WESTERN NAVAJO WATER SUPPLY PROJECT

LAKE POWELL TO CAMERON ARIZONA

APPRAISAL LEVEL STUDY

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

PHOENIX AREA OFFICE

PHOENIX ARIZONA

AUGUST 1999

SUPPLEMENTAL REPORT 2000

TO THE APPRAISAL LEVEL REVIEW STUDY COMPLETED IN AUGUST 1999

ON THE

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MAY 2000

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CHAPTER 1 - GENERAL

NAVAJO NATION - WESTERN PIPELINE PROJECT
SUPPLEMENTAL REPORT 2000

CHAPTER 1 - GENERAL

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1.1 Introduction: This is a supplement to the Bureau of Reclamation's Phoenix Area Office appraisal level study on the Western Navajo Water Supply Pipeline Project (WNWSPP) entitled, "Navajo Nation's - Western Navajo Water Supply Pipeline Project - Appraisal Level Study," completed in August 1999. The Western Navajo Water Supply Pipeline is the first pipeline section in the "Phase I - North Central Arizona Regional Water Study, (Phase I)" report, which was completed in 1995.

The Western Navajo Water Supply Pipeline begins at Lake Powell and ends at Cameron, Arizona. The distribution points for the proposed Western Navajo Water Supply Pipeline are LeChee, Coppermine, Bitter Springs, Cedar Ridge, Bodaway/Gap, and Cameron, AZ.

In February 2000, the Bureau of Reclamation Phoenix Area Office completed an appraisal level peer review study on the entire Phase I report, which included the Western Navajo Water Supply Pipeline, entitled, "Water Delivery System Analyses - Appraisal Level Peer Review Study of the Arizona Department of Water Resources, Phase I - North Central Arizona Regional Water Study."

This supplemental report reevaluates the costs established in the WNWSPP August 1999 study using information obtained during the Appraisal Level Peer Review of the Phase I Report completed in February 2000. The additional information included updated information on pipeline excavation practices, and additional construction considerations of the narrow canyon between Explosive Rock and Bitter Springs.

This supplemental report evaluates the costs for operation, maintenance and replacement on an inflation rate of 3-percent and interest rate of 6.625-percent over 40 and 100 year periods.

1.2 Capital Costs:

During the WNWSPP August 1999 study the cost for excavation was based on a combination of rock blasting and normal excavation methods. The rock blasting method was considered for half of the entire pipeline length at a cost of $84.50 per cubic yard, while the remaining excavation was considered to be done under normal methods.

Since the WNWSPP August 1999 study, additional methods of excavation were evaluated. From these methods, rock trenching was considered to be the ideal method because it is faster and the average cost over the entire length of the pipeline was estimated to be $20 per cubic yard.

Comparing the estimated excavation volumes between the blasting and normal excavation volumes estimated in the WNWSPP August 1999 study (256,000 cubic yards of blasting, and 342,000 cubic yards of normal excavation, for a total of 598,000 cubic yards), to the estimated volume using rock trenching (276,000 cubic-yards) indicates that rock trenching would reduce the amount of material removed. Rock trenching resulted in less yardage being disturbed because the side slopes are normally vertical, in lieu of the one-to-one side slopes used in normal excavation practices. By removing less yardage also lowered the bedding and backfill volumes required, which added to the lower construction costs.

The WNWSPP August 1999 study analyzed two sizes of the pipeline from Lake Powell to Explosive Rock, 18 inch and 24 inch diameters. For comparison of costs, only the 18-inch diameter pipeline cost from the WNWSPP August 1999 study will be used in this supplemental report.

The WNWSPP August 1999 study, evaluated and estimated the costs for the Supervisory Control and Data Acquisition (S.C.A.D.A.) system, power system and cathodic protection system. However, these costs were not incorporated into the Total Capital costs, the operation, maintenance, and replacement totals, so an equal comparison with the Phase I

report cost could be done. This Supplemental 2000 Report includes the systems in the capital, operation, maintenance, and replacement cost totals.

Water Treatment facilities were estimated in the Phase I and the Appraisal Level Peer review studies, but were not included in the capital, operation, maintenance, and replacement costs. It is apparent that a pre-treatment facility may be required near the delivery system intake, but that a treatment facility, or facilities, will be required for any water that will be used for municipal purposes. It is recommended that the treatment facilities be located at the final distribution points, which would treat only the portion of the delivered water that is to be used for municipal purposes. The estimated total capital cost for the pre-treatment and water treatment facilities is $5 million. However, for the water treatment facilities, this does not include the capital costs for the furnishing and installing a pipeline, to connect the distribution system and the treated water delivery system.

Table S-1 - CAPITAL COSTS

CAPITAL COSTS - 1999 DOLLARS		
FEATURE	**WNWSPP August 1999 Study**	**Supplement Report 2000***
PIPELINE	$41,067,074	$24,900,198
PUMP/MOTOR	$947,468	$947,467
STORAGE	$4,266,861	$4,266,861
STRUCTURES	$425,278	$425,278
WATER TREATMENT		$5,000,000
S.C.A.D.A. SYSTEM		$648,600
POWER SYSTEM		$17,413,352
CATHODIC PROTECTION		$251,917
SUBTOTALS	$46,706,681	$53,853,673
CONTINGENCIES 25%	$11,676,670	$13,463,418
MOBILIZATION 2 %	$934,134	$1,077,073
OTHER (ENGINEERING) 25 %	$11,676,670	$13,463,418
TOTAL	**$70,994,155**	**$81,857,583**

* Includes the CAPITAL costs for the Water Treatment, S.C.A.D.A system, power system, and cathodic protection system.

1.2.1 Capital Costs - Contingencies, Other (Engineering) and Mobilization Costs:

The Phoenix Area Office estimates, for this degree of study, that the percentage for contingencies (unlisted items), and other (Engineering) costs would be approximately 25 percent for each.

The contingency's costs are primarily associated with the construction process, for items that may not have been considered, or not adequately investigated because of the degree of complexity required for this level of study. These costs could include additional work on items such as but not limited to; NEPA studies, right-of way, investigations, design, contract administration, and inspection. However, costs for environmental issues, and obtaining right-of-ways for this project alignment could exceed the estimated percentage due to the locations.

Other engineering costs are considered to be related to the design type features that were not analyzed, because of the degree of complexity required for this level of study and could include items related to the pipeline crossing features similar to, highways, railroads, canyons, valleys, washes, rivers, and/or creeks that could require scour protection, thrust blocks, saddles, or some special structure to protect the pipeline or adjacent structures or features from damage.

The "mobilization" cost is an item used by the Bureau of Reclamation for the purposes of providing for expenses incident to the initiation of construction and discouraging unbalanced bidding. This cost item is intended to compensate the contractors for operations including, but not limited to, the necessary movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of offices, buildings, plants, and other facilities; for payment of bonds; and necessary payments for acquiring equipment. The Bureau of Reclamation normally estimates the mobilization costs to be 5-percent of the total contract value or less. In this report, the Phoenix Area Office selected 2-percent, based on the size and type of construction work to be accomplished.

Non-contract costs: Non-Contract costs are for items of work, similar too but not limited to the following: Environmental, Easements, Geotechnical, Archeological, Investigations (geological, survey and design types), Construction inspection, and Contract Administration, were not included in this study.

1.3 Operations and Maintenance Costs:

The operation and maintenance costs for S.C.A.D.A. system, power system, cathodic protection system and the water treatment facilities, were evaluated by using either, R.S Means, information obtained from other offices, percentages used in the Phase I report, or combination of these sources. For the S.C.A.D.A. system, power system, cathodic protection system, it was estimated that it would cost about 2.5 percent of the systems construction cost for the annual operation and maintenance costs. For the Water Treatment Facilities, the results indicated that 10 percent of the facilities construction cost would give the approximate yearly cost for operation and maintaining the water treatment plant(s).

Table S-2 Compares the operations and maintenance estimated costs from the WNWSPP August 1999 study, and this Supplemental Report 2000.

Table S-2 - ANNUAL OPERATIONS AND MAINTENANCE COSTS

OPERATIONS AND MAINTENANCE COSTS - 1999 DOLLARS		
FEATURE	**WNWSPP August 1999 Study**	**Supplement Report 2000***
OPERATIONS	$532,414	$532,414
MAINTENANCE	$920,000	$920,000
O & M (SCADA,Power,cathodic)		$580,000
O & M (water treatment facilities)		$500,000
FIRST YEAR ANNUAL COST	**$1,452,414**	**$2,532,414**

* Includes the OPERATION and MAINTENANCE costs for the Water Treatment, S.C.A.D.A system, power system, and cathodic protection system.

Table S-3 shows the estimated operation and maintenance costs for the first year of the project, and the present value required to be placed in a "Trust Type" fund to cover the life of the project. The trust type fund costs were based on an inflation rate of 3 percent and a interest rate of 6.625 percent over a 40-year and 100-year period.

Table S-3 - OPERATIONS AND MAINTENANCE COSTS OVER THE LIFE OF THE PROJECT

OPERATION AND MAINTENANCE COSTS OVER THE LIFE OF THE PROJECT COSTS		
FEATURE	**WNWSPP August 1999 Study**	**Supplement 2000 Report***
INFLATION RATE 3-PERCENT; INTEREST RATE 6.625-PERCENT; OVER 40 YEARS		
FIRST YEAR ANNUAL O & M COSTS	$1,425,414	$2,532,414
1999 DOLLAR - TRUST FUND TYPE - O & M FUNDS	**$29,464,414**	**$52,346,964**
INFLATION RATE 3-PERCENT; INTEREST RATE 6.625-PERCENT; OVER 100 YEARS		
FIRST YEAR O AND M COSTS	$1,425,414	$2,532,414
1999 DOLLAR - TRUST FUND TYPE - O & M FUNDS	**$38,084,534**	**$67,661,610**

* Includes the OPERATION and MAINTENANCE costs for the Water Treatment, S.C.A.D.A system, power system, and cathodic protection system.

1.4 Replacement Costs:

The life expectancy of the system was considered to be 40 years. The pumps and motors were estimated to have a 20-year life, and the pipeline and structures were estimated to have a 40-year life. The replacement costs (present value) in Table S-5 are the costs today to reconstruct based on the life expectancy of the system. The annual replacement "Sinking Fund" costs are estimated using 3-percent inflation, and 6.625-percent interest over 40 and 100 years, of project operations.

Table S-4 - REPLACEMENT COSTS

REPLACEMENT COSTS - 1999 DOLLARS		
FEATURE	**WNWSPP August 1999 Study**	**Supplement 2000 Report***
PIPELINE	$20,533,537	$18,781,119
PUMPS/MOTORS	$1,894,936	$1,894,934
STORAGE	$4,266,861	$4,266,861
STRUCTURES	$425,278	$425,278
WATER TREATMENT		$5,000,000
SCADA, POWER, CATHODIC		$18,313,869
TOTALS	**$27,120,612**	**$48,682,061**

* Includes the REPLACEMENT costs for the Water Treatment, S.C.A.D.A system, power system, and cathodic protection system.

Table S-5 - REPLACEMENT'S AMORTIZED COST OVER THE LIFE OF PROJECT COST

AMORTIZED REPLACEMENT COSTS - 1999 DOLLARS		
FEATURE	**WNWSPP August 1999 Study**	**Supplement 2000 Report***
INFLATION RATE 3-PERCENT; INTEREST RATE 6.625-PERCENT; OVER 40 YEAR		
REPLACEMENT COST (PRESENT VALUE)	$27,120,612	$48,682,061
ANNUAL REPLACEMENT "SINKING FUND" 40 YEARS	**$487,910**	**$875,809**
INFLATION RATE 3-PERCENT; INTEREST RATE 6.625-PERCENT; OVER 100 YEAR		
REPLACEMENT COST (PRESENT VALUE)	$67,801,530	$121,705,153
ANNUAL REPLACEMENT "SINKING FUND" 100 YEARS	**$141,565**	**$254,112**

* Includes the REPLACEMENT costs for the Water Treatment, S.C.A.D.A system, power system, and cathodic protection system.

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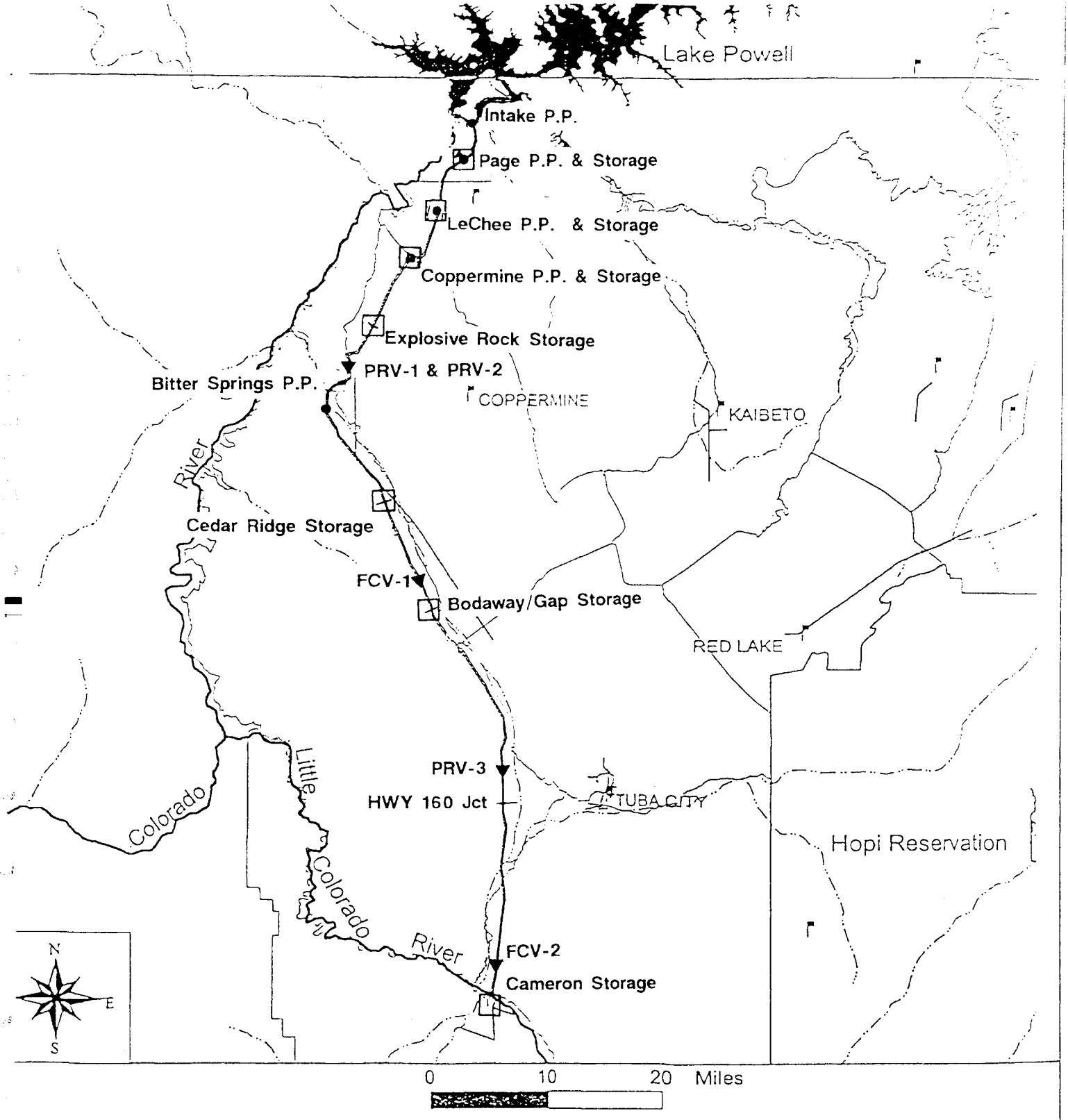
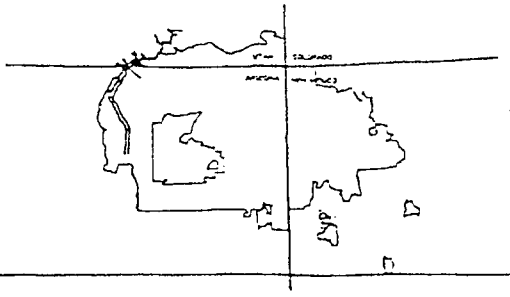


Legend

- Communities
- Chapter Houses
- States
- Existing Waterlines
- Lake Powell
- Western Pipeline
- Washes
- Rivers
- Hopi Reservation
- Chapter Boundaries

Vicinity Map



Western Navajo Pipeline

Lake Powell to Cameron

Figure 1

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NAVAJO NATION - WESTERN PIPELINE PROJECT

CHAPTER 1 - GENERAL

CHAPTER 1 - GENERAL

1.1 General - Introduction and Inputs: This report presents a review of the design and estimated cost of the Navajo Nation's - Western Navajo Water Supply Pipeline Project, which was included as part of the feasibility report titled "North Central Arizona Water Supply Study and Western Pipeline Project" dated May 11, 1995.

The Western Navajo Water Supply Pipeline Project initiates at Lake Powell and ends at Cameron, Arizona. The distribution points for the proposed Western Navajo Water Supply Pipeline Project are LeChee, Coppermine, Bitter Springs, Cedar Ridge, Bodaway/Gap, and Cameron, Arizona.

