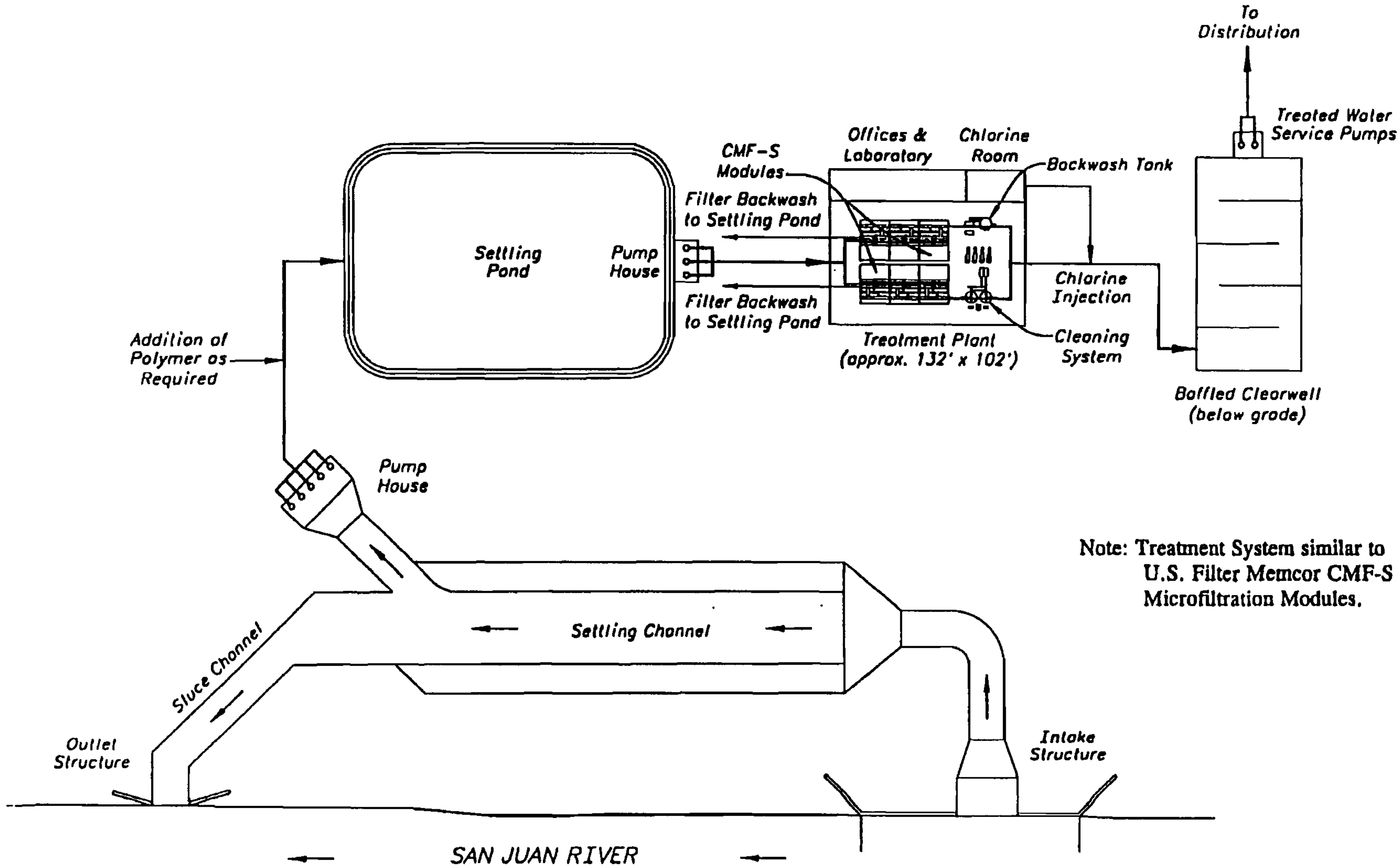


Note: Treatment System similar to
Aqua Care Inc. Leaf Filters.

Figure 3 - 30 MGD Diatomaceous Earth Water Treatment Plant for Navajo Indian Irrigation Project (NIIP) Water

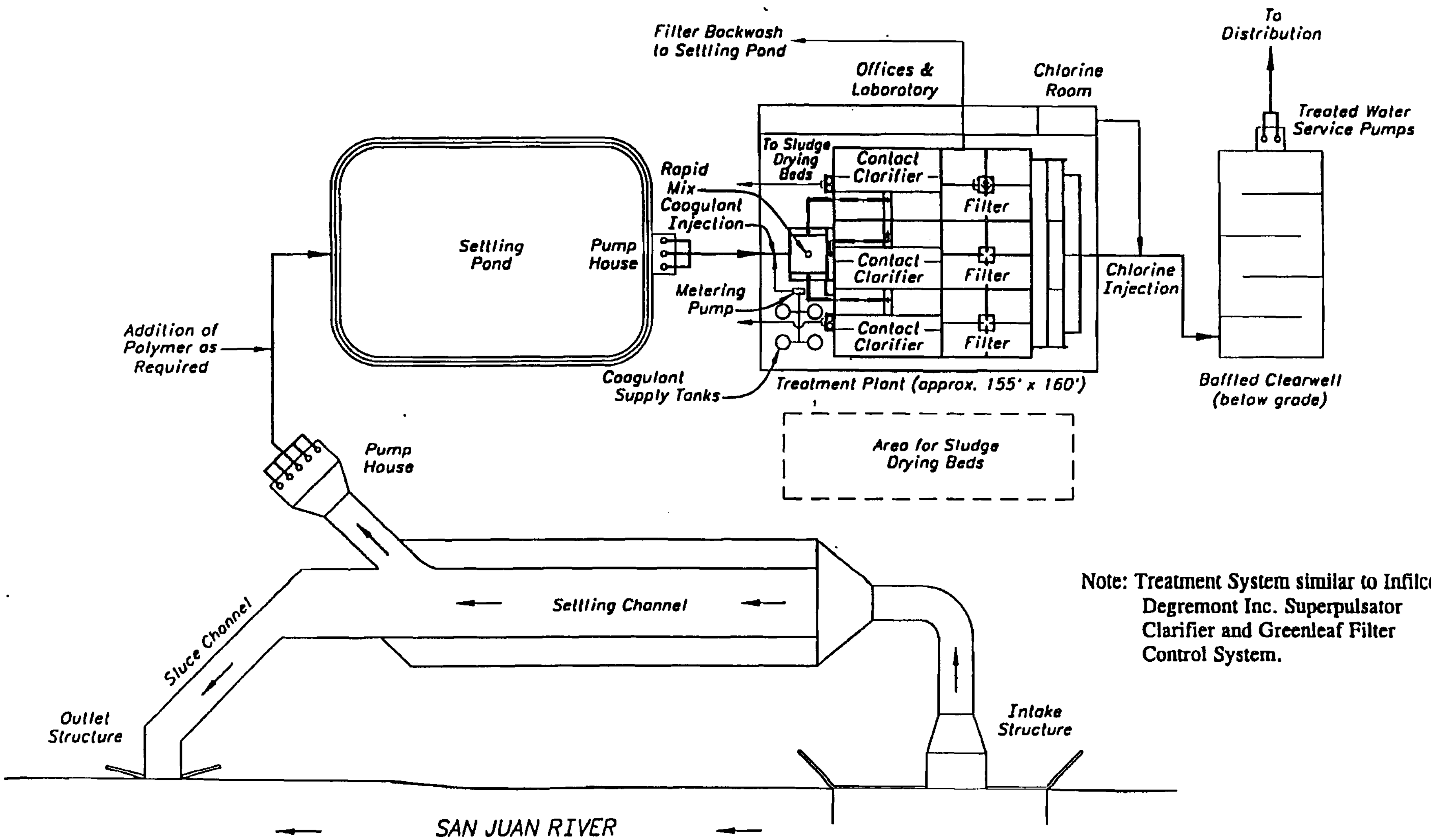
8.5.1 Conventional Water Treatment Systems

Most water treatment plants use conventional treatment systems. Conventional systems use aluminum sulfate (alum) or ferric chloride, and a polymer to coagulate and flocculate inorganics and organics. This process is followed by gravity settling and filtration. Conventional treatment systems generate large quantities of sludge that is typically dewatered in drying beds and disposed in domestic landfills. To reduce the footprint of the conventional treatment systems, solid contact clarifiers and filters are used. Figures 8.10 and 8.11 provide a site layouts of conventional treatment system for NIIP and San Juan River water. The treatment systems shown are similar to the 30 million gallon per day plant that is presently in operation in Green River Wyoming. Estimated costs in Table 8.11 are prorated from the Green River facility. Annual operation and maintenance costs are also provided in Table 8.11. Operation and maintenance costs include: (1) seven operators (four operators, two maintenance personnel and one supervisor) per day working seven days a week; (2) chlorine for disinfection; (3) alum for flocculation; and (4) the annualized cost for replacing the filter media every ten years and the pumps every five years. The annualized costs are based on a plant life of 50 years and an interest rate of eight percent. The estimated construction cost is between $34 and $38 million.



Note: Treatment System similar to U.S. Filter Memcor CMF-S Microfiltration Modules.

Figure 4 - 30 MGD Microfiltration Treatment System on San Juan River



Note: Treatment System similar to Infilco Degremont Inc. Superpulsator Clarifier and Greenleaf Filter Control System.

Figure 5 - 30 MGD Conventional Treatment Plant on San Juan River

8.5.2 Microfiltration Treatment Systems

Microfiltration treatment systems use a relative new technology that does not require chemicals to coagulate suspended solids to meet the drinking water requirements. This process physically separates the suspended particles larger than 0.2 microns from the water. These particles include *Giardia* which are 5 to 15 microns in size, *Cryptosporidium* which are 4 to 6 microns in size, and the majority of organic molecules. The continuous Microfiltration System (CMF-S) is a bundle membrane system which can filter water with high and variable turbidities by drawing untreated water through tubular hollow fiber membranes. Designed for large scale systems, the pre-engineered modules are submerged into open top concrete or steel tanks. The 30 million gallon per day, *US Filters CMF-S Memcor System*, as shown in figures 8.7 and 8.10, provides six Microfiltration cells located in steel tanks. Each cell has a five million gallon per day capacity and contains 576 membrane modules which are continually monitored for proper operation. Large scale CMF-S treatment systems have not been in operation as long as conventional systems. These systems have had great success in meeting the drinking water requirements. Construction cost data are from *US Filter* and are prorated for the proposed plants. The annual operation and maintenance estimates are provided in Table 8.11. The operations and maintenance costs include: (1) seven operators (four operators, two maintenance personnel and one supervisor) per day working seven days a week; (2) chlorine for disinfection; and (3) the annualize cost for the replacement of the microfiltration modules and pumps every five years. The annualized costs are based on a plant life of 50 years and an interest rate of eight percent. The annualized costs used for replacing the microfiltration modules use current costs. Future replacement costs are expected to go down as microfiltration becomes more widely used. This option has been recommended by Reclamation. The estimated construction cost is between $39 and $47 million.

8.5.3 Diatomaceous Earth Water Treatment Systems

Diatomaceous Earth Water Treatment Systems have a precoat filter using diatomaceous earth (DE). These systems require no coagulants and operate effectively in low turbidity water sources. DE is a soft powdery material resembling chalk that contains the remains of single cell algae called diatoms. The system constantly monitors the turbidity of the filtered water. If the turbidity is greater than the determined set point, the system recycles the water until enough DE is added to meet the set point requirements. The spent media cake is air dried before being disposed as a soil amendment or to a domestic landfill. Although different types of DE filters are available, Figure 8.9 is the site plan for a 30 million gallons per day DE system using large diameter leaf filters manufactured by *Aqua Care Systems*. These large leaf filters are typically used in the chemical, steel and mining industry. Construction cost estimates in Table 8.11 are prorated from information from the *Aqua Care Systems*. Annual operation and maintenance estimates are provided in Table 8.11. Estimated operations and maintenance costs include: (1) seven operators, (four operators, two maintenance personnel and one supervisor) per day working seven days a week; (2) chlorine for disinfection; (3) DE material and (4) the annualized cost for the replacement of pumps every five years. The estimated construction cost is between $32 and $40 million.

Table 8.11
Appraisal Level Costs for the Proposed Treatment Plants

Plant Type, Capacity and Location	Estimated Construction Cost	Estimated Annual Operation and Maintenance Cost
Conventional, 38 MGD, Moncisco Reservoir	$34,200,000 to $38,000,000	$1,777,000 to $1,955,000
Microfiltration,38 MGD Moncisco Reservoir	$39,140,000 to $47,120,000	$5,411,000 to $5,914,000
DE Filtration, 38 MGD, Moncisco Reservoir	$29,260,000 to $35,985,000	$1,263,000 to $1,389,000
Conventional, 34.8 MGD, San Juan River	$31,320,000 to $34,800,000	$1,702,000 to $1,872,000
Microfiltration, 34.8 MGD, San Juan River	$35,844,000 to $43,152,000	$5,030,000 to $5,498,000
Conventional, 28.3 MGD, San Juan River	$25,470,000 to $28,300,000	$1,551,000 to $1,706,000
Microfiltration, 28.3 MGD, San Juan River	$29,149,000 to $35,092,000	$4,258,000 to $4,655,000
Conventional, 3.2 MGD, Cutter Reservoir	$2,880,000 to $3,200,000	$969,000 to $1,065,000
Microfiltration, 3.2 MGD, Cutter Reservoir	$3,296,000 to $3,968,000	$1,275,000 to $1,399,000
DE Filtration, 3.2 MGD, Cutter Reservoir	$2,454,000 to $3,115,000	$925,000 to $1,017,000

8.6 Wastewater treatment

Increasing the domestic water supply will result in more wastewater. To protect human health and safety wastewater treatment must be developed in conjunction with the new water supply. Wastewater improvements are considered to be a programmatic cost, not a Project cost. On the Navajo Reservation wastewater treatment facilities are funded by the IHS. Several EPA and USDA programs also provide assistance in developing these facilities which can be phased in as the demands gradually increase.

Wastewater on the Navajo Reservation is typically processed by sewage lagoons or septic tanks. Based on projects in similar regions, Natural Resource Consulting Engineers estimated that the average cost of providing sewerage is $10,000 to $13,000 per household, excluding engineering and contingency costs. Assuming 4.5 people per household, approximately 25,000 new homes will be constructed over the next 40 years in the Project service area. Providing sewerage for those homes is approximately 250 million. However, these expenditures are non-Project costs, and should be considered to be part of the Navajo Nation's ongoing housing program.

In 1999 the City of Gallup produced approximately 3.0 million gallons of waste water pre day. This flow rate exceeded the plant capacity of 2.5 million gallons per day. In 1999 Sterling and Mataya prepared a plan for increasing the City's treatment capacity to 5.5 million gallons per day which will meet the City's needs through the year 2035. The four phase plan has an estimated cost of $24 million. The City has secured grants and loans of approximately $6 million to initiate the first phase of this plan. This phased plan will provide adequate waste treatment capacity for the Project's water supply. Assuming that the unit cost of water treatment for the City's demand is comparable to the unit costs of the on-reservation treatment requirement, the cost for regional waste treatment facilities for the Project service area will be $113 million.

8.7 Terminus storage

Terminus storage stores and facilitates the distribution of water so that instantaneous and daily demands for water can be met without interruptions. This storage may be considered "equalizing" storage because it provides equalizing flow to meet maximum and minimum daily requirements. Terminus storage provides:

- A ready and continuous supply of water during repairs
- Adequate reserve for normal and emergency use without interruptions in supply
- Constant pressure in the system
- Lower energy and pumping costs
- Potential reduction in the peak water treatment plant capacity
- Potential reduction in the maximum pipe sizes

The objective of terminus storage is to ensure that adequate water is available during peak demand and when the conveyance system is under repair. Terminus storage can also be used to reduce the velocity of the water in pipes during high demand periods. The lower velocities result in lower frictional losses and lower energy and maintenance requirements. If the terminus storage is able to manage the peak demands, then a smaller, less expensive conveyance system may be possible. These tradeoffs can only be determined after more extensive site investigations and system hydraulic modeling runs are completed. After careful review,

- The Chuska Dam Site

  Approximately 2,000 acre-feet of terminus storage was considered to increase operational efficiency of the water deliveries to Gallup and Window Rock. From an operational standpoint the best site for terminus storage is as close to the final distribution point as possible. The NDWR identified 17 potential terminus storage sites along the main line using criteria such as proximity to the proposed pipeline alignment, elevation, geology, land status, and capacity. Based on this preliminary investigation, Chuska Reservoir near Tohatchi was the highest ranking site. Chuska Reservoir is close to U.S. Highway 666 between Tohatchi and Gallup. Using this existing reservoir could result in lower construction costs, and it may raise fewer environmental and land status concerns. The existing Chuska Reservoir water supply may help to ensure that the lift pumps are submerged year round. Improvements to Chuska Reservoir to provide terminus storage will cost approximately $7 million. No geologic or environmental field investigations have been performed on any of the potential terminus storage sites. However, the geology of the area is relatively uniform and should not present significant problems. Additional treatment will be needed after the water leaves the reservoir.

The City of Gallup considered several terminus storage options: (1) the Cliff Dwellers site, (2) the Hogback Site, (3) the Mine Dump Site and (4) excavated storage, and (5) concrete covered tanks. These proposed sites may store either San Juan River water from the north or imported groundwater from the east. In August 1999, Reclamation conducted a reconnaissance geology report for the proposed terminus storage sites.

- The Cliff Dwellers Site

  The Cliff Dwellers Canyon Site is located approximately 6 miles northeast of Gallup and east of the Hogback (Section 29 and 30, T.16N, R. 17 W.). The Cliff Dwellers Canyon is a narrow vertical walled canyon which would minimize reservoir evaporation. The Cliff Dwellers Canyon site was not considered feasible by Reclamation because of anticipated high reservoir losses through the Dakota Sandstone.

- The Hogback Site

  The Hogback Site is located approximately 1.5 miles northeast of the Gallup along the topographic feature named "The Hogback"(Section 12, T.15 N., R. 18 W.). The Hogback Site has potential based on reservoir holding capacity, geology, and available construction materials. The Hogback site appears to be a feasible site for a zoned earth fill, but numerous petroleum pipelines cross through the dam axis and would make it an expensive site to use. This site location can take advantage of possible groundwater imported from wells near Mt. Taylor.

- The Mine Dump Site

The Mine Dump Site is located approximately 3 miles west of Highway 666 and north of Interstate 40 (Section 13 and 14, T.16N., R. 19 W.). The Mine Dump site has potential based on reservoir holding capacity, geology, and available construction materials. The Mine Dump Site appears to be feasible for a zoned earth fill dam. The Mine Dump Site location could receive effluent from the nearby sewage treatment plant. The effluent could be blended with Project water providing for significant water reuse opportunities.

- Excavated Storage

If the required capacity is relatively small, it may be possible to excavate a storage site. An excavated site can be located in the most convenient location and its lining reduces seepage. Sterling and Mataya estimated that a 1,500 acre-foot storage reservoir with a natural clay liner would cost $5.9 million and a reservoir with a synthetic liner would cost $9.6 million. These costs include engineering, construction and contingency.

- Water tanks

If the water is treated and the capacity is relatively small, it may be possible to utilize closed tanks to store water for peaking purposes. The current alternatives anticipate that the water will be treated near the San Juan River or at NIIP and that potable water will be conveyed through the water system. For this technical memorandum, steel tanks have been included in the cost estimate.

8.8 Project rights-of-way

According to the 1984 Environmental Statement, the proposed pipeline corridor needs a 66-foot wide permanent easement and a 100-foot temporary easement. The majority of land for the Project lies on the Navajo Nation. In the 1984 cost estimate the cost of a permanent right-of-way easement was included as part of the 15 percent contingency factor.

The Navajo Nation requires that an appraisal of the proposed right of way be conducted. This evaluation is based on the beneficial use of the land and the value of the product in the pipeline. For comparative purposes, a study of the fair market value of rights-of-way by Winius (1991) for the Transwestern pipeline expansion along the same corridor as the NIIP Alternative main line was reviewed. The study identified 25,318 rods of Navajo Tribal Land and 1,902 rods of Individual Allotment land along the corridor. One rod is equal to 16.5 feet. In 1999 the typical right-of-way consideration by the Navajo Nation was 300 to 500 dollars per rod for Tribal land and 25 to 50 dollars per rod for allotted land.

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The total length of the NIIP Alternative pipeline is approximately 240 miles. Of this corridor, 8,300 rods or 12.5 percent is allotted trust land and 47,000 rods, or 61.2 percent, is Tribal trust land. The remainder is split between a variety of state, federal and private ownership. The total length of the San Juan River Alternative pipeline is approximately 287 miles. Of this corridor, 8,300 rods or 10.1 percent is allotted trust land and 47,000 rods or 51 percent is Tribal trust land. The remainder is split between a variety of state, federal and private ownership. The distribution of the land status is shown in Table 8.12. Based on the Winius study the fair market value of the corridor through the allotted land is between $240,000 and $480,000 and the fair market value of the corridor with either alternative through Tribal Trust land is between $14.1 and $23.5 million.

Table 8.12
Land Status of the Navajo-Gallup Water Supply Pipeline

Land Status	NIIP Alternative (Miles)	San Juan River Alternative (Miles)
Main Navajo Reservation	97	117
BLM	11	25
Indian Allotment	29	29
Navajo Fee	21	17
Navajo Trust	50	30
PLO 2198	5	5
Private	17	32
State	8	15
Other		17
Total	240	287

As described in the Code of Federal Regulations 25 Part 169 - Rights-Of-Way Over Indian Lands the BIA has a multi-step process for establishing right-of-ways across trust land. Information on the specific procedures is available from the BIA. Depending on the number of Indian land allotments the Project corridor crosses, the rights-of-way procedures may be complicated. The land affected must be appraised, the individual allotment owners must be contacted and informed about the fair market value of the land, and consents for the Project must be obtained. This process may take up to 18 months to complete.

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The BIA estimates that rights-of-way clearance will require 2 ½ full-time staff plus support services and incidentals including: (1) a full time Real Estate Specialist to work on the process, (2) a half-time appraiser, and (3) other managers, accountants, clerical staff and legal services as needed. As part of these costs, travel, training, and per diem expenses are included. The cost estimate for the BIA to perform the Rights-Of-Way procedures are presented in Table 8.13.

Table 8.13
Estimated BIA Rights-Of-Way Clearance Costs

Personnel	Salary	Travel/Per diem	Training	Incidentals
1 GS-11 Real Estate Specialist – full time	$47, 412	$15,000	$2,000	GSA Vehicle Rental $6500
1 GS-9 Appraiser – half time	$39, 184	$15,000	$2,000	GSA Vehicle Rental $4500
Other personnel, equivalent to full time FTE, GS-11 (Rights Protection Section Chief, clerical staff, and accounting staff)	$47, 412	$5,000	$5,000	Legal Services $1,500.00
Total				**$190,508**

The general process for completing a right-of-way is described in the following section:

- General Approach for Permission to Survey

  The Branch of Real Estate Services, Navajo Region, counsels the applicant concerning right-of-way procedures and assists in determining the land status of the proposed application. The applicant uses Form 5-104B in obtaining the signed consent of the owners of each trust allotment crossed. Official ownership records of Indian allotted land in New Mexico are located at: 1) the Eastern Navajo Agency, Real Estate Services (P.O. Box 328, Crownpoint, New Mexico, 87313), 2) the Shiprock Agency, Real Estate Services (P.O. Box 3538, Shiprock, New Mexico, 87420), the Office of Special Trustee, Records and Litigation Support and 4) the BIA Office of Land, Titles and Records, Southwest Regional Office, P.O. (Box 26567, Albuquerque, NM 87125-6567).

- Action to be taken by the Applicant

  The Applicant will provide an application for the Permit to Survey to the Navajo Regional Office Director (25 CFR 169.4). The application cites the statute under which it is filed and it shows the width, length, area and land status for the entire corridor.