The following information was taken from the Navajo Nation's 1995 report and used as the basis for this review analysis. The daily water supply demands were estimated using a 2.48 percent annual growth rate to the year 2040. The daily water demand and storage capacities were based on the year 2040 capita, at a daily demand rate of 160 gallons per day per capita, and the storage volume of 2000 gallons per household with 4.5 persons per household. The peak day usage rate used was 2 times the average daily rate.

CHAPTER COMMUNITY	CAPITA	DAILY DEMANDS		STORAGE	PEAK DEMANDS
	YEAR 2040	GALLONS	CFS	GALLONS	CFS
Lake Powell intake					
LeChee	5313	850,117	1.32	2,361,333	2.63
Coppermine	1440	230,365	0.36	640,000	0.71
Bitter Springs	1871	299,360	0.46	831,556	0.93
Cedar Ridge	1871	299,360	0.46	831,556	0.93
Bodaway / Gap	1871	299,360	0.46	831,556	0.93
Cameron	3441	550,558	0.85	1,529,333	1.70
TOTALS	**15,807**		**3.92**		**7.83**

1.2 Cost Indexing to 1999 dollars: The Navajo Nation's 1995 report presented the cost for the Western Pipeline Project in 1995 dollars. Therefore, to adequately compare costs, the Navajo Nation's 1995 report dollars were index to 1999. The "Index cost trend" used, (Appendix D)was prepared by Bureau of Reclamations, Denver Office, indicates that the 1995 dollar multiplied by 1.13, will bring the Navajo Nations 1995 cost estimate up to the 1999 dollar.

	NAVAJO NATION CAPITAL COSTS	
FEATURE	1995 ($)	1999 ($)
INTAKE	$ 2,000,000	$ 2,260,000
PUMPS	$ 332,799	$ 376,063
STORAGE	$ 2,315,040	$ 2,615,995
PIPE	$ 27,183,223	$ 30,717,042
SUBTOTALS	**$ 31,831,062**	**$ 35,969,100**
CONTINGENCIES 20%	$ 6,366,212	$ 7,193,820
MOBILIZATION 2 %	$ 636,621	$ 719,382
OTHER (ENGINEERING) 15 %	$ 4,774,659	$ 5,395,365
TOTALS	**$ 43,608,555**	**$ 49,277,666**

	NAVAJO NATION OPERATIONS AND MAINTENANCE COSTS	
	1995 ($)	1999 ($)
TOTALS	**$ 541,845**	**$ 612,284**

The Navajo Nation's report did not indicate replacement costs to provide for a comparison. Therefore, the replacement costs was estimated by using the Navajo Nation's 1995 capital costs and a life expectancy of 20 years for the pumps and motors and 40 years for the remaining major feature, except for the pipeline. The pipeline replacement costs was based on a life expectancy of 40 years but only for 50 percent of the pipelines capital cost because the future installation would not require rock excavation, as anticipated in the initial installation.

Using the Navajo Nation's 1995 capital costs for the estimated costs for replacement, required the 1995 dollar to be index to 1999 dollars for comparison with the values of this review.

ESTIMATING THE NATION'S REPLACEMENT COST

NATIONS CAPITAL COSTS 1995 ($)		ESTIMATING THE NATIONS TOTAL REPLACEMENT COSTS	
FEATURE	1995 ($)	1995 ($)	1999 ($)
INTAKE	$ 2,000,000	$ 2,000,000	$ 2,260,000
PUMPS	$ 332,799	$ 665,598	$ 752,126
STORAGE	$ 2,315,040	$ 2,315,040	$ 2,615,995
PIPE	$ 27,183,223	$ 13,591,611	$15,358,521
SUBTOTALS	**$ 31,831,062**	**$ 18,572,249**	**$ 20,986,642**

1.3 Cost Comparison -

1.3.1 Cost Comparison - Capital Costs: To compare the capital costs, the Navajo Nation's 1995 Report costs were indexed to 1999 dollars. In addition, the following adjustments were included to adequately compare the Total Capital Cost between the two estimates: To the Navajo Nation's Capital cost a "mobilization cost (2 %)" was added, and to the Bureau of Reclamations cost "other (engineering) costs (15 %)" was added. These items were included as specified for comparison purposes only.

COMPARING CAPITAL COSTS - 1999 DOLLARS

	CAPITAL COSTS ($) MILLIONS		
FEATURE	NATIONS	BOR 18-INCH	BOR 24- INCH
SUBTOTALS	$ 35.97	$ 46.71	$ 49.47
CONTINGENCIES 20%	$ 7.19	$ 9.34	$ 9.89
MOBILIZATION 2 %	$ 0.72	$ .93	$ 0.99
OTHER (ENGINEERING) 15 %	$ 5.40	$ 7.00	$ 7.42
TOTALS	**$ 49.28**	**$ 63.99**	**$ 67.77**

See Appendix B; Tables B-7, B-8 and B-9 for capital cost comparison of individual line items.

1.3.2 Cost Comparison - Operations, and Maintenance Costs:

COMPARING ANNUAL OPERATIONS AND MAINTENANCE - 1999 DOLLARS

	OPERATIONS AND MAINTENANCE COSTS ($) MILLIONS		
	NATIONS	BOR 18-INCH	BOR 24- INCH
TOTALS	**$0.612**	**$1.452**	**$1.436**

See Appendix B; Tables B-6 and B-9.

1.3.3 Cost Comparison - Replacement Costs:

NATIONS ESTIMATED REPLACEMENT COSTS 1999 ($)		RECLAMATION REPLACEMENT COSTS 1999 ($)	
FEATURE	1999 ($)	BOR -18-INCH	BOR - 24-INCH
INTAKE	$ 2,260,000		
PUMPS	$ 752,126	$ 1,894,936	$ 1,787,344
STORAGE	$ 2,615,995	$ 4,266,861	$ 4,266,861
STRUCTURES		$ 425,278	$ 425,278
PIPE	$ 15,358,521	$ 20,533,537	$ 21,941,762
SUBTOTALS	**$ 20,986,642**	**$ 27,120,611**	**$ 28,421,243**

See Appendix B; Tables B-6 and B-9.

1.4 Annual Cost Comparison - Operations, Maintenance, and Replacement Costs:

Annualizing the values for the Navajo Nation's and Reclamations replacement costs, for 40 years at an interest rate of 4 percent, and including the operations and maintenance annual costs, provides the following.

ANNUAL COST FOR OPERATIONS, MAINTENANCE AND REPLACEMENT

ANNUAL COSTS ($) MILLIONS		
NATION	**RECLAMATION**	
	18-INCH	24-INCH
1999 ($)	1999 ($)	1999 ($)
$ 1.672	**$ 2.822**	**$ 2.872**

See appendix Tables B-6, B-7, B-8, and B-9 for comparison of individual line items.

1.5 Capital Costs not included in Total (Capital Costs): Cost not included in the Total Capital Cost are the Supervisory Control and Data Acquisition (S.C.A.D.A.) system, power system and cathodic protection system, and are provide below. These items were evaluated in this review but were not included as part of the Total Capital Cost.

S.C.A.D.A., POWER, & CATHODIC PROTECTION	
	1999 ($) MILLIONS
SUBTOTALS	$ 18.3
CONTINGENCY 20%	$ 3.67
MOBILIZATION 2 %	$ 0.37
OTHER (ENGIN.) - 15 %	$ 2.75
TOTALS	**$ 25.09**

See Appendix B; Tables B-4.

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NAVAJO NATION - WESTERN PIPELINE PROJECT

CHAPTER 2 - PROJECT REVIEW ANALYSIS

CHAPTER 2 - PROJECT REVIEW ANALYSIS:

2.1 Distribution locations and quantities: The distribution locations and demands (normal and peak) used in this review were taken from the Navajo Nation report titled; "North Central Arizona Water Supply Study and Western Pipeline Project" dated May 11, 1995. The normal demand volumes were based on the projected growth to the year 2040 at 160 gallons per day per capita. The peak distribution volumes were based on a peaking factor of 2 times the normal demand volume. The peak distribution volumes were used to evaluate the Western Pipeline Project which includes: pressure pipeline, pumping structures, and pressure reducing or flow control structures. The normal distribution volumes were used to evaluate the operational, and maintenance cost for the Western Pipeline Project. The normal and peak distribution volumes and locations are as follows:

DISTRIBUTION LOCATION	NORMAL WATER DEMANDS			PEAK DEMAND
	AC-FT/YR	AC-FT/DAY	CFS	CFS
LeChee	956	2.62	1.32	2.63
Coppermine	259	0.71	0.36	0.71
Bitter Springs	332	0.91	0.46	0.93
Cedar Ridge	332	0.91	0.46	0.93
Bodaway/Gap	332	0.91	0.46	0.93
Cameron	617	1.69	0.85	1.70
TOTAL	2,828	7.75	3.91	7.83

2.2 Storage: In this review 6 storage/regulating tanks and one regulating tank, at Page Arizona, were utilized to meet the storage and operating requirements. The 6 storage/regulating tanks were situated near the pipeline distribution locations, with the exception of Bitter Springs. The Bitter Springs storage/regulating tank was located near Explosive Rock. Explosive Rock is the highest point along the alignment and placing the storage/regulating tank at Explosive Rock would assist in the protection of the pipeline

against surge (water hammer) and would still provide Bitter Springs with the required storage volume at a constant pressure without the assistance of a pump and motor.

To maintain the storage volume required, in the 6 storage/regulating tanks, and to help protect the pipeline system during surges (water hammer), an additional volume of water, one percent of the storage volume, was included with the storage tank volumes. The one percent operating volume was determined by estimating the water required to support the pipeline system in case of a power failure.

The regulating tank, at Page Arizona, was included for pipeline protection and system operations. The size, 850,000 gallons, was determined by providing a volume that would supply approximately 4 hours of peak delivery rate of 7.83 cfs, or 8 hours of normal delivery rate of 3.91 cfs.

The total installed estimated cost for the storage/regulating tanks was approximately $ 4.3 million, (See appendix Table B-2).

STORAGE AND OPERATING WATER DEMANDS

DISTRIBUTION LOCATION	POPULATION	GALLONS		
	YEAR 2040	STORAGE	OPERATING	TOTAL
Page			850,000	850,000
LeChee	5,313	2,361,333	23,613	2,384,946
Coppermine	1,440	640,000	6,400	646,400
Bitter Springs	1,871	831,556	8,316	839,872
Cedar Ridge	1,871	831,556	8,316	839,872
Bodaway/Gap	1,871	831,556	8,316	839,872
Cameron	3,441	1,529,333	15,293	1,544,626
TOTAL	15,807	7,025,333	920,253	7,945,588

2.3 Pipeline: In this review, the design of the pipeline was based on the peak delivery demands, which was estimated by the Navajo Nations report to be two times the normal delivery demands. The normal daily delivery rate form Lake Powell was estimated at 3.92 cubic feet per second (cfs), with a peak delivery rate at 7.83 cfs. The normal daily delivery rate was based on the projected population in the year 2040 (rate of population growth per year of 2.48 %) using 160 gallons per capita per day. The velocities in the pipeline were limited to less than 5 feet per second (ft/s).

The design of the pipeline included; pipeline, pumping stations, storage/regulating tanks, and pressure reducing or flow control stations. Additional items included in this report but not included in the capital cost were cathodic protection, power system, and Supervisory Control and Data Acquisition (S.C.A.D.A.).

The pipeline alignment parallels State Route 89 and is estimated at 83 miles long. The alignment, elevations and distances were based on the United States Geological Survey (USGS) 1:24000 scale quad maps. Excavation of the pipeline and related structures were considered to be in rock for 50 percent of the length of the pipeline. The normal excavation and backfill was with side slopes at approximately 1:1, except in rock. The rock excavation and backfill was estimated at 75 percent of the normal since the side slopes could be much steeper. The nominal cover was estimated at 4 feet over top of the pipeline.

Excavation conditions for the pipeline and related structures are not known. The General Soil Map of Coconino County (Soil Conservation Service, May 1972) indicates that most of the area is Moenkopie - Rock outcrop association and Sheppard - Rock outcrop association. These are described as containing 20 and 30 percent rock outcrops. Moenkopie - Rock outcrop soils are usually underlain by sandstone at depths of nine to twenty inches but maybe as shallow as five inches. Sheppard soils are sandy and thicker (60-inches or more). According to the Geologic Map of Arizona (1988) , bedrock in the northern third of the project is Navajo sandstone, the middle third in Moenkopie formation and the southern third is Chinle formation. For this estimate it was assumed that 50 percent of the excavation would be in rock and 50 percent could be excavated by common methods or by ripping.

The rock excavation could be accomplished by blasting or rock trenching. The estimated average cost is $ 84.50 per yard for excavating in the rock. This cost makes up more that $\hbar$ $23 million or about 60 percent of the total capital costs. A more economical method may be considered, which would be to use a track trencher, that could cut the trench to the required width and depth. A recent project completed near the Grand Canyon for installation of a 200-mm (8-inch) diameter sewer line was bid at $220 per meter ($ 67/ft)and excavation was by trenching thorough topsoil and limestone to depths of five to eight feet. On that project, spoil created by the trenching was allowed to be used as backfill in the trench. A recent Reclamation project using a trencher was bid at $75 per linear foot to furnish and install a 12-inch diameter utility pipe. The rate of excavation by trencher is dependent upon depth to rock and the rocks strength characteristics. Since these are not known it is difficult to estimate costs. It is possible that using a trench excavator could cost approximately $40 per linear foot. This would reduce the rock excavation to around $ 9,000,000 at a savings over this estimated cost of about $14,000,000.

The pipeline analysis estimated that to deliver the peak demand water, would require 5 pumping stations, 7 storage/regulating tanks, and 5 pressure reducing or flow control stations, all connected by a pipeline that ranged from the initial 18 or 24-inches diameter, from Lake Powell to Explosive Rock, 15-inch from Explosive Rock to Cedar Ridge, and 10-inch from Cedar Ridge to Cameron, Arizona. The pipeline begins at the lowest elevation of the system, Lake Powell. Lake Powell's water level varies from elevation 3600 to 3700 feet, and to ensure water availability the intake was estimated at an elevation 3550. The highest elevation of the system was in the Explosive Rock area, which was between Coppermine and Bitter Springs at an estimated elevation 6130, approximately 21.3 miles from the start of the pipeline. Cedar Ridge was the second highest area of the system at elevation 5910, approximately 44.3 miles from the start of the pipeline.

The pipeline pressures in this review ranged up to 500 pound per square inch (psi), (See Appendix C; Table C-1 and Figure 3). The higher pressures were principally at the bottom of the gravity sections and at the discharge points of the pumping stations. In this review the pressure in the gravity portions of the pipeline was controlled by installation of pressure reducing and or flow control structures, and by using smaller diameter pipe, and allowing

friction to reduce the pressure. However, if the pressure in the pipeline pumping portion of the system, was to be reduced, it would require additional pumping stations to be installed. In the review process the costs between using the higher pressure pipeline and increasing the number of pumping stations was evaluated. The evaluation included the costs pumps and motors, structures, power system, S.C.A.D.A. system, operations, maintenance and replacement costs.

The types of pipeline material evaluated consisted of steel, ductile iron, concrete and Poly-Vinyl Chloride (PVC). See Section 4.0 Pipeline Material Evaluation.

For the peak pumping demands from Lake Powell to Explosive Rock two different sizes of pipeline were evaluated, 18-inch and 24-inch, which provided a velocity that was less than 5 feet per second, (fps). The evaluation between the two different sizes of pipeline was to compare the costs between furnishing and installing vs. the operational costs. The results show that the 18 inch pipeline was less expensive to furnish and install but was slightly more expensive to operate. The amortized cost were closely comparable for both sizes of pipeline.

The total installed estimated capital cost, without markups, for the pipeline was approximately $ 41.1 million and $43.9 million, for the 18 inch and 24 inch diameter pipeline, respectively, (See appendix Table B-1).

2.4 Pumping Plants and Pressure Reducing or Flow Control Stations: The initial pumping station site at Lake Powell is outlined in the report titled: "Western Navajo Water supply Project Lake Powell Pumping Station" dated July 1999. The estimated cost for this pumping station is covered in this report. The total installed estimated cost for the pumping plants and pressure reducing or flow control stations was approximately $ 1.5 million (see appendix Table B-3).

The pumping stations were positioned downstream of the storage reservoir tanks, and would lift the water to the next reservoir, which was generally located near the anticipated distribution point. The highest system pressure in this report between LeChee -

Coppermine, and Bitter Springs - Cedar Ridge, is approximately 500 pounds per square inch. Explosive Rock area, which is between Coppermine and Bitter Springs, is considered the highest point along this pipeline study, and Cedar Ridge area is the next highest.

In the gravity portion of this study, from Explosive Rock to Bitter Springs and from Cedar Ridge to Cameron, pressure reducing or flow control stations are required to minimize the pressure build up in the pipeline and maintain the flow.

2.5 Cost Data- Construction: The construction costs for furnishing and installing the Western Navajo Water Supply Pipeline which includes: pump/motor units, storage/reservoir tanks, structures, cathodic protection, supervisory control and data acquisition system, and pipeline, were taken from 1999 Heavy Construction Cost Data, and/or 1999 Mechanical Cost Data. The Power System construction costs used were from study prepared by the Bureau of Reclamation Technical Service Center, Denver, Colorado, on the "Power System to Support the Lake Powell - Black Mesa Pipeline Project" dated July 1999 The estimated Capital cost for installing the Navajo Nation - Western Pipeline Project is in the range of $ 49 million to $ 52 million, (See appendix Table B-5). This capital cost does not include the cost for S.C.A.D.A, power system and cathodic protection, which is estimated at $ 22 million, (See appendix Table B-5).

Included with the Capital costs (See appendix Table B-5) is a line item called "contingencies and unlisted items 20 percent". This item covers construction items that could required additional construction considerations but are not known at this time. The additional considerations could be related to pipeline crossing; highways, railroad, canyons, valleys, washes, rivers, and or creeks, and could require scour protection, thrust blocks, saddles, or some special structure to protect the pipeline or adjacent structures or features from damage.

2.6 Cost data- Operation, Maintenance and Replacement:

2.6.1 Cost data-Operation: The cost for operating the system are based on the power required to deliver the demand volumes at a rate of 0.060 mills per kilowatt-hour.

2.6.2 **Cost data-Maintenance**: The cost for the maintenance was based on an estimated number of employees that would be required to maintain the system and a value for the equipment and materials required by the personnel for doing the work.

2.6.3 **Cost data-Replacement:** The cost for replacement was based on the life expectancy of the system. The pumps and motors were estimated to have a 20 year life, while the pipeline and structures were estimated with a 40 year life expectancy. The replacement costs for the pipeline were based on normal excavation requirements, with no rock excavation. The value for the system replacement was annualized over the next 40 years for the "estimated future value" of construction at a interest rate of 4 percent.

2.7 Pipeline Project Systems not included in the Capital Costs:

2.7.1 **Cathodic Protection:** In the analysis, cathodic protection was included to ensure electrical continuity of the system. The number of test stations that were estimated was based on the topographical features, (fence lines, road intersection, power line crossings, section lines, etc) that existed along the pipeline alignment right of way. Outside of the requirements for the topographical features, the test stations were considered to be at a maximum of 1000 feet apart. The test stations were considered to be the two wire type, one wire for bonding while the other wire for determining pipe to soil potentials. The estimated cost for installing the cathodic protection is $ 0.25 million, (See appendix Table B-4).

In accordance with the United States Department of Agriculture, Soil Conservation Service report "General soil Map, Coconino County, Arizona "revised May 1972, the corrosivity of the soil is moderate to high for uncoated steel, and low to high for concrete. Therefore, external surface protection may be required on the pipeline and structures to help minimize corrosion.

2.7.2 **Supervisory Control and Data Acquisition (S.C.A.D.A.):** The S.C.A.D.A. system is considered to provide control and monitoring of all the features in this study. The principle features of a S.C.A.D.A. system are fiber optic cable, microwave radio

communications, and a master control station. The estimated cost for installing the S.C.A.D.A. system is $ 0.65 million, (See appendix Table B-4).

The S.C.A.D.A. system at a minimum would control, monitor and record the pumping stations, storage and regulating tanks, and the initial point of each distribution points, assuring that the system equilibrium is maintained.

The pumping stations, pump into a storage reservoir, and the storage reservoir supplies the next pumping station, and distribution pipeline. The pumps would start or stop based on the information received from the upstream and downstream storage and regulating tanks to keep the system in balance. The information at each pumping station can be collected and processed from control logic at a Remote Terminal Unit (RTU). The data from the RTU's will communicate with the master control station via the fiber optic cable or radio communications.

The fiber optic cable can be included in the same trench as the pipeline, or can be installed with the overhead power cabling. The master control unit allows operations personnel to monitor the activity and status of the entire system, which can be encompassed into an existing Supervisory Control and Data Acquisition system.

2.7.3 Power System:

NOTE: No discussions have been held with an existing power supplier for connections to or for willingness to provide power or services.

The power delivery system for the Navajo Nation Western Water Supply Project would be required to serve the pumping plants and associated features for the proposed pipeline project which is approximately 83 miles long. In addition, potential water treatment facilities, for each distribution system and a Supervisory Control Operations Center could be served. The loads used in this study are shown in Table 1 - System Estimated Power Loads. The estimated cost for installing the power system is $ 17.5 million, (See appendix Table B-4).

Utilizing the guideline used in the study prepared by the Bureau of Reclamation Technical Service Center, Denver, Colorado, on the "Power System to Support the Lake Powell - Black Mesa Pipeline Project" dated July 1999, to estimate the power level required for the Western Water Supply Pipeline system. It was determined that a 69 kV-voltage level power system would be the most appropriate voltage level.

To enhance the reliability of the system, two connection taps to the Power Grid System are proposed. The connection taps proposed would be located at Page, Arizona, which would service from Lake Powell to Coppermine, Arizona; the second around Bodaway/Gap, Arizona area, which would service from Bitter Springs to Cameron, Arizona.

The power delivery system was analyzed for overhead conductor on wood pole structures, with ground wire(s). The fiber optic cable used to support the communication/telemetry needs of the S.C.A.D.A. system could be included in the overhead power system.

TABLE 1 - SYSTEM ESTIMATED POWER LOADS

NAVAJO NATION - WESTERN PIPELINE PROJECT

LOAD POINTS		HP	MWatts	MVars		HP	MWatts	MVars
		18-INCH	18-INCH	18-INCH		24-INCH	24-INCH	24-INCH
LAKE POWELL		668	0.50	0.31		640	0.48	0.30
PAGE		616	0.46	0.29		530	0.39	0.24
LECHEE		991	0.74	0.45		955	0.71	0.44
COPPERMINE		370	0.28	0.17		341	0.25	0.15
BITTER SPRINGS		513	0.38	0.23		513	0.38	0.23
TREATMENT ea. (5 required)			0.41	0.25			0.41	0.25
SERVICE CENTER			1.00	0.60			1.00	0.60

2.8 Non-contract: The costs associated with Non-Contract costs were not included in this report. Non-Contract costs are similar to but not limited to the following: Environmental; Easements; Geotechnical; Archeological; Investigation, geological, survey and design; Design; Construction inspection; and Contract Administration.

NAVAJO NATION - WESTERN PIPELINE PROJECT

CHAPTER 3 - REDUCING THE PIPELINE PROJECT PEAK DELIVERY RATES

CHAPTER 3 -REDUCING THE PIPELINE PROJECT PEAK DELIVERY RATE:

3.1 Reducing the Peak Delivery Rate to 1.5 Times Normal Delivery Rates: The pipeline system was evaluated using a peak delivery rate of 1.5 times the normal delivery rate at 5.87 cfs, in lieu of the 2 times the normal delivery at 7.83 cfs.

USING A PEAK DELIVERY RATE OF 1.5 TIMES THE NORMAL DAILY RATE

CHAPTER COMMUNITY	CAPITA	DAILY DEMANDS		STORAGE	PEAK DEMANDS
	YEAR 2040	GALLONS	CFS	GALLONS	CFS
Lake Powell intake					
LeChee	5313	850,117	1.32	2,361,333	1.98
Coppermine	1440	230,365	0.36	640,000	0.54
Bitter Springs	1871	299,360	0.46	831,556	0.69
Cedar Ridge	1871	299,360	0.46	831,556	0.69
Bodaway / Gap	1871	299,360	0.46	831,556	0.69
Cameron	3441	550,558	0.85	1,529,333	1.28
TOTALS	**15,807**		**3.92**		**5.87**

Four pipeline sizes were evaluated 24, 18, 15, and 12 inch diameters, for the peak delivery rate of 1.5 times the normal delivery rate. The 12-inch, pipeline was not considered since the velocity was over 5 fps and the frictional head was high. The 15-inch pipeline also had a high frictional head, and a velocity just below 5 fps. The 18-inch and 24-inch would be the pipeline sizes that best suited the peak delivery rate of 1.5 times the normal delivery rate. The capital and annualized cost for operations, maintenance and replacement for the 15-inch, 18-inch and 24-inch diameter pipelines for the 1.5 times the normal delivery rates and the 18-inch and 24-inch pipeline sizes for the 2.0 times the normal delivery rate, are shown below for comparison.

COSTS for PEAK DELIVERY OF 1.5 TIMES NORMAL DELIVERY- 1999 DOLLARS

	PIPELINE SIZES FOR 2.0 PEAK DELIVERIES		PIPELINE SIZES FOR 1.5 PEAK DELIVERIES	
FEATURE	24-INCH	18-INCH	24-INCH	18-INCH
VELOCITIES (fps)	2.49	4.43	1.87	3.32
CAPITAL COSTS ($ MILLIONS)	$ 67.77	$63.99	$ 67.45	$ 63.64
ANNUAL O, M, & R ($ MILLIONS)	$ 2.89	$ 2.84	$ 2.87	$ 2.81

The volume difference between using the peak delivery rates of 1.5 in lieu of the 2.0 times the normal delivery rate is approximately 900 gallons per minute. The difference between the capital costs for the peak delivery rates of 1.5 and 2.0 times the normal delivery rate are approximately: $ 320,000 for the 24-inch diameter and $ 350,000 for the 18-inch diameter. The difference in the annual operation, maintenance, and replacement costs is approximately: $ 20,000 for the 24-inch and $ 30,000 for the 18-inch diameters.

NAVAJO NATION - WESTERN PIPELINE PROJECT

CHAPTER 4 - PIPELINE MATERIAL EVALUATION

CHAPTER 4 - PIPELINE MATERIAL EVALUATION

4.1 Pipeline Material Evaluation:

POLY-VINYL CHLORIDE (PVC): Poly-Vinyl Chloride (PVC) pressure pipe up to and including diameters of 24-inches can be used for lower pressure pipelines. PVC is more resistant to corrosion, generally less expensive than steel, ductile iron and concrete pipelines for smaller diameter pipelines. However, the financial advantages of PVC pipe decreases for pipe size larger than 12-inches in diameter.

The PVC pressure rating depends on the standard dimension ratio (SDR) which is the pipe diameter to thickness ratio. The SDR provides the pressure rating of the pipe. If surge or water hammer pressure are considered then the SDR rating is the maximum pressure of the pipe. Therefore, the working pressure would be less than 66 percent of the SDR pressure.

From the ASTM D2241, with the pipe material meeting the requirements for PVC 1120, 1220, or 2120, the SDR pressure ratings for SDR-17 is 260 psi, SDR-21 is 200 psi, and SDR-26 is 160. Therefore, PVC could be used for portions of the pipeline project if the working pressure is less than 66 percent of the SDR pressure rating.

CONCRETE PIPE: Reinforced concrete pipe is not available for pressures in the 500 psi range. Standard reference concrete pipe is ASTM C361. Concrete pipe can be used for crossing under streams, creeks etc. if the internal pressures were to high.

STEEL PIPE / DUCTILE IRON: Steel pipe can be obtained commercially in a variety of sizes and pressure ranges. If the size or pressure required exceeds what is commercially available, steel pipe can be manufactured to meet the needs. When obtained commercially the thickness of the pipe is usually classified for each size by a Schedule Number. When using the commercial sizing the diameters are the nominal inside diameters for pipe sizes up to and including 12-inches, but when the diameters are over 12-inches the commercial sizing is for the outside diameter of the pipe.

The working pressure of a steel pipeline is usually based on half of the allowable yield strength, of the material used. The surge (water hammer) is usually 1.5 times the working pressure or 75 % of the yield strength.

Steel pipe will usually require an internal and external coatings to be applied. Cement mortar lining or epoxy for the internal coating, and there are several different types of external coatings i.e. tape, polyurethane, or mortar coating. Price per foot of steel pipe depends primarily on the weight.

Ductile iron pipe is similar to steel, and could be used in lieu of the steel.

For this review the cost per linear foot for the pipeline was based on the following:(steel)
24 inch ranged from $ 50 to $ 85 per linear ft., depending on the pressure, used ($60).
18 inch ranged from $ 45 to $ 60 per linear ft., depending on the pressure. used ($50).
15 inch ranged from $ 30 to $ 48 per linear ft., depending on the pressure. used ($37)
10 inch ranged from $ 20 to $ 35 per linear ft., depending on the pressure. used ($25).

APPENDIXES

APPENDIX A - HYDRAULIC ANALYSIS

APPENDIX B - ENGINEERING DATA AND COST ESTIMATE TABLES;

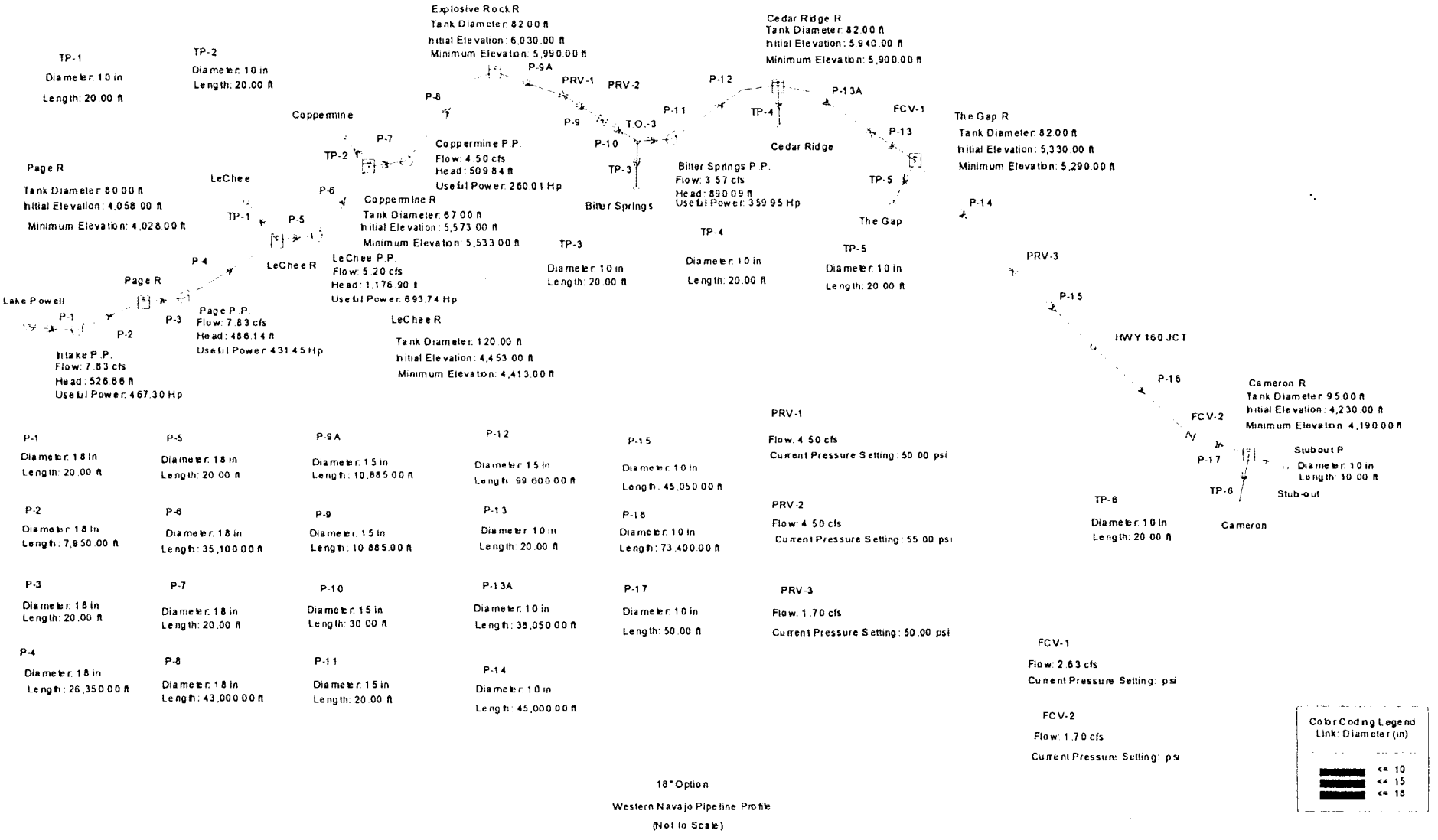
APPENDIX C - OPERATING PRESSURE DISTRIBUTION;

APPENDIX D - CONSTRUCTION COST TREND INDEX;

APPENDIXES
INDEX

APPENDIX A - HYDRAULIC ANALYSIS

Scenario: P)emand Delivery



18" Option

Western Navajo Pipeline Profile

(Not to Scale)

Title: Western Navajo Pipeline
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08/04/99 08:54:40 AM

Bureau of Reclamation

Project Engineer: Michael Lee
Cybernet v3.1 [071]

Analysis Results
Scenario: Peak Demand Delivery
Steady State Analysis

Note:
The input data may have been modified since the last calculation was performed.
The calculated results may be outdated.