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- Action to be taken by Navajo Region Real Estate Services

  Prior to acceptance, the BIA Regional Office reviews the application for completeness. If the application is complete, the BIA processes the application according to BIA procedures. If there are no conflicts, the map is sent to the Realty Officer for acceptance. The Project sponsors are responsible for the archeological clearance and for complying with environmental laws. For the Project the Navajo Region Real Estate Services Office will coordinate with the Navajo Nation, Reclamation, state, county and local governments.

- Upon compliance with these requirements, Real Estate Services will prepare the Grant of Easement for Right-of-Way.

  After approval from the Navajo Nation for the corridor within tribal lands, the BIA Real Estate Services Office will distribute signed copies of the easement to: 1) the Applicant, 2) the Tribe (through the Project Review Office), and 3) the Title Plant (for recording). For allotted lands the Navajo Nation's approval is not required. However, the BIA anticipates distributing signed copies of the easements.

8.9 Other direct and indirect costs

Different entities have various methods to determine "other direct and indirect costs". Table 8.14 presents the results of methodologies for three Reclamation cost estimates, one prepared by Depauli Engineering, and one prepared by MSE-HKM. Some methods include 5 percent for mobilization, 30 percent for contingency and 25 percent for engineering (Reclamation September 2000). MSE-HKM reports that Reclamation often uses 7 percent for mobilization, 15 percent for preparation, and 25 percent for contingency. After peer review sessions with Reclamation on the Lake Powell Core Pipeline from Lake Powell to Black Mesa, MSE-HKM recommends 10 percent of the construction cost of major items for appurtenances. This total value results in the contract cost. The contingency is 20 percent of the contract cost. The contract costs plus the contingency is the field cost. And, 27 percent of the field cost is added for non-contract cost. The non-contract costs plus the contract costs result in the total cost.

Table 8.14
Indirect Costs Incurred on Municipal Pipeline Projects

Activity	Reclamation NGWSP (1993)	Reclamation Mt Taylor (1999)	Reclamation West. Nav. (2000)	DePauli NGWSP (2000)	MSE-HKM Lake Powell (1997)
Mobilization	5%	5%	5%		
Appurtenants					10%
Unlisted Items	5%	5%			
Contingencies	25%	25%	30%	15%	20%
Engineering			25%	22%	
Indirect	19%	19%			27%
ROW	10%	10%			
Total Percent	64%	64%	60%	37.00%	57.00%

The non-contract costs include engineering design, construction inspection, contract administration, NEPA compliance, easements, geotechnical investigations, archaeological clearances, design survey, and other special investigations. These percentages which are shown in Table 8.15 reflect costs typically incurred on non-Indian projects (MSE-HKM, August 1996, Lake Powell Pipeline Cost Estimate).

Table 8.15
Indirect Costs Incurred on non-Indian Projects

Activity	Percent	Activity	Percent
Facilitation	1%	Archeological	1%
TERO Service	2%	Design survey	1%
Contract Administration	1%	Investigations	2%
Environmental	2%	Design	6%
Easements	1%	Construction Observation	10%
Geochemical	1%		

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8.10 Summary of the capital costs

Cost summaries were prepared for the NIIP and the San Juan River Alternatives. As presented in this technical memorandum, both alternatives serve the same area. The total Project cost for the San Juan River Alternative is $368 million and the total Project cost for the NIIP Alternative is $390 million. These estimates include the Gallup Regional System and delivery to the Shiprock Subarea. The cost of power transmission lines is assumed to be incorporated in the unit price of the power. The separate allocated costs for the Navajo Nation and City of Gallup are based on each ones share of the annual capacity of each component or pipe segment. The total project and programmatic costs, and the allocated costs, are shown in Tables 8.16 and 8.17.

The NDWR investigated the mutual benefits due to the shared economy of scale of a joint Navajo /City of Gallup Project. The NDWR estimates that a stand-alone Gallup only system would cost approximately $107 million. A stand-alone Navajo project using the San Juan River Alternative would cost $324 million and a stand-alone NIIP Alternative would cost $354 million. By partnering with the Navajo Nation, the City's share of the resulting project is approximately $60 million. By partnering with the City, the Navajo Nation's share of the resulting project is $310 million for the San Juan Alternative and $326 for the NIIP Alternative. The operation and maintenance costs presented in Tables 8.16 and 8.17 show similar benefits with partnering.

The water delivery costs have been divided between programmatic and Project costs. A number of federal and state programs may be able to assist with water development in the region. For instance, the IHS has P.L. 86-121 authorization to construct domestic water systems on the Navajo Nation. The IHS annual budget is approximately $25 million per year. The EPA, USDA, HUD and other federal agencies also assist with water development. The Project will provide a core system around which programmatic funding can build on.

Table 8.16
Navajo-Gallup Water Supply Project Capital Costs
(Millions of Dollars)

Component	Project Cost	Programmatic Cost	Total Cost
1A. 36,700 af NIIP Alternative			
8,800 af Moncisco Reservoir	$59.72	$0.00	$59.72
65 CFS Treatment Plant	$78.21	$0.00	$78.21
Conveyance to Yah-ta-hey	$129.58	$0.00	$129.58
Project Laterals	$122.60	$27.30	$149.90
Power Lines, SCADA etc.	$5.10	$0.00	$5.10
1B. 36,700 af San Juan River Alternative			
Diversion Structure	$3.14	$0.00	$3.14
Water Treatment Plant	$70.81	$0.00	$70.81
Regulating Reservoir	$15.07	$0.00	$15.07
Conveyance to Yah-ta-hey	$161.47	$0.00	$161.47
Project Laterals	$117.44	$30.30	$147.74
Power lines, SCADA, etc.	$5.10	$0.00	$5.10
2. Groundwater Component	$0.00	$73.00	$73.00
3. Wastewater treatment	$0.00	$113.00	$113.00
4. Value of Water Rights	$0.00	$90.00	$90.00
5. Value of Rights-of-way	$0.00	$24.80	$24.80
Total NIIP Alternative	$395.21	$328.10	$723.31
Total SJR Alternative	$373.03	$331.10	$704.13

Table 8.17
Navajo-Gallup Water Supply Project Summary of Allocated Capital Costs

Scenario	Water Supply (Acre Feet)		Capital Cost (Millions of Dollars)		
	Navajo Nation	City of Gallup	Navajo Nation	City of Gallup	Total
SJR Alternative					
	29,067	0	$324	$0	$324
	29,067	7,500	$310	$58	$368
NIIP Alternative					
	29,067	0	$354	$0	$354
	29,067	7,500	$326	$64	$390

Note: Tabulated costs exclude transmission lines and groundwater components.

8.11 Summary of the Project's operation and maintenance

In the 1984 Planning Report and Draft Environmental Statement Reclamation assumed that NTUA would require seven management personnel at half time and 14 field positions at full-time to operate the Project. This staff would have an estimated annual cost of $400,000 (or $3.17 per acre-foot) in 1984 dollars. For this technical memorandum, the annual operation and maintenance expenses are based on the following fixed percentages of the capital investment. For the annual operating costs the following values were used:

- Intake - 6 percent
- Pumps - 4 percent
- Storage - 4 percent
- Conveyance pipes - 0.5 percent
- Wells - 4 percent
- Others - 4 percent

The cost of energy is based on 6.5 cents per kilowatt. If CRSP set aside power is available to NTUA at 3.5 cents per kilowatt, it may be possible to finance the power distribution infrastructure through the power fees.

Table 8.18
Navajo-Gallup Water Supply Project Summary of Allocated O&M Costs

Scenario	Water Supply (Acre Feet)		O&M Cost (Millions of Dollars)		
	Navajo Nation	City of Gallup	Navajo Nation	City of Gallup	Total
SJR Alternative	29,067	0	$8.58	$0.00	$8.58
	29,067	7,500	$7.99	$1.95	$9.95
NIIP Alternative	29,067	0	$6.16	$0.00	$6.16
	29,067	7,500	$5.33	$1.71	$7.04

Note: Tabulated costs exclude transmission lines, Shiprock conveyance, groundwater components, NIIP conveyance losses of 10%, and NIIP canal operation and maintenance.

Navajo-Gallup Water Supply Project

For Project authorization, a contracting entity must be identified for repayment obligations and for the operation and maintenance of the Project. Several other projects may provide constructive examples:

- Mni Wiconi - The Mni Wiconi Project is owned by the federal government and is operated by the Department of the Interior.

- NIIP - NIIP is owned by the federal government. It is authorized for construction by the BIA and Reclamation is providing technical assistance. NIIP facilities are operated under a PL. 638 Indian Self Determination Act contract by NAPI. Upon completion of NIIP, the NIIP facilities will eventually be transferred to the Navajo Nation. The scheduling and the conditions of that transfer are currently being formulated.

- Hammond Irrigation Project - The Hammond Irrigation Project was built by the federal government. A contracting entity, the Hammond Irrigation District, was established to contract with the United States for repayment of the reimbursable portion of the project costs and to operate the facilities.

The Project could be operated by NTUA under a contract to the Department of the Interior. Because this project has a significant non-Indian component, this contract would not necessarily be a P.L. 638 contract, but the same contractual relationship that the Department of the Interior has with other contracting entities.

The eventual ownership of the Project also needs to be evaluated. In other circumstances, after the repayment obligation has been met, federally constructed projects are candidates for transferring to the contracting entity. In some cases the contracting entities are eager to assume control of, and responsibility for, the water control facilities. In other cases the contracting entities have little interest in transferring facilities. Under different administrations the Department of the Interior has maintained different policies to address the transfer and ownership of water projects. This Project has the added complication that it combines Indian and non-Indian interests. Due to the Indian component, this Project will retain a significant residual trust responsibility. On the other hand, the City will only be able to invest in the Project if it has adequate guarantees that its investment will be protected. The eventual transfer to the Tribe or to a joint holding entity can only be considered if these issues are addressed.

9.0 THE UNIT COST OF PROJECT WATER

For the water users the single most important variable is the price that they must pay every month for the water service that they desire. To determine the overall aggregate cost of Project water this technical memorandum includes: (1) amortized capital cost (main line and laterals), (2) Colorado River Storage Project Fees, (3) acquiring water rights, (4) NIIP Cost of Services agreement, (5) the City of Gallup municipal system improvements, (6) NTUA and Gallup retail costs, and (7) Project operation and maintenance. The amortized capital costs are presented in Table 9.1 and the annual unit costs are presented in Table 9.3. These costs are described in the following sections.

9.1 Amortized capital costs

The annual amortized cost depends on the total capital cost, the life cycle or repayment period, and the interest rates. For this estimate it is assumed that the Project will deliver 29,067 acre-feet to the Navajo water users and 7,500 acre-feet to the City of Gallup water users. To determine the annualized cost, it has been assumed that the total capital cost is $370 million. The average unit capital cost of the water is approximately $10,100 per acre-foot of Project capacity. The unit capital cost for the Navajo component is approximately $10,700 per acre-foot and the unit capital cost for the Gallup component is approximately $7,700 per acre-foot.

For every one million dollars of capital expenditures, the annual amortized cost over a forty-year period at 4 percent is $50,523, at 6 percent is $66,461, at 7 percent is $75,009 and at 8 percent is $83,860. At 4 percent, a $370 million Project would have a total annualized cost of $18.7 million per year. This figure results in an average unit cost of 511 dollars per acre-foot or $1.58 per thousand gallons. The annual amortized costs at a range of interests rates are shown in Table 9.1.

NTUA has expressed concerns that during the early life the overall demands will be less than the total. Consequently, the Project costs would be distributed over a smaller volume of water. Based on the Project's 2010 demand, the Project will deliver 11,141 acre feet to Navajo water users. At this rate, the unit capital cost of the water would be $15,169 per acre-foot.

Table 9.1
A Range of Amortized Capital Costs for the Navajo Gallup Water Supply Project which delivers 36,700 acre-feet of water for a Project cost of $370 million

Interest Rate (Percent)	Annual Cost ($/Year)	Annual Unit Cost ($/AF/Year)	Annual Unit Cost ($/1000 Gallon/Year)
4%	$17,694,000	$482	$1.48
6%	$24,591,000	$670	$2.06
7%	$27,753,000	$756	$2.34
8%	$31,028,000	$845	$2.60

9.2 Colorado River Storage Project fees

With either alternative the water may come from Navajo Reservoir. Navajo Dam is a feature of the Colorado River Storage Project Act (CRSPA). Consequently, water from the Navajo Reservoir is subject to a CRSPA fee. The current fee for municipal water is approximately 60 dollars per acre-foot.

9.3 Acquiring water rights

To determine the cost of acquiring the water rights for the Project, a range of values can be applied. The most secure option is to secure water rights that are already within the environmental baseline. For this assessment it has been assumed that these water rights would cost approximately $3,000 per acre-foot, or $90 million. A less costly option may be to pursue a new contract with the Secretary of the Interior. However, the long-term availability of this water has not been established. Presumably this contract water would only be subject to the CRSP fee. However, a new contract will require the tacit approval of the Tribes in the basin, and there may be additional costs associated with environmental compliance. Securing a long-term water supply form either NIIP or the Jicarilla Apache Nation would require lease options and possibly forbearance agreements between the parties. These agreements may cost at least as much as securing water from the Secretary, and potentially as much as securing private water rights. Consequently, for the purposes of this cost estimate, a unit cost of $3,000 per acre-foot has been used. Amortized at 7 percent per year over 40 years, the annualized cost of the water rights is $191 per acre-foot or $0.59 per thousand gallons.

9.4 NIIP Cost of Services and Potential Repayment Obligation

With the San Juan River Alternative most of the water supply will be diverted directly from the San Juan River. Only the 3,600 acre-feet of diversion from Cutter Reservoir will require the use of any of the NIIP facilities. However, for the NIIP Alternative the municipal water conveyed through the NIIP facilities will share some of the operation and maintenance responsibility. This responsibility justifies a cost of services agreement. The cost of services principal suggests that the revenue received from a water user should equal the cost of serving that water user. One component of determining this cost is the degree to which a particular user affects base and peak demands. If the municipal water requires the construction of additional NIIP infrastructure that is only used for brief periods of time, then the municipal water use may be expected to contribute a greater share of the operating revenue. If the municipal water requires extra management to ensure an additional degree of reliability, or if the municipal water requires more expensive delivery during the winter months, then the municipal water users may be expected to contribute a greater share of the overall operating revenue.

There is a trade off between conveying water through the NIIP canals during the winter months and minimizing the storage requirement verses not using the canals during the winter months and providing extra reservoir storage. However, with or without the municipal Project, NIIP is winterizing a portion of the Gravity Main Canal to enable limited winter delivery for the proposed french fry factory.

In addition the municipal Project would only use a small segment of the Main Canal and the Burnham Lateral. Consequently, it could be argued that the cost of delivering water to Moncisco Reservoir should be less than the overall NIIP average water delivery expense. Determining which conveyance scenario is the most cost effective, and what the appropriate share of the overall operating expense should be assigned to the municipal water will require a more refined analysis of the alternatives.

From 1991 through 1996 the NIIP operation and maintenance budget ranged from $3.5 to $3.9 million. Based on the total water diversion from Navajo Dam, the unit operating cost of the water ranged from $19.68 to $29.94 per acre-foot. However, the conveyance efficiency of the NIIP canals ranged from a low of 80 percent to a high of 90 percent. Consequently, the average unit cost of the water delivered is between $21.87 and $33.27 per acre-foot.

Based on NAPI's assessment of its operation, maintenance and repair costs, the actual operating cost in 1996 was $6.1 million per year. Based on NAPI's assessment of its needs, the average unit operating cost is $52.13 per acre-foot. For this technical memorandum an average unit NIIP conveyance cost of $50 per acre-foot is assumed.

The municipal water conveyed through the NIIP system may be subject to a repayment obligation to the federal government for the use of the NIIP facilities. The cost of the main canal is $108 million, the cost of the Moncisco Pump station is $54 million, and the cost of the Burnham Lateral is $8 million. Assuming that the Project has an average capacity of approximately 50 cfs, and that the repayment obligation for irrigation water and municipal water is equally shared, the total repayment obligation for the municipal component may be approximately $7.8 million. These values, which are shown in Table 9.2, have not been included in the total cost estimate.

Assuming a conveyance efficiency of 90 percent, 10 percent of the water diverted from Navajo Reservoir through the NIIP facilities may not reach Moncisco Reservoir. With the NIIP Alternative this loss may be greater than 3,000 acre-feet per year. Some of this loss may return to the San Juan River. However, incidental losses will deplete a portion of the water conveyed. These losses need to be included in the overall cost of the NIIP Alternative

Table 9.2
Potential Capital Repayment Obligation of the Navajo Gallup Water Supply Project for the use of NIIP Facilities

NIIP Facility	Original Cost (Dollars)	Nominal Capacity (CFS)	Design Life (Years)	Percent of Capacity (Percent)	Potential Obligation (Dollars)
Main Canal	$108,000,000	1,200	100	4.17%	$4,500,000
Gallegos Pump	$54,000,000	880	40	5.68%	$3,068,000
1/4 of the Burnham Lateral	$8,000,000	440	100	11.36%	$227,000
Total	$170,000,000				$7,795,000

9.5 The City of Gallup and NTUA municipal system improvements

In addition to the Project components which will convey water from the San Juan River south toward Yah-ta-hey, additional facilities will be needed to distribute the Project water throughout the City. For the cost estimate in presented in this technical memorandum, the Gallup Area Lateral conveys water south to the Gallup Junction and then east toward Church Rock and south toward Red Rock. This lateral has been included with the Project costs. However, the City's internal conveyance system will need programmatic upgrades over the next 40 years to deliver this water to the water users. For this cost estimate it has been assumed that the internal system improvements will cost $40 million. This same unit cost has also been applied to the NTUA system upgrades.

9.6 City of Gallup and NTUA retail costs

In addition to the cost of operating the Project, both NTUA and the City of Gallup will incur additional retail costs for delivering the water to individual water users. These costs include billing, meter reading, and other administrative expenses. To develop an estimate of the retail cost of water, the water rates in the Southwestern Water Rate Survey were reviewed. The City of Page, Arizona delivers slightly more than 3,000 acre-feet of water per year. This volume is approximately the same volume of water delivered by the City of Gallup. The City of Page charges slightly more than $1.00 per thousand gallons ($312 per acre-foot). With its location next to Lake Powell and its intake built into the dam, the City of Page has very few fixed capital or variable costs. Based on its overall water use, the City of Page's nominal water treatment cost should be approximately $380,000 per year. It is reasonable to assume that the balance of their budget, approximately $0.60 per thousand gallons (or $195.per acre-foot), reflects the retail cost of the water.

9.7 Project operation and maintenance

For the San Juan River Alternative with a 36,700 acre-foot diversion, the annual energy cost is approximately $4.3 million per year and the operation and maintenance cost is $5.7 million per year. The average unit cost of this alternative is approximately $272 per acre foot. For the NIIP Alternative with a 36,700 acre-foot diversion, the annual energy cost is approximately $2.9 million per year and the operation and maintenance cost is $4.1 million per year. The unit cost of this alternative is approximately $191 per acre foot. These values are presented in Table 8.18. While the unit cost of the NIIP alternative is less than the San Juan River alternative, the NIIP alternative will require the cost of service agreement with NIIP which may add at least $50 per acre-foot. This value increases the operation and maintenance cost of the NIIP Alternative to $240 per acre-foot. Therefore, the cost advantage of using the NIIP facilities may be eliminated by the cost of utilizing the NIIP canals.

NTUA has expressed concerns that during the early life the overall demands will be less than the total. Consequently, the Project operation and maintenance costs would be distributed over a smaller volume of water. Based on the Project's 2010 demand, the Project will deliver 11,141 acre feet to Navajo water users. At this rate, the unit operation and maintenance cost of the Navajo Nation water would be $424 per acre-foot (or $1.30 per thousand gallons) and the Gallup cost would be $331 per acre-foot (or $1.02 per thousand gallons). Based on the Project's 2020 demand, the Project will deliver 15,430 acre-feet to Navajo water users. At this rate, the unit operation and maintenance cost of the Navajo Nation water would be $368 per acre-foot (or $1.13 per thousand gallons) and the Gallup cost would be $307 per acre-foot (or $0.94 per thousand gallons). Based on the Project's 2030 demand, the Project will deliver 21,391 acre-feet to Navajo water users. At this rate, the unit operation and maintenance cost of the Navajo Nation water would be $282 per acre-foot (or $0.97 per thousand gallons) and the Gallup cost would be $282 per acre-foot (or $0.87 per thousand gallons). And, based on the Project's 2040 demand, the Project will deliver 29,067 acre-feet to Navajo water users. At this rate, the unit operation and maintenance cost of the Navajo

Nation water would be $275 per acre-foot (or $0.85 per thousand gallons) and the Gallup cost would be $261 per acre-foot (or $0.80 per thousand gallons).

9.8 Phasing and conjunctive use

Some of the Project facilities do not need to be fully built until later in the Project's planning horizon. For instance, the construction of the water treatment plant, pumping stations, regulating storage, and groundwater components can readily be phased as the Project's demands justify the capital expenditures. Deferring these facilities will result in a lower present cost of the Project's facilities.

With the San Juan River Alternative 60 percent of the total cost is for the pipeline which does not lend itself to phasing. The water treatment plant which is 25 percent of the total cost, the storage tanks which are 10 percent, and the pump stations which are 5 percent may be phased. With the NIIP Alternative 50 percent of the total cost is for the pipeline and 15 percent is for Moncisco Reservoir. These costs do not lend themselves to phasing. The water treatment plant which is 20 percent of the total cost, the storage tanks which are 10 percent, and the pump stations which are 5 percent may be phased. An analysis of the potential reduction in the present value of the Project with phasing is beyond the scope of this technical memorandum.

9.9 Conclusion of the Unit Cost Analysis

The unit costs of the Project water including several important noncapital costs are presented in Table 9.3. Based on the data presented in Table 9.3 the total unit cost of the Project water is approximately $4.81 per thousand gallons. Included in this estimated rate is the full cost of amortizing the capital investment and the value of the water rights. This estimate also includes the cost of using the NIIP, improving the local systems and the retail expense of the water utilities. The estimated rate is approximately $2 per thousand gallons more than NTUA and the City of Gallup are currently charging for water. For a family of four, using 160 gallons per capita per day, the monthly water bill would be $94 per month.

Table 9.3
Estimated Average Unit Cost of Navajo-Gallup Water Supply Project Water Based on 36,700 acre-feet of Diversion

Cost Component	Estimated 2000 Cost (Dollars/AF)	Estimated Cost (Dollars/1000 gal)
1.Amortized $370 Million Capital Cost (7% and 40 Years)	$756	$2.34
2. CRSP fee	$60	$0.18
3. Amortized Water Rights ($3,000/af, 7% and 40 years)	$191	$0.59
4. NIIP Cost of Services ($50 to $300 per acre-foot)	$50	$0.16
5. City of Gallup improvements	$36	$0.11
6. City of Gallup retail cost	$195	$0.60
7. Project Operation and Maintenance	$272	$0.83
Total Unit Cost	$1,560	$4.81

Note:

During the first decade of operation the Project operation and maintenance expense will be approximately $1.30 per thousand gallons for the Navajo Nation and $1.02 dollars per thousand gallons for the City of Gallup.

10.0 PLAN OF APPROACH AND PROJECT TIME LINE

To expedite the Project, the Navajo Nation, the City of Gallup and Reclamation have developed a plan of approach. This approach includes a time line for NEPA Compliance, preparing the Planning Report/EIS, Construction Authorization, and Starting Construction. In addition, the planning report and the Environmental Impact Statement will be compiled into a single document. This schedule anticipates Congressional authorization for design and construction by October 2002 and a Record of Decision on the EIS by February 2003.

Any major action supported by federal funding, such as the construction of the Navajo-Gallup Water Supply Project, is subject to the National Environmental Policy Act. The NEPA legislation requires that careful consideration be given to the human and natural environments to attain the widest range of beneficial use of natural resources without environmental degradation, risk to human health, safety and welfare, or destruction of cultural and historic resources. Article 22.1 of NEPA requires preparation of an Environmental Impact Statement (EIS) to assure compliance with the NEPA objectives. The EIS should present a detailed description of the proposed action (a definite plan), discuss probable environmental impacts, analyze the cost and environmental mitigation potential of alternatives to the proposed action, and solicit and consider public comment concerning the proposed action. To the fullest extent feasible, the parties will utilize NEPA compliance, and the funds made available to carry out planning and NEPA compliance to prepare the technical analysis needed for a definite planing document.