Title: Western Navajo Pipeline
Project Engineer: Michael Lee
Project Date: 06/22/99
Comments:

Scenario Summary	
Label	Peak Demand Delivery
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Liquid Characteristics			
Liquid	Water at 20C(68F)	Specific Gravity	1.00
Kinematic Viscosity	0.108e-4 ft²/s		

Network Inventory			
Number of Pipes	26	Number of Tanks	7
Number of Reservoirs	1	- Constant Area:	7
Number of Junctions	9	- Variable Area:	0
Number of Pumps	5	Number of Valves	5
- Constant Power:	0	- FCV's:	2
- One Point (Design Point):	5	- PBV's:	0
- Standard (3 Point):	0	- PRV's:	3
- Standard Extended:	0	- PSV's:	0
- Custom Extended:	0	- TCV's:	0
- Multiple Point:	0	Number of Spot Elevations	0

Pipe Inventory			
Total Length	435,600.00 ft		
10 in	201,700.00 ft	18 in	112,480.00 ft
15 in	121,420.00 ft		

Junctions @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
Bitter Springs	N/A	5,241.61	54.75	0.93	126.61
Cameron	N/A	4,229.44	10.57	1.70	24.44
Cedar Ridge	N/A	5,939.83	12.90	0.93	29.83
Coppermine	N/A	5,572.90	12.06	0.71	27.90
HWY 160 JCT	N/A	4,832.20	163.11	0.00	377.20
LeChee	N/A	4,451.66	11.53	2.63	26.66

Analysis Results
Scenario: Peak Demand Delivery
Steady State Analysis

Junctions @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
Stub-out	N/A	4,230.00	10.81	0.00	25.00
T.O.-3	N/A	5,241.79	54.83	0.00	126.79
The Gap	N/A	5,329.83	12.90	0.93	29.83

Tanks @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Tank Level (ft)	Pressure (psi)	Percent Full (%)	Current Storage Volume (ft^3)	Tank Inflow (cfs)	Tank Outflow (cfs)	Status
Cameron R	N/A	4,230.00	40.00	17.30	88.9	283,528.74	0.00	0.00	Steady
Cedar Ridge R	N/A	5,940.00	40.00	17.30	88.9	211,240.69	0.01	N/A	Filling
Coppermine R	N/A	5,573.00	40.00	17.30	95.2	141,026.09	N/A	0.01	Draining
Explosive Rock R	N/A	6,030.00	40.00	17.30	88.9	211,240.69	0.18e-2	N/A	Filling
LeChee R	N/A	4,453.00	40.00	17.30	95.2	452,389.34	0.29e-3	N/A	Full
Page R	N/A	4,058.00	30.00	12.97	81.1	150,796.45	N/A	0.2e-2	Draining
The Gap R	N/A	5,330.00	40.00	17.30	88.9	211,240.69	0.00	0.00	Full

Reservoirs @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
Lake Powell	N/A	3,560.00	N/A	7.83

Pipes @ 0.00 hr

Label	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1	Open	N/A	7.83	4.43	3,560.00	3,559.20	0.07	0.73	0.80	40.05
P-2	Open	N/A	7.83	4.43	4,085.86	4,058.00	26.86	1.00	27.86	3.50
P-3	Open	N/A	7.83	4.43	4,058.00	4,056.93	0.07	1.00	1.07	53.39
P-4	Open	N/A	7.83	4.43	4,543.07	4,453.00	89.07	1.00	90.07	3.42
P-5	Open	N/A	5.20	2.94	4,453.00	4,452.19	0.03	0.78	0.81	40.45
P-6	Open	N/A	5.20	2.94	5,629.09	5,573.00	55.65	0.44	56.09	1.60
P-7	Open	N/A	4.50	2.55	5,573.00	5,572.65	0.02	0.33	0.35	17.72
P-8	Open	N/A	4.50	2.55	6,082.48	6,030.00	52.15	0.33	52.48	1.22
P-9	Open	N/A	4.50	3.67	5,685.62	5,653.04	32.06	0.53	32.58	2.99
P-9A	Open	N/A	4.50	3.67	6,030.00	5,997.94	32.06	0.00	32.06	2.95
P-10	Open	N/A	4.50	3.67	5,242.19	5,241.79	0.09	0.31	0.40	13.38
P-11	Open	N/A	3.57	2.91	5,241.79	5,241.45	0.04	0.30	0.34	16.87
P-12	Open	N/A	3.57	2.91	6,131.54	5,940.00	191.11	0.43	191.54	1.92
P-13	Open	N/A	2.63	4.82	5,331.34	5,330.00	0.16	1.19	1.34	67.07
P-13A	Open	N/A	2.63	4.82	5,940.00	5,639.79	299.03	1.19	300.21	7.89
P-14	Open	N/A	1.70	3.12	5,330.00	5,171.75	157.75	0.50	158.25	3.52
P-15	Open	N/A	1.70	3.12	4,990.62	4,832.20	157.93	0.50	158.42	3.52
P-16	Open	N/A	1.70	3.12	4,832.20	4,574.39	257.31	0.50	257.81	3.51

Analysis Results
Scenario: Peak Demand Delivery
Steady State Analysis

Pipes @ 0.00 hr

Label	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
P-17	Open	N/A	1.70	3.12	4,230.67	4,230.00	0.17	0.50	0.67	13.40
Stubout P	Open	N/A	0.00	0.00	4,230.00	4,230.00	0.00	0.00	0.00	0.00
TP-1	Open	N/A	2.63	4.82	4,453.00	4,451.66	0.16	1.19	1.34	67.07
TP-2	Open	N/A	0.71	1.30	5,573.00	5,572.90	0.01	0.09	0.10	5.00
TP-3	Open	N/A	0.93	1.71	5,241.79	5,241.61	0.02	0.15	0.17	8.54
TP-4	Open	N/A	0.93	1.71	5,940.00	5,939.83	0.02	0.15	0.17	8.54
TP-5	Open	N/A	0.93	1.71	5,330.00	5,329.83	0.02	0.15	0.17	8.54
TP-6	Open	N/A	1.70	3.12	4,230.00	4,229.44	0.07	0.50	0.56	28.25

Pumps @ 0.00 hr

Label	Status	Constituent (mg/l)	From Grade (ft)	To Grade (ft)	Flow (cfs)	Head (ft)	Relative Speed	Useful Power (Hp)
Bitter Springs P.P.	On	N/A	5,241.45	6,131.54	3.57	890.09	1.00	359.95
Coppermine P.P.	On	N/A	5,572.65	6,082.48	4.50	509.84	1.00	260.01
Intake P.P.	On	N/A	3,559.20	4,085.86	7.83	526.66	1.00	467.30
LeChee P.P.	On	N/A	4,452.19	5,629.09	5.20	1,176.90	1.00	693.74
Page P.P.	On	N/A	4,056.93	4,543.07	7.83	486.14	1.00	431.45

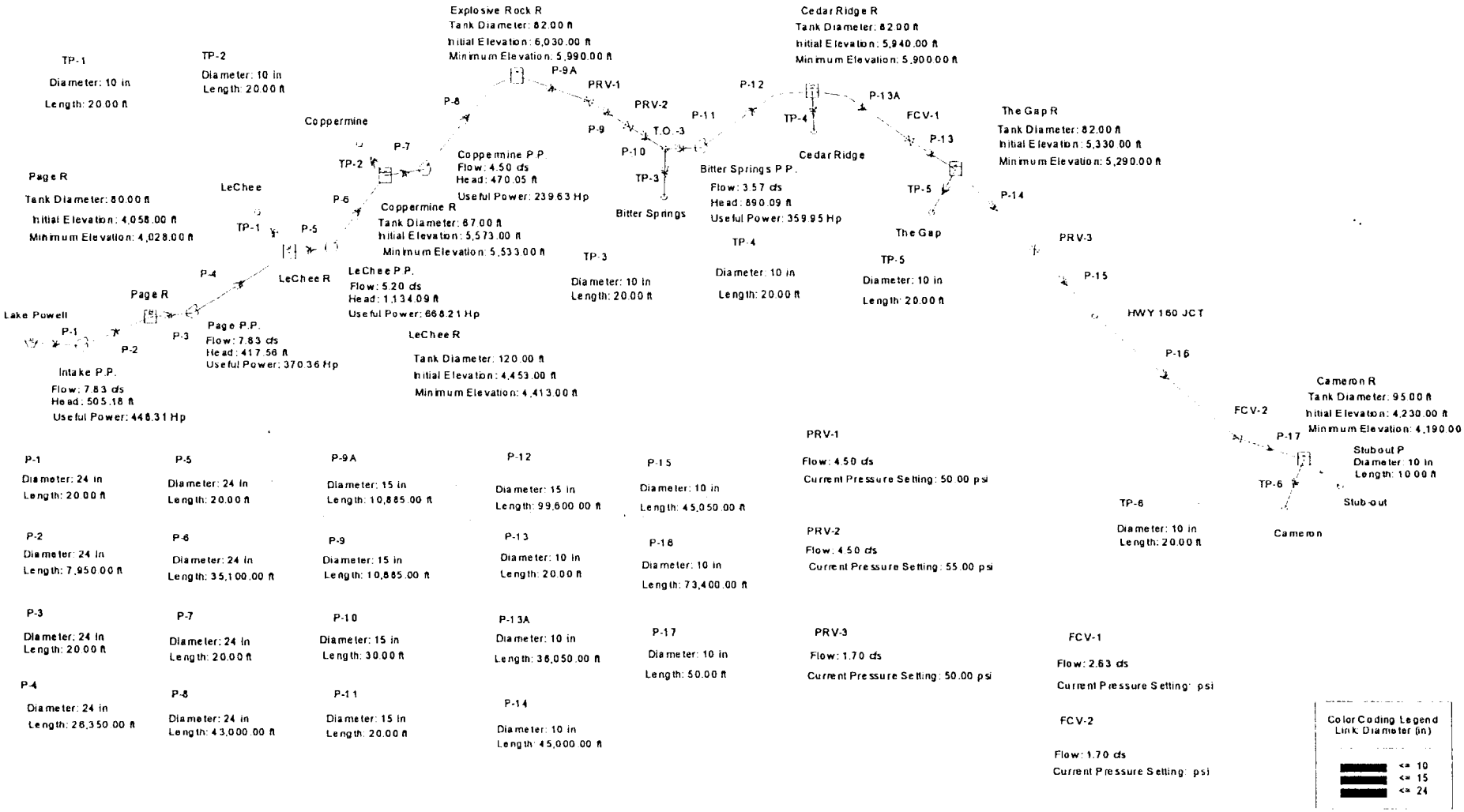
PRVs @ 0.00 hr

Label	Status	Constituent (mg/l)	From Grade (ft)	To Grade (ft)	Flow (cfs)	Headloss (ft)	Setting (psi)
PRV-1	Throttling	N/A	5,997.94	5,685.62	4.50	312.32	50.00
PRV-2	Throttling	N/A	5,653.04	5,242.19	4.50	410.85	55.00
PRV-3	Throttling	N/A	5,171.75	4,990.62	1.70	181.13	50.00

FCVs @ 0.00 hr

Label	Status	Constituent (mg/l)	From Grade (ft)	To Grade (ft)	Flow (cfs)	Headloss (ft)	Setting (cfs)
FCV-1	Throttling	N/A	5,639.79	5,331.34	2.63	308.45	2.63
FCV-2	Throttling	N/A	4,574.39	4,230.67	1.70	343.72	1.70

Scenario: P)emand Delivery



24"Option

Western Navajo Pipeline Profile

(Not to Scale)

Analysis Results
Scenario: Peak Demand Delivery
Steady State Analysis

Note:
The input data may have been modified since the last calculation was performed.
The calculated results may be outdated.

Title: Western Navajo Pipeline
Project Engineer: Michael Lee
Project Date: 06/22/99
Comments:

Scenario Summary	
Label	Peak Demand Delivery
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Liquid Characteristics			
Liquid	Water at 20C(68F)	Specific Gravity	1.00
Kinematic Viscosity	0.108e-4 ft²/s		

Network Inventory			
Number of Pipes	26	Number of Tanks	7
Number of Reservoirs	1	- Constant Area:	7
Number of Junctions	9	- Variable Area:	0
Number of Pumps	5	Number of Valves	5
- Constant Power:	0	- FCV's:	2
- One Point (Design Point):	5	- PBV's:	0
- Standard (3 Point):	0	- PRV's:	3
- Standard Extended:	0	- PSV's:	0
- Custom Extended:	0	- TCV's:	0
- Multiple Point:	0	Number of Spot Elevations	0

Pipe Inventory			
Total Length	435,600.00 ft		
10 in	201,700.00 ft	24 in	112,480.00 ft
15 in	121,420.00 ft		

Junctions @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
Bitter Springs	N/A	5,241.61	54.75	0.93	126.61
Cameron	N/A	4,229.44	10.57	1.70	24.44
Cedar Ridge	N/A	5,939.83	12.90	0.93	29.83
Coppermine	N/A	5,572.90	12.06	0.71	27.90
HWY 160 JCT	N/A	4,832.20	163.11	0.00	377.20
LeChee	N/A	4,451.66	11.53	2.63	26.66

Analysis Results
Scenario: Peak Demand Delivery
Steady State Analysis

Junctions @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
Stub-out	N/A	4,230.00	10.81	0.00	25.00
T.O.-3	N/A	5,241.79	54.83	0.00	126.79
The Gap	N/A	5,329.83	12.90	0.93	29.83

Tanks @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Tank Level (ft)	Pressure (psi)	Percent Full (%)	Current Storage Volume (ft^3)	Tank Inflow (cfs)	Tank Outflow (cfs)	Status
Cameron R	N/A	4,230.00	40.00	17.30	88.9	283,528.74	0.00	0.00	Steady
Cedar Ridge R	N/A	5,940.00	40.00	17.30	88.9	211,240.69	0.01	N/A	Filling
Coppermine R	N/A	5,573.00	40.00	17.30	95.2	141,026.09	N/A	0.01	Draining
Explosive Rock R	N/A	6,030.00	40.00	17.30	88.9	211,240.69	0.11e-3	N/A	Full
LeChee R	N/A	4,453.00	40.00	17.30	95.2	452,389.34	N/A	0.24e-2	Draining
Page R	N/A	4,058.00	30.00	12.97	81.1	150,796.45	0.41e-2	N/A	Filling
The Gap R	N/A	5,330.00	40.00	17.30	88.9	211,240.69	0.00	0.00	Full

Reservoirs @ 0.00 hr

Label	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
Lake Powell	N/A	3,560.00	N/A	7.83

Pipes @ 0.00 hr

Label	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
P-1	Open	N/A	7.83	2.49	3,560.00	3,559.75	0.02	0.23	0.25	12.43
P-2	Open	N/A	7.83	2.49	4,064.94	4,058.00	6.62	0.32	6.94	0.87
P-3	Open	N/A	7.83	2.49	4,058.00	4,057.67	0.02	0.32	0.33	16.64
P-4	Open	N/A	7.83	2.49	4,475.23	4,453.00	21.92	0.32	22.23	0.84
P-5	Open	N/A	5.20	1.66	4,453.00	4,452.75	0.01	0.25	0.25	12.67
P-6	Open	N/A	5.20	1.66	5,586.84	5,573.00	13.70	0.14	13.84	0.39
P-7	Open	N/A	4.50	1.43	5,573.00	5,572.89	0.01	0.10	0.11	5.52
P-8	Open	N/A	4.50	1.43	6,042.94	6,030.00	12.84	0.10	12.94	0.30
P-9	Open	N/A	4.50	3.67	5,685.62	5,653.04	32.06	0.53	32.58	2.99
P-9A	Open	N/A	4.50	3.67	6,030.00	5,997.94	32.06	0.00	32.06	2.95
P-10	Open	N/A	4.50	3.67	5,242.19	5,241.79	0.09	0.31	0.40	13.38
P-11	Open	N/A	3.57	2.91	5,241.79	5,241.45	0.04	0.30	0.34	16.87
P-12	Open	N/A	3.57	2.91	6,131.54	5,940.00	191.11	0.43	191.54	1.92
P-13	Open	N/A	2.63	4.82	5,331.34	5,330.00	0.16	1.19	1.34	67.07
P-13A	Open	N/A	2.63	4.82	5,940.00	5,639.79	299.03	1.19	300.21	7.89
P-14	Open	N/A	1.70	3.12	5,330.00	5,171.75	157.75	0.50	158.25	3.52
P-15	Open	N/A	1.70	3.12	4,990.62	4,832.20	157.93	0.50	158.42	3.52
P-16	Open	N/A	1.70	3.12	4,832.20	4,574.39	257.31	0.50	257.81	3.51

Analysis Results
Scenario: Peak Demand Delivery
Steady State Analysis

Pipes @ 0.00 hr

Label	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
P-17	Open	N/A	1.70	3.12	4,230.67	4,230.00	0.17	0.50	0.67	13.40
Stubout P	Open	N/A	0.00	0.00	4,230.00	4,230.00	0.00	0.00	0.00	0.00
TP-1	Open	N/A	2.63	4.82	4,453.00	4,451.66	0.16	1.19	1.34	67.07
TP-2	Open	N/A	0.71	1.30	5,573.00	5,572.90	0.01	0.09	0.10	5.00
TP-3	Open	N/A	0.93	1.71	5,241.79	5,241.61	0.02	0.15	0.17	8.54
TP-4	Open	N/A	0.93	1.71	5,940.00	5,939.83	0.02	0.15	0.17	8.54
TP-5	Open	N/A	0.93	1.71	5,330.00	5,329.83	0.02	0.15	0.17	8.54
TP-6	Open	N/A	1.70	3.12	4,230.00	4,229.44	0.07	0.50	0.56	28.25

Pumps @ 0.00 hr

Label	Status	Constituent (mg/l)	From Grade (ft)	To Grade (ft)	Flow (cfs)	Head (ft)	Relative Speed	Useful Power (Hp)
Bitter Springs P.P.	On	N/A	5,241.45	6,131.54	3.57	890.09	1.00	359.95
Coppermine P.P.	On	N/A	5,572.89	6,042.94	4.50	470.05	1.00	239.63
Intake P.P.	On	N/A	3,559.75	4,064.94	7.83	505.18	1.00	448.31
LeChee P.P.	On	N/A	4,452.75	5,586.84	5.20	1,134.09	1.00	668.21
Page P.P.	On	N/A	4,057.67	4,475.23	7.83	417.56	1.00	370.36

PRVs @ 0.00 hr

Label	Status	Constituent (mg/l)	From Grade (ft)	To Grade (ft)	Flow (cfs)	Headloss (ft)	Setting (psi)
PRV-1	Throttling	N/A	5,997.94	5,685.62	4.50	312.32	50.00
PRV-2	Throttling	N/A	5,653.04	5,242.19	4.50	410.85	55.00
PRV-3	Throttling	N/A	5,171.75	4,990.62	1.70	181.13	50.00

FCVs @ 0.00 hr

Label	Status	Constituent (mg/l)	From Grade (ft)	To Grade (ft)	Flow (cfs)	Headloss (ft)	Setting (cfs)
FCV-1	Throttling	N/A	5,639.79	5,331.34	2.63	308.45	2.63
FCV-2	Throttling	N/A	4,574.39	4,230.67	1.70	343.72	1.70

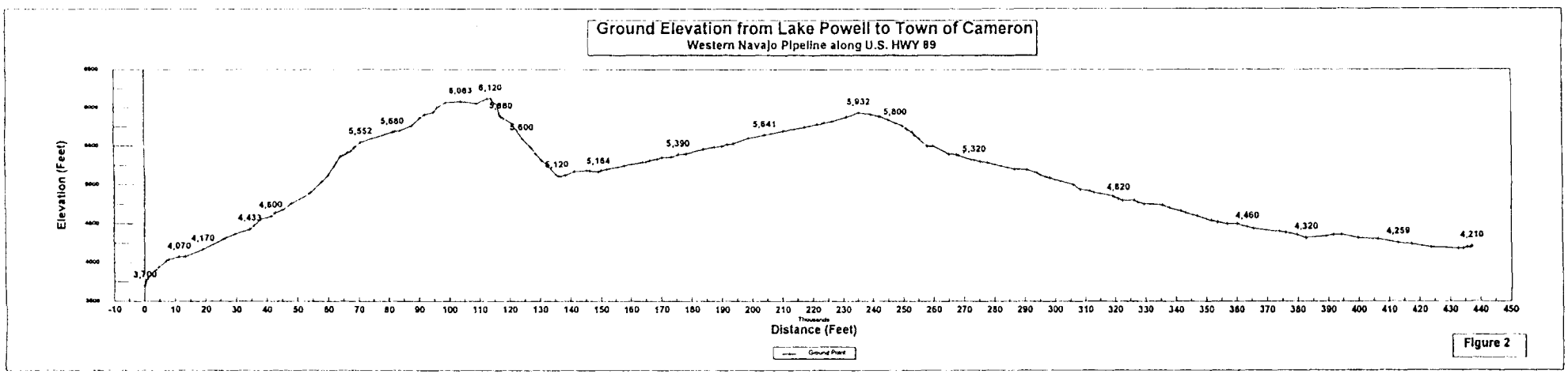

Ground Elevation from Lake Powell to Town of Cameron
Western Navajo Pipeline along U.S. HWY 89
Elevation (Feet)
3,700
4,070
4,170
4,433
4,600
5,552
5,680
6,083
6,120
5,880
5,600
5,120
5,184
5,390
5,641
5,932
5,800
5,320
4,820
4,460
4,320
4,259
4,210
-10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450
Thousands
Distance (Feet)
Ground Point

Figure 2

APPENDIX B - ENGINEERING DATA AND COST ESTIMATE TABLES;

13-Aug-99

TABLE B-1 PIPELINE - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

		NORMAL DELIVERY RATES			PEAK DELIVERY RATES		PEAK RATES USED FOR SIZING THE SYSTEM		THE SYSTEM - SIZED BY PEAK RATES DEMAND								
ORIGIN	DESTINATION	AC/YR	CFS	GPM	CFS	GPM	CFS	GPM	PIPE SIZE (IN)	PIPE AREA SQUARE FEET	VELOCITY FEET/SECOND	ELEVATION START (FEET)	ELEVATION END (FEET)	ELEVATION DIFFERENCE (FEET)	TOTAL HEAD (FT)	MAX PRESSURE (PSI)	PIPELINE LENGTH (LIN FT)
LAKE POWELL	PAGE						7.83	3,514.34	18	1.77	4.43	3,550	4,028	478	527	232	7,950
							7.83	3,514.34	24	3.14	2.49	3,550	4,028	478	505	223	7,950
PAGE	LECHEE	952.26	1.32	590.36	2.63	1,180.72	7.83	3,514.34	18	1.77	4.43	4,058	4,433	375	486	218	26,350
		952.26	1.32	590.36	2.63	1,180.72	7.83	3,514.34	24	3.14	2.49	4,058	4,433	375	418	188	26,350
LECHEE	COPPERMINE	258.08	0.36	160.00	0.71	319.95	5.20	2,333.92	18	1.77	2.94	4,443	5,572	1,129	1,177	521	35,100
		258.08	0.36	160.00	0.71	319.95	5.20	2,333.92	24	3.14	1.66	4,443	5,572	1,129	1,134	502	35,100
COPPERMINE	EXPLOSIVE ROCK						4.48	2,010.76	18	1.77	2.54	5,572	5,990	418	510	232	43,000
							4.48	2,010.76	24	3.14	1.43	5,572	5,990	418	470	215	43,000
EXPLOSIVE ROCK	BITTER SPRINGS	335.33	0.46	207.89	0.93	415.78	4.48	2,010.76	15	1.23	3.65	6,030	5,115	(915)	915	232	21,730
BITTER SPRINGS	CEDAR RIDGE	335.33	0.46	207.89	0.93	415.78	3.56	1,597.83	15	1.23	2.90	5,115	5,940	825	890	386	99,600
CEDAR RIDGE	BODAWAY/GAP	335.33	0.46	207.89	0.93	415.78	2.63	1,180.42	10	0.55	4.82	5,940	5,330	(610)	610	147	38,070
BODAWAY/GAP	CAMERON	616.73	0.85	382.35	1.70	764.71	1.70	763.01	10	0.55	3.12	5,330	4,230	(1,100)	1,100	162	163,500

ORIGIN	DESTINATION	PIPE SIZE (IN)	EXCAVATION CUBIC YARDS / LIN FT	PIPE BEDDING CU YDS / LIN FT	COMPACTED BACKFILL CU YDS / LIN FT	BACKFILL CU YDS / LIN FT	EXCAVATION CUBIC YARDS	ROCK EXCAVATION CU YDS	PIPE BEDDING CU YDS	COMPACTED BACKFILL	BACKFILL CU YDS	EXCAVATION	ROCK EXCAVATION	BEDDING	COMPACTED BACKFILL	BACKFILL	PIPELINE	SUBTOTALS COST - 18-INCH	SUBTOTALS COST - 24-INCH
LAKE POWELL	PAGE	18	1.83	0.15	0.16	1.46	7,287.50	5,465.63	1,171.80	1,294.30	11,588.57	$30,972	$461,845	$17,577	$6,795	$37,663	$397,500	$952,352	
		24	2.22	0.20	0.24	1.66	8,833.33	6,625.00	1,612.10	1,925.84	13,203.71	$37,542	$559,813	$24,181	$10,111	$42,912	$477,000		$1,151,558
PAGE	LECHEE	18	1.83	0.15	0.16	1.46	24,154.17	18,115.63	3,883.91	4,289.92	38,409.90	$102,655	$1,530,770	$58,259	$22,522	$124,832	$1,317,500	$3,156,538	
		24	2.22	0.20	0.24	1.66	29,277.78	21,958.33	5,343.24	6,383.13	43,763.23	$124,431	$1,855,479	$80,149	$33,511	$142,231	$1,581,000		$3,816,800
LECHEE	COPPERMINE	18	1.83	0.15	0.16	1.46	32,175.00	24,131.25	5,173.63	5,714.47	51,164.62	$136,744	$2,039,091	$77,604	$30,001	$166,285	$1,755,000	$4,204,725	
		24	2.22	0.20	0.24	1.66	39,000.00	29,250.00	7,117.56	8,502.76	58,295.61	$165,750	$2,471,625	$106,763	$44,639	$189,461	$2,106,000		$5,084,239
COPPERMINE	EXPLOSIVE ROCK	18	1.83	0.15	0.16	1.46	39,416.67	29,562.50	6,338.06	7,000.63	62,680.30	$167,521	$2,498,031	$95,071	$36,753	$203,711	$2,150,000	$5,151,087	
		24	2.22	0.20	0.24	1.66	47,777.78	35,833.33	8,719.52	10,416.49	71,416.28	$203,056	$3,027,917	$130,793	$54,687	$232,103	$2,580,000		$6,228,554
EXPLOSIVE ROCK	BITTER SPRINGS	15	1.65	0.12	0.13	1.36	17,957.43	13,468.07	2,626.67	2,777.21	29,523.33	$76,319	$1,138,052	$39,400	$14,580	$95,951	$804,010	$2,168,312	$2,168,312
BITTER SPRINGS	CEDAR RIDGE	15	1.65	0.12	0.13	1.36	82,308.33	61,731.25	12,039.39	12,729.43	135,320.90	$349,810	$5,216,291	$180,591	$66,830	$439,793	$3,685,200	$9,938,514	$9,938,514
CEDAR RIDGE	BODAWAY/GAP	10	1.37	0.08	0.08	1.20	26,124.17	19,593.13	2,985.25	2,910.99	45,583.06	$111,028	$1,655,619	$44,779	$15,283	$148,145	$951,750	$2,926,603	$2,926,603
BODAWAY/GAP	CAMERON	10	1.37	0.08	0.08	1.20	112,195.99	84,146.99	12,820.79	12,501.88	195,766.51	$476,833	$7,110,421	$192,312	$65,635	$636,241	$4,087,500	$12,568,942	$12,568,942
					SUBTOTAL - 18-INCH		341,619	256,214	47,039	49,219	570,037	$1,451,882	$21,650,120	$705,592	$258,399	$1,852,621	$15,148,460	$41,067,074	
					SUBTOTAL - 24-INCH		363,475	272,606	53,265	58,148	592,873	$1,544,768	$23,035,216	$798,968	$305,276	$1,926,836	$16,272,460		$43,883,523
															TOTAL COST 18-INCH PIPELINE			$41,067,074	
															TOTAL COST 24-INCH PIPELINE				$43,883,523

12 Aug 99

TABLE B-2 STORAGE/RESERVOIR TANKS - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

LOCATION	YEAR 2040 ESTIMATED	VOLUME						RESERVOIR / TANK SIZING			EXCAVATION	COMPACTED BACKFILL	CONCRETE	STORAGE/RESERVOIR TANK SUB TOTAL COSTS				TANKS TOTAL COSTS		
	POPULATION NOTE 1	STORAGE GALLONS NOTE 2	STORAGE CU FT	OPERATING GALLONS	OPERATING CU FT	TOTAL RESERVOIR GALLONS	TOTAL RESERVOIR CU FT	HEIGHT (FT)	DIAMETER (FT)	BOTTOM ELEVATION (FT)	CU YDS	CU YDS	CU YDS	EXCAVATION	COMPACTED BACKFILL	CONCRETE	TANKS	TOTALS	AVERAGE	ESTIMATED
PAGE				850,000	113,628	850,000	142,035	10	134	4,028	8,112	1,802	1,608	$405,578	$9,461	$562,849	**$256,452**	$1,234,340	$852,237	
								20	95		4,462	1,307	860	$223,106	$6,864	$301,012		$787,434		
								30	78		3,191	1,088	602	$159,569	$5,713	$210,727		$632,461		
								40	67		2,535	958	470	$126,747	$5,027	$164,418		$552,644		
								50	60		2,130	868	389	$106,515	$4,559	$136,035		$503,561		
								60	**55**		**1,854**	**803**	**334**	**$92,709**	**$4,214**	**$116,760**		**$470,135**		**$470,135**
LECHEE	5,313	2,361,333	315,663	23,613	3,157	2,384,947	398,525	10	225	4,413	20,646	2,942	4,208	$1,032,277	$15,447	$1,472,689	**$719,558**	$3,239,971	$2,230,390	
								20	159		10,965	2,114	2,197	$548,262	$11,097	$769,015		$2,047,933		
								30	130		7,648	1,747	1,513	$382,380	$9,169	$529,422		$1,640,529		
								40	113		5,953	1,528	1,165	$297,674	$8,020	$407,670		$1,432,923		
								50	101		4,919	1,378	953	$245,949	$7,236	$333,620		$1,306,363		
								60	**92**		**4,219**	**1,268**	**810**	**$210,931**	**$6,657**	**$283,661**		**$1,220,808**		**$1,220,808**
COPPERMINE	1,440	649,000	85,555	6,400	856	646,400	108,013	10	117	5,532	6,384	1,586	1,253	$319,207	$8,326	$438,570	**$195,024**	$961,128	$664,380	
								20	83		3,554	1,155	675	$177,682	$6,061	$236,393		$615,161		
								30	68		2,563	963	475	$128,141	$5,058	$166,379		$494,603		
								40	59		2,049	850	372	$102,452	$4,460	$130,355		$432,291		
								50	52		1,731	772	309	$86,570	$4,052	$108,220		$393,865		
								60	**48**		**1,514**	**714**	**266**	**$75,703**	**$3,750**	**$93,155**		**$367,632**		**$367,632**
AT EXPLOSIVE ROCK FOR BITTER SPRINGS	1,871	831,556	111,162	8,316	1,112	839,871	140,342	10	134	6,090	8,026	1,792	1,591	$401,314	$9,408	$556,702	**$253,396**	$1,220,821	$842,943	
CEDAR RIDGE	1,871	831,556	111,162	8,316	1,112	839,871	140,342	20	95	5,900	4,417	1,300	851	$220,869	$6,826	$297,823	**$253,396**	$778,915		
BODAWAY/GAP	1,871	831,556	111,162	8,316	1,112	839,871	140,342	30	77	5,290	3,160	1,082	596	$158,024	$5,683	$208,542	**$253,396**	$625,645		
								40	67		2,511	953	465	$125,554	$5,001	$162,741		$546,693		
								50	60		2,111	864	385	$105,537	$4,535	$134,668		$498,137		3 TANKS AT
								60	**55**		**1,838**	**798**	**330**	**$91,876**	**$4,192**	**$115,601**		**$465,065**		**$465,065**
CAMERON	3,441	1,529,333	204,441	15,293	2,044	1,544,627	258,107	10	181	4,190	13,856	2,390	2,796	$692,778	$12,547	$978,570	**$466,027**	$2,149,923	$1,481,507	
								20	128		7,456	1,723	1,473	$372,793	$9,046	$515,618		$1,363,484		
								30	105		5,249	1,428	1,021	$262,474	$7,495	$357,248		$1,093,244		
								40	91		4,118	1,251	790	$205,895	$6,570	$276,490		$954,982		
								50	81		3,424	1,131	649	$171,221	$5,939	$227,231		$870,418		
								60	**74**		**2,954**	**1,043**	**554**	**$147,676**	**$5,474**	**$193,915**		**$813,091**		**$813,091**
TOTALS	15,807	7,025,333	939,147	920,253	123,019	7,945,587	1,327,708										$2,397,250			**$4,266,861**

NOTES: FROM THE NAVAJO NATION PIPELINE STUDY

NOTE 1 PROJECTED POPULATION FOR THE YEAR 2040.

NOTE 2 STORAGE GALLONS BASED ON: 2000 GALLONS PER HOUSEHOLD AT 4.5 PERSONS/HOUSEHOLD

STEEL TANKS

SIZE GALLONS	COST	ELECTRICAL COST	MECHANICAL COST	COST / GAL
10,000,000	$2,607,000	$10,000	$68,000	$0.27
8,000,000	$2,000,000	$10,000	$68,000	$0.26
6,000,000	$1,500,000	$10,000	$68,000	$0.26
4,000,000	$1,000,000	$10,000	$68,000	$0.27
2,000,000	$605,000	$10,000	$68,000	$0.34
1,000,000	$330,000	$10,000	$68,000	$0.41
TOTALS = 31,000,000	$8,042,000	$60,000	$408,000	$0.302

ELECTRICAL COST INCLUDE: LEVEL DEVICE(S), CONDUIT, WIRE, FREEZE PROTECTION OF ELECTRICAL EQUIPMENT, ETC.
MECHANICAL EQUIPMENT, STAND PIPE FOR LEVEL DEVICE, PLATFORM (INSIDE), OUTSIDE LADDER AND PLATFORMS, MANHOLE, SLEEVE TYPE COUPLINGS, VALVES, ETC.