In addition to NEPA requirements, the Navajo Nation and the City of Gallup must acquire the water rights, acquire the appropriate rights-of-way, determine repayment obligations, and assess the ability to pay for the proposed Project. On a separate and concurrent track, the participants are seeking Congressional authorization. It is anticipated that authorization will be obtained by October 2002. The legislation will authorize the construction of the Project, subject to the completion of NEPA compliance, and it will describe the repayment obligation. Based on the current schedule, the Draft Planning Report/EIS will be available prior to authorization.

The NEPA public scoping meetings were held in Shiprock, Farmington, Crownpoint, Window Rock and Gallup during April and May 2000. In January 2001 the City and the Navajo requested two new Secretarial water contracts. According to the schedule these contracts will be executed by April 2002. The major components of the time line follow:

- Conduct the appraisal level cost estimates of the facilities by October 2001
- Conduct the appraisal level cost estimates of the operation, maintenance, and replacement by October 2001
- Conduct the Cultural Resource Impact Analysis by October 2001
- Conduct the Terrestrial, Riparian, and Aquatic Impact Analysis by October 2001
- Conduct the Social and Economic Analysis by October 2001

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- Conduct the Repayment Analysis by October 2001
- Conduct the Water Availability Analysis and Draft Water Supply Contracts by October 2001
- Conduct the Hydrologic Impact Analysis by October 2001
- Define the water supply by October 2001
- Analyze alternatives, complete the Draft Planning Report and select the preferred plan by December 2001
- Submit water contracts for Congressional authorization by January 2002
- Complete Analyses that depend on the water supply by February 2002
- Develop the Biological Assessment and submit to the USFWS by February 2002
- Prepare the Preliminary Draft Planning Report/EIS by March 2002
- Execute the Secretarial water contract by April 2002
- Obtain a Biological Opinion from the USFWS and Coordination Act Report by June 2002
- Publish the Preliminary Draft Planning Report/EIS by June 2002
- Public Review and comment on the Draft Planning Report /EIS by July 2002
- Draft required legislation and obtain Congressional authorization beginning January 2002 through October 2002.
- Respond to comments and prepare the Final Draft Planning Report/EIS by November 2002
- Print the Final Planning Report/EIS by January 2003
- Record of Decision by February 2003
- Start Construction by March 2003

APPENDIX A
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Navajo-Gallup Water Supply Project

APPENDIX B
MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF AGREEMENT

<u>Between the Navajo Nation and the City of Gallup</u>
<u>To Cooperate on the Navajo-Gallup Water Supply Project</u>.

WHEREAS:

1. The Navajo Nation and the City of Gallup have severe water quality and water quantity problems; and

2. During the Congressional Hearings for the proposed Navajo Indian Irrigation Project (NIIP), the New Mexico State Engineer testified that NIIP would be part of the regional water infrastructure intended to provide water from Navajo Dam to Navajo Communities in northwest New Mexico and to the City of Gallup (Hearings before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs, S. 3648, July 9 and 10, 1958); and

3. In the 1960's, the Bureau of Reclamation first considered a water pipeline project that would bring water to Navajo Communities in northwest New Mexico and to the City of Gallup, and the Bureau was authorized under Public Law 92-199 (approved December 15, 1971) to conduct feasibility studies for such a project; and

4. In 1984, the Bureau of Reclamation completed a draft Environmental Impact Statement for the proposed Gallup-Navajo Indian Water Supply Project which evaluated three alternative routes for a water pipeline and recommended a route parallel to Highway 666; and

5. Following public hearings in 1984 and 1985, the Navajo Nation recommended reformulation of the project to serve additional communities along Highway 371, and a revised EIS in 1985 supported the recommendation of the route along Highway 371; and

6. By letter of March 5, 1992 from Navajo Nation Vice President Marshall Plummer to Gallup Mayor George Galanis, the Navajo Nation agreed to join the City of Gallup in further discussions to evaluate the project; and

7. In 1992, discussions commenced between technical staff from the Navajo Nation and the City of Gallup to further evaluate the project; and

8. In 1992, Congress authorized $300,000 for a preliminary reassessment of the project by the Bureau of Reclamation, and in subsequent years, Congress has authorized additional funding to develop a project definition, conduct a biological assessment, and provide an assessment of alternatives; and

9. In 1995, the Navajo Nation entered into Cooperative Agreement No. 5-FC-40-17490 (authorized by RCAU-205-95 and IGRS-190-95) with the Bureau of Reclamation to engage in public meetings and technical studies related to the project; and

10. Seventeen Chapters within the preliminary project area, including Burnham, Becenti, Coyote Canyon, Crownpoint, Dalton Pass, Nageezi, Whitehorse Lake, Mexican Springs, St. Michaels, Tseyatoh, Huerfano, Lake Valley, Pueblo Pintado, Standing Rock, Twin Lakes, Whiterock, Fort Defiance, Tohatchi, and Naschitti have approved continued planning for the project; and

11. By letter of February 15, 1996 Navajo Area Director Wilson Barber, committed the Bureau of Indian Affairs to serve as the lead agency for consultation with the Fish and Wildlife Service concerning compliance with the requirements of the Endangered Species Act, and directed the Bureau of Indian Affairs-Navajo Indian Irrigation Project Office to initiate this consultation as quickly as possible.

NOW, THEREFORE, THE CITY OF GALLUP AND THE NAVAJO NATION AGREE THAT:

1. A cooperative effort by the Navajo Nation and the City of Gallup (the Parties) to proceed with the planning and development of the Navajo-Gallup Water Supply Project is in the best interests of the Parties; and

2. The Parties are committed to a project that will work conjunctively with the Navajo Indian Irrigation Project and will otherwise be developed in a manner that is consistent with the water rights of the parties; and

3. The Parties are committed to a project that will result in a fair and equitable distribution of project water between the City of Gallup and the Navajo communities; and

4. The Parties are committed to cooperatively investigate all viable alternative project configurations, including a pipeline from the San Juan River; and

5. In order to ensure that the project will be in compliance with the requirements of the Endangered Species Act, the Parties support commitment of the Bureau of Indian Affairs to engage in consultation with the Fish and Wildlife Service as quickly as possible; and

6. The Parties will work together to resolve issues affecting the implementation of the Project; and

7. The planning efforts between the Navajo Nation and the City of Gallup will be voluntary and are without prejudice to any position either party may assert in the San Juan River General Stream Adjudication, or in any other matter concerning the water resources of the Parties.

This Memorandum of Agreement was executed on this 17th day of April, 1998.

THE NAVAJO NATION	**THE CITY OF GALLUP**
Thomas E. Atcitty, President	George Galanis, Mayor

**RESOLUTION OF THE
INTERGOVERNMENTAL RELATIONS COMMITTEE
OF THE NAVAJO NATION COUNCIL**

Approving a Memorandum of Agreement Between the City of Gallup and the Navajo Nation to Cooperate on the Navajo-Gallup Water Supply Project

WHEREAS:

1. The Intergovernmental Relations Committee of the Navajo Nation Council is established to ensure the presence and voice of the Navajo Nation, pursuant to 2 N.N.C §822(B), and has the power to authorize, review and approve agreements between the Navajo Nation and any state authority upon the recommendation of the standing committee with oversight authority for such agreement, pursuant to 2 N.N.C. §824(B)(6); and

2. Attached to this resolution as Exhibit A is a proposed Memorandum of Agreement between the City of Gallup and the Navajo Nation to cooperate on the Navajo-Gallup Water Supply Project; and

3. The Resources Committee of the Navajo Nation Council is charged with ensuring the optimum utilization of all resources of the Navajo Nation and to protect the rights, interests and freedoms of the Navajo Nation and People, pursuant to 2 N.N.C. §693 (1995); and

4. By Resolution RCJA-13-98, attached to this resolution as Exhibit B, the Resources Committee of the Navajo Nation Council determined that the water resources of the Navajo Nation are essential to provide a permanent homeland for the Navajo people, that protection of such water resources is essential in order to protect the health, welfare and the economic security of the citizens of the Navajo Nation, that the proposed Memorandum of Agreement would provide opportunity to advance this vitally needed project and that executing this agreement is in the best interests of the Navajo Nation; and

5. The Intergovernmental Relations Committee of the Navajo Nation Council accepts the recommendation of the Resources Committee and concurs that executing the proposed Memorandum of Agreement between the City of Gallup and the Navajo Nation to cooperate on the Navajo-Gallup Water Supply Project is in the best interests of the Navajo Nation.

NOW THEREFORE BE IT RESOLVED THAT:

The Intergovernmental Relations Committee of the Navajo Nation Council authorizes the execution of the proposed Memorandum of Agreement between the Navajo Nation and the City of Gallup to cooperate on the Navajo-Gallup Water Supply Project, attached as Exhibit A.

CERTIFICATION

I hereby certify that the foregoing resolution was duly considered by the Intergovernmental Relations Committee of the Navajo Nation Council at a duly called meeting at Window Rock, Navajo Nation (Arizona), at which a quorum was present and that same was passed by a vote of 4 in favor, 2 opposed and 0 abstained, this 23rd day of February, 1998.

Kelsey A. Begaye, Chairperson
Intergovernmental Relations Committee

Motion: Rex Morris, Jr.
Second: Genevieve Jackson

APPENDIX C
NAVAJO NATION GROUNDWATER PRODUCTION IN THE SERVICE AREA

Navajo-Gallup Groundwater Production and Use (page 1 of 2) 17-Jan-01

Service Area	Chapter	Point of Use [1]	1998 GW production (gal/yr) [2]	1998 G.W. production (ac-ft/yr)	est. sustain. 2040 G.W. production (gal/yr) [3]	est. sustain. 2040 G.W. production (ac-ft/ft)	2000 G.W. use (ac-ft/yr) [4]	2010 G.W. use (ac-ft/yr) [5]	2020 G.W. use (ac-ft/yr) [5]	2030 G.W. use (ac-ft/yr) [5]	2040 G.W. use (ac-ft/yr) [3]	2050 G.W. use (ac-ft/yr) [6]	2060 G.W. use (ac-ft/yr) [6]
City of Gallup, NM[7]	City of Gallup	L.C.	1,412,550,000	4,335	0	0	4,335	0	0	0	1,439	3,947	6,951
Central Area, NM	Burnham	U.C.	8,000	0	0	0	0	0	0	0	0	0	0
	Lake Valley	U.C.	7,224,924	22	15,000,000	46	22	28	34	40	46	46	46
	White Rock	U.C.	0	0	see Lk Vly	see Lk Vly	see Lk Vly	see Lk Vly	see Lk Vly	see Lk Vly	see Lk Vly	see Lk Vly	see Lk Vly
	White Horse Lake	U.C.	1,678,712	5	10,000,000	31	5	12	18	24	31	31	31
	SUBTOTAL		*8,911,636*	*27*	*25,000,000*	*77*	*27*	*40*	*52*	*64*	*77*	*77*	*77*
Crown Point, NM	Becenti	U.C.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.
	Coyote Canyon	U.C.	10,553,160	32	20,000,000	61	32	40	47	54	61	61	61
	Crownpoint	U.C.	85,695,314	263	200,000,000	614	263	351	438	526	614	614	614
	Dalton Pass	U.C.	58,700	0	100,000	0	0	0	0	0	0	0	0
	Little Water	U.C.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.	see Crwn Pt.
	Standing Rock	U.C.	11,109,089	34	25,000,000	77	34	45	55	66	77	77	77
	SUBTOTAL		*107,416,263*	*330*	*245,100,000*	*752*	*330*	*435*	*541*	*647*	*752*	*752*	*752*
Gallup Area, NM	Bread Springs	L.C.	13,948,780	43	25,000,000	77	43	51	60	68	77	77	77
	Chichiltah	L.C.	unknown	unknown	see Brd spr.	see Brd spr.	unknown	see Brd spr.	see Brd spr.	see Brd spr.	see Brd spr.	see Brd spr.	see Brd spr.
	Church Rock	L.C.	18,852,450	58	40,000,000	123	58	74	90	107	123	123	123
	Iyanbito	L.C.	unknown	unknown	50,000,000	153	unknown	38	77	115	153	153	153
	Mariano Lake	L.C.	39,804,005	122	30,000,000	92	122	115	107	100	92	92	92
	Pinedale	L.C.	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk	see Mrno Lk
	Red Rock	L.C.	11,565,569	35	20,000,000	61	35	42	48	55	61	61	61
	SUBTOTAL		*84,170,804*	*258*	*165,000,000*	*506*	*258*	*320*	*382*	*444*	*506*	*506*	*506*
Huerfano, NM	Huerfano	U.C.	19,305,279	59	10,000,000	31	59	52	45	38	31	31	31
	Nageezi	U.C.	10,121,491	31	5,000,000	15	31	27	23	19	15	15	15
	SUBTOTAL		*29,426,770*	*90*	*15,000,000*	*46*	*90*	*79*	*68*	*57*	*46*	*46*	*46*
Rock Springs, NM	Manuelito	L.C.	unknown	unknown	15,000,000	46	unknown	12	23	35	46	46	46
	Rock Springs	L.C.	12,995,250	40	25000000	77	40	49	58	68	77	77	77
	Tsayatoh	L.C.	5,771,955	18	15,000,000	46	18	25	32	39	46	46	46
	SUBTOTAL		*18,767,205*	*58*	*55,000,000*	*169*	*58*	*85*	*113*	*141*	*169*	*169*	*169*
Route 666, NM	Mexican Springs	U.C.	13,765,359	42	see Tohatchi	see Tohatchi	42	see Tohatchi	see Tohatchi	see Tohatchi	see Tohatchi	see Tohatchi	see Tohatchi
	Naschitti	U.C.	26,702,440	82	25,000,000	77	82	81	79	78	77	77	77
	Newcomb	U.C.	4,110,826	13	4,000,000	12	13	13	12	12	12	12	12
	Sanostee	U.C.	29,001,234	89	50,000,000	153	89	105	121	137	153	153	153
	Sheep Springs	U.C.	4,000,000	12	5,000,000	15	12	13	14	15	15	15	15
	Tohatchi	U.C.	44,794,400	137	100,000,000	307	137	180	222	265	307	307	307
	Twin Lakes	U.C.	28,419,760	87	50,000,000	153	87	104	120	137	153	153	153
	Two Grey Hills	U.C.	18,036,128	55	25,000,000	77	55	61	66	71	77	77	77
	SUBTOTAL		*168,830,147*	*518*	*259,000,000*	*795*	*518*	*556*	*635*	*715*	*795*	*795*	*795*
Torreon, NM	Counselor	U.C.	see Pbl Pndo	see Pbl Pndo	0	0	0	0	0	0	0	0	0
	Ojo Encino	R.G.	6,839,565	21	5,000,000	15	21	20	18	17	15	15	15
	Pueblo Pintado	U.C.	23,000	0	0	0	0	0	0	0	0	0	0
	Torreon	R.G.	29,920,434	92	20,000,000	61	92	84	77	69	61	61	61
	SUBTOTAL		*36,782,999*	*113*	*25,000,000*	*77*	*113*	*104*	*95*	*86*	*77*	*77*	*77*
San Juan River, NM [8]	Beclaibito	U.C.	0	0	0	0	0	0	0	0	0	0	0
	Cudei	U.C.	0	0	0	0	0	0	0	0	0	0	0
	Hogback	U.C.	0	0	0	0	0	0	0	0	0	0	0
	Nenahnezad	U.C.	0	0	0	0	0	0	0	0	0	0	0
	San Juan	U.C.	0	0	0	0	0	0	0	0	0	0	0
	Shiprock	U.C.	0	0	0	0	0	0	0	0	0	0	0
	Upper Fruitland	U.C.	0	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL		*0*	*0*	*0*	*4,680*	*0*	*4,680*	*4,680*	*4,680*	*4,680*	*4,680*	*4,680*
NAPI Industrial, NM [9]		U.C.	0	0	0	700	0	400	500	600	700	700	700
NEW MEXICO UPPER BASIN		*U.C.*	*351,367,815*	*1,078*	*569,100,000*	*7,127*	*1,078*	*6,294*	*6,571*	*6,849*	*7,127*	*7,127*	*7,127*
NEW MEXICO LOWER BASIN		*L.C.*	*1,515,488,009*	*4,651*	*220,000,000*	*675*	*4,651*	*406*	*498*	*585*	*2,114*	*4,622*	*7,626*
TOTAL NEW MEXICO			*1,866,855,824*	*5,730*	*789,100,000*	*7,802*	*5,730*	*6,700*	*7,067*	*7,434*	*9,241*	*11,749*	*14,753*

Navajo-Gallup Groundwater Production and Use (page 2 of 2)

17-Jan-01

Service Area	Chapter	Point of Use [1]	1998 GW production (gal/yr) [2]	1998 G.W. production (ac-ft/yr)	est. sustain. 2040 G.W. production (gal/yr) [3]	est. sustain. 2040 G.W. production (ac-ft/ft)	2000 G.W. use (ac-ft/yr) [4]	2010 G.W. use (ac-ft/yr) [5]	2020 G.W. use (ac-ft/yr) [5]	2030 G.W. use (ac-ft/yr) [5]	2040 G.W. use (ac-ft/yr) [3]	2050 G.W. use (ac-ft/yr) [6]	2060 G.W. use (ac-ft/yr) [6]
Window Rock, AZ	Fort Defiance	L.C.	339,701,688	1,043	250,000,000	767	1,043	974	905	836	767	767	767
	Saint Michaels	L.C.	65,000	0	see Ft. Dfnc.	see Ft. Dfnc.	see Ft. Dfnc.	see Ft. Dfnc.	see Ft. Dfnc.	see Ft. Dfnc.	see Ft. Dfnc.	see Ft. Dfnc.	see Ft. Dfnc.
TOTAL ARIZONA		*L.C.*	*339,766,688*	*1,043*	*250,000,000*	*767*	*1,043*	*974*	*905*	*836*	*767*	*767*	*767*
PROJECT TOTAL			**2,206,622,512**	**6,772**	**1,039,100,000**	**8,569**	**6,772**	**7,673**	**7,972**	**8,270**	**10,008**	**12,516**	**15,520**
GROUNDWATER ONLY TOTAL [10]			**2,206,622,512**	**6,772**	**1,039,100,000**	**3,189**	**6,772**	**2,593**	**2,792**	**2,990**	**4,628**	**7,136**	**10,140**

Notes: Rounding error may cause subtotals to be off by 1

1 U.C.=Upper Colorado River Basin, L.C.=Lower Colorado River Basin, R.G.=Rio Grande River Basin
2 Compiled from NTUA, NDWR, BIA, and other records
3 Estimates consider current groundwater production and hydrogeologic properties of source aquifers
4 Assumed equal to 1998 production
5 Assumed linear change from year 2000 production to year 2040 production levels
6 Production limited to estimated sustainable levels
7 City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8 Groundwater production effectively zero. Ignores any potential alluvial production directly from SJR. 4680 ac-ft/yr diversions from ALP assumed to be fully available beginning in
9 400 Ac-ft/yr of depletions from the Navajo-Gallup project assumed available in 2010 and ramping up to 700 ac-ft/yr by 2040.
10 Shows solely groundwater production. Omits NAPI industrial water and additional diversions from ALP.

Navajo-Gallup Water Supply Project

APPENDIX D
COST ESTIMATE SPREADSHEETS

SJR Alternative: Navajo - Gallup Water Supply Project Cost Scenarios. With GW.

SJR Alternative: With Prorated Project Cost for the City of Gallup, New Mexico.

Demand Years	Cost 2000 dollars	Navajo A/F	Navajo $Cost	Gallup A/F	Gallup $Cost	Totals $ Cost $
2040	Project Cost $$	12,940	$188,452,168	3,750	$39,740,045	$228,192,214
50% Demands	Annual Energy $		$1,747,456		$596,600	$2,344,055
	Annual O&M $		$3,446,640		$736,459	$4,183,100
2010	Project Cost $$	11,141	$169,002,355	7,500	$78,300,643	$247,302,998
	Annual Energy $		$1,668,101		$1,160,945	$2,829,046
	Annual O&M $		$3,051,375		$1,322,370	$4,373,745
2020	Project Cost $$	15,230	$206,032,056	7,500	$71,616,358	$277,648,414
	Annual Energy $		$2,092,009		$1,116,018	$3,208,027
	Annual O&M $		$3,521,153		$1,186,149	$4,707,302
2030	Project Cost $$	21,291	$252,600,414	7,500	$64,029,690	$316,630,105
	Annual Energy $		$2,605,354		$1,068,942	$3,674,296
	Annual O&M $		$4,066,108		$1,040,265	$5,106,374
(Attached) 2040	Project Cost $$	29,067	$309,811,865	7,500	$58,121,032	$367,932,897
	Annual Energy $		$3,249,942		$1,028,460	$4,278,402
	Annual O&M $		$4,744,196		$926,440	$5,670,636
2040: No GW	Project Cost $$	32,254	$330,627,493	7,500	$56,113,728	$386,741,221
	Annual Energy $		$3,611,272		$1,014,790	$4,626,062
	Annual O&M $		$4,994,648		$879,979	$5,874,626
2040: Laterals	Project Cost $$		$6,289,466		Total:	$393,030,687
Lake Valley, Burnham	Annual Energy $		$45,042			$4,671,104
Whiterock, Whitehorse Lake	Annual O&M $		$50,944			$5,925,570

SJR Alternative: Navajo - Gallup Water Supply Project Cost/AF over Forty-Year Increments

Demand Years	Cost 2000 dollars	Navajo A/F	Navajo $Cost/AF	Gallup A/F	Gallup $Cost/AF
2010	Share Cost $$	11,141	$15,169	7,500	$10,440
	Annual Energy $		$150		$155
	Annual O&M $		$274		$176
2020	Share Cost $$	15,430	$13,528	7,500	$9,549
	Annual Energy $		$137		$149
	Annual O&M $		$231		$158
2030	Share Cost $$	21,391	$11,864	7,500	$8,537
	Annual Energy $		$122		$143
	Annual O&M $		$191		$139
2040	Share Cost $$	29,067	$10,659	7,500	$7,749
	Annual Energy $		$112		$137
	Annual O&M $		$163		$124

NOTE:

1.) ALL COST ESTIMATES HAVE BEEN COST INDEXED TO 2000 DOLLARS
2.) MAINLINE IS CORE LINE FROM GALLEGOS - YAHTAHEY - WINDOW ROCK - GALLUP - CHURCHROCK
3.) NASCHITTI LATERAL INCLUDES SANOSTEE, NEWCOMB, TWO GREY HILLS, SHEEP SPRINGS, NASCHITTI CHAPTERS.
4.) COYOTE CYN. JCT. LATERAL INCLUDES CROWNPOINT, DALTON PASS, BECENTI, COYOTE CANYON, STANDING ROCK, LITTLEWATER CHAPTERS.
5.) GALLEGOS RESERVOIR COST IS $38,037,430 FOR 8,800 A/F
6.) WHOLE PROJECT HAS A PF=1.30.
7.) HUERFANO LATERAL IS FROM GALLEGOS/WTP-HUERFANO, NAGEEZI, PUEBLO PINTADO, TORREON NTUA SYSTEM.
8.) ASSUMME PIPE COST ARE DIVIDED BY 90% COMMON AND 10% ROCK EXCAVATION.
9.) ALL COST ESTIMATES INCLUDES NAPI AND SHIPROCK AREA DEMANDS.

Year 2040

SJR Alternative: Navajo - Gallup Water Supply Project Cost Scenario. With GW.

SJR Alternative: With Prorated Project Cost for the City of Gallup, New Mexico.