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TABLE B-3 PUMPING UNITS - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

		VALUES BASED ON PEAK DEMANDS												
ORIGIN	DESTINATION	PEAK GPM	PEAK CFS	PEAK ACRE-FT / DAY	HEAD	BHP - 18-INCH	BHP - 24-INCH	COST FOR PUMPS - 18-INCH	COST FOR PUMPS - 24-INCH	PUMP STRUCTURE COST - 18-INCH	PUMP STRUCTURE COST - 24-INCH	COST FOR PRV/FCV STATION	SUBTOTAL - 18-INCH	SUBTOTAL - 24-INCH
LAKE POWELL	PAGE	3,514	7.8299	15.5307	527.00	668		$200,439		$129,927			$330,366	
		3,514	7.8299	15.5307	505.00		640		$192,072		$129,927			$321,998
PAGE	LECHEE	3,514	7.8299	15.5307	486.00	616		$184,845		$43,309			$228,154	
		3,514	7.8299	15.5307	418.00		530		$158,982		$43,309			$202,291
LECHEE	COPPERMINE	2,334	5.2000	10.3141	1,177.00	991		$297,296		$43,309			$340,605	
		2,334	5.2000	10.3141	1,134.00		955		$286,435		$43,309			$329,744
COPPERMINE	EXPLOSIVE ROCK	2,011	4.4800	8.8860	510.00	370		$110,983		$43,309			$154,292	
		2,011	4.4800	8.8860	470.00		341		$102,279		$43,309			$145,588
EXPLOSIVE ROCK	BITTER SPRINGS	2,011	4.4800	8.8860	915.00							$48,846	$48,846	$48,846
BITTER SPRINGS	CEDAR RIDGE	1,598	3.5600	7.0612	890.00	513	513	$153,904	$153,904	$43,309	$43,309		$197,213	$197,213
CEDAR RIDGE	BODAWAY/GAP	1,180	2.6300	5.2166	610.00							$24,423	$24,423	$24,423
BODAWAY/GAP	CAMERON	763	1.7000	3.3719	1,100.00							$48,846	$48,846	$48,846
						SUBTOTAL - 18-INCH		$947,468		$303,162		$122,116	$1,372,746	
						SUBTOTAL - 24-INCH			$893,672		$303,162	$122,116		$1,318,949

PRV/FCV STATION - ESTIMATED COSTS

MISC. EQUIP.	COST EA.	NO. REQUIRED	MISC. SUB TOTALS	EXCAVATION CU. YDS.	EXCAVATION costs	BACKFILL COMPACTED CU. YDS.	COMPACTED BACKFILL costs	SUB - TOTAL
VAULT	$5,600.00	1	$5,600.00	83.66	$355.56	28.11	$147.55	$6,103.11
GATE VALVE	$1,200.00	2	$2,400.00					$2,400.00
FLANGES	$295.00	6	$1,770.00					$1,770.00
COUPLING	$650.00	1	$650.00					$650.00
PIPE	$30.00	10	$300.00					$300.00
SUPPORT	$200.00	1	$200.00					$200.00
PRV/FCV VALVE	$12,000.00	1	$12,000.00					$12,000.00
AIR VALVE ASSE	$1,000.00	1	$1,000.00					$1,000.00
						TOTAL =		**$24,423.11**

PUMP STATION

MISC. EQUIP.	COST EA.	NO. REQUIRED	MISC. SUB TOTALS	EXCAVATION CU. YDS.	EXCAVATION costs	BACKFILL COMPACTED CU. YDS.	COMPACTED BACKFILL costs	SUB - TOTAL
PUMPS	CALCULATED ELSEWHERE							
VALVES								
CHECK	$15,200.00	1	$15,200.00					$15,200.00
BUTTERFLY	$10,000.00	1	$10,000.00					$10,000.00
AIR VALVES	$1,000.00	1	$1,000.00					$1,000.00
COUPLING	$650.00	1	$650.00					$650.00
STRUCTURE				248.89	$1,057.78	182.22	$956.67	$2,014.44
CONCRETE	$250.00	58	$14,444.44					$14,444.44
						TOTAL =		**$43,308.89**

UNITS OF USAGE

Brake Horsepower (BHP) = (GPM x Head x lb. of water per gal. (8.33))
(foot-lbf per minute in 1 HP (33000)) x unit efficiency

= (GPM X HEAD IN FEET) / (3960 x UNIT EFFICIENCY)

Unit efficiency = 70 % (used in the Navajo Nation report dated May 11, 1995)

TABLE B-4 SUMMATION OF POTENTIAL COSTS (S.C.A.D.A., CATHODIC PROTECTION, AND POWER) - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

Supervisory Control and Data Acquisition (S.C.A.D.A.)

	COST EA.	NO. REQUIRED	SUB TOTALS
Master Control Station			
computor/software/printer	$50,000.00	1	$50,000.00
pump/control system	$150,000.00	1	$150,000.00
panel/power supply, etc.	$86,000.00	1	$86,000.00
Remote Terminal Unit			
computor/software	$15,000.00	8	$120,000.00
pump/control system	$3,200.00	8	$25,600.00
panel - 48 pt. w function board	$5,000.00	8	$40,000.00
Radio communications system	$32,000.00	1	$32,000.00
CABLE	COST / FT	FEET	
	$0.2900	500,000	$145,000.00
PIPELINE LENGTH		435,300	
COST PER FOOT OF PIPELINE =			$1.49
		TOTAL	$648,600

Cathodic Protection System

	COST EA.	NO. REQUIRED	SUB TOTALS
TEST STATION	$500.00	100	$50,000
ANODES 9#	$190.00	200	$38,000
MISCELLANEOUS	$15,000.00	1	$15,000
CABLE	COST / FT	FEET	
	$0.0400	700,000	$28,000
PIPELINE LENGTH		435,300	
	CU YDS /LIN. FT	TOTAL CU YD	SUB TOTAL
EXCAVATION	0.05	20,153	$70,535
BACKFILL	0.05	20,153	$50,382
COST PER FOOT OF PIPELINE =			$0.58
		TOTAL	$251,917

Power

SUBSTATION LOCATION	DISTANCE (MILES)	COST POWER LINE	COST 230-69-KV SUBSTATION	COST 69-KV UNIT SUBSTATION	COST 69-KV UTILITY TAP	COST 69-KV TAP	SUBTOTALS
LAKE POWELL	1.5	$195,739		$70,000	$400,000	$10,000	$675,739
PAGE	1.5	$195,739	$2,000,000	$70,000	$400,000	$10,000	$2,675,739
LECHEE	5.0	$648,769		$70,000	$400,000	$10,000	$1,128,769
COPPERMINE	6.6	$864,205		$70,000	$400,000	$10,000	$1,344,205
BITTER SPRINGS	12.3	$1,593,731				$10,000	$1,603,731
CEDAR RIDGE	18.9	$2,452,273		$70,000	$400,000	$10,000	$2,932,273
BODAWAY/GAP	7.2	$937,330				$10,000	$947,330
CAMERON	31.0	$4,025,568	$2,000,000	$70,000		$10,000	$6,105,568
					TOTAL		$17,413,352

POWER LINE COST PER MILE ESTIMATED AT	$130,000
230-69 kV SUBSTATION ESTIMATED AT	$2,000,000
69-kV UNIT SUBSTATION ESTIMATED AT	$70,000
69-kV UTILITY TAP ESTIMATED AT	$400,000
69-kV TAP ESTIMATED AT	$10,000

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TABLE B-5 SUMMATION OF COSTS (CONSTRUCTION) - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

			SUMMATION OF CONSTUCTION COSTS							S.C.A.D.A., POWER, AND CATHODIC PROTECTION COSTS			
ORIGIN	DESTINATION	PIPELINE SIZE (IN)	PIPELINE	PUMPING STRUCTURES	PRESSURE REDUCING - FLOW CONTROL STATIONS	PUMP / MOTOR UNIT COSTS	STORAGE / REGULATING TANK	SUB TOTAL 18-INCH	SUB TOTAL - 24 INCH	S.C.A.D.A. SYSTEM	POWER SYSTEM	CATHODIC PROTECTION	SUB TOTAL POTENTIAL COSTS
LAKE POWELL	PAGE	18	$952,352	$129,927	$0	$200,439	$470,135	$1,752,852		$11,846	$675,739	$4,601	$692,185
		24	$1,151,558	$129,927	$0	$192,072			$1,943,691				
PAGE	LECHEE	18	$3,156,538	$43,309	$0	$184,845	$1,220,808	$4,605,500		$39,262	$2,675,739	$15,249	$2,730,250
		24	$3,816,800	$43,309	$0	$158,982			$5,239,899				
LECHEE	COPPERMINE	18	$4,204,725	$43,309	$0	$297,296	$367,632	$4,912,962		$52,299	$1,128,769	$20,313	$1,201,381
		24	$5,084,239	$43,309	$0	$286,435			$5,781,615				
COPPERMINE	EXPLOSIVE ROCK	18	$5,151,087	$43,309	$0	$110,983	$465,065	$5,770,444		$64,070	$1,344,205	$24,885	$1,433,160
		24	$6,228,554	$43,309	$0	$102,279			$6,839,207				
EXPLOSIVE ROCK	BITTER SPRINGS	15	$2,168,312	$0	$48,846	$0		$2,217,159	$2,217,159	$32,378	$1,603,731	$12,576	$1,648,684
BITTER SPRINGS	CEDAR RIDGE	15	$9,938,514	$43,309	$0	$153,904	$465,065	$10,600,792	$10,600,792	$148,405	$2,932,273	$57,640	$3,138,318
CEDAR RIDGE	BODAWAY/GAP	10	$2,926,603	$0	$24,423	$0	$465,065	$3,416,091	$3,416,091	$56,725	$947,330	$22,032	$1,026,086
BODAWAY/GAP	CAMERON	10	$12,568,942	$0	$48,846	$0	$813,091	$13,430,879	$13,430,879	$243,616	$6,105,568	$94,621	$6,443,805
										SUBTOTALS			
SUBTOTALS - 18-INCH			$41,067,074	$303,162	$122,116	$947,468	$4,266,861	$46,706,681		$648,600	$17,413,352	$251,917	$18,313,869
SUBTOTALS - 24-INCH			$43,883,523	$303,162	$122,116	$893,672	$4,266,861		$49,469,333				
					CONTINGENCIES & UNLISTED ITEMS @ 20 %			$9,341,336		CONTINGENCIES & UNLISTED ITEMS @ 20 %			$3,662,774
									$9,893,867				
				SUBTOTAL	PIPELINE SUMMATION - 18"			$56,048,017		POTENTIAL CONSTRUCTION COSTS SUBTOTAL			$21,976,643
					PIPELINE SUMMATION - 24"				$59,363,200				
					MOBILIZATION 2 PERCENT OF SUBTOTAL			$934,134		MOBILIZATION 2 PERCENT OF SUBTOTAL			$366,277
									$989,387				
				TOTALS*	**PIPELINE SUMMATION - 18"**			**$56,982,150**					
					PIPELINE SUMMATION - 24"				**$60,352,586**	TOTAL			**$22,342,920**

* The total value does not include the costs associated with preparation, monitoring, inspection, and close-outs of construction contracts, NON-CONTRACT type costs. These non-contract type costs include items, similar to but not limited to; geological and survey investigations, drilling, designing, contract specifications paragraphs and drawings preparations, contract specification issuance, construction monitoring, and construction and specification close out work.

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TABLE B-6 SUMMATION OF COSTS (OPERATION) - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

		PEAK RATES FOR SIZING THE SYSTEM			DELIVERY RATES @ DESTINATIONS			DELIVERY RATES FOR COST - MAIN PIPELINE				ESTIMATED POWER COSTS ($) @ DELIVERY RATES - MAIN PIPELINE									
ORIGIN	DESTINATION	PEAK DELIVERY GPM	PEAK DELIVERY CFS	HEAD	DELIVERY GPM	DELIVERY CFS	HEAD	DELIVERY GPM	DELIVERY CFS	ACRE-FT / YEAR	HEAD	KWH / 1000 GAL - 18-INCH	KWH / 1000 GAL - 24-INCH	COST PER HOUR - 18-INCH	COST PER HOUR - 24-INCH	COST PER DAY - 18-INCH	COST PER DAY - 24-INCH	COST PER YEAR - 18-INCH	COST PER YEAR - 24-INCH	POWER COST PER ACRE-FT - 18-INCH	POWER COST PER ACRE-FT - 24-INCH
LAKE POWELL	PAGE	3,514.34	7.83	527.00				1,756.38	3.91	2,833.06	488.03	2.20		$14		$333		$121,642		$43	
		3,514.34	7.83	505.00				1,756.38	3.91	2,833.06	480.38		2.16		$14		$328		$119,735		$42
PAGE	LEGHEE	3,514.34	7.83	486.00	590.36	1.32	486.00	1,756.38	3.91	2,833.06	431.86	1.94		$12		$295		$107,642		$38	
		3,514.34	7.83	418.00	590.36	1.32	418.00	1,756.38	3.91	2,833.06	388.49		1.75		$11		$265		$96,832		$34
LEGHEE	COPPERMINE	2,333.92	5.20	1,177.00	160.00	0.36	1,177.00	1,166.02	2.60	1,880.80	1,138.34	5.12		$22		$516		$188,364		$100	
		2,333.92	5.20	1,134.00	160.00	0.36	1,134.00	1,166.02	2.60	1,880.80	1,131.22		5.09		$21		$513		$187,185		$100
COPPERMINE	EXPLOSIVE ROCK	2,010.76	4.48	510.00				1,006.02	2.24	1,622.72	436.07	1.96		$7		$171		$62,256		$38	
		2,010.76	4.48	470.00				1,006.02	2.24	1,622.72	422.29		1.90		$7		$165		$60,289		$37
EXPLOSIVE ROCK		2,010.76	4.48	915.00	207.89	0.46	915.00	415.78	2.24	1,622.72											
BITTER SPRINGS	CEDAR RIDGE	1,597.83	3.56	890.00	207.89	0.46	890.00	415.78	1.78	1,287.39	889.95	4.00	4.00	$6	$6	$144	$144	$52,511	$52,511	$41	$41
CEDAR RIDGE	BODAWAY/GAP	1,180.42	2.63	610.00	207.89	0.46	610.00	415.78	1.32	952.06											
BODAWAY/GAP	CAMERON	763.01	1.70	1,100.00	382.35	0.85	1,100.00	764.71	0.85	616.73											
										TOTALS		15.23	14.91	$61	$59	$1,459	$1,415	$532,414	$516,552		

UNITS OF USAGE

Unit efficiency = 70 percent (used in the Navajo Nation report dated May 11, 1995)

UNIT EFFICIENCY /0.00% POWER RATE / KWH 0.06

1 Kilowatt (KW) = 1000 Watts (W) = 1.341 Horsepower (HP) = 737.5 foot-pounds per second (ft-lb/s)

KWH/1000 gallons = Head (ft) x 0.00315 / unit efficiency (decimal)

Cost per hour = (0.000189 x GPM x total head x power rate per KWH) / unit efficiency (decimal)

Cost per Acre-foot = 1.024 x total head x power rate per KWH / unit efficiency (decimal)

SUMMATION OF COSTS (REPLACEMENT) - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

		20 YEAR REPLACEMENT		40 YEAR REPLACEMENT				SUB TOTALS COST	
ORIGIN	DESTINATION	PUMP / MOTOR UNIT COSTS		PRV/FCV STATIONS	STORAGE / REGULATING TANK	PIPELINE*	PUMPING STRUCTURES	18-INCH	24-INCH
LAKE POWELL	PAGE	$200,439		$0	$470,135	$476,176	$129,927	$1,477,115	
			$192,072		$470,135	$575,779	$129,927		$1,559,983
PAGE	LEGHEE	$184,845		$0	$1,220,808	$1,578,269	$43,309	$3,212,076	
			$158,982		$1,220,808	$1,908,400	$43,309		$3,490,481
LEGHEE	COPPERMINE	$297,296		$0	$367,632	$2,102,362	$43,309	$3,107,896	
			$286,435		$367,632	$2,542,119	$43,309		$3,525,931
COPPERMINE	EXPLOSIVE ROCK	$110,983		$0	$465,065	$2,575,544	$43,309	$3,305,884	
			$102,279		$465,065	$3,114,277	$43,309		$3,827,209
EXPLOSIVE ROCK	BITTER SPRINGS	$0	$0	$48,846	$0	$1,084,156	$0	$1,133,002	$1,133,002
BITTER SPRINGS	CEDAR RIDGE	$153,904	$153,904	$0	$465,065	$4,969,257	$43,309	$5,785,439	$5,785,439
CEDAR RIDGE	BODAWAY/GAP	$0	$0	$24,423	$465,065	$1,463,302	$0	$1,952,790	$1,952,790
BODAWAY/GAP	CAMERON	$0	$0	$48,846	$813,091	$6,284,471	$0	$7,146,409	$7,146,409
SUBTOTALS - 18-INCH		$1,894,936		$122,116	$4,266,861	$20,533,537	$303,162		
SUBTOTALS - 24-INCH			$1,787,343	$122,116	$4,266,861	$21,941,762	$303,162		
TOTAL REPLACEMENT					PIPELINE SUMMATION - 18"			$27,120,611	
					PIPELINE SUMMATION - 24"				$28,421,243
				THE FUTURE VALUE FOR REPLACEMENT @ AN INTEREST RATE OF 4 PERCENT, 40 YEARS IS EQUAL TO				$130,206,615	$136,450,974

* Pipeline costs shown are calculated at half the capital costs, since excavation would not be in rock surfacing