Peaking Factor = 1.3 Demands: 29,066 Acre-Feet

	Navajo		Gallup		Totals
	A/F	$Cost	A/F	$Cost	$ Cost $
Project Cost $$	29,066	$323,971,647	0	$0	$323,971,647
Annual Energy $		$3,323,467		$0	$3,323,467
Annual O&M $		$5,257,567		$0	$5,257,567

Peaking Factor = 1.3 Demands: 36,567 Acre-Feet

	Navajo		Gallup		Totals
	A/F	$Cost	A/F	$Cost	$ Cost $
Project Cost $$	29,067	$309,811,865	7,500	$58,121,032	$367,932,897
Annual Energy $		$3,249,942		$1,028,460	$4,278,402
Annual O&M $		$4,744,196		$926,440	$5,670,636

NOTE:

1.) ALL COST ESTIMATES HAVE BEEN COST INDEXED TO 2000 DOLLARS
2.) MAINLINE GOES FROM PNM DIV.-RES./WTP-666HIGHWAY.-WR-GALLUP-GALLUP AREA NAVAJOS.
3.) CUTTER LATERAL INCLUDES HUERFANO, NAGEEZI, PUEBLO PINTADO, TORREON, WHITEHORSE LAKE, COUNSELOR CHAPTERS.
4.) COYOTE CYN. JCT. LATERAL INCLUDES DALTON PASS, BECENTI, LAKE VALLEY, STANDING ROCK, WHITEROCK, AND CROWNPOINT, AND LITTLEWATER CHAPTERS.
5.) RESERVOIR COST IS $9,600,000 FOR 1,500 A/F
6.) WHOLE PROJECT HAS A PF=1.30.
7.) ASSUMME PIPE COST ARE DIVIDED BY 90% COMMON AND 10% ROCK EXCAVATION.

Navajo - Gallup Water Supply Project - San Juan River Alternative

(Cost Estimate for Main Waterline to Gallup and Church Rock, with G.W. demands, plus Gallup area Navajo Demands)

Chapter Community	Populations (1) 1990	Populations 2040	Daily Demand (2,3,4) Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Annual Ground Water Production Est. 2040 Prod. Ac-Ft	Annual Ground Water Production Est. GW Dev. Cost $$	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	Peak Daily Demand cfs	Cummulative Flow cfs
Hogback Div. Intake	0	0	0	0	0	$0	0	0	0.00	59.18
Reservoir/WTP	0	0	0	0	0	$0	0	0	0.00	59.18
NAPI Jct.	0	0	624,920	0	0	$0	700	624,920	0.97	59.18
Shiprock Jct.	13,804	46,985	3,339,749	0	0	$0	3,741	4,341,674	6.72	58.22
Sanostee	2,081	7,083	1,123,208	89	153	$0	1,117	1,296,734	2.00	51.50
Burnham Jct.	246	837	133,971	0	0	$0	150	174,162	0.27	49.49
Newcomb	1,534	5,221	835,413	113	89	$0	847	982,746	1.52	49.22
Sheepsprings	660	2,246	359,434	0	15	$0	386	449,856	0.70	47.70
Naschitti	1,538	5,238	838,136	82	77	$0	862	1,000,213	1.55	47.01
Tohatchi	2,318	7,890	1,262,376	180	307	$0	1,107	1,284,797	1.99	45.46
Coyote Cyn. Jct.	5,924	20,164	3,226,187	352	798	$0	2,816	3,267,925	5.06	43.47
Twin Lakes	1,967	6,695	1,071,224	87	153	$0	1,047	1,215,024	1.88	38.42
Ya-ta-hey Jct.	14,885	50,663	8,106,337	1,100	890	$0	8,191	9,505,335	14.71	36.53
Gamerco Hill	0	0	0	0	0	$0	0	0	0.00	21.83
Gallup Jct.	23,630	82,330	9,118,848	4,413	184	$0	10,029	11,638,358	18.01	21.83
Church Rock	4,089	13,918	2,225,860	250	368	$0	2,127	2,467,830	3.82	3.82

229,273 2040 Population Served

38.25 MGD

33,121 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Pipeline Dimensions Diameter ft.	Pipeline Dimensions Diameter inches	Pipeline Dimensions Length ft.	Elevation Beginning ft.	Elevation Ending ft.	Elevation Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal.
Hogback Div. Intake	14.80	4.34	52.1	0	5,075	5,075	0	0.0	0.0	0
Reservoir/WTP	14.80	4.34	52.1	288	5,075	5,110	35	0.3	338.2	0
NAPI Jct.	14.80	4.34	52.1	8,100	5,110	5,250	140	7.1	1411.3	0
Shiprock Jct.	14.55	4.30	51.7	91,042	5,250	5,160	-90	80.1	0.0	0
Sanostee	12.87	4.05	48.6	94,323	5,160	5,580	420	86.8	4230.4	4,983,591
Burnham Jct.	12.37	3.97	47.6	51,075	5,580	5,590	10	49.3	475.7	0
Newcomb	12.31	3.96	47.5	19,088	5,590	5,550	-40	18.4	0.0	3,779,794
Sheepsprings	11.93	3.90	46.8	51,174	5,550	5,890	340	49.4	3010.7	1,730,217
Naschitti	11.75	3.87	46.4	29,635	5,890	5,890	0	30.1	229.0	3,846,974
Tohatchi	11.36	3.80	45.6	90,183	5,890	6,100	210	91.5	2221.1	4,941,528
Coyote Cyn. Jct.	10.87	3.72	44.6	34,954	6,100	6,250	150	35.4	1306.6	0
Twin Lakes	9.60	3.50	42.0	15,554	6,250	6,380	130	17.6	918.8	4,673,171
Ya-ta-hey Jct.	9.13	3.41	40.9	31,161	6,380	6,560	180	35.1	1273.8	0
Gamerco Hill	5.46	2.64	31.6	20,482	6,560	6,935	375	31.6	1438.6	0
Gallup Jct.	5.46	2.64	31.6	14,523	6,560	6,477	-83	22.4	0.0	0
Church Rock	0.95	1.10	13.2	48,082	6,477	6,660	183	185.7	228.2	9,491,654

597,484 Total Pipeline Length(ft.)

113.20 Total Pipeline Length (Miles)

17,082

Chapter Community	Total Capital Cost Reservoir / WTP $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $	Annual Energy Cost $	Annual O&M Cost $
Hogback Div. Intake	$2,000,000						$2,000,000	$12,000	$120,000
Reservoir/WTP	$54,701,038	$206,955	$0	52	$48,252	$8,031	$54,963,276	$319,974	$2,345,318
NAPI Jct.		$863,596	$0	52	$1,300,839	$169,623	$2,334,161	$276,678	$41,900
Shiprock Jct.		$0	$0	52	$14,621,108	$1,906,525	$16,527,632	$0	$82,636
Sanostee		$2,589,012	$1,296,675	50	$14,532,291	$1,893,441	$20,311,419	$829,367	$237,556
Burnham Jct.		$291,121	$0	48	$7,538,257	$981,444	$8,810,821	$93,258	$54,243
Newcomb		$0	$962,421	48	$2,817,234	$366,790	$4,146,445	$0	$54,417
Sheepsprings		$1,842,530	$599,352	48	$7,552,868	$983,346	$10,978,096	$590,238	$140,356
Naschitti		$140,126	$962,421	46	$4,183,420	$544,286	$5,830,253	$44,868	$67,740
Tohatchi		$1,359,317	$1,296,675	46	$12,730,867	$1,656,331	$17,042,990	$435,445	$178,175
Coyote Cyn. Jct.		$799,648	$0	46	$4,934,275	$641,977	$6,375,900	$256,160	$59,867
Twin Lakes		$562,322	$1,296,675	42	$2,003,236	$260,328	$4,122,561	$180,135	$85,678
Ya-ta-hey Jct.		$779,576	$0	42	$4,003,004	$520,205	$5,302,784	$249,730	$53,799
Gamerco Hill		$880,405	$0	32	$1,998,788	$259,480	$3,138,673	$282,030	$46,508
Gallup Jct.		$0	$0	32	$1,417,264	$183,987	$1,601,251	$0	$8,006
Church Rock		$139,635	$2,305,200	14	$2,081,603	$275,512	$4,801,951	$44,731	$109,579
Sub-Total	$56,701,038	$10,454,345	$8,719,419		$81,761,106	$10,649,306	$168,285,214	$3,602,635	$3,785,781

Capital Cost	$56,701,038	$10,454,345	$8,719,419	$81,761,106	$10,649,306	$168,285,214
Contingency Cost	20%					$33,657,043
Mobilization Cost	10%					$16,828,521
Indirect Cost	27%					$45,437,008
Totals						$264,207,785

NOTES:

1) ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993
2) CITY OF GALLUP ANNUAL DEMAND IS 7,[illegible] AC-FT.
3) ASSUME NAVAJO DEMANDS OF [illegible] GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
4) ASSUME PIPELINE DEMANDS FOR NAPI AT [illegible] AF/YR AND A PF OF 1.[illegible]
5) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON 5-DAY AVERAGE DEMAND. COST FROM THE 1998 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.
STORAGE COST ARE FOR SANOSTEE, NEWCOMB, TWO GREY HILLS, SHEEPSPRINGS, TOHATCHI, MEXICAN SPR., CHURCH ROCK, PINEDALE, MARIANO LAKE, AND [illegible] FOR THIS COST ESTIMATE SHEET.
6) ASSUME GALLON / DAY PEAKING FACTOR OF 1.30
7) ASSUME VELOCITY [illegible] FEET PER SECOND FROM [illegible] ASSOCIATES, 1998
8) ASSUME $/HP PER PUMP FROM [illegible] ASSOCIATES, 1998. COST INDEXED TO 2000 [illegible] ASSUME PUMPING EFFICIENCY AT 70%
9) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA (DUCTILE IRON FRICTION COEFFICIENT)
10) BASED ON [illegible] ANALYSIS BASED ON [illegible] COSTS FROM [illegible], MORRISON KNUDSEN, & USBOR SOURCES. ASSUME WTP COST OF $45,101,038
11) PIPE INSTALLED COST FROM [illegible] ANALYSIS BASED ON [illegible] DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION
12) SETTLING RESERVOIR IS ASSUMED TO BE 1,[illegible] AF CAPACITY. COST ESTIMATE FROM STERLING & MATAYA. $9,600,000
13) ANNUAL ENERGY COST BASED ON INTAKE/WTP/RESERVOIR ANNUAL O&M COST [illegible], PUMPING BASED ON [illegible] PER KILOWATT HOUR
14) ANNUAL O&M COST BASED ON: WTP COST, BOR O&M COST, INTAKE/RESERVOIR COST * [illegible], PUMP COST * [illegible], STORAGE COST * [illegible], PIPELINE COST * [illegible]
15) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANCES AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.
16) INDIRECT COST INCLUDE FACILITATING [illegible], TERO 2%, CONTRACT ADMIN. [illegible], ENVIRON. 2%, EASEMENTS 1%, GEOTECH [illegible], ADMIN. [illegible], DESIGN SURVEY [illegible], INVEST. [illegible], DESIGN 9%, AND CONSTRUCTION OBSER. 10%.

Navajo - Gallup Water Supply Project - San Juan River Alternative

(Cost Estimate for Lateral Waterline from Cutter Reservior to Huerfano, Nageezi, Pueblo Pintado, Torreon)

Chapter Community	Populations (1) 1990	Populations 2040	Daily Demand (3,4) Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Annual Ground Water Production Est. 2040 Prod. Ac-Ft	Annual Ground Water Production Est. GW Dev. Cost $$	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	Peak Daily Demand cfs	Cummulative Flow cfs
Cutter Dam Intake/WTP	0	0	0	0	0	$0	0	0	0.00	6.19
Huerfano	511	1,738	278,289	59	31	$0	281	325,799	0.50	6.19
Nageezi	981	3,339	534,250	21	15	$0	583	677,117	1.05	5.68
Counselor	2,447	8,329	1,332,831	5	31	$0	1,462	1,696,442	2.62	4.64
Torreon	1,960	6,671	1,067,412	113	76	$0	1,120	1,299,432	2.01	2.01

4.00 MGD

20,079 2040 Population Served

3,446 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Pipeline Dimensions Diameter ft.	Pipeline Dimensions Diameter inches	Pipeline Dimensions Length ft.	Elevation Beginning ft.	Elevation Ending ft.	Elevation Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal
Cutter Dam Intake/WTP	1.55	1.40	16.8	0	5,930	5,930	0	0.0	0.0	0
Huefano	1.55	1.40	16.8	136,961	5,930	6,850	920	412.4	1336.2	1,253,072
Nageezi	1.42	1.35	16.1	61,308	6,850	6,950	100	211.6	287.1	2,604,296
Counselor	1.16	1.21	14.6	105,773	6,950	6,860	-90	365.1	206.7	4,863,978
Torreon	0.50	0.80	9.6	85,396	6,860	6,600	-260	508.5	81.0	4,997,816

389,438 Total Pipeline Length(ft.)

73.76 Total Pipeline Length (Miles)

1,911

Total Capital Cost	Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Cutter Dam Intake/WTP	$5,715,197	$0	$0	15	$0	$0	$5,715,197
Huefano		$817,775	$320,423	18	$7,735,813	$1,014,245	$9,888,256
Nageezi		$175,688	$599,352	16	$3,115,144	$410,084	$4,300,268
Counselor		$125,517	$1,296,675	15	$5,374,472	$707,508	$7,505,170
Torreon		$49,566	$1,296,675	10	$2,912,223	$392,204	$4,650,868
Sub-Total	$5,715,197	$1,169,546	$3,513,125		$19,137,852	$2,524,038	$32,059,559
Capital Cost	$5,715,197	$1,169,546	$3,513,125		$19,137,852	$2,524,038	$32,059,559
Contingency Cost	20%						$6,411,912
Mobilization Cost	10%						$3,205,956
Indirect Cost	27%						$8,656,081
Totals							$50,333,507

Annual Energy Cost	
Treatment	$114,536
Pump Stations	$374,654
	$489,190
Annual Operation and Maintanence Cost	
Treatment	$1,145,359
Pump Stations	$46,782
Storage Tanks	$140,525
Conveyance Pipe	$108,308
	$1,440,974
Total	$1,930,164

NOTES :

1) ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993
2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON 3,000 GAL/HOUSEHOLD @ 4.5 PERSONS/HOUSEHOLD. COST FROM THE 1998 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.
4) ASSUME GALLON / DAY PEAKING FACTOR OF: 1.36
5) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1996)
6) ASSUME [illegible] PER PUMP FROM (HKM ASSOCIATES, 1996). COST INDEXED TO 2000 [illegible] ASSUME PUMPING EFFICIENCY AT: 70%
7) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
8) BASED ON KNOWN ANALYSIS BASED ON BID COSTS FROM [illegible], MORRISON MAIERLE, & LABOR SOURCES. ASSUME WTP COST OF: $4,715,197
9) PIPE INSTALLED COST FROM KNOWN ANALYSIS BASED ON BOR-FM(1998 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.
10) ASSUME A CUTTER DIVERSION/INTAKE COST OF: $1,000,000
11) ANNUAL ENERGY COST BASED ON INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING BASED ON [illegible] PER KILOWATT HOUR.
12) ANNUAL O&M COST BASED ON WTP COST, BOR O&M COST, INTAKE/RESERVOIR COST * 3%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%.
13) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%, ADDITIONAL CONTINGENCY COST AT 20%.
14) INDIRECT COST INCLUDE FACILITATING 1%, TERO 2%, CONTRACT ADMIN 1%, ENVIRON 2%, EASEMENTS 1%, GEOCHEM 0.5%, ACHEOL 0.5%, DESIGN SURVEY 1%, INVEST 2%, DESIGN 9%, AND CONSTRUCTION OBSER 10%.

Navajo - Gallup Water Supply Project - San Juan River Alternative

(Cost Estimate for Lateral Waterline to Red Rock NTUA Water line)

Chapter Community	Populations(1,2) (1) 1990	2040	Daily Demand Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Est. 2040 Prod. Ac-Ft	Est. Prog. Dev. Cost $	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(5)	cfs	Cummulative Flow cfs
Gallup Jct.	0	0	0	0	0	$0	0	0	0.00	3.93
Red Rock	3,815	12,985	2,077,840	78	138	$0	2,189	2,540,774	3.93	3.93

12,985 2040 Population Served

2,189 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Elevation Beginning ft.	Ending ft.	Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal
Gallup Jct.	0.98	1.12	13.4	0	6,477	6,477	0	0.0	0.0	0
Red Rock	0.98	1.12	13.4	26,320	6,477	6,750	273	106.1	241.6	9,772,209

26,320 Total Pipeline Length(ft.)

4.98 Total Pipeline Length (Miles)

242

	Total Capital Cost: Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Gallup Jct.	$0	$0	$0	14	. $0	$0	$0
Red Rock		$147,830	$2,305,200	14	$1,189,436	$157,429	$3,799,894
Sub-Total	$0	$147,830	$2,305,200		$1,189,436	$157,429	$3,799,894
Capital Cost	$0	$147,830	$2,305,200		$1,189,436	$157,429	$3,799,894
Contingency Cost	20%						$759,979
Mobilization Cost	10%						$379,989
Indirect Cost	27%						$1,025,971
Totals							$5,965,834

Annual Energy Cost	
Treatment	$0
Pump Stations	$47,356
	$47,356

Annual Operation and Maintanence Cost	
Treatment	$0
Pump Stations	$5,913
Storage Tanks	$92,208
Conveyance Pipe	$6,734
	$104,856
Total	$152,211

NOTES:

1) ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", [illegible]
2) ASSUME NAVAJO DEMANDS OF [illegible] GALLONS PER CAPITA AND BASED ON [illegible] PROJECTED DEMANDS.
3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON [illegible] GAL/HOUSEHOLD @ 4.5 PERSONS/HOUSEHOLD. COST FROM THE 1990 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO [illegible] DOLLARS.
4) RED ROCK DEMANDS INCLUDE RED ROCK, [illegible] CHAPTERS
5) ASSUME GALLON / DAY PEAKING FACTOR OF 1.30
6) ASSUME VELOCITY =4 FEET PER SECOND FROM [illegible] ASSOCIATES, [illegible]
7) ASSUME [illegible] PER PUMP FROM [illegible] ASSOCIATES, [illegible], COST INDEXED TO [illegible]. ASSUME PUMPING EFFICIENCY AT 70%
8) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
9) BASED ON [illegible] ANALYSIS BASED ON BID COSTS FROM [illegible] SOURCES. ASSUME WTP COST OF $0
10) PIPE INSTALLED COST FROM [illegible] ANALYSIS BASED ON [illegible] DOLLARS. ASSUME [illegible] OF PIPE LENGTH IS COMMON AND [illegible] IS ROCK EXCAVATION.
11) ANNUAL ENERGY COST BASED ON: [illegible] ANNUAL O&M COST * [illegible]. PUMPING: BASED ON [illegible] PER KILOWATT HOUR.
12) ANNUAL O&M COST BASED ON: WTP COST, [illegible] O&M COST, [illegible] COST * [illegible], PUMP COST * [illegible], STORAGE COST * [illegible], PIPELINE COST * [illegible]
13) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT [illegible]. ADDITIONAL CONTINGENCY COST AT [illegible]
14) INDIRECT COST INCLUDE FACILITATING [illegible], [illegible], CONTRACT ADMIN. [illegible], ENVIRON. [illegible], EASEMENTS [illegible], [illegible], ARCHEOL. [illegible], DESIGN SURVEY [illegible], INVEST. [illegible], DESIGN [illegible], AND CONSTRUCTION [illegible]

Navajo - Gallup Water Supply Project - San Juan River Alternative

(Cost Estimate for Lateral Waterline to Coyote Canyon, Standing Rock, and Dalton Pass NTUA Water Line)

Chapter Community	Populations(1,2) (1) 1990	2040	Daily Demand Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Est. 2040 Prod. Ac-Ft	Est. Prog. Dev. Cost $	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	cfs	Cummulative Flow cfs
Coyote Cyn. Jct.	0	0	0	0	0	0	0	0	0.00	5.06
Coyote Canyon	1,234	4,200	672,034	32	61	0	692	802,849	1.24	5.06
Standing Rock	251	854	136,694	34	77	0	76	88,339	0.14	3.81
Dalton Pass	4,439	15,109	2,417,469	285	660	0	2,048	2,376,737	3.68	3.68

20,164 2040 Population Served

2,816 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Elevation Beginning ft.	Ending ft.	Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal
Coyote Cyn. Jct.	1.26	1.27	15.2	0	6,250	6,250	0	0.0	0.0	0
Coyote Canyon	1.26	1.27	15.2	35,938	6,250	6,160	-90	124.1	27.9	3,067,881
Standing Rock	0.95	1.10	13.2	81,321	6,160	6,280	120	327.8	276.8	339,764
Dalton Pass	0.92	1.08	13.0	37,998	6,280	6,740	460	153.2	365.5	8,830,096

155,257 Total Pipeline Length(ft.)
29.40 Total Pipeline Length (Miles)

670

Chapter Community	Total Capital Cost Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Coyote Cyn. Jct.	$0	$0	$0	16	$0	$0	$0
Coyote Canyon		$17,086	$962,421	16	$1,826,059	$240,386	$3,045,952
Standing Rock		$169,412	$212,078	14	$3,675,005	$486,408	$4,542,902
Dalton Pass		$223,671	$2,305,200	14	$1,717,180	$227,279	$4,473,330
Sub-Total	$0	$410,169	$3,479,699		$7,218,245	$954,072	$12,062,185
Capital Cost	$0	$410,169	$3,479,699		$7,218,245	$954,072	$12,062,185
Contingency Cost	20%						$2,412,437
Mobilization Cost	10%						$1,206,218
Indirect Cost	27%						$3,256,790
Totals							$18,937,630

Annual Energy Cost	
Treatment	$0
Pump Stations	$131,394
	$131,394
Annual Operation and Maintanence Cost	
Treatment	$0
Pump Stations	$16,407
Storage Tanks	$139,188
Conveyance Pipe	$40,862
	$196,456
Total	$327,850

NOTES :

1) ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993
2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON 2,000 GAL/HOUSEHOLD @ 4.5 PERSONS/HOUSEHOLD. COST FROM THE 1993 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 1998 DOLLARS.
4) DALTON PASS DEMANDS INCLUDE DALTON PASS, CROWNPOINT, LITTLEWATER, BECENTI, LAKE VALLEY, AND WHITEROCK CHAPTERS.
5) ASSUME GALLON / DAY PEAKING FACTOR OF 1.30
6) ASSUME VELOCITY of 4 FEET PER SECOND FROM (HKM ASSOCIATES, 1998)
7) ASSUME [illegible] PER PUMP FROM (HKM ASSOCIATES, 1990), COST INDEXED TO 2000 [illegible] ASSUME PUMPING EFFICIENCY AT : 70%
8) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
9) BASED ON HKM/WR ANALYSIS BASED ON BID COSTS FROM [illegible], MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COST OF $0
10) PIPE INSTALLED COST FROM HKM/WR ANALYSIS BASED ON BOR-PN(1998 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.
11) ANNUAL ENERGY COST BASED ON: INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING: BASED ON $0.06 PER KILOWATT HOUR.
12) ANNUAL O&M COST BASED ON: WTP COST, BOR O&M COST, INTAKE/RESERVOIR COST * 5%, PUMP COST * 5%, STORAGE COST * 4%, PIPELINE COST * 0.5%.
13) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%, ADDITIONAL CONTINGENCY COST AT 20%.
14) INDIRECT COST INCLUDE FACILITATING 1%, TERO 2%, CONTRACT ADMIN 1%, ENVIRON 2%, EASEMENTS 1%, GEOCHEM 0.5%, ARCHEOL 0.5%, DESIGN SURVEY 1%, INVEST 2%, DESIGN 6%, AND CONSTRUCTION OBSER. 10%.

Navajo - Gallup Water Supply Project - San Juan River Alternative

(Cost Estimate for Main Waterline from Yahtahey to Rock Springs and Window Rock)

Chapter Community	Populations (1) 1990	Populations 2040	Daily Demand (2,3,4) Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Annual Ground Water Production Est. 2040 Prod. Ac-Ft	Annual Ground Water Production Est. Prog. Dev. Cost $	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	Peak Daily Demand cfs	Cummulative Flow cfs
Ya-ta-hey Jct.	0	0	0	0	0	$0	0	0	0.00	14.71
Rock Springs	3,118	10,613	1,698,056	58	123	$0	1,779	2,064,723	3.19	14.71
Window Rock	11,767	40,052	6,408,281	1,043	787	$0	6,412	7,440,612	11.51	11.51

50,665 2040 Population Served

8,191 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Elevation Beginning ft.	Ending ft.	Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal
Ya-ta-hey Jct.	3.68	2.16	26.0	0	6,560	6,560	0	0.0	0.0	0
Rock Springs	3.68	2.16	26.0	29,439	6,560	6,760	200	57.9	614.7	7,941,242
Window Rock	2.88	1.91	23.0	58,887	6,650	6,760	110	127.0	442.3	28,617,740

88,326 Total Pipeline Length(ft.)

16.73 Total Pipeline Length (Miles)

1,057

Total Capital Cost	Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Ya-ta-hey Jct.	$0	$0	$0	26	$0	$0	$0
Rock Springs		$376,203	$1,728,900	26	$2,345,352	$304,981	$4,755,436
Window Rock		$270,670	$6,339,300	24	$4,345,622	$565,779	$11,521,371
Sub-Total	$0	$646,873	$8,068,200		$6,690,974	$870,760	$16,276,807
Capital Cost	$0	$646,873	$8,068,200		$6,690,974	$870,760	$16,276,807
Contingency Cost	20%						$3,255,361
Mobilization Cost	10%						$1,627,681
Indirect Cost	27%						$4,394,738
Totals							$25,554,586

Annual Energy Cost	
Treatment	$0
Pump Stations	$207,220
	$207,220
Annual Operation and Maintanence Cost	
Treatment	$0
Pump Stations	$25,875
Storage Tanks	$322,728
Conveyance Pipe	$37,809
	$386,412
Total	$593,632

NOTES :

1). ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993

2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS

3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON 2,800 GAL./HOUSEHOLD @ 4.5 PERSONS/HOUSEHOLD. COST FROM THE 1993 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.

4) ROCK SPRINGS DEMANDS INCLUDE ROCK SPRINGS, TSAYATOH, AND MANUELITO CHAPTERS. WINDOW ROCK INCLUDES ST. MICHAELS AND FT. DEFIANCE CHAPTERS

5) ASSUME GALLON / DAY PEAKING FACTOR OF: 1.30

6) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1999)

7). ASSUME [illegible] PER PUMP FROM (HKM ASSOCIATES, 1999), COST INDEXED TO 2000 [illegible] ASSUME PUMPING EFFICIENCY AT : 70%

8). HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)

9). BASED ON KNOWN ANALYSIS BASED ON BID COSTS FROM USE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COST OF: $0

10) PIPE INSTALLED COST FROM KNOWN ANALYSIS BASED ON BOR-FUND 1999 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.

11). ANNUAL ENERGY COST BASED ON INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING: BASED ON $0.06 PER KILOWATT HOUR

12). ANNUAL O&M COST BASED ON: WTP COST, BOR O&M COST, INTAKE/RESERVOIR COST * 4%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%

13). MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.

14). INDIRECT COST INCLUDE FACILITATING 1%, TERO 2%, CONTRACT ADMIN. 1%, ENVIRON. 2%, EASEMENTS 1%, GEOCHEM 0.5%, ARCHEOL. 0.5%, DESIGN SURVEY 1%, INVEST. 2%, DESIGN 8%, AND CONSTRUCTION OBSER. 10%

Navajo - Gallup Water Supply Project - San Juan River Alternative

(Cost Estimate for Lateral Waterline to Manuelito NTUA Water line)

Chapter Community	Populations(1,2) (1) 1990	Populations(1,2) 2040	Daily Demand Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Annual Ground Water Production Est. 2040 Prod. Ac-Ft	Annual Ground Water Production Est. Prog. Dev. Cost $	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(5)	Peak Daily Demand cfs	Cummulative Flow cfs
Gallup Jct.	0	0	0	0	0	$0	0	0	0.00	0.61
Manuelito	831	2,148	343,641	78	46	$0	339	393,348	0.61	0.61

2,148 2040 Population Served

339 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Pipeline Dimensions Diameter ft.	Pipeline Dimensions Diameter inches	Pipeline Dimensions Length ft.	Elevation Beginning ft.	Elevation Ending ft.	Elevation Change ft.	Headloss due to friction (9) ft	Pump Horsepower HP	Storage Demands (5) Gal
Gallup Jct.	0.15	0.44	5.3	0	6,477	6,477	0	0.0	0.0	0
Manuelito	0.15	0.44	5.3	47,050	6,477	6,375	-102	506.7	39.9	1,512,875

47,050 Total Pipeline Length(ft.)

8.91 Total Pipeline Length (Miles)

40

Chapter Community	Total Capital Cost Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (In.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Gallup Jct.	$0	$0	$0	6	$0	$0	$0
Manuelito		$24,434	$599,352	6	$1,092,292	$152,426	$1,868,505
Sub-Total	$0	$24,434	$599,352		$1,092,292	$152,426	$1,868,505
Capital Cost	$0	$24,434	$599,352		$1,092,292	$152,426	$1,868,505
Contingency Cost	20%						$373,701
Mobilization Cost	10%						$186,850
Indirect Cost	27%						$504,496
Totals							$2,933,553

Annual Energy Cost

Treatment	$0
Pump Stations	$7,827
	$7,827

Annual Operation and Maintanence Cost

Treatment	$0
Pump Stations	$977
Storage Tanks	$23,974
Conveyance Pipe	$8,224
	$31,175
Total	**$39,002**

NOTES :

1. ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", [illegible]
2. ASSUME NAVAJO DEMANDS OF [illegible] GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
3. ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON [illegible] GAL/HOUSEHOLD @ 4.1 PERSONS/HOUSEHOLD. COST FROM THE [illegible] MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO [illegible] DOLLARS.
4. RED ROCK DEMANDS INCLUDE RED ROCK, BREADSPRINGS, CHICHILTAH CHAPTERS.
5. ASSUME GALLON / DAY PEAKING FACTOR OF: 1.30
6. ASSUME VELOCITY [illegible] FEET PER SECOND FROM [illegible] ASSOCIATES, [illegible]
7. ASSUME [illegible] PER PUMP FROM [illegible] ASSOCIATES, [illegible] COST INDEXED TO [illegible] ASSUME PUMPING EFFICIENCY AT : 70%
8. HEAD LOSS BASED ON [illegible] FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
9. BASED ON [illegible] ANALYSIS BASED ON BID COSTS FROM [illegible] SOURCES. ASSUME WTP COST OF: $0
10. PIPE INSTALLED COST FROM [illegible] ANALYSIS BASED ON [illegible] DOLLARS. ASSUME [illegible] OF PIPE LENGTH IS COMMON AND [illegible] IS ROCK EXCAVATION.
11. ANNUAL ENERGY COST BASED ON [illegible] ANNUAL O&M COST [illegible] PUMPING. BASED ON [illegible] PER KILOWATT HOUR.
12. ANNUAL O&M COST BASED ON: WTP COST: [illegible] O&M COST, [illegible] COST [illegible] PUMP COST [illegible] STORAGE COST [illegible] PIPELINE COST [illegible]
13. MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT [illegible] ADDITIONAL CONTINGENCY COST AT [illegible]
14. INDIRECT COST INCLUDE FACILITATING [illegible] CONTRACT ADMIN [illegible] EASEMENTS [illegible] DESIGN SURVEY [illegible] DESIGN [illegible] AND CONSTRUCTION [illegible]

NIIP Alternative: Navajo - Gallup Water Supply Project Cost Scenarios. With GW.

NIIP Alternative: With Prorated Project Cost for the City of Gallup, New Mexico.

Demand Years	Cost 2000 dollars	Navajo A/F	Navajo $Cost	Gallup A/F	Gallup $Cost	Totals $ Cost $
2010	Project Cost $$	11,141	$177,472,504	7,500	$84,323,220	$261,795,72
	Annual Energy $		$1,209,292		$677,369	$1,886,66
	Annual O&M $		$929,415		$1,770,058	$2,699,47
2020	Project Cost $$	15,230	$221,037,608	7,500	$76,811,215	$297,848,82
	Annual Energy $		$1,559,858		$644,212	$2,204,07
	Annual O&M $		$1,508,585		$1,553,408	$3,061,99
2030	Project Cost $$	21,291	$289,756,411	7,500	$69,702,466	$359,458,87
	Annual Energy $		$1,862,118		$607,680	$2,469,79
	Annual O&M $		$2,409,182		$1,309,836	$3,719,01
2040	Project Cost $$	29,067	$326,392,762	7,500	$63,733,056	$390,125,81
	Annual Energy $		$2,391,538		$577,956	$2,969,49
	Annual O&M $		$2,947,375		$1,130,182	$4,077,55
2040: No GW	Project Cost $$	32,254	$348,110,088	7,500	$61,334,101	$409,444,18
	Annual Energy $		$2,645,752		$566,693	$3,212,44
	Annual O&M $		$3,243,243		$1,079,273	$4,322,51
2040: Laterals	Project Cost $$		$8,121,709		**Total:**	**$417,565,89**
Lake Valley,Burnham	Annual Energy $		$53,903			$3,266,34
Whiterock,Whitehorse Lake	Annual O&M $		$24,396			$4,346,91

NIIP Alternative: Navajo - Gallup Water Supply Project Cost/AF over Forty-Year Increments

Demand Years	Cost 2000 dollars	Navajo A/F	Navajo $Cost/AF	Gallup A/F	Gallup $Cost/AF
2010	Share Cost $$	11,141	$15,929	7,500	$11,243
	Annual Energy $		$109		$90
	Annual O&M $		$83		$236
2020	Share Cost $$	15,230	$14,514	7,500	$10,241
	Annual Energy $		$102		$86
	Annual O&M $		$99		$207
2030	Share Cost $$	21,291	$13,610	7,500	$9,294
	Annual Energy $		$87		$81
	Annual O&M $		$113		$175
2040	Share Cost $$	29,067	$11,229	7,500	$8,498
	Annual Energy $		$82		$77
	Annual O&M $		$101		$151

NOTE:

1.) ALL COST ESTIMATES HAVE BEEN COST INDEXED TO 2000 DOLLARS
2.) MAINLINE IS CORE LINE FROM GALLEGOS - YAHTAHEY - WINDOW ROCK - GALLUP - CHURCHROCK
3.) NASCHITTI LATERAL INCLUDES SANOSTEE, NEWCOMB,TWO GREY HILLS, SHEEP SPRINGS, NASCHITTI CHAPTERS.
4.) COYOTE CYN. JCT. LATERAL INCLUDES CROWNPOINT, DALTON PASS, BECENTI, COYOTE CANYON, STANDING ROCK, LITTLEWATER CHAPTERS.
5.) GALLEGOS RESERVOIR COST IS $38,037,430 FOR 8,800 A/F
6.) WHOLE PROJECT HAS A PF=1.30.
7.) HUERFANO LATERAL IS FROM GALLEGOS/WTP-HUERFANO,NAGEEZI, PUEBLO PINTADO, TORREON NTUA SYSTEM.
8.) ASSUMME PIPE COST ARE DIVIDED BY 90% COMMON AND 10% ROCK EXCAVATION.
9.) ALL COST ESTIMATES INCLUDES NAPI AND SHIPROCK AREA DEMANDS.

2040 NIIP Alternative: Navajo - Gallup Water Supply Project Cost. With GW.

NIIP Alternative: With Prorated Project Cost for the City of Gallup, New Mexico.

Peaking Factor = 1.3 Demands: 29,066 Acre-Feet

	Navajo		Gallup		Totals
	A/F	$Cost	A/F	$Cost	$ Cost $
Project Cost $$	29,066	$353,693,927	0	$0	$353,693,927
Annual Energy $		$2,433,493		$0	$2,433,493
Annual O&M $		$3,734,238		$0	$3,734,238

Peaking Factor = 1.3 Demands: 36,567 Acre-Feet

	Navajo		Gallup		Totals
	A/F	$Cost	A/F	$Cost	$ Cost $
Project Cost $$	29,067	$326,392,762	7,500	$63,733,056	$390,125,818
Annual Energy $		$2,391,538		$577,956	$2,969,494
Annual O&M $		$2,947,375		$1,130,182	$4,077,556

NOTE:

1.) ALL COST ESTIMATES HAVE BEEN COST INDEXED TO 2000 DOLLARS
2.) MAINLINE IS CORE LINE FROM GALLEGOS - YAHTAHEY - WINDOW ROCK - GALLUP - CHURCHROCK
3.) NASCHITTI LATERAL INCLUDES SANOSTEE, NEWCOMB,TWO GREY HILLS, SHEEP SPRINGS, NASCHITTI CHAPT
4.) COYOTE CYN. JCT. LATERAL INCLUDES CROWNPOINT, DALTON PASS, BECENTI, COYOTE CANYON, STANDING ROCK, LITTLEWATER CHAPTERS.
5.) GALLEGOS RESERVOIR COST IS $38,037,430 FOR 8,800 A/F
6.) WHOLE PROJECT HAS A PF=1.30.
7.) HUERFANO LATERAL IS FROM GALLEGOS/WTP-HUERFANO,NAGEEZI, PUEBLO PINTADO, TORREON NTUA SYSTEM.
8.) ASSUMME PIPE COST ARE DIVIDED BY 90% COMMON AND 10% ROCK EXCAVATION.

Navajo - Gallup Water Supply Project - NIIP Alternativ

(Cost Estimate for Main Waterline to Gallup and Church Rock, with G.W. demands, plus Gallup area Navajo Demands)

Chapter Community	Populations (1) 1990	Populations 2040	Daily Demand Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Annual Ground Water Production Est. 2040 Prod. Ac-Ft	Annual Ground Water Production Est. GW Dev. Cost $$	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	Peak Daily Demand cfs	Cummulati Flow cfs
Gallegos Reservoir	0	0	0	0	0	$0	0	0	0.00	65
WTP	0	20,873	3,964,670	0	0	$0	4,441	4,968,595	7.68	65
Huerfano Jct.	5,898	20,079	3,212,582	208	153	$0	3,446	3,998,790	6.19	57
Burnham	245	837	133,971	0	0	$0	150	174,162	0.27	51
Lake Valley	637	2,168	346,909	22	46	$0	343	397,595	0.62	51
Naschitti Jct	5,814	19,789	3,166,291	851	334	$0	3,213	3,728,550	5.77	50
Tohatchi	2,318	7,890	1,262,378	180	307	$0	1,107	1,284,797	1.99	44
Coyote Cyn. Jct.	5,287	17,996	2,879,288	330	752	$0	2,473	2,870,330	4.44	42
Twin Lakes	1,967	6,695	1,071,224	104	153	$0	1,047	1,215,024	1.88	38
Yah-ta-hey Jct.	14,885	50,665	8,106,337	1,048	890	$0	8,191	9,505,335	14.71	36
Gamerco Hill	0	0	0	0	0	$0	0	0	0.00	21
Gallup Jct.	23,600	62,330	9,116,848	105	184	$0	10,029	11,638,358	18.01	21
Church Rock	4,089	13,918	2,226,860	275	368	$0	2,127	2,467,830	3.82	3

42.25 MGD

223,240 2040 Population Served

36,567 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Pipeline Dimensions Diameter ft.	Pipeline Dimensions Diameter inches	Pipeline Dimensions Length ft.	Elevation Beginning ft.	Elevation Ending ft.	Elevation Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal
Gallegos Reservoir	16.34	4.56	54.7	0	5,960	5,960	0	0.0	0.0	
WTP	16.34	4.56	54.7	1,000	5,960	6,005	45	0.8	485.3	
Huerfano Jct.	14.42	4.29	51.4	4,478	6,005	6,010	5	3.9	83.8	
Burnham	12.87	4.05	48.6	56,732	6,010	6,195	185	52.2	1980.1	
Lake Valley	12.81	4.04	48.5	72,046	6,195	5,740	-455	66.3	0.0	
Naschitti Jct.	12.65	4.01	48.2	76,272	5,740	5,695	-45	73.6	234.8	
Tohatchi	11.21	3.78	45.3	82,686	5,695	6,100	405	83.9	3553.1	4,941,
Coyote Cyn. Jct.	10.71	3.69	44.3	34,954	6,100	6,250	150	37.3	1301.2	
Twin Lakes	9.60	3.50	42.0	15,594	6,250	6,380	130	17.6	918.8	4,673,
Yah-ta-hey Jct.	9.13	3.41	40.9	31,161	6,380	6,560	180	35.1	1273.8	
Gamerco Hill	5.46	2.64	31.6	20,482	6,560	6,490	-70	31.6	0.0	
Gallup Jct.	5.46	2.64	31.6	15,072	6,490	6,477	-13	23.3	36.4	
Church Rock	0.95	1.10	13.2	46,041	6,477	6,660	183	185.6	228.1	9,491,

456,518 Total Pipeline Length(ft.)
86.46 Total Pipeline Length (Miles)

10,096

Chapter Community	Total Capital Cost Reservoir / WTP $(10)	Total Capital Cost Pump $(8)	Total Capital Cost Storage $(5)	Total Capital Cost Pipe Diameter used (in.)	Total Capital Cost Pipe-Common $(11)	Total Capital Cost Pipe-Rock $(11)	Total Capital Cost Total $	Annual Energy Cost $	Annual O&M Cost $
Gallegos Reservoir	$38,037,430						$38,037,430	$228,225	$2,282,246
WTP	$49,816,237	$297,025	$0	56	$173,806	$22,702	$50,309,769	$301,448	$2,075,851
Huerfano Jct.		$51,149	$0	52	$719,155	$93,774	$864,079	$16,365	$6,111
Burnham		$1,211,807	$0	50	$8,740,667	$1,138,839	$11,091,313	$388,192	$97,870
Lake Valley		$0	$0	50	$11,100,088	$1,446,253	$12,546,338	$0	$62,732
Naschitti Jct.		$143,688	$0	48	$11,257,130	$1,465,623	$12,866,440	$46,029	$69,361
Tohatchi		$2,174,501	$1,296,675	46	$11,672,354	$1,518,638	$16,662,168	$696,582	$204,802
Coyote Cyn. Jct.		$796,306	$0	44	$4,711,388	$612,596	$6,120,287	$255,069	$58,472
Twin Lakes		$562,322	$962,421	42	$2,003,236	$260,328	$3,788,307	$180,135	$72,306
Yah-ta-hey Jct.		$779,576	$0	42	$4,003,004	$520,205	$5,302,784	$249,730	$53,799
Gamerco Hill		$0	$0	32	$1,998,788	$259,480	$2,258,268	$0	$11,291
Gallup Jct.		$22,267	$0	32	$1,470,840	$190,942	$1,684,049	$7,133	$9,200
Church Rock		$139,603	$2,305,200	14	$2,080,654	$275,386	$4,800,844	$44,721	$109,572
Sub-Total	$87,853,667	$6,178,242	$4,564,296		$59,931,105	$7,804,766	$186,332,077	$2,185,444	$2,831,368
Capital Cost	$87,853,667	$6,178,242	$4,564,296		$59,931,105	$7,804,766	$186,332,077		
Contingency Cost	20%						$33,266,415		
Mobilization Cost	10%						$16,633,208		
Indirect Cost	27%						$44,909,661		
Totals							$281,141,360		

NOTES:

1). NAVAJO 1990 POPULATION FROM CENSUS DATA FROM THE "CHAPTER IMAGES, 1996 EDITION, DIVISION OF COMMUNITY DEVELOPMENT"
2). GALLUP DEMANDS ARE 7,3[illegible] AF PER YEAR FOR THE YEAR 2040
3) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
4.) ASSUME 709 AF PER YEAR FOR NAPI. NAPI DELIVERY WILL BE AT THE WTP FACILITY. SHIPROCK LATERALS DEMANDS AT THE WTP ALSO (3,741 AF/YR).
5) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON AVG DAILY DEMAND - GW PROD * 5 DAYS. COST FROM THE 1998 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.
STORAGE DEMANDS ARE ONLY MET FOR TOHATCHI, MEXICAN SPRINGS, TWIN LAKES, MANUELITO, AND CHURCH ROCK CHAPTERS, SINCE THEY FALL ON THE MAIN LINE TO GALLUP.
6) ASSUME GALLON / DAY PEAKING FACTOR OF: 1.30 EXCEPT FOR NAPI DEMANDS WHICH IS 1.0 P.F.
7) ASSUME VELOCITY = 4 FEET PER SECOND FROM (HKM ASSOCIATES, 1999)
8). ASSUME 3000HP PER PUMP FROM (HKM ASSOCIATES, 1999). COST INDEXED TO 2000 ($613/HP) ASSUME PUMPING EFFICIENCY AT: 70%
9). HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
10). BASED ON KNOWN ANALYSIS BASED ON BID COSTS FROM MSE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COST OF: $49,816,237
11) PIPE INSTALLED COST FROM KNOWN ANALYSIS BASED ON BOR-PN 1999 DOLLARS. ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.
12) GALLEGOS RESERVOIR IS ASSUMED TO BE 1,600 AF PLUS CAPACITY. 1998 COST ESTIMATE FROM USBR INDEXED TO 2000. $38,037,430
13). ANNUAL ENERGY COST BASED ON INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING BASED ON $0.06 PER KILOWATT HOUR.
14). ANNUAL O&M COST BASED ON: WTP COST: BOR O&M COST, INTAKE/RESERVOIR COST * 6%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%.
15). MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.
16). INDIRECT COST INCLUDE FACILITATING 1%, TERO 2%, CONTRACT ADMIN 1%, ENVIRON. 2%, EASEMENTS 1%, GEOCHEM 0.5%, ARCHEOL 0.5%, DESIGN SURVEY 1%, INVEST 2%, DESIGN 8%, AND CONSTRUCTION OBSER. 10%.