SUMMATION OF COSTS (MAINTENANCE) - SCENARIO FOR NAVAJO NATION - WESTERN PIPELINE PROJECT

	YEARLY ($)			
	EMPLOYEE COSTS ($)	EQUIPMENT ($)	MATERIALS ($)	TOTAL ($)
SYSTEM - GENERAL	$450,000	$120,000	$40,000	
SYSTEM SUPPORT	$270,000	$30,000	$10,000	
SUBTOTALS	$720,000	$150,000	$50,000	$920,000

SUMMATION OF O M & R COSTS - YEARLY

MAINTENANCE COSTS		OPERATIONS COSTS		YEARLY COSTS O & M		REPLACEMENT COSTS*		YEARLY COSTS O M & R	
18-INCH	24-INCH	18-INCH	24-INCH	18-INCH	24-INCH	18-INCH	24-INCH	18-INCH	24-INCH
$920,000		$532,414		$1,452,414		$1,370,228		$2,822,642	
	$920,000		$516,552		$1,436,552		$1,435,940		$2,872,492

TABLE B-7 COMPARISON CHARTS (TECHNICAL AND COST DATA) RECLAMATION 18-INCH PIPELINE - NAVAJO NATION - WESTEN PIPELINE PROJECT

ORIGIN	DESTINATION	ELEVATION (NATION)* START	ELEVATION (NATION)* END	ELEVATION (NATION)* CHANGE (FT)	ELEVATION (RECLAMATION) START	ELEVATION (RECLAMATION) END	ELEVATION (RECLAMATION) CHANGE (FT)	PIPELINE SIZE (inches) NATION*	PIPELINE SIZE (inches) RECLAMATION	PIPELINE LENGTH (FEET) NATION*	PIPELINE LENGTH (FEET) RECLAMATION	CAPITAL PIPELINE COST ($) NATION*	CAPITAL PIPELINE COST ($) RECLAMATION
LAKE POWELL	PAGE	4,200	4,200	0	3,550	4,058	508	18.9	18	0	7,950	--	$952,352
PAGE	LECHEE	4,200	4,600	400	4,058	4,413	355	18.9	18	33,324	26,350	$3,283,612	$3,156,538
LECHEE	COPPERMINE	4,600	5,680	1,080	4,443	5,572	1,129	15.4	18	38,524	35,100	$3,036,799	$4,204,725
COPPERMINE	EXPLOSIVE ROCK	5,680			5,572	6,130	558	15.4	18	--	43,000	--	$5,151,087
EXPLOSIVE ROCK	BITTER SPRINGS		5,100	(580)	6,130	5,115	(1,015	14.3	15	59,978	21,730	$3,930,067	$2,168,312
BITTER SPRINGS	CEDAR RIDGE	5,100	5,940	840	5,115	5,940	825	12.8	15	75,388	99,600	$5,199,900	$9,938,514
CEDAR RIDGE	BODAWAY/GAP	5,940	5,200	(740)	5,940	5,330	(610	11	10	63,022	38,070	$3,725,960	$2,926,603
BODAWAY/GAP	CAMERON	5,200	4,500	(700)	5,330	4,230	(1,100	8.8	10	162,517	163,500	$8,006,884	$12,568,942
								TOTALS		432,753	435,300	$27,183,222	$41,067,074
								DIFFERENCE		(2,547)	2,547	($13,883,852)	$13,883,852

CONTINUED - COMPARISON CHARTS (TECHNICAL AND COST DATA) RECLAMATION 18-INCH PIPELINE
NAVAJO NATION - WESTERN PIPELINE PROJECT

ORIGIN	DESTINATION	PUMP HORSEPOWER NATION*	PUMP HORSEPOWER RECLAMATION	CAPITAL PUMP COST ($) NATION*	CAPITAL PUMP COST ($) RECLAMATION	STORAGE /OPERATING TANKS (GALLONS) NATION*	STORAGE /OPERATING TANKS (GALLONS) RECLAMATION	CAPITAL TANK COST ($) NATION*	CAPITAL TANK COST ($) RECLAMATION	STRUCTURES NATION*	STRUCTURES RECLAMATION	CAPITAL COST STRUCTURES ($) NATION*	CAPITAL COST STRUCTURES ($) RECLAMATION
LAKE POWELL	PAGE	--	668.13	--	$200,439	--	850,000	--	$470,135	--	PUMP	--	$129,927
PAGE	LECHEE	208.4	616.15	$116,719	$184,845	2,361,436	2,384,947	$885,100	$1,220,808	--	PUMP	--	$43,309
LECHEE	COPPERMINE	140.2	990.99	$78,488	$297,296	639,902	646,400	$195,040	$367,632	--	PUMP	--	$43,309
COPPERMINE	EXPLOSIVE ROCK	--	369.94	--	$110,983	--	839,871	--	$465,065	--	PUMP	--	$43,309
EXPLOSIVE ROCK	BITTER SPRINGS	--	--	--	--	831,556	--	$227,900	--	--	PRV/FCV	--	$48,846
BITTER SPRINGS	CEDAR RIDGE	171.8	513.01	$96,181	$153,904	831,556	839,871	$227,900	$465,065	--	PUMP	--	$43,309
CEDAR RIDGE	BODAWAY/GAP	--	--	--	--	831,556	839,871	$227,900	$465,065	--	PRV/FCV	--	$24,423
BODAWAY/GAP	CAMERON	73.9	--	$41,411	--	1,529,412	1,544,627	$551,200	$813,091	--	PRV/FCV	--	$48,846
TOTALS		594	3,158	$332,799	$947,468	7,025,418	7,945,587	$2,315,040	$4,266,861	0	0	$0	$425,278
DIFFERENCE		(2,564)	2,564	($614,669)	$614,669	(920,169)	920,169	($1,951,821)	$1,951,821	0	0	($425,278)	$425,278

CONTINUED - COMPARISON CHARTS (TECHNICAL AND COST DATA) RECLAMATION 18-INCH PIPELINE - NAVAJO NATION - WESTEN PIPELINE PROJECT

ORIGIN	DESTINATION	INTAKE NATION*	INTAKE RECLAMATION	CONSTRUCTION COSTS ($) SUB-TOTAL NATION*	CONSTRUCTION COSTS ($) SUB-TOTAL RECLAMATION
LAKE POWELL	PAGE	$2,000,000	--	$2,000,000	$1,752,852
PAGE	LECHEE			$4,285,431	$4,605,500
LECHEE	COPPERMINE			$3,310,327	$4,912,962
COPPERMINE	EXPLOSIVE ROCK			$0	$5,770,444
EXPLOSIVE ROCK	BITTER SPRINGS			$4,157,967	$2,217,159
BITTER SPRINGS	CEDAR RIDGE			$5,523,981	$10,600,792
CEDAR RIDGE	BODAWAY/GAP			$3,953,860	$3,416,091
BODAWAY/GAP	CAMERON			$8,599,495	$13,430,879
TOTALS		$2,000,000	$0	**$31,831,061**	**$46,706,681**
DIFFERENCE		$2,000,000	($2,000,000	($14,875,620)	$14,875,620

S.C.A.D.A., POWER AND CATHODIC PROTECTION COSTS ($) SCADA	POWER	CATHODIC	SUBTOTALS
$11,846	$675,739	$4,601	$692,185
$39,262	$2,675,739	$15,249	$2,730,250
$52,299	$1,128,769	$20,313	$1,201,381
$64,070	$1,344,205	$24,885	$1,433,160
$32,378	$1,603,731	$12,576	$1,648,684
$148,405	$2,932,273	$57,640	$3,138,318
$56,725	$947,330	$22,032	$1,026,086
$243,616	$6,105,568	$94,621	$6,443,805
$648,600	$17,413,352	$251,917	**$18,313,869**

*Values used are from the cost estimate included in the Navajo Nation DWR-WMB report titled, " North Central Arizona Supply Study and Western Pipeline Project " dated May 11, 1995 1995 DOLLARS

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TABLE B-8 COMPARISON CHARTS (TECHNICAL AND COST DATA) RECLAMATION 24-INCH PIPELINE - NAVAJO NATION - WESTEN PIPELINE PROJECT

ORIGIN	DESTINATION	ELEVATION (NATION)* START	ELEVATION (NATION)* END	ELEVATION (NATION)* CHANGE (FT)	ELEVATION (RECLAMATION) START	ELEVATION (RECLAMATION) END	ELEVATION (RECLAMATION) CHANGE (FT)	PIPELINE SIZE (inches) NATION*	PIPELINE SIZE (inches) RECLAMATION	PIPELINE LENGTH (FEET) NATION*	PIPELINE LENGTH (FEET) RECLAMATION	CAPITAL PIPELINE COST ($) NATION*	CAPITAL PIPELINE COST ($) RECLAMATION
LAKE POWELL	PAGE	4,200	4,200	0	3,550	4,058	508	18.9	24	0	7,950	--	$1,151,558
PAGE	LECHEE	4,200	4,600	400	4,058	4,413	355	18.9	24	33,324	26,350	$3,283,612	$3,816,800
LECHEE	COPPERMINE	4,600	5,680	1,080	4,443	5,572	1,129	15.4	24	38,524	35,100	$3,036,799	$5,084,239
COPPERMINE	EXPLOSIVE ROCK	5,680			5,572	6,130	558	15.4	24	--	43,000	--	$6,228,554
EXPLOSIVE ROCK	BITTER SPRINGS		5,100	(580)	6,130	5,115	(1,015)	14.3	15	59,978	21,730	$3,930,067	$2,168,312
BITTER SPRINGS	CEDAR RIDGE	5,100	5,940	840	5,115	5,940	825	12.8	15	75,388	99,600	$5,199,900	$9,938,514
CEDAR RIDGE	BODAWAY/GAP	5,940	5,200	(740)	5,940	5,330	(610)	11	10	63,022	38,070	$3,725,960	$2,926,603
BODAWAY/GAP	CAMERON	5,200	4,500	(700)	5,330	4,230	(1,100)	8.8	10	162,517	163,500	$8,006,884	$12,568,942
TOTALS										432,753	435,300	$27,183,222	$43,883,523
DIFFERENCE										(2,547)	2,547	($16,700,301)	$16,700,301

CONTINUED - COMPARISON CHARTS (TECHNICAL AND COST DATA) RECLAMATION 24-INCH PIPELINE
NAVAJO NATION - WESTERN PIPELINE PROJECT

ORIGIN	DESTINATION	PUMP HORSEPOWER NATION*	PUMP HORSEPOWER RECLAMATION	CAPITAL PUMP COST ($) NATION*	CAPITAL PUMP COST ($) RECLAMATION	STORAGE /OPERATING TANKS (GALLONS) NATION*	STORAGE /OPERATING TANKS (GALLONS) RECLAMATION	CAPITAL TANK COST ($) NATION*	CAPITAL TANK COST ($) RECLAMATION	STRUCTURES NATION*	STRUCTURES RECLAMATION	CAPITAL COST STRUCTURES ($) NATION*	CAPITAL COST STRUCTURES ($) RECLAMATION
LAKE POWELL	PAGE	--	640.2	--	$192,072	--	850,000	--	$470,135	--	PUMP	--	$129,927
PAGE	LECHEE	208.4	529.9	$116,719	$158,982	2,361,436	2,384,947	$885,100	$1,220,808	--	PUMP	--	$43,309
LECHEE	COPPERMINE	140.2	954.8	$78,488	$286,435	639,902	646,400	$195,040	$367,632	--	PUMP	--	$43,309
COPPERMINE	EXPLOSIVE ROCK	--	340.9	--	$102,279	--	839,871	--	$465,065	--	PUMP	--	$43,309
EXPLOSIVE ROCK	BITTER SPRINGS	--	--	--	--	831,556	--	$227,900	--	--	PRV/FCV	--	$48,846
BITTER SPRINGS	CEDAR RIDGE	171.8	513.0	$96,181	$153,904	831,556	839,871	$227,900	$465,065	--	PUMP	--	$43,309
CEDAR RIDGE	BODAWAY/GAP	--	--	--	--	831,556	839,871	$227,900	$465,065	--	PRV/FCV	--	$24,423
BODAWAY/GAP	CAMERON	73.9	--	$41,411	--	1,529,412	1,544,627	$551,200	$813,091	--	PRV/FCV	--	$48,846
TOTALS		594	2,979	$332,799	$893,672	7,025,418	7,945,587	$2,315,040	$4,266,861	0	0	$0	$425,278
DIFFERENCE		(2,385)	2,385	($560,873)	$560,873	(920,169)	920,169	($1,951,821)	$1,951,821	0	0	($425,278)	$425,278

CONTINUED - COMPARISON CHARTS (TECHNICAL AND COST DATA) RECLAMATION 24-INCH PIPELINE - NAVAJO NATION - WESTEN PIPELINE PROJECT

ORIGIN	DESTINATION	INTAKE NATION*	INTAKE RECLAMATION	CONSTRUCTION COSTS ($) SUB-TOTAL NATION*	CONSTRUCTION COSTS ($) SUB-TOTAL RECLAMATION
LAKE POWELL	PAGE	$2,000,000	--	$2,000,000	$1,943,691
PAGE	LECHEE			$4,285,431	$5,239,899
LECHEE	COPPERMINE			$3,310,327	$5,781,615
COPPERMINE	EXPLOSIVE ROCK			$0	$6,839,207
EXPLOSIVE ROCK	BITTER SPRINGS			$4,157,967	$2,217,159
BITTER SPRINGS	CEDAR RIDGE			$5,523,981	$10,600,792
CEDAR RIDGE	BODAWAY/GAP			$3,953,860	$3,416,091
BODAWAY/GAP	CAMERON			$8,599,495	$13,430,879
TOTALS		$2,000,000	$0	**$31,831,061**	**$49,469,333**
DIFFERENCE		$2,000,000	($2,000,000)	($17,638,272)	$17,638,272

S.C.A.D.A., POWER AND CATHODIC PROTECTION COSTS ($)			
S C A D A	POWER	CATHODIC	SUBTOTALS
$11,846	$675,739	$4,601	$692,185
$39,262	$2,675,739	$15,249	$2,730,250
$52,299	$1,128,769	$20,313	$1,201,381
$64,070	$1,344,205	$24,885	$1,433,160
$32,378	$1,603,731	$12,576	$1,648,684
$148,405	$2,932,273	$57,640	$3,138,318
$56,725	$947,330	$22,032	$1,026,086
$243,616	$6,105,568	$94,621	$6,443,805
POTENTIAL COST			
$648,600	$17,413,352	$251,917	**$18,313,869**

*Values used are from the cost estimate included in the Navajo Nation DWR-WMB report titled, " North Central Arizona Supply Study and Western Pipeline Project " dated May 11, 1995 1995 DOLLARS

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TABLE B-9 SUMMATION OF THE ESTIMATED COST FOR THE - NAVAJO NATION - WESTERN NAVAJO PIPELINE PROJECT

	NATIONS - CAPITAL COSTS		NATIONS ESTIMATED REPLACEMENT COSTS	
	NOTE 1	NOTE 2	NOTE 8	NOTE 8
	1995 ($)	1999 ($)	1995 ($)	1999 ($)
INTAKE	$2,000,000	$2,260,000	$2,000,000	$2,260,000
PUMPS	$332,799	$376,063	$665,598	$752,126
STORAGE	$2,315,040	$2,615,995	$2,315,040	$2,615,995
PIPE	$27,183,223	$30,717,042	$13,591,612	$15,358,521
SUBTOTALS	**$31,831,062**	**$35,969,100**	**$18,572,250**	**$20,986,642**

	CAPITAL COSTS			
	NATION		RECLAMATION	
	NOTES 1and 6	NOTES 2 and 6	NOTES 3 and 7	NOTES 4 and 7
	1995 ($)	1999 ($)	1999 ($)	1999 ($)
SUBTOTALS	$31,831,061	$35,969,100	$46,706,681	$49,469,333
CONTINGENCY 20%	$6,366,212	$7,193,820	$9,341,336	$9,893,867
MOBILIZATION 2 %	$636,621	$719,382	$934,134	$989,387
OTHER (ENGIN) - 15 %	$4,774,659	$5,395,365	$7,006,002	$7,420,400
TOTALS	**$43,608,555**	**$49,277,666**	**$63,988,152**	**$67,772,986**

ANNUAL COSTS ($)							
OPERATIONS AND MAINTENANCE				OPERATIONS, MAINTENANCE, AND REPLACEMENT			
NATION		RECLAMATION		NATION		RECLAMATION	
NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTES 1 and 8	NOTES 2 and 8	NOTE 3	NOTE 4
1995 ($)	1999 ($)	1999 ($)	1999 ($)	1995 ($)	1999 ($)	1999 ($)	1999 ($)
$541,844	$612,284	$1,452,414	$1,436,552	$1,480,180	$1,672,602	$2,822,642	$2,872,492
$541,845	**$612,284**	**$1,452,414**	**$1,436,552**	**$1,480,180**	**$1,672,602**	**$2,822,642**	**$2,872,492**

S.C.A.D.A., POWER, & CATHODIC PROTECTION	
	NOTES 5 and 7
	1999 ($)
SUBTOTALS	$18,313,869
CONTINGENCY 20%	$3,662,774
MOBILIZATION 2 %	$366,277
OTHER (ENGIN) - 15 %	$2,747,080
TOTALS	**$25,090,001**

NOTE 1 Values used are from the Navajo Nation DWR-WMB report titled; " North Central Arizona Supply Study and Western Pipeline Project " dated May 11, 1995, and are 1995 dollars.