Navajo - Gallup Water Supply Project - NIIP Alternative

(Cost Estimate for Lateral Waterline from Gallegos/WTP to Huerfano, Nageezi, Pueblo Pintado, Torreon)

Chapter Community	Populations (1) 1990	Populations 2040	Daily Demand (3,4) Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Annual Ground Water Production Est. 2040 Prod. Ac-Ft	Annual Ground Water Production Est. GW Dev. Cost $$	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	Peak Daily Demand cfs	Cummulative Flow cfs
Huerfano Jct.	0	0	0	0	0	$0	0	0	0.00	6.1
Huerfano	511	1,739	278,289	59	31	$0	281	325,799	0.50	6.1
Nageezi	981	3,339	534,250	31	15	$0	583	677,117	1.05	5.6
Counselor	2,447	8,329	1,332,631	5	31	$0	1,462	1,696,442	2.62	4.6
Torreon	1,960	6,671	1,067,412	113	76	$0	1,120	1,299,432	2.01	2.0

20,079 2040 Population Served **$0** **3,446 Total Annual Demand(AF)**

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Pipeline Dimensions Diameter ft.	Pipeline Dimensions Diameter inches	Pipeline Dimensions Length ft.	Elevation Beginning ft.	Elevation Ending ft.	Elevation Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal
Huerfano Jct.	1.55	1.40	16.8	0	6,010	6,010	0	0.0	0.0	[illegible]
Huerfano	1.55	1.40	16.8	98,788	6,010	6,803	793	297.5	1093.6	1,253,07
Nageezi	1.42	1.35	16.1	61,308	6,803	6,947	144	211.6	327.8	2,604,29
Counselor	1.16	1.21	14.6	105,773	6,947	6,800	-147	365.1	163.9	5,002,35
Torreon	0.50	0.80	9.6	85,396	6,800	6,692	-108	508.5	130.5	4,997,81

351,265 Total Pipeline Length(ft.)
66.53 Total Pipeline Length (Miles)
1,716

Total Capital Cost	Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Huerfano Jct.	$0	$0	$0	18	$0	$0	$0
Huerfano		$669,279	$320,423	18	$5,579,730	$731,560	$7,300,992
Nageezi		$200,493	$962,421	16	$3,115,144	$410,084	$4,688,141
Counselor		$100,306	$1,296,675	16	$5,374,472	$707,506	$7,478,961
Torreon		$79,881	$1,296,675	10	$2,912,223	$392,204	$4,680,983
Sub-Total	$0	$1,049,960	$3,876,194		$16,981,570	$2,241,353	$24,149,077
Capital Cost	$0	$1,049,960	$3,876,194		$16,981,570	$2,241,353	$24,149,077
Contingency Cost	20%						$4,829,815
Mobilization Cost	10%						$2,414,908
Indirect Cost	27%						$6,520,251
Totals							$37,914,051

Annual Energy Cost

Treatment	$0
Pump Stations	$336,345
	$336,345

Annual Operation and Maintanence Cost

Treatment	$0
Pump Stations	$41,998
Storage Tanks	$155,048
Conveyance Pipe	$96,115
	$293,161
Total	**$629,506**

NOTES:

1). ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993
2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON AVG DAILY DEMAND - GW PROD. * 5 DAYS, COST FROM THE 1999 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.
4) ASSUME GALLON / DAY PEAKING FACTOR OF: 1.30
5) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1990)
6) ASSUME $600/HP PER PUMP FROM (HKM ASSOCIATES, 1990), COST INDEXED TO 2000 ($612/HP) ASSUME PUMPING EFFICIENCY AT: 70%
7) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA (DUCTILE IRON FRICTION COEFFIECENT)
8) BASED ON NNDWR ANALYSIS BASED ON BID COSTS FROM MSE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COST OF: $0
9) PIPE INSTALLED COST FROM NNDWR ANALYSIS BASED ON BOR-PIA(1999 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.
10) ANNUAL ENERGY COST BASED ON: INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING BASED ON $0.06 PER KILOWATT HOUR.
11) ANNUAL O&M COST BASED ON: WTP COST: BOR O&M COST, INTAKE/RESERVOIR COST * 5%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%
12) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.
13) INDIRECT COST INLUDE FACILITATING 1%, TERO 2%, CONTRACT ADMIN. 1%, ENVIRON. 2%, EASEMENTS 1%, GEOCHEM. 0.5%, ARCHEOL. 0.5%, DESIGN SURVEY 1%, INVEST. 2%, DESIGN 6%, AND CONSTRUCTION OBSER. 10%

Navajo - Gallup Water Supply Project - NIIP Alternative

(Cost Estimate for Lateral Waterline to Red Rock NTUA Water line)

Chapter Community	Populations(1,2) (1) 1990	2040	Daily Demand Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Est. 2040 Prod. Ac-Ft	Est. GW Dev. Cost $$	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	cfs	Cummu... Flo... cfs
Gallup Jct.	0	0	0	0	0	$0	0	0	0.00	
Red Rock	3,815	12,985	2,077,640	78	138	$0	2,189	2,540,774	3.93	

12,985 2040 Population Served $0 2,189 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Elevation Beginning ft.	Ending ft.	Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Stora... Dema... (5) Ga...
Gallup Jct.	0.98	1.12	13.4	0	6,490	6,490	0	0.0	0.0	
Red Rock	0.98	1.12	13.4	26,320	6,490	6,750	260	106.1	233.3	9,77...

26,320 Total Pipeline Length(ft.)
4.98 Total Pipeline Length (Miles)
233

	Total Capital Cost Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Gallup Jct.	$0	$0		14	$0	$0	$0
Red Rock		$142,760	$2,305,200	14	$1,189,436	$157,429	$3,794,825
Sub-Total	$0	$142,760	$2,305,200		$1,189,436	$157,429	$3,794,825
Capital Cost	$0	$142,760	$2,305,200		$1,189,436	$157,429	$3,794,825
Contingency Cost	20%						$758,965
Mobilization Cost	10%						$379,482
Indirect Cost	27%						$1,024,603
Totals							$5,957,875

Annual Energy Cost	
Treatment	$0
Pump Stations	$45,732
	$45,732
Annual Operation and Maintanence C...	
Treatment	$0
Pump Stations	$5,710
Storage Tanks	$92,208
Conveyance Pipe	$6,734
	$104,653
Total	$150,385

NOTES :

1) ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1990
2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON AVG DAILY DEMAND - GW PROD * 5 DAYS. COST FROM THE 1993 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.
4) RED ROCK DEMANDS INCLUDE RED ROCK, BREADSPRINGS, CHICHILTAH CHAPTERS.
5) ASSUME GALLON / DAY PEAKING FACTOR OF: 1.30
6) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1990)
7) ASSUME $500/HP PER PUMP FROM (HKM ASSOCIATES, 1990); COST INDEXED TO 2000 ($612/HP) ASSUME PUMPING EFFICIENCY AT 70%
8) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
9) BASED ON NNDWR ANALYSIS BASED ON BID COSTS FROM MSE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COS $0
10) PIPE INSTALLED COST FROM NNDWR ANALYSIS BASED ON BOR-PIA(1999 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION
11) ANNUAL ENERGY COST BASED ON: INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING BASED ON $0.06 PER KILOWATT HOUR.
12) ANNUAL O&M COST BASED ON: WTP COST, BOR O&M COST, INTAKE/RESERVOIR COST * 6%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%.
13) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%, ADDITIONAL CONTINGENCY COST AT 20%.
14) INDIRECT COST INLUCE FACILITATING 1%, TERO 2%, CONTRACT ADMIN 1%, ENVIRON 2%, EASEMENTS 1%, GEOCHEM 0.5%, ARCHEOL 0.5%, DESIGN SURVEY 1%, INVEST 2%, DESIGN 6%, AND CONSTRUCTION OBSER. 10%

Navajo - Gallup Water Supply Project - NIIP Alternative

(Cost Estimate for Lateral Waterline to Coyote Canyon, Standing Rock, and Dalton Pass NTUA Water Line)

Chapter Community	Populations(1,2)		Daily Demand	Annual Ground Water Production			Annual Demand Minus Production	Peak Daily Demand		Cummulative Flow
	(1) 1990	2040	Gal.	1998 Prod. Ac-Ft	Est. 2040 Prod. Ac-Ft	Est. GW Dev. Cost $$	Ac-Ft	Gal./Day(6)	cfs	cfs
oyote Cyn. Jct.	0	0	0	0	0	$0	0	0	0.00	4.44
oyote Canyon	1,234	4,200	672,034	32	61	$0	692	802,849	1.24	4.44
tanding Rock	251	854	136,694	34	77	$0	76	88,339	0.14	3.20
alton Pass	3,802	12,941	2,070,561	263	614	$0	1,705	1,979,142	3.06	3.06

17,996 2040 Population Served $0 2,473 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions				Elevation			Headloss due to friction	Pump Horsepower	Storage Demands
	Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Beginning ft.	Ending ft.	Change ft.	(9) ft.	HP	(5) Gal
oyote Cyn. Jct.	1.11	1.19	14.3	0	6,250	6,250	0	0.0	0.0	0
oyote Canyon	1.11	1.19	14.3	35,938	6,250	6,160	-90	144.8	39.5	3,087,881
tanding Rock	0.80	1.01	12.1	81,321	6,160	6,280	120	391.9	265.4	339,764
alton Pass	0.77	0.99	11.8	37,996	6,280	6,740	460	183.1	319.2	7,612,083

155,257 Total Pipeline Length(ft.) 624

29.40 Total Pipeline Length (Miles)

	Total Capital Cost								
	Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $	Annual Energy Cost	
oyote Cyn. Jct.	$0	$0	$0	14	$0	$0	$0	Treatment	$0
oyote Canyon		$24,164	$962,421	14	$1,624,086	$214,957	$2,825,628	Pump Stations	$122,364
tanding Rock		$162,452	$212,078	12	$3,222,079	$429,588	$4,026,197		
alton Pass		$195,363	$1,728,900	12	$1,505,547	$200,729	$3,630,539		$122,364
								Annual Operation and Maintanence Cost	
Sub-Total	$0	$381,979	$2,903,399		$6,351,712	$845,273	$10,482,364	Treatment	$0
								Pump Stations	$15,279
apital Cost	$0	$381,979	$2,903,399		$6,351,712	$845,273	$10,482,364	Storage Tanks	$116,136
ontingency Cost	20%						$2,096,473	Conveyance Pipe	$35,985
obilization Cost	10%						$1,048,236		$187,400
ndirect Cost	27%						$2,830,238		
Totals							$16,457,311	Total	$289,764

NOTES:

1) ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993

2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.

3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON AVG DAILY DEMAND - GW PROD * 5 DAYS. COST FROM THE 1993 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.

4) DALTON PASS DEMANDS INCLUDE DALTON PASS, CROWNPOINT, LITTLEWATER, BECENTI, LAKE VALLEY, AND WHITEROCK CHAPTERS.

5) ASSUME GALLON/DAY PEAKING FACTOR OF 1.30

6) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1980)

7) ASSUME $300/HP PER PUMP FROM (HKM ASSOCIATES, 1980). COST INDEXED TO 2000 ($612/HP) ASSUME PUMPING EFFICIENCY 70%

8) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)

9) BASED ON NNDWR ANALYSIS BASED ON BID COSTS FROM MSE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP C $0

10) PIPE INSTALLED COST FROM NNDWR ANALYSIS BASED ON BOR-PIA(1999 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.

11) ANNUAL ENERGY COST BASED ON: INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING: BASED ON $0.06 PER KILOWATT HOUR

12) ANNUAL O&M COST BASED ON: WTP COST: BOR O&M COST, INTAKE/RESERVOIR COST * 6%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%.

13) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.

14) INDIRECT COST INCLUDE FACILITATING 1%, TERO 2%, CONTRACT ADMIN. 1%, ENVIRON. 2%, EASEMENTS 1%, GEOCHEM 0.5%, ARCHEOL. 0.5%, DESIGN SURVEY 1%, INVEST. 2%, DESIGN 8%, AND CONSTRUCTION OBSER. 10%.

Navajo - Gallup Water Supply Project - NIIP Alternative

(Cost Estimate for Main Waterline from Yahtahey to Rock Springs and Window Rock)

Chapter Community	Populations (1) 1990	Populations 2040	Daily Demand (2,3,4) Gal.	Annual Ground Water Production: 1998 Prod. Ac-Ft	Est. 2040 Prod. Ac-Ft	Est. GW Dev. Cost $$	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	Peak Daily Demand cfs	Cumm... Flo... cf...
Ya-ta-hey Jct.	0	0	0	0	0	$0	0	0	0.00	
Rock Springs	3,118	10,613	1,698,056	58	123	$0	1,779	2,064,723	3.19	
Window Rock	11,767	40,052	6,408,281	1,043	767	$0	6,412	7,440,612	11.51	

50,665 2040 Population Served $0 8,191 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions: Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Elevation: Beginning ft.	Ending ft.	Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Stor... Dem... (5 G...
Ya-ta-hey Jct.	3.68	2.16	26.0	0	6,560	6,560	0	0.0	0.0	
Rock Springs	3.68	2.16	26.0	29,439	6,560	6,760	200	57.9	614.7	7,9...
Window Rock	2.88	1.91	23.0	58,887	6,760	6,760	0	127.0	237.0	28,6...

88,326 Total Pipeline Length(ft.)
16.73 Total Pipeline Length (Miles)
852

Total Capital Cost

	Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (In.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Ya-ta-hey Jct.	$0	$0	$0	26	$0	$0	$0
Rock Springs		$376,203	$1,728,900	26	$2,345,352	$304,981	$4,755,436
Window Rock		$145,049	$6,339,300	24	$4,345,622	$565,779	$11,395,750
Sub-Total	$0	$521,252	$8,068,200		$6,690,974	$870,760	$16,151,187
Capital Cost	$0	$521,252	$8,068,200		$6,690,974	$870,760	$16,151,187
Contingency Cost	20%						$3,230,237
Mobilization Cost	10%						$1,615,119
Indirect Cost	27%						$4,360,820
Totals							$25,357,363

Annual Energy Cost	
Treatment	$0
Pump Stations	$166,979
	$166,979
Annual Operation and Maintanence ...	
Treatment	$0
Pump Stations	$20,850
Storage Tanks	$322,728
Conveyance Pipe	$37,809
	$381,387
Total	$548,365

NOTES :

1) ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993
2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON AVG DAILY DEMAND - GW PROD * 5 DAYS. COST FROM THE 1990 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.
4) ROCK SPRINGS DEMANDS INCLUDE ROCK SPRINGS, TSAYATOH, AND MANUELITO CHAPTERS. WINDOW ROCK INCLUDES ST. MICHAELS AND FT. DEFIANCE CHAPTERS.
5) ASSUME GALLON / DAY PEAKING FACTOR OF: 1.30
6) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1993)
7) ASSUME 1000HP PER PUMP FROM (HKM ASSOCIATES, 1993), COST INDEXED TO 2000 ($612/HP) ASSUME PUMPING EFFICIENCY AT: 70%
8) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
9) BASED ON NNDWR ANALYSIS BASED ON BID COSTS FROM [illegible], MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COST C $0
10) PIPE INSTALLED COST FROM NNDWR ANALYSIS BASED ON BOR-PIA(1999 DOLLARS). ASSUMME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION
11) ANNUAL ENERGY COST BASED ON INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING BASED ON $0.05 PER KILOWATT HOUR
12) ANNUAL O&M COST BASED ON: WTP COST: BOR O&M COST, INTAKE/RESERVOIR COST * 8%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%
13) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%
14) INDIRECT COST INLUDE FACILITATING:1%, TERO:2%, CONTRACT ADMIN:1%, ENVIRON:2%, EASEMENTS:1%, GEOCHEM:0.5%, ARCHEOL:0.5%, DESIGN SURVEY:1%, INVEST.:2%, DESIGN: 6%, AND CONSRUCTION OBSER.:10%.

Navajo - Gallup Water Supply Project - NIIP Alternative

(Cost Estimate for Lateral Waterline from mainline to Naschiti, Sheepsprings, Newcomb, Two Grey Hills, Sanostee)

Chapter Community	Populations (1) 1990	Populations 2040	Daily Demand (3,4) Gal.	Annual Ground Water Production 1998 Prod. Ac-Ft	Annual Ground Water Production Est. 2040 Prod. Ac-Ft	Annual Ground Water Production Est. GW Dev. Cost $$	Annual Demand Minus Production Ac-Ft	Peak Daily Demand Gal./Day(6)	Peak Daily Demand cfs	Cummulative Flow cfs
Naschitti Jct.	0	0	0	0	0	$0	0	0	0.00	5.77
Naschitti	1,539	5,238	838,136	82	77	$0	862	1,000,213	1.55	5.77
Sheepsprings	660	2,248	359,434	0	15	$0	386	449,858	0.70	4.22
Newcomb	1,534	5,221	835,413	680	89	$0	847	982,746	1.52	3.53
Sanostee	2,081	7,083	1,133,308	89	153	$0	1,117	1,295,734	2.00	2.00

19,789 2040 Population Served $0 3,213 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions Area sq.ft.(7)	Pipeline Dimensions Diameter ft.	Pipeline Dimensions Diameter inches	Pipeline Dimensions Length ft.	Elevation Beginning ft.	Elevation Ending ft.	Elevation Change ft.	Headloss due to friction (9) ft.	Pump Horsepower HP	Storage Demands (5) Gal
Naschitti Jct.	1.44	1.36	16.3	0	5,695	5,895	0	0.0	0.0	0
Naschitti	1.44	1.36	16.3	51,679	5,895	5,890	195	178.4	349.2	3,846,974
Sheepsprings	1.06	1.16	13.9	29,635	5,890	5,883	-7	119.4	76.9	1,730,217
Newcomb	0.88	1.06	12.7	51,174	5,883	5,550	-333	206.3	0.0	3,779,794
Sanostee	0.50	0.80	9.6	51,019	5,550	5,580	30	303.8	108.5	4,983,591

183,507 Total Pipeline Length(ft.) 535

34.76 Total Pipeline Length (Miles)

Total Capital Cost	Water Treatment $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (in.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Naschitti Jct.	$0	$0	$0	16	$0	$0	$0
Naschitti		$213,688	$962,421	16	$2,625,881	$345,678	$4,147,667
Sheepsprings		$47,087	$599,352	14	$1,339,245	$177,257	$2,162,941
Newcomb		$0	$962,421	14	$2,312,622	$306,089	$3,581,131
Sanostee		$66,386	$1,296,675	10	$1,739,879	$234,318	$3,337,259
Sub-Total	$0	$327,161	$3,820,869		$8,017,627	$1,063,340	$13,228,997
Capital Cost	$0	$327,161	$3,820,869		$8,017,627	$1,063,340	$13,228,997
Contingency Cost	20%						$2,645,799
Mobilization Cost	10%						$1,322,900
Indirect Cost	27%						$3,571,829
Totals							$20,769,526

Annual Energy Cost	
Treatment	$0
Pump Stations	$104,803
	$104,803
Annual Operation and Maintanence Cost	
Treatment	$0
Pump Stations	$13,086
Storage Tanks	$152,835
Conveyance Pipe	$40,088
	$206,009
Total	$310,813

NOTES :

1). ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993
2) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2040 PROJECTED DEMANDS.
3) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON AVG DAILY DEMAND - GW PROD * 5 DAYS. COST FROM THE 1999 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.
4) ASSUME GALLON / DAY PEAKING FACTOR OF 1.30
5) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1999)
6). ASSUME 350HP PER PUMP FROM (HKM ASSOCIATES, 1999). COST INDEXED TO 2000 ($612/HP) ASSUME PUMPING EFFICIENCY AT : 70%
7). HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFICIENT)
8). BASED ON NNDWR ANALYSIS BASED ON BID COSTS FROM MSE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COST $0
9) PIPE INSTALLED COST FROM NNDWR ANALYSIS BASED ON BOR-FA(1999 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION
10). ANNUAL ENERGY COST BASED ON INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING BASED ON $0.06 PER KILOWATT HOUR
11). ANNUAL O&M COST BASED ON: WTP COST: BOR O&M COST, INTAKE/RESERVOIR COST * 5%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%.
12). MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.
13). INDIRECT COST INCLUDE FACILITATING 1%, TERO 2%, CONTRACT ADMIN. 1%, ENVIRON. 2%, EASEMENTS 1%, GEOCHEM 3.5%, ARCHEOL. 0.5%, DESIGN SURVEY 1%, INVEST. 2%, DESIGN 8%, AND CONSTRUCTION OBSER. 10%.

Navajo - Gallup Water Supply Project - NIIP Alternative

(Cost Estimate for Lateral to Shiprock/666 Jct. from Gallegos Reservoir)

Chapter Community	2040 Shiprock Populations		Daily Demand	Annual Ground Water Production			Annual Demand Minus Production	Peak Daily Demand		Cumm… Flo…
	Total Population	Population Served	Gal.	1998 Prod. Ac-Ft	Est. 2040 Prod. Ac-Ft	Est. GW Dev. Cost $$	Ac-Ft	Gal./Day(6)	cfs	cf…
WTP	0	0	0	0	0	$0	0	0	0.00	
Hogback	0	0	0	0	0	$0	0	0	0.00	
Shiprock	46,985	20,873	3,339,749	0	0	$0	3,741	4,341,674	6.72	

4.34 MGD

20,873 2040 Population Served

3,741 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions				Elevation			Headloss due to friction	Horsepower	Stor… Dema…
	Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Beginning ft.	Ending ft.	Change ft.	(9) ft.	HP	(5) Ga…
WTP	1.68	1.46	17.5	0	6,010	6,010	0	0.0	0.0	
Hogback	1.68	1.46	17.5	139,824	6,010	5,400	-610	421.1	0.0	
Shiprock	1.68	1.46	17.5	55,532	5,400	5,164	-236	167.2	0.0	

195,356 Total Pipeline Length(ft.)

37.00 Total Pipeline Length (Miles)

0

	Total Capital Cost							Annual	
	Reservoir / WTP $(10)	Pump $(8)	Storage $(5)	Pipe Diameter used (In.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $	Energy Cost $	O&M Cost $
WTP	$0	$0	$0	18	$0	$0	$0	$0	$0
Hogback		$0	$0	18	$7,897,520	$1,035,446	$8,932,966	$0	$44,665
Shiprock		$0	$0	18	$3,136,551	$411,234	$3,547,785	$0	$17,739
Sub-Total	$0	$0	$0		$11,034,071	$1,446,680	$12,480,751	$0	$62,404
Capital Cost	$0	$0	$0		$11,034,071	$1,446,680	$12,480,751		
Contingency Cost	20%						$2,496,150		
Mobilization Cost	10%						$1,248,075		
Indirect Cost	27%						$3,369,803		
Totals							$19,594,779		

NOTES :

1) NAVAJO 1990 POPULATION FROM CENSUS DATA FROM THE "CHAPTER IMAGES, 1992 EDITION, DIVISION OF COMMUNITY DEVELOPMENT"
2) GALLUP DEMANDS ARE 4,300 AF PER YEAR FOR THE YEAR 2010.
3) ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2010 PROJECTED DEMANDS.
4) ASSUME NO PIPELINE DEMANDS FOR NAPI, SINCE THEIR DEMANDS ARE MET VIA NIIP CANALS.
5) ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON 2,000 GAL./HOUSEHOLD @ 4.5 PERSONS/HOUSEHOLD. COST FROM THE 1999 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS. STORAGE DEMANDS ARE ONLY MET FOR BURNHAM, NASCHITTI, TOHATCHI, MEXICAN SPRINGS, AND TWIN LAKES CHAPTERS, SINCE THEY FALL ON THE MAIN LINE TO GALLUP.
6) ASSUME GALLON / DAY PEAKING FACTOR OF: 1.30
7) ASSUME VELOCITY =4 FEET PER SECOND FROM (HKM ASSOCIATES, 1999)
8) ASSUME $800/HP PER PUMP FROM (HKM ASSOCIATES, 1999), COST INDEXED TO 2000 ($819/HP) ASSUME PUMPING EFFICIENCY AT : 70%
9) HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA (DUCTILE IRON FRICTION COEFFICIENT)
10) BASED ON NNOWR ANALYSIS BASED ON BID COSTS FROM MSE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP COST ($5,119,511
11) PIPE INSTALLED COST FROM NNOWR ANALYSIS BASED ON BOR PLA(1999 DOLLARS). ASSUME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.
12) GALLEGOS RESERVOIR IS ASSUMED TO BE 8,300 AF PLUS CAPACITY, 1996 COST ESTIMATE FROM USBR INDEXED TO 2000. $0
13) ANNUAL ENERGY COST BASED ON INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING BASED ON $0.06 PER KILOWATT HOUR.
14) ANNUAL O&M COST BASED ON: WTP COST; BOR O&M COST, INTAKE/RESERVOIR COST * 5%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%
15) MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.
16) INDIRECT COST INLUDE FACILITATING:1%, TERO:2%, CONTRACT ADMIN.:1%, ENVIRON.:2%, EASEMENTS:1%, GEOCHEM:0.5%, ARCHEOL.:0.5%, DESIGN SURVEY:1%, INVEST.:2%, DESIGN: 6%, AND CONSTRUCTION OBSER.:10%

Navajo - Gallup Water Supply Project - NIIP Alternative

(Cost Estimate for Lateral Waterline to Manuelito NTUA Water line)

Chapter Community	Populations(1,2)		Daily Demand	Annual Ground Water Production			Annual Demand Minus Production	Peak Daily Demand		Cummulativ Flow
	(1) 1990	2040	Gal.	1998 Prod. Ac-Ft	Est. 2040 Prod. Ac-Ft	Est. GW Dev. Cost $$	Ac-Ft	Gal./Day(6)	cfs	cfs
Gallup Jct.	0	0	0	0	0	$0	0	0	0.00	0.6
Manuelito	631	2,148	343,641	78	46	$0	339	393,348	0.61	0.6

2,148 2040 Population Served $0 339 Total Annual Demand(AF)

Chapter Community	Pipeline Dimensions				Elevation			Headloss due to friction	Pump Horsepower	Storage Demands
	Area sq.ft.(7)	Diameter ft.	Diameter inches	Length ft.	Beginning ft.	Ending ft.	Change ft.	(9) ft.	HP	(5) Gal
Gallup Jct.	0.15	0.44	5.3	0	6,477	6,477	0	0.0	0.0	(
Manuelito	0.15	0.44	5.3	47,050	6,477	6,375	-102	506.7	39.9	1,512,87

47,050 Total Pipeline Length(ft.) 40

8.91 Total Pipeline Length (Miles)

	Total Capital Cost						
	Water Treatme $(10)	Pump $(8)	Storage $(5)	Pipe Diamete used (In.)	Pipe-Common $(11)	Pipe-Rock $(11)	Total $
Gallup Jct.	$0	$0		6	$0	$0	$0
Manuelito		$24,434	$599,352	6	$1,092,292	$152,426	$1,868,505
Sub-Total	$0	$24,434	$599,352		$1,092,292	$152,426	$1,868,505
Capital Cost	$0	$24,434	$599,352		$1,092,292	$152,426	$1,868,505
Contingency Cost	20%						$373,701
Mobilization Cost	10%						$186,850
Indirect Cost	27%						$504,496
Totals							$2,933,553

Annual Energy Cost

Treatment	$0
Pump Stations	$7,827
	$7,827

Annual Operation and Maintanence Cost

Treatment	$0
Pump Stations	$977
Storage Tanks	$23,974
Conveyance Pipe	$6,224
	$31,175
Total	$39,002

NOTES :

1). ALL 1990 POPULATIONS FROM "1990 CENSUS POPULATION AND HOUSING CHARACTERISTICS OF THE NAVAJO NATION", 1993

2). ASSUME NAVAJO DEMANDS OF 160 GALLONS PER CAPITA AND BASED ON 2010 PROJECTED DEMANDS.

3). ESTIMATED NAVAJO STORAGE DEMANDS ARE BASED ON AVG DAILY DEMAND - GW PROD * 5 DAYS. COST FROM THE 1999 MEANS HEAVY CONSTRUCTION COST DATA AND INDEXED TO 2000 DOLLARS.

4). RED ROCK DEMANDS INCLUDE RED ROCK, BREADSPRINGS, CHICHILTAH CHAPTERS.

5). ASSUME GALLON / DAY PEAKING FACTOR C 1.30

6). ASSUME VELOCITY =4 FEET PER SECOND FROM (H/CM ASSOCIATES, 1990)

7). ASSUME $500/HP PER PUMP FROM (HKM ASSOCIATES, 1990). COST INDEXED TO 2000 ($612/HP) ASSUME PUMPING EFFICIENC 70%

8). HEAD LOSS BASED ON 4 FEET PER SECOND BASED ON HAZEN-WILLIAMS HEADLOSS FORMULA. (DUCTILE IRON FRICTION COEFFIECENT)

9). BASED ON NNDWR ANALYSIS BASED ON BID COSTS FROM MSE-HKM, MORRISON MAIERLE, & USBOR SOURCES. ASSUME WTP $0

10). PIPE INSTALLED COST FROM NNDWR ANALYSIS BASED ON BOR-PN (1999 DOLLARS). ASSUMME 90% OF PIPE LENGTH IS COMMON AND 10% IS ROCK EXCAVATION.

11). ANNUAL ENERGY COST BASED ON: INTAKE/WTP/RESERVOIR ANNUAL O&M COST * 10%, PUMPING: BASED ON $0.08 PER KILOWATT HOUR

12). ANNUAL O&M COST BASED ON: WTP COST; BOR O&M COST, INTAKE/RESERVOIR COST * 5%, PUMP COST * 4%, STORAGE COST * 4%, PIPELINE COST * 0.5%.

13). MOBILIZATION COST INCLUDES ADDITIONAL MOBILIZATION/PREPARATION AND APPURTENANTS AT 10%. ADDITIONAL CONTINGENCY COST AT 20%.

14). INDIRECT COST INLUDE FACILITATING:1%, TERO:2%, CONTRACT ADMIN.:1%, ENVIRON.:2%, EASEMENTS:1%, GEOCHEM.:0.5%, ACHEOL.:0.5%, DESIGN SURVEY:1%, INVEST.:2%, DESIGN: 8%, AND CONSRUCTION OBSER.:10%.

Navajo-Gallup Water Supply Project

APPENDIX E
UPPER BASIN DEPLETION SCHEDULES

Navajo-Gallup M&I Demands for Year 2060

17-Jan-01

Service Area	Chapter	Point of Use [1]	1990 Census Pop.	2060 Pop. [2]	2060 SJR Demand [3] (Ac-ft/yr)	2060 G.W. Production [4] (Ac-ft/yr)	2060 SJR Diversion [5] (Ac-ft/yr)	2060 SJR Depletion [6] (Ac-ft/yr)
City of Gallup, NM	City of Gallup [7]	L.C.	19,154	67,698	12,134	6,951	7,500	7,500
Central Area, NM	Burnham	U.C.	246	1,367	245	0	245	245
	Lake Valley	U.C.	436	2,422	434	46	388	388
	White Rock	U.C.	201	1,117	200	see Lk Vly	200	200
	White Horse Lake	U.C.	610	3,389	607	31	577	577
	SUBTOTAL		*1,493*	*8,295*	*1,487*	*77*	*1,410*	*1,410*
Crownpoint, NM	Becenti	U.C.	193	1,072	192	see Crwn Pt.	192	192
	Coyote Canyon	U.C.	1,234	6,856	1,229	61	1,167	1,167
	Crownpoint	U.C.	2,658	14,767	2,647	614	2,033	2,033
	Dalton Pass	U.C.	313	1,739	312	0	311	311
	Little Water	U.C.	638	3,545	635	see Crwn Pt.	635	635
	Standing Rock	U.C.	251	1,394	250	77	173	173
	SUBTOTAL		*5,287*	*29,373*	*5,265*	*752*	*4,512*	*4,512*
Gallup Area, NM	Bread Springs	L.C.	1,219	6,772	1,214	77	1,137	1,137
	Chichiltah	L.C.	1,555	8,639	1,548	see Brd spr.	1,548	1,548
	Church Rock	L.C.	1,780	9,889	1,772	123	1,650	1,650
	Iyanbito	L.C.	974	5,411	970	153	816	816
	Mariano Lake	L.C.	726	4,033	723	92	631	631
	Pinedale	L.C.	609	3,383	606	see Mrno Lk	606	606
	Red Rock	L.C.	1,041	5,783	1,037	61	975	975
	SUBTOTAL		*7,904*	*43,912*	*7,871*	*506*	*7,364*	*7,364*
Huerfano, NM	Huerfano	U.C.	511	2,839	509	31	478	478
	Nageezi	U.C.	981	5,450	977	15	962	962
	SUBTOTAL		*1,492*	*8,289*	*1,486*	*46*	*1,440*	*1,440*
Rock Springs, NM	Manuelito	L.C.	631	3,506	628	46	582	582
	Rock Springs	L.C.	1,685	9,361	1,678	77	1,601	1,601
	Tsayatoh	L.C.	1,433	7,961	1,427	46	1,381	1,381
	SUBTOTAL		*3,749*	*20,828*	*3,733*	*169*	*3,564*	*3,564*
Route 666, NM	Mexican Springs	U.C.	711	3,950	708	see Tohatchi	708	708
	Naschitti	U.C.	1,539	8,550	1,532	77	1,456	1,456
	Newcomb	U.C.	651	3,617	648	12	636	636
	Sanostee	U.C.	2,081	11,561	2,072	153	1,919	1,919
	Sheep Springs	U.C.	660	3,667	657	15	642	642
	Tohatchi	U.C.	1,607	8,928	1,600	307	1,293	1,293
	Twin Lakes	U.C.	1,967	10,928	1,959	153	1,805	1,805
	Two Grey Hills	U.C.	883	4,906	879	77	803	803
	SUBTOTAL		*10,099*	*56,107*	*10,056*	*795*	*9,261*	*9,261*
Torreon, NM	Counselor	U.C.	1,365	7,584	1,359	0	1,359	1,359
	Ojo Encino [8]	R.G.	596	3,311	593	15	578	578
	Pueblo Pintado	U.C.	472	2,622	470	0	470	470
	Torreon [8]	R.G.	1,364	7,578	1,358	61	1,297	1,297
	SUBTOTAL		*3,797*	*21,095*	*3,781*	*77*	*3,704*	*3,704*
San Juan River, NM	Beclabito	U.C.	388	2,156	386	0	386	193
	Cudei	U.C.	495	2,750	493	0	493	246
	Hogback	U.C.	740	4,111	737	0	737	368
	Nenahnezad	U.C.	1,253	6,961	1,248	0	1,248	624
	San Juan	U.C.	540	3,000	538	0	538	269
	Shiprock	U.C.	8,100	45,001	8,066	0	8,066	4,033
	Upper Fruitland	U.C.	2,288	12,711	2,278	0	2,278	1,139
	SUBTOTAL [9]		*13,804*	*76,691*	*13,746*	*4,680*	*9,066*	*4,533*
NAPI Industrial, NM [10]		U.C.	n/a	n/a	7,274	700	700	700
NEW MEXICO UPPER BASIN		*U.C.*	*35,972*	*199,849*	*43,094*	*7,127*	*30,093*	*25,561*
NEW MEXICO LOWER BASIN		*L.C.*	*30,807*	*132,439*	*23,738*	*7,626*	*18,429*	*18,429*
TOTAL NEW MEXICO			*66,779*	*332,288*	*66,832*	*14,753*	*48,522*	*43,989*
Window Rock, AZ	Fort Defiance	L.C.	6,187	34,373	6,161	767	5,394	5,394
	Saint Michaels	L.C.	5,580	31,001	5,556	see Ft. Dfnc.	5,556	5,556
TOTAL ARIZONA [11]		*L.C.*	*11,767*	*65,374*	*11,717*	*767*	*10,950*	*10,950*
PROJECT TOTAL			**78,546**	**397,662**	**78,549**	**15,520**	**59,472**	**54,939**

Notes: Rounding error may cause subtotals to be off by 1

1. U.C.=Upper Colorado Basin, L.C.=Lower Colorado Basin, R.G.=Rio Grande Basin
2. Growth for the City of Gallup is 1.82%. Growth for Navajo Nation is ----- 2.48%
3. Demand is 160 gal/capita/day
4. Estimated sustainable groundwater production
5. Diversions = demand - groundwater use. Gallup limited to 7,500 ac-ft/yr
6. Depletions assume zero return flow and use of sustainable groundwater
7. City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8. Point of use in Rio Grande Basin. Depletions counted towards New Mexico U.C. allocation
9. 4680 Ac-ft/yr of diversion provided from the ALP Project. Assumes a 50% return flow
10. Div. and depl. limited to 700 Ac-ft/yr including 400 Ac-ft/yr for proposed french fry factory
11. Depletions counted towards Arizona L.C. allocation

Navajo-Gallup M&I Demands for Year 2000

17-Jan-01

Service Area	Chapter	Point of Use [1]	1990 Census Pop.	2000 Pop. [2]	2000 SJR Demand [3] (Ac-ft/yr)	2000 G.W. Production [4] (Ac-ft/yr)	2000 SJR Diversion [5] (Ac-ft/yr)	2000 SJR Depletion [6] (Ac-ft/yr)
City of Gallup, NM	City of Gallup [7]	L.C.	19,154	22,940	4,112	4,335	0	0
Central Area, NM	Burnham	U.C.	246	314	56	0	56	56
	Lake Valley	U.C.	436	557	100	22	78	78
	White Rock	U.C.	201	257	46	see Lk Vly	46	46
	White Horse Lake	U.C.	610	779	140	5	135	135
	SUBTOTAL		*1,493*	*1,907*	*342*	*27*	*315*	*315*
Crownpoint, NM	Becenti	U.C.	193	247	44	see Crwn Pt.	44	44
	Coyote Canyon	U.C.	1,234	1,577	283	32	250	250
	Crownpoint	U.C.	2,658	3,396	609	263	346	346
	Dalton Pass	U.C.	313	400	72	0	71	71
	Little Water	U.C.	638	815	146	see Crwn Pt.	146	146
	Standing Rock	U.C.	251	321	57	34	23	23
	SUBTOTAL		*5,287*	*6,755*	*1,211*	*330*	*881*	*881*
Gallup Area, NM	Bread Springs	L.C.	1,219	1,557	279	43	236	236
	Chichiltah	L.C.	1,555	1,987	356	unknown	356	356
	Church Rock	L.C.	1,780	2,274	408	58	350	350
	Iyanbito	L.C.	974	1,244	223	unknown	223	223
	Mariano Lake	L.C.	726	928	166	122	44	44
	Pinedale	L.C.	609	778	139	see Mrno Lk	139	139
	Red Rock	L.C.	1,041	1,330	238	35	203	203
	SUBTOTAL		*7,904*	*10,098*	*1,810*	*258*	*1,552*	*1,552*
Huerfano, NM	Huerfano	U.C.	511	653	117	59	58	58
	Nageezi	U.C.	981	1,253	225	31	194	194
	SUBTOTAL		*1,492*	*1,906*	*342*	*90*	*251*	*251*
Rock Springs, NM	Manuelito	L.C.	631	806	144	unknown	144	144
	Rock Springs	L.C.	1,685	2,153	386	40	346	346
	Tsayatoh	L.C.	1,433	1,831	328	18	310	310
	SUBTOTAL		*3,749*	*4,790*	*858*	*58*	*801*	*801*
Route 666, NM	Mexican Springs	U.C.	711	908	163	42	121	121
	Naschitti	U.C.	1,539	1,966	352	82	270	270
	Newcomb	U.C.	651	832	149	13	136	136
	Sanostee	U.C.	2,081	2,659	477	89	388	388
	Sheep Springs	U.C.	660	843	151	12	139	139
	Tohatchi	U.C.	1,607	2,053	368	137	231	231
	Twin Lakes	U.C.	1,967	2,513	450	87	363	363
	Two Grey Hills	U.C.	883	1,128	202	55	147	147
	SUBTOTAL		*10,099*	*12,902*	*2,313*	*518*	*1,794*	*1,794*
Torreon, NM	Counselor	U.C.	1,365	1,744	313	0	313	313
	Ojo Encino [8]	R.G.	596	761	136	21	115	115
	Pueblo Pintado	U.C.	472	603	108	0	108	108
	Torreon [8]	R.G.	1,364	1,743	312	92	221	221
	SUBTOTAL		*3,797*	*4,851*	*869*	*113*	*757*	*757*
San Juan River, NM	Beclaibito	U.C.	388	496	89	0	89	44
	Cudei	U.C.	495	632	113	0	113	57
	Hogback	U.C.	740	945	169	0	169	85
	Nenahnezad	U.C.	1,253	1,601	287	0	287	143
	San Juan	U.C.	540	690	124	0	124	62
	Shiprock	U.C.	8,100	10,348	1,855	0	1,855	927
	Upper Fruitland	U.C.	2,288	2,923	524	0	524	262
	SUBTOTAL [9]		*13,804*	*17,636*	*3,161*	*0*	*3,161*	*1,580*
NAPI Industrial, NM [10]		U.C.	n/a	n/a	7,274	0	0	0
NEW MEXICO UPPER BASIN & R.G		*U.C.*	*35,972*	*45,957*	*15,511*	*1,078*	*7,159*	*5,578*
NEW MEXICO LOWER BASIN		*L.C.*	*30,807*	*37,828*	*6,780*	*4,651*	*2,352*	*2,352*
TOTAL NEW MEXICO			*66,779*	*83,785*	*22,291*	*5,730*	*9,511*	*7,931*
Window Rock, AZ	Fort Defiance	L.C.	6,187	7,904	1,417	1,043	374	374
	Saint Michaels	L.C.	5,580	7,129	1,278	see Ft. Dfnc.	1,278	1,278
TOTAL ARIZONA [11]		*L.C.*	*11,767*	*15,033*	*2,695*	*1,043*	*1,652*	*1,652*
PROJECT TOTAL			**78,546**	**98,818**	**24,986**	**6,772**	**11,163**	**9,583**

Notes: Rounding error may cause subtotals to be off by 1

1 U.C.=Upper Colorado Basin, L.C.=Lower Colorado Basin, R.G.=Rio Grande Basin
2 Growth for the City of Gallup is 1.82%. Growth for Navajo Nation is — 2.48%
3 Demand is 160 gal/capita/day
4 Estimated sustainable groundwater production
5 Diversions = demand - groundwater use. Gallup limited to 7,500 ac-ft/yr
6 Depletions assume zero return flow and use of sustainable groundwater
7 City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8 Point of use in Rio Grande Basin. Depletions counted towards New Mexico U.C. allocation
9 4680 Ac-ft/yr of diversion provided from the ALP Project. Assumes a 50% return flow
10 Div. and depl. limited to 700 Ac-ft/yr including 400 Ac-ft/yr for proposed french fry factory
11 Depletions counted towards Arizona L.C. allocation

Navajo-Gallup M&I Demands for Year 2010

17-Jan-01

Service Area	Chapter	Point of Use [1]	1990 Census Pop.	2010 Pop. [2]	2010 SJR Demand [3] (Ac-ft/yr)	2010 G.W. Production [4] (Ac-ft/yr)	2010 SJR Diversion [5] (Ac-ft/yr)	2010 SJR Depletion [6] (Ac-ft/yr)
City of Gallup, NM	City of Gallup [7]	L.C.	19,154	27,474	4,924	0	7,500	7,500
Central Area, NM	Burnham	U.C.	246	402	72	0	72	72
	Lake Valley	U.C.	436	712	128	28	99	99
	White Rock	U.C.	201	328	59	see Lk Vly	59	59
	White Horse Lake	U.C.	610	996	178	12	167	167
	SUBTOTAL		*1,493*	*2,437*	*437*	*40*	*397*	*397*
Crownpoint, NM	Becenti	U.C.	193	315	56	see Crwn Pt.	56	56
	Coyote Canyon	U.C.	1,234	2,014	361	40	321	321
	Crownpoint	U.C.	2,658	4,338	778	351	427	427
	Dalton Pass	U.C.	313	511	92	0	91	91
	Little Water	U.C.	638	1,041	187	see Crwn Pt.	187	187
	Standing Rock	U.C.	251	410	73	45	29	29
	SUBTOTAL		*5,287*	*8,630*	*1,547*	*435*	*1,111*	*1,111*
Gallup Area, NM	Bread Springs	L.C.	1,219	1,990	357	51	305	305
	Chichiltah	L.C.	1,555	2,538	455	see Brd spr.	455	455
	Church Rock	L.C.	1,780	2,905	521	74	447	447
	Iyanbito	L.C.	974	1,590	285	38	247	247
	Mariano Lake	L.C.	726	1,185	212	115	98	98
	Pinedale	L.C.	609	994	178	see Mrno Lk	178	178
	Red Rock	L.C.	1,041	1,699	305	42	263	263
	SUBTOTAL		*7,904*	*12,901*	*2,312*	*320*	*1,992*	*1,992*
Huerfano, NM	Huerfano	U.C.	511	834	149	52	97	97
	Nageezi	U.C.	981	1,601	287	27	260	260
	SUBTOTAL		*1,492*	*2,435*	*436*	*79*	*357*	*357*
Rock Springs, NM	Manuelito	L.C.	631	1,030	185	12	173	173
	Rock Springs	L.C.	1,685	2,750	493	49	444	444
	Tsayatoh	L.C.	1,433	2,339	419	25	394	394
	SUBTOTAL		*3,749*	*6,119*	*1,097*	*85*	*1,011*	*1,011*
Route 666, NM	Mexican Springs	U.C.	711	1,161	208	see Tohatchi	208	208
	Naschitti	U.C.	1,539	2,512	450	81	370	370
	Newcomb	U.C.	651	1,063	190	13	178	178
	Sanostee	U.C.	2,081	3,397	609	105	504	504
	Sheep Springs	U.C.	660	1,077	193	13	180	180
	Tohatchi	U.C.	1,607	2,623	470	180	290	290
	Twin Lakes	U.C.	1,967	3,211	575	104	472	472
	Two Grey Hills	U.C.	883	1,441	258	61	198	198
	SUBTOTAL		*10,099*	*16,484*	*2,955*	*556*	*2,399*	*2,399*
Torreon, NM	Counselor	U.C.	1,365	2,228	399	0	399	399
	Ojo Encino [8]	R.G.	596	973	174	20	155	155
	Pueblo Pintado	U.C.	472	770	138	0	138	138
	Torreon [8]	R.G.	1,364	2,226	399	84	315	315
	SUBTOTAL		*3,797*	*6,198*	*1,111*	*104*	*1,007*	*1,007*
San Juan River, NM	Beclaibito	U.C.	388	633	114	0	114	57
	Cudei	U.C.	495	808	145	0	145	72
	Hogback	U.C.	740	1,208	216	0	216	108
	Nenahnezad	U.C.	1,253	2,045	367	0	367	183
	San Juan	U.C.	540	881	158	0	158	79
	Shiprock	U.C.	8,100	13,221	2,370	0	2,370	1,185
	Upper Fruitland	U.C.	2,288	3,735	669	0	669	335
	SUBTOTAL [9]		*13,804*	*22,531*	*4,038*	*4,680*	*0*	*0*
NAPI Industrial, NM [10]		U.C.	n/a	n/a	7,274	400	400	400
NEW MEXICO UPPER BASIN		*U.C.*	*35,972*	*58,715*	*17,798*	*6,294*	*5,672*	*5,672*
NEW MEXICO LOWER BASIN		*L.C.*	*30,807*	*46,494*	*8,333*	*406*	*10,503*	*10,503*
TOTAL NEW MEXICO			*66,779*	*105,209*	*26,131*	*6,700*	*16,175*	*16,175*
Window Rock, AZ	Fort Defiance	L.C.	6,187	10,099	1,810	974	836	836
	Saint Michaels	L.C.	5,580	9,108	1,632	see Ft. Dfnc.	1,632	1,632
TOTAL ARIZONA [11]		*L.C.*	*11,767*	*19,206*	*3,442*	*974*	*2,469*	*2,469*
PROJECT TOTAL			**78,546**	**124,416**	**29,574**	**7,673**	**18,644**	**18,644**

Notes: Rounding error may cause subtotals to be off by 1

1 U.C.=Upper Colorado Basin, L.C.=Lower Colorado Basin, R.G.=Rio Grande Basin
2 Growth for the City of Gallup is 1.82%. Growth for Navajo Nation is — 2.48%
3 Demand is 160 gal/capita/day
4 Estimated sustainable groundwater production
5 Diversions = demand - groundwater use. Gallup limited to 7,500 ac-ft/yr
6 Depletions assume zero return flow and use of sustainable groundwater
7 City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8 Point of use in Rio Grande Basin. Depletions counted towards New Mexico U.C. allocation
9 4680 Ac-ft/yr of diversion provided from the ALP Project. Assumes a 50% return flow
10 Div. and depl. limited to 700 Ac-ft/yr including 400 Ac-ft/yr for proposed french fry factory
11 Depletions counted towards Arizona L.C. allocation

Navajo-Gallup M&I Demands for Year 2020

17-Jan-01

Service Area	Chapter	Point of Use [1]	1990 Census Pop.	2020 Pop. [2]	2020 SJR Demand [3] (Ac-ft/yr)	2020 G.W. Production [4] (Ac-ft/yr)	2020 SJR Diversion [5] (Ac-ft/yr)	2020 SJR Depletion [6] (Ac-ft/yr)
City of Gallup, NM	City of Gallup [7]	L.C.	19,154	32,904	5,898	0	7,500	7,500
Central Area, NM	Burnham	U.C.	246	513	92	0	92	92
	Lake Valley	U.C.	436	909	163	34	129	129
	White Rock	U.C.	201	419	75	see Lk Vly	75	75
	White Horse Lake	U.C.	610	1,272	228	18	210	210
	SUBTOTAL		*1,493*	*3,113*	*558*	*52*	*506*	*506*
Crownpoint, NM	Becenti	U.C.	193	402	72	see Crwn Pt.	72	72
	Coyote Canyon	U.C.	1,234	2,573	461	47	414	414
	Crownpoint	U.C.	2,658	5,543	993	438	555	555
	Dalton Pass	U.C.	313	653	117	0	117	117
	Little Water	U.C.	638	1,330	238	see Crwn Pt.	238	238
	Standing Rock	U.C.	251	523	94	55	38	38
	SUBTOTAL		*5,287*	*11,025*	*1,976*	*541*	*1,435*	*1,435*
Gallup Area, NM	Bread Springs	L.C.	1,219	2,542	456	60	396	396
	Chichiltah	L.C.	1,555	3,243	581	see Brd spr.	581	581
	Church Rock	L.C.	1,780	3,712	665	90	575	575
	Iyanbito	L.C.	974	2,031	364	77	287	287
	Mariano Lake	L.C.	726	1,514	271	107	164	164
	Pinedale	L.C.	609	1,270	228	see Mrno Lk	228	228
	Red Rock	L.C.	1,041	2,171	389	48	341	341
	SUBTOTAL		*7,904*	*16,482*	*2,954*	*382*	*2,572*	*2,572*
Huerfano, NM	Huerfano	U.C.	511	1,066	191	45	146	146
	Nageezi	U.C.	981	2,046	367	23	343	343
	SUBTOTAL		*1,492*	*3,111*	*558*	*68*	*489*	*489*
Rock Springs, NM	Manuelito	L.C.	631	1,316	236	23	213	213
	Rock Springs	L.C.	1,685	3,514	630	58	571	571
	Tsayatoh	L.C.	1,433	2,988	536	32	504	504
	SUBTOTAL		*3,749*	*7,818*	*1,401*	*113*	*1,288*	*1,288*
Route 666, NM	Mexican Springs	U.C.	711	1,483	266	see Tohatchi	266	266
	Naschitti	U.C.	1,539	3,209	575	79	496	496
	Newcomb	U.C.	651	1,358	243	12	231	231
	Sanostee	U.C.	2,081	4,340	778	121	657	657
	Sheep Springs	U.C.	660	1,376	247	14	233	233
	Tohatchi	U.C.	1,607	3,351	601	222	378	378
	Twin Lakes	U.C.	1,967	4,102	735	120	615	615
	Two Grey Hills	U.C.	883	1,841	330	66	264	264
	SUBTOTAL		*10,099*	*21,060*	*3,775*	*635*	*3,139*	*3,139*
Torreon, NM	Counselor	U.C.	1,365	2,846	510	0	510	510
	Ojo Encino [8]	R.G.	596	1,243	223	18	205	205
	Pueblo Pintado	U.C.	472	984	176	0	176	176
	Torreon [8]	R.G.	1,364	2,844	510	77	433	433
	SUBTOTAL		*3,797*	*7,918*	*1,419*	*95*	*1,324*	*1,324*
San Juan River, NM	Beclaibito	U.C.	388	809	145	0	145	73
	Cudei	U.C.	495	1,032	185	0	185	93
	Hogback	U.C.	740	1,543	277	0	277	138
	Nenahnezad	U.C.	1,253	2,613	468	0	468	234
	San Juan	U.C.	540	1,126	202	0	202	101
	Shiprock	U.C.	8,100	16,891	3,027	0	3,027	1,514
	Upper Fruitland	U.C.	2,288	4,771	855	0	855	428
	SUBTOTAL [9]		*13,804*	*28,786*	*5,159*	*4,680*	*479*	*240*
NAPI Industrial, NM [10]		U.C.	n/a	n/a	7,274	500	500	500
NEW MEXICO UPPER BASIN		*U.C.*	*35,972*	*75,013*	*20,719*	*6,571*	*7,874*	*7,634*
NEW MEXICO LOWER BASIN		*L.C.*	*30,807*	*57,205*	*10,253*	*496*	*11,360*	*11,360*
TOTAL NEW MEXICO			*66,779*	*132,218*	*30,972*	*7,067*	*19,234*	*18,994*
Window Rock, AZ	Fort Defiance	L.C.	6,187	12,902	2,312	905	1,408	1,408
	Saint Michaels	L.C.	5,580	11,636	2,086	see Ft. Dfnc.	2,086	2,086
TOTAL ARIZONA [11]		*L.C.*	*11,767*	*24,538*	*4,398*	*905*	*3,493*	*3,493*
PROJECT TOTAL			**78,546**	**156,756**	**35,370**	**7,972**	**22,727**	**22,487**

Notes: Rounding error may cause subtotals to be off by 1

1 U.C.=Upper Colorado Basin, L.C.=Lower Colorado Basin, R.G.=Rio Grande Basin
2 Growth for the City of Gallup is 1.82%. Growth for Navajo Nation is ---- 2.48%
3 Demand is 160 gal/capita/day
4 Estimated sustainable groundwater production
5 Diversions = demand - groundwater use. Gallup limited to 7,500 ac-ft/yr
6 Depletions assume zero return flow and use of sustainable groundwater
7 City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8 Point of use in Rio Grande Basin. Depletions counted towards New Mexico U.C. allocation
9 4680 Ac-ft/yr of diversion provided from the ALP Project. Assumes a 50% return flow
10 Div. and depl. limited to 700 Ac-ft/yr including 400 Ac-ft/yr for proposed french fry factory
11 Depletions counted towards Arizona L.C. allocation

Navajo-Gallup M&I Demands for Year 2030

17-Jan-01

Service Area	Chapter	Point of Use [1]	1990 Census Pop.	2030 Pop. [2]	2030 SJR Demand [3] (Ac-ft/yr)	2030 G.W. Production [4] (Ac-ft/yr)	2030 SJR Diversion [5] (Ac-ft/yr)	2030 SJR Depletion [6] (Ac-ft/yr)
City of Gallup, NM	City of Gallup [7]	L.C.	19,154	39,408	7,063	0	7,500	7,500
Central Area, NM	Burnham	U.C.	246	655	117	0	117	117
	Lake Valley	U.C.	436	1,162	208	40	168	168
	White Rock	U.C.	201	536	96	see Lk Vly	96	96
	White Horse Lake	U.C.	610	1,625	291	24	267	267
	SUBTOTAL		*1,493*	*3,978*	*713*	*64*	*649*	*649*
Crownpoint, NM	Becenti	U.C.	193	514	92	see Crwn Pt.	92	92
	Coyote Canyon	U.C.	1,234	3,288	589	54	535	535
	Crownpoint	U.C.	2,658	7,081	1,269	526	743	743
	Dalton Pass	U.C.	313	834	149	0	149	149
	Little Water	U.C.	638	1,700	305	see Crwn Pt.	305	305
	Standing Rock	U.C.	251	669	120	66	54	54
	SUBTOTAL		*5,287*	*14,086*	*2,525*	*647*	*1,878*	*1,878*
Gallup Area, NM	Bread Springs	L.C.	1,219	3,248	582	68	514	514
	Chichiltah	L.C.	1,555	4,143	743	see Brd spr.	743	743
	Church Rock	L.C.	1,780	4,742	850	107	743	743
	Iyanbito	L.C.	974	2,595	465	115	350	350
	Mariano Lake	L.C.	726	1,934	347	100	247	247
	Pinedale	L.C.	609	1,622	291	see Mrno Lk	291	291
	Red Rock	L.C.	1,041	2,773	497	55	442	442
	SUBTOTAL		*7,904*	*21,058*	*3,774*	*444*	*3,330*	*3,330*
Huerfano, NM	Huerfano	U.C.	511	1,361	244	38	206	206
	Nageezi	U.C.	981	2,614	468	19	449	449
	SUBTOTAL		*1,492*	*3,975*	*712*	*57*	*655*	*655*
Rock Springs, NM	Manuelito	L.C.	631	1,681	301	35	267	267
	Rock Springs	L.C.	1,685	4,489	805	68	737	737
	Tsayatoh	L.C.	1,433	3,818	684	39	645	645
	SUBTOTAL		*3,749*	*9,988*	*1,790*	*141*	*1,649*	*1,649*
Route 666, NM	Mexican Springs	U.C.	711	1,894	340	see Tohatchi	340	340
	Naschitti	U.C.	1,539	4,100	735	78	657	657
	Newcomb	U.C.	651	1,734	311	12	299	299
	Sanostee	U.C.	2,081	5,544	994	137	856	856
	Sheep Springs	U.C.	660	1,758	315	15	301	301
	Tohatchi	U.C.	1,607	4,281	767	265	503	503
	Twin Lakes	U.C.	1,967	5,240	939	137	802	802
	Two Grey Hills	U.C.	883	2,352	422	71	350	350
	SUBTOTAL		*10,099*	*26,906*	*4,822*	*715*	*4,107*	*4,107*
Torreon, NM	Counselor	U.C.	1,365	3,637	652	0	652	652
	Ojo Encino [8]	R.G.	596	1,588	285	17	268	268
	Pueblo Pintado	U.C.	472	1,257	225	0	225	225
	Torreon [8]	R.G.	1,364	3,634	651	69	582	582
	SUBTOTAL		*3,797*	*10,116*	*1,813*	*86*	*1,727*	*1,727*
San Juan River, NM	Beclaibito	U.C.	388	1,034	185	0	185	93
	Cudei	U.C.	495	1,319	236	0	236	118
	Hogback	U.C.	740	1,971	353	0	353	177
	Nenahnezad	U.C.	1,253	3,338	598	0	598	299
	San Juan	U.C.	540	1,439	258	0	258	129
	Shiprock	U.C.	8,100	21,580	3,868	0	3,868	1,934
	Upper Fruitland	U.C.	2,288	6,096	1,093	0	1,093	546
	SUBTOTAL [9]		*13,804*	*36,776*	*6,592*	*4,680*	*1,912*	*956*
NAPI Industrial, NM [10]		U.C.	n/a	n/a	7,274	600	600	600
NEW MEXICO UPPER BASIN		*U.C.*	*35,972*	*95,836*	*24,451*	*6,849*	*11,528*	*10,572*
NEW MEXICO LOWER BASIN		*L.C.*	*30,807*	*70,454*	*12,628*	*585*	*12,479*	*12,479*
TOTAL NEW MEXICO			*66,779*	*166,290*	*37,079*	*7,434*	*24,007*	*23,052*
Window Rock, AZ	Fort Defiance	L.C.	6,187	16,483	2,954	836	2,118	2,118
	Saint Michaels	L.C.	5,580	14,866	2,665	see Ft. Dfnc.	2,665	2,665
TOTAL ARIZONA [11]		*L.C.*	*11,767*	*31,349*	*5,619*	*836*	*4,783*	*4,783*
PROJECT TOTAL			**78,546**	**197,639**	**42,698**	**8,270**	**28,790**	**27,834**

Notes: Rounding error may cause subtotals to be off by 1

1. U.C.=Upper Colorado Basin, L.C.=Lower Colorado Basin, R.G.=Rio Grande Basin
2. Growth for the City of Gallup is 1.82%. Growth for Navajo Nation is —— 2.48%
3. Demand is 160 gal/capita/day
4. Estimated sustainable groundwater production
5. Diversions = demand - groundwater use. Gallup limited to 7,500 ac-ft/yr
6. Depletions assume zero return flow and use of sustainable groundwater
7. City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8. Point of use in Rio Grande Basin. Depletions counted towards New Mexico U.C. allocation
9. 4680 Ac-ft/yr of diversion provided from the ALP Project. Assumes a 50% return flow
10. Div. and depl. limited to 700 Ac-ft/yr including 400 Ac-ft/yr for proposed french fry factory
11. Depletions counted towards Arizona L.C. allocation

Navajo-Gallup M&I Demands for Year 2040

17-Jan-01

Service Area	Chapter	Point of Use [1]	1990 Census Pop.	2040 Pop. [2]	2040 SJR Demand [3] (Ac-ft/yr)	2040 G.W. Production [4] (Ac-ft/yr)	2040 SJR Diversion [5] (Ac-ft/yr)	2040 SJR Depletion [6] (Ac-ft/yr)
City of Gallup, NM	City of Gallup [7]	L.C.	19,154	47,197	8,459	1,439	7,500	7,500
Central Area, NM	Burnham	U.C.	246	837	150	0	150	150
	Lake Valley	U.C.	436	1,484	266	46	220	220
	White Rock	U.C.	201	684	123	see Lk Vly	123	123
	White Horse Lake	U.C.	610	2,076	372	31	341	341
	SUBTOTAL		*1,493*	*5,082*	*911*	*77*	*834*	*834*
Crownpoint, NM	Becenti	U.C.	193	657	118	see Crwn Pt.	118	118
	Coyote Canyon	U.C.	1,234	4,200	753	61	691	691
	Crownpoint	U.C.	2,658	9,047	1,622	614	1,008	1,008
	Dalton Pass	U.C.	313	1,065	191	0	191	191
	Little Water	U.C.	638	2,172	389	see Crwn Pt.	389	389
	Standing Rock	U.C.	251	854	153	77	76	76
	SUBTOTAL		*5,287*	*17,996*	*3,225*	*752*	*2,473*	*2,473*
Gallup Area, NM	Bread Springs	L.C.	1,219	4,149	744	77	667	667
	Chichiltah	L.C.	1,555	5,293	949	see Brd spr.	949	949
	Church Rock	L.C.	1,780	6,059	1,086	123	963	963
	Iyanbito	L.C.	974	3,315	594	153	441	441
	Mariano Lake	L.C.	726	2,471	443	92	351	351
	Pinedale	L.C.	609	2,073	372	see Mrno Lk	372	372
	Red Rock	L.C.	1,041	3,543	635	61	574	574
	SUBTOTAL		*7,904*	*26,903*	*4,822*	*506*	*4,316*	*4,316*
Huerfano, NM	Huerfano	U.C.	511	1,739	312	31	281	281
	Nageezi	U.C.	981	3,339	598	15	583	583
	SUBTOTAL		*1,492*	*5,078*	*910*	*46*	*864*	*864*
Rock Springs, NM	Manuelito	L.C.	631	2,148	385	46	339	339
	Rock Springs	L.C.	1,685	5,735	1,028	77	951	951
	Tsayatoh	L.C.	1,433	4,878	874	46	828	828
	SUBTOTAL		*3,749*	*12,761*	*2,287*	*169*	*2,118*	*2,118*
Route 666, NM	Mexican Springs	U.C.	711	2,420	434	see Tohatchi	434	434
	Naschitti	U.C.	1,539	5,238	939	77	862	862
	Newcomb	U.C.	651	2,216	397	12	385	385
	Sanostee	U.C.	2,081	7,083	1,270	153	1,116	1,116
	Sheep Springs	U.C.	660	2,246	403	15	387	387
	Tohatchi	U.C.	1,607	5,470	980	307	673	673
	Twin Lakes	U.C.	1,967	6,695	1,200	153	1,047	1,047
	Two Grey Hills	U.C.	883	3,005	539	77	462	462
	SUBTOTAL		*10,099*	*34,374*	*6,161*	*795*	*5,366*	*5,366*
Torreon, NM	Counselor	U.C.	1,365	4,646	833	0	833	833
	Ojo Encino [8]	R.G.	596	2,029	364	15	348	348
	Pueblo Pintado	U.C.	472	1,607	288	0	288	288
	Torreon [8]	R.G.	1,364	4,643	832	61	771	771
	SUBTOTAL		*3,797*	*12,924*	*2,316*	*77*	*2,240*	*2,240*
San Juan River, NM	Beclaibito	U.C.	388	1,321	237	0	237	118
	Cudei	U.C.	495	1,685	302	0	302	151
	Hogback	U.C.	740	2,519	451	0	451	226
	Nenahnezad	U.C.	1,253	4,265	764	0	764	382
	San Juan	U.C.	540	1,838	329	0	329	165
	Shiprock	U.C.	8,100	27,570	4,942	0	4,942	2,471
	Upper Fruitland	U.C.	2,288	7,788	1,396	0	1,396	698
	SUBTOTAL [9]		*13,804*	*46,985*	*8,421*	*4,680*	*3,741*	*1,871*
NAPI Industrial, NM [10]		U.C.	n/a	n/a	7,274	700	700	700
NEW MEXICO UPPER BASIN		*U.C.*	*35,972*	*122,439*	*29,219*	*7,127*	*16,219*	*14,348*
NEW MEXICO LOWER BASIN		*L.C.*	*30,807*	*86,861*	*15,568*	*2,114*	*13,934*	*13,934*
TOTAL NEW MEXICO			*66,779*	*209,300*	*44,788*	*9,241*	*30,153*	*28,282*
Window Rock, AZ	Fort Defiance	L.C.	6,187	21,059	3,774	767	3,007	3,007
	Saint Michaels	L.C.	5,580	18,993	3,404	see Ft. Dfnc.	3,404	3,404
TOTAL ARIZONA [11]		*L.C.*	*11,767*	*40,052*	*7,179*	*767*	*6,411*	*6,411*
PROJECT TOTAL			**78,546**	**249,352**	**51,967**	**10,008**	**36,564**	**34,693**

Notes: Rounding error may cause subtotals to be off by 1

1 U.C.=Upper Colorado Basin, L.C.=Lower Colorado Basin, R.G.=Rio Grande Basin
2 Growth for the City of Gallup is 1.82%. Growth for Navajo Nation is ----- 2.48%
3 Demand is 160 gal/capita/day
4 Estimated sustainable groundwater production
5 Diversions = demand - groundwater use. Gallup limited to 7,500 ac-ft/yr
6 Depletions assume zero return flow and use of sustainable groundwater
7 City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8 Point of use in Rio Grande Basin. Depletions counted towards New Mexico U.C. allocation
9 4680 Ac-ft/yr of diversion provided from the ALP Project. Assumes a 50% return flow
10 Div. and depl. limited to 700 Ac-ft/yr including 400 Ac-ft/yr for proposed french fry factory
11 Depletions counted towards Arizona L.C. allocation

Navajo-Gallup M&I Demands for Year 2050

17-Jan-01

Service Area	Chapter	Point of Use [1]	1990 Census Pop.	2050 Pop. [2]	2050 SJR Demand [3] (Ac-ft/yr)	2050 G.W. Production [4] (Ac-ft/yr)	2050 SJR Diversion [5] (Ac-ft/yr)	2050 SJR Depletion [6] (Ac-ft/yr)
City of Gallup, NM	City of Gallup [7]	L.C.	19,154	56,526	10,131	3,947	7,500	7,500
Central Area, NM	Burnham	U.C.	246	1,070	192	0	192	192
	Lake Valley	U.C.	436	1,896	340	46	294	294
	White Rock	U.C.	201	874	157	see Lk Vly	157	157
	White Horse Lake	U.C.	610	2,653	475	31	445	445
	SUBTOTAL		*1,493*	*6,492*	*1,164*	*77*	*1,087*	*1,087*
Crownpoint, NM	Becenti	U.C.	193	839	150	see Crwn Pt.	150	150
	Coyote Canyon	U.C.	1,234	5,366	962	61	900	900
	Crownpoint	U.C.	2,658	11,559	2,072	614	1,458	1,458
	Dalton Pass	U.C.	313	1,361	244	0	244	244
	Little Water	U.C.	638	2,774	497	see Crwn Pt.	497	497
	Standing Rock	U.C.	251	1,091	196	77	119	119
	SUBTOTAL		*5,287*	*22,991*	*4,121*	*752*	*3,369*	*3,369*
Gallup Area, NM	Bread Springs	L.C.	1,219	5,301	950	77	873	873
	Chichiltah	L.C.	1,555	6,762	1,212	see Brd spr.	1,212	1,212
	Church Rock	L.C.	1,780	7,740	1,387	123	1,265	1,265
	Iyanbito	L.C.	974	4,236	759	153	606	606
	Mariano Lake	L.C.	726	3,157	566	92	474	474
	Pinedale	L.C.	609	2,648	475	see Mrno Lk	475	475
	Red Rock	L.C.	1,041	4,527	811	61	750	750
	SUBTOTAL		*7,904*	*34,371*	*6,161*	*506*	*5,654*	*5,654*
Huerfano, NM	Huerfano	U.C.	511	2,222	398	31	368	368
	Nageezi	U.C.	981	4,266	765	15	749	749
	SUBTOTAL		*1,492*	*6,488*	*1,163*	*46*	*1,117*	*1,117*
Rock Springs, NM	Manuelito	L.C.	631	2,744	492	46	446	446
	Rock Springs	L.C.	1,685	7,327	1,313	77	1,237	1,237
	Tsayatoh	L.C.	1,433	6,232	1,117	46	1,071	1,071
	SUBTOTAL		*3,749*	*16,303*	*2,922*	*169*	*2,753*	*2,753*
Route 666, NM	Mexican Springs	U.C.	711	3,092	554	see Tohatchi	554	554
	Naschitti	U.C.	1,539	6,692	1,200	77	1,123	1,123
	Newcomb	U.C.	651	2,831	507	12	495	495
	Sanostee	U.C.	2,081	9,049	1,622	153	1,469	1,469
	Sheep Springs	U.C.	660	2,870	514	15	499	499
	Tohatchi	U.C.	1,607	6,988	1,253	307	946	946
	Twin Lakes	U.C.	1,967	8,554	1,533	153	1,380	1,380
	Two Grey Hills	U.C.	883	3,840	688	77	611	611
	SUBTOTAL		*10,099*	*43,916*	*7,871*	*795*	*7,076*	*7,076*
Torreon, NM	Counselor	U.C.	1,365	5,936	1,064	0	1,064	1,064
	Ojo Encino [8]	R.G.	596	2,592	465	15	449	449
	Pueblo Pintado	U.C.	472	2,053	368	0	368	368
	Torreon [8]	R.G.	1,364	5,931	1,063	61	1,002	1,002
	SUBTOTAL		*3,797*	*16,512*	*2,959*	*77*	*2,883*	*2,883*
San Juan River, NM	Beclaibito	U.C.	388	1,687	302	0	302	151
	Cudei	U.C.	495	2,153	386	0	386	193
	Hogback	U.C.	740	3,218	577	0	577	288
	Nenahnezad	U.C.	1,253	5,449	977	0	977	488
	San Juan	U.C.	540	2,348	421	0	421	210
	Shiprock	U.C.	8,100	35,223	6,313	0	6,313	3,157
	Upper Fruitland	U.C.	2,288	9,950	1,783	0	1,783	892
	SUBTOTAL [9]		*13,804*	*60,028*	*10,759*	*4,680*	*6,079*	*3,040*
NAPI Industrial, NM [10]		U.C.	n/a	n/a	7,274	700	700	700
NEW MEXICO UPPER BASIN		*U.C.*	*35,972*	*156,427*	*35,311*	*7,127*	*22,311*	*19,271*
NEW MEXICO LOWER BASIN		*L.C.*	*30,807*	*107,200*	*19,214*	*4,622*	*15,907*	*15,907*
TOTAL NEW MEXICO			*66,779*	*263,626*	*54,525*	*11,749*	*38,218*	*35,178*
Window Rock, AZ	Fort Defiance	L.C.	6,187	26,905	4,822	767	4,055	4,055
	Saint Michaels	L.C.	5,580	24,265	4,349	see Ft. Dfnc.	4,349	4,349
TOTAL ARIZONA [11]		*L.C.*	*11,767*	*51,170*	*9,171*	*767*	*8,404*	*8,404*
PROJECT TOTAL			**78,546**	**314,796**	**63,697**	**12,516**	**46,622**	**43,583**

Notes: Rounding error may cause subtotals to be off by 1

1 U.C.=Upper Colorado Basin, L.C.=Lower Colorado Basin, R.G.=Rio Grande Basin
2 Growth for the City of Gallup is 1.82%. Growth for Navajo Nation is ----- 2.48%
3 Demand is 160 gal/capita/day
4 Estimated sustainable groundwater production
5 Diversions = demand - groundwater use. Gallup limited to 7,500 ac-ft/yr
6 Depletions assume zero return flow and use of sustainable groundwater
7 City of Gallup plans to recharge aquifer and use groundwater for summer daily peaking
8 Point of use in Rio Grande Basin. Depletions counted towards New Mexico U.C. allocation
9 4680 Ac-ft/yr of diversion provided from the ALP Project. Assumes a 50% return flow
10 Div. and depl. limited to 700 Ac-ft/yr including 400 Ac-ft/yr for proposed french fry factory
11 Depletions counted towards Arizona L.C. allocation