NOTE 2 Values are from the Navajo Nation DWR-WMB report multiplied by the index cost trend value (1.13) to bring to 1999 dollars.

NOTE 3 Reclamations cost estimate for the 18-inch pipeline option.

NOTE 4 Reclamations cost estimate for the 24-inch pipeline option.

NOTE 5 Cost estimate for Supervisory Control and Data Acquisition, (S.C.A.D.A.), Cathodic Protection, and the Power System.

NOTE 6 Mobilization cost of 2% was added to Navajo Nation estimate, for comparison with Reclamation's, which was not included in the Nation's estimate.

NOTE 7 Bureau of Reclamation utilized the Navajo Nation's "Other (Engineering) cost of 15 % " for direct comparison of final costs. Reclamation may not agree with this percentage rate.

NOTE 8 Navajo Nation's report did not include a replacement cost. Therefore, for comparison, using a life expectancy for the pumps and motors 20 years and the remaining major features 40 years. The pipeline replacement costs were estimated at 50 % of the construction costs, since construction costs included rock excavation.

APPENDIX C - OPERATING PRESSURE DISTRIBUTION;

Table C - 1

Operating Pressure Distribution

Western Navajo Pipeline Project

No	From	To	Average Demand		Peak Demand	
			18 " Option (psi)	24" Option (psi)	18 " Option (psi)	24" Option (psi)
1	Intake P. P. (D)	Page P. P. (U)	223 - 20	221 - 20	232 - 20	223 - 20
2	Page P. P. (D)	LeChee P. P. (U)	190 - 20	181 - 20	218 - 20	188 - 20
3	LeChee P. P. (D)	Coppermine P. P. (U)	503 - 20	498 - 20	521 - 20	502 - 20
4	Coppermine P. P. (D)	Explosive Rock	216 - 20	221 - 20	232 - 20	215 - 20
5	Explosive Rock	PRV-1 (U)	20 - 195	20 - 195	20 - 185	20 - 185
6	PRV-1 (D)	PRV-2 (U)	50 - 243	50 - 243	50 - 233	50 - 233
7	PRV-2 (D)	Bitter Springs P. P. (U)	55 - 55	55 - 55	55 - 55	55 - 55
8	Bitter Springs P. P. (D)	Cedar Ridge	380 - 20	380 - 20	440 - 20	440 - 20
9	Cedar Ridge	FCV-1 (U)	20 - 241	20 - 241	20 - 147	20 - 147
10	FCV-1 (D)	Bodaway/The Gap	20 - 20	20 - 20	20 - 20	20 - 20
11	Bodaway/The Gap	PRV-3 (U)	20 - 180	20 - 180	20 - 128	20 - 128
12	PRV-3 (D)	HWY 160 Jct	50 - 210	50 - 210	50 - 163	50 - 163
13	HWY 160 Jct	FCV- 2 (U)	210 - 290	210 - 290	163 - 162	163 - 162
14	FCV- 2 (D)	Cameron	20 - 20	20 - 20	20 - 20	20 - 20

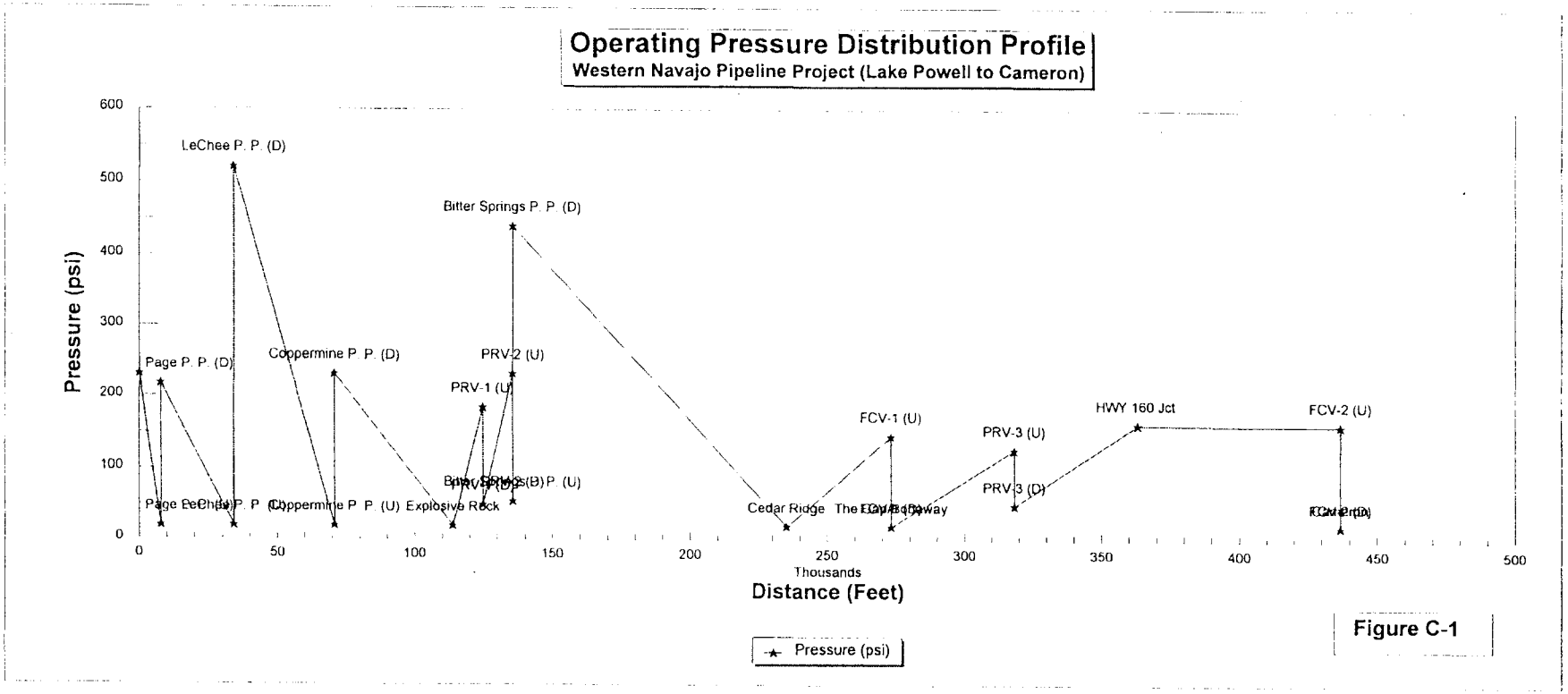
Operating Pressure Distribution Profile
Western Navajo Pipeline Project (Lake Powell to Cameron)
Pressure (psi)
600
500
400
300
200
100
0
LeChee P. P. (D)
Bitter Springs P. P. (D)
Page P. P. (D)
Coppermine P. P. (D)
PRV-2 (U)
PRV-1 (U)
FCV-1 (U)
PRV-3 (U)
HWY 160 Jct
FCV-2 (U)
PRV-3 (D)
Explosive Rock
Cedar Ridge
0
50
100
150
200
250
300
350
400
450
500
Thousands
Distance (Feet)
Pressure (psi)

Figure C-1

APPENDIX D - CONSTRUCTION COST TREND INDEX;

Bureau of Reclamation Construction Cost Trends

(Base: 1977 = 100 For Indexing Field Costs Only)

	1992				1993				1994				1995			
	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
Construction Indexes																
Earth dams	162	160	161	162	164	165	165	166	168	163	167	168	173	175	178	178
Dam structure	147	145	146	148	150	151	152	152	154	145	155	156	162	163	165	163
Spillway	175	171	171	172	174	175	175	176	178	176	173	175	180	182	187	188
Outlet works	189	185	186	188	189	190	191	192	194	194	191	193	196	198	202	204
Concrete dams	186	184	184	186	188	189	189	190	193	192	188	190	193	196	199	201
Diversion dams	183	182	183	185	186	187	188	189	191	191	191	193	195	198	201	202
Pumping plants	185	185	187	188	189	190	191	192	193	195	195	197	200	202	204	206
Structures and improvements	172	171	173	174	175	176	177	178	181	183	182	184	188	191	194	197
Equipment	201	201	203	204	205	206	207	208	208	209	211	213	213	215	217	218
Pumps and prime movers	204	205	206	208	209	210	211	211	210	213	214	215	217	219	220	221
Accessory elect + misc. equip.	195	196	197	199	199	200	201	203	204	204	206	208	209	210	211	213
Powerplants	197	198	199	201	202	203	204	205	207	207	208	209	212	213	215	216
Structures and improvements	173	172	173	175	176	176	178	179	182	183	183	185	189	191	194	197
Equipment	212	213	215	217	218	219	220	221	222	222	223	224	226	227	228	228
Turbines and generators	216	217	218	220	221	222	223	224	226	225	225	227	228	229	230	231
Accessory elect + misc. equip.	191	191	192	194	195	195	197	198	199	200	202	204	205	206	207	208
Steel pipelines	195	195	196	198	199	200	201	202	203	204	204	206	209	211	212	213
Concrete pipelines	178	178	179	181	181	182	183	184	184	185	185	186	188	189	191	191
Canals	167	166	167	169	170	171	172	172	174	176	176	178	182	184	187	189
Canal earthwork	167	166	168	170	172	172	173	173	174	175	176	177	181	182	185	181
Canal structures	172	171	172	174	174	175	176	178	180	183	182	183	188	191	194	198
Tunnels	196	195	196	198	200	200	202	203	205	205	206	208	210	212	216	220
Laterals and drains	167	165	166	169	170	171	175	176	178	180	180	182	188	190	192	190
Lateral earthwork	167	166	167	170	171	172	173	173	174	175	176	177	181	181	185	182
Lateral structures	168	166	168	170	171	172	178	179	181	184	184	186	192	196	197	196
Distribution pipelines	178	178	179	181	181	182	183	184	184	185	185	187	188	190	192	193
Switchyards and substations	189	188	188	190	190	191	192	194	194	196	195	197	198	202	203	204
Wood pole transmission lines	172	171	173	175	177	180	185	198	195	201	208	210	209	217	214	214
Poles and fixtures	157	158	163	166	171	176	186	208	208	220	229	230	221	218	209	208
Overhead conductors and devices	191	188	187	186	185	185	184	186	180	179	182	185	195	218	222	222
Steel tower transmission lines	197	196	195	196	196	196	197	198	196	196	198	201	205	215	218	219
Primary roads	188	185	185	186	188	188	191	196	196	200	197	199	201	204	206	208
Secondary roads	216	211	209	210	212	209	214	215	217	211	216	217	224	229	230	231
Bridges	189	188	188	190	191	191	194	194	196	196	198	199	204	207	208	212
General property	185	185	187	189	190	191	194	198	201	203	205	208	208	209	209	210
Land Indexes																
Arizona	182	185	188	191	194	197	200	203	206	209	212	215	221	227	233	239
California	271	275	279	283	287	289	291	291	291	291	291	291	291	291	292	295
Colorado	162	164	166	168	168	168	171	174	178	182	186	190	194	198	202	206
Idaho	145	146	147	148	149	150	151	155	159	163	167	171	175	179	183	187
Kansas	113	114	115	116	118	120	122	124	126	128	130	132	134	136	137	138
Montana	139	139	139	142	145	148	151	154	157	160	163	166	169	172	175	178
Nebraska	123	123	123	123	123	123	124	126	128	130	134	136	138	140	142	144
Nevada	210	214	218	222	226	230	234	238	242	247	252	257	262	267	272	277
New Mexico	205	205	204	203	200	199	198	202	206	210	214	218	222	226	232	238
North Dakota	118	118	119	120	121	122	123	124	125	126	127	129	131	133	135	137
Oklahoma	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138
Oregon	151	155	159	163	168	173	178	183	188	193	200	207	214	221	228	235
South Dakota	148	146	144	144	143	143	144	145	146	148	150	152	153	154	155	156
Texas	165	164	163	163	163	163	164	167	169	171	173	176	178	181	183	185
Utah	160	163	165	169	173	176	180	185	190	195	200	207	212	219	225	233
Washington	166	166	166	166	167	168	169	176	183	190	197	198	199	200	201	202
Wyoming	140	142	143	145	147	149	151	153	155	160	164	168	171	173	175	178
Other Indicators																
Composite trend	186	185	186	188	189	190	190	194	195	196	197	199	201	204	206	207
Machinery and equipment (BLS)	204	206	207	209	211	214	213	213	214	215	215	216	216	218	219	220
Federal salary	187	187	187	187	194	194	194	194	200	200	200	200	202	202	202	202

Inquiries to: D-8170 Fax: (303) 445-6475 or rbaumgarten@do.usbr.gov or lpedde@do.usbr.gov

NOTE: The land indexes have been reinstated as part of the Construction Cost Trends. Because of a newly located source of land values from the U.S. Department of Agriculture, it was apparent that our previously published land index values lagged actual values significantly. Because of this it was necessary to recompute our values from 1985 forward.

Bureau of Reclamation Construction Cost Trends

(Base: 1977 = 100 for Indexing Field Costs Only)

Item	1996 Jan	1996 Apr	1996 Jul	1996 Oct	1997 Jan	1997 Apr	1997 Jul	1997 Oct	1998 Jan	1998 Apr	1998 Jul	1998 Oct	1999 Jan	1999 Apr	1999 Jul	1999 Oct
Construction Indexes																
Earth dams	175	180	174	176	177	179	181	180	180	181	183	183	184	185		
Dam structure	160	167	157	159	162	164	165	164	164	163	163	163	162	162		
Spillway	186	189	187	186	187	188	191	191	190	192	198	198	200	203		
Outlet works	203	205	205	206	206	207	211	211	211	212	218	219	221	224		
Concrete dams	200	202	202	203	200	205	208	208	209	210	216	217	219	222		
Diversion dams	202	205	205	207	204	209	211	212	213	214	216	217	218	219		
Pumping plants	207	211	213	215	214	216	217	219	219	220	221	222	222	223		
Structures and improvements	195	202	205	209	205	208	210	211	211	212	213	213	214	215		
Equipment	221	222	222	223	224	226	227	228	229	230	232	233	233	234		
Pumps and prime movers	225	227	227	228	230	231	232	233	234	235	237	237	237	239		
Accessory elect. & misc. equip.	213	214	214	216	216	217	220	221	221	222	225	226	226	227		
Powerplants	215	216	217	219	217	220	223	224	225	225	226	227	227	229		
Structures and improvements	196	202	205	209	205	208	210	211	211	212	213	214	214	215		
Equipment	226	226	227	228	226	229	231	233	233	233	235	236	236	238		
Turbines and accessories	228	229	230	231	228	230	233	235	235	236	238	238	239	241		
Accessory elect. & misc. equip.	210	207	207	209	209	215	216	218	218	219	221	222	222	223		
Steel pipelines	214	217	219	222	229	229	231	232	233	233	236	237	238	239		
Concrete pipelines	191	194	193	196	197	200	202	203	205	206	209	211	212	213		
Canals	186	196	194	199	198	200	201	201	201	201	202	202	203	203		
Canal earthwork	178	189	177	181	185	187	188	187	186	186	185	185	184	184		
Canal structures	197	203	208	213	209	211	213	215	215	216	218	219	219	221		
Tunnels	221	224	223	226	226	231	233	234	235	236	239	240	241	242		
Laterals and drains	186	195	197	202	214	216	218	219	219	219	220	220	220	220		
Lateral earthwork	177	184	174	178	182	183	185	184	183	183	183	182	182	182		
Lateral structures	193	203	209	215	231	234	237	238	238	239	241	240	240	240		
Distribution pipelines	193	195	195	198	198	201	203	204	206	207	210	211	212	213		
Switchyards and substations	204	186	188	190	189	211	212	213	213	215	216	218	218	220		
Wood pole transmission lines	216	213	220	234	234	233	230	226	218	211	198	205	191	196		
Poles and fixtures	217	217	231	255	262	254	245	238	224	212	192	209	186	198		
Overhead conductors and devices	215	209	207	207	200	208	212	212	212	210	205	200	199	196		
Steel tower transmission lines	218	216	216	217	214	219	221	222	223	223	224	222	222	222		
Primary roads	208	209	214	219	217	222	224	224	223	219	221	225	224	226		
Secondary roads	227	230	230	237	240	247	256	258	257	237	243	247	254	253		
Bridges	211	218	221	226	224	227	231	232	233	229	232	233	236	237		
General property	211	210	212	217	219	220	221	222	220	219	219	222	219	221		
Composite trend	207	208	209	212	213	217	219	219	219	219	220	221	220	222		
Land Indexes																
Arizona	245	251	257	263	270	277	284	291	298	303	310	315	322	329		
California	301	307	313	319	325	331	335	339	343	346	350	355	359	359		
Colorado	210	214	218	222	225	228	231	234	236	237	242	245	247	248		
Idaho	190	193	196	199	202	205	208	211	214	216	220	224	227	230		
Kansas	139	140	141	142	143	144	145	146	147	148	150	150	151	150		
Montana	181	184	187	190	193	195	197	199	201	202	204	205	202	198		
Nebraska	146	148	150	153	156	159	162	165	167	168	172	174	167	167		
Nevada	282	287	292	297	302	307	312	317	322	325	330	335	340	346		
New Mexico	244	250	256	262	267	272	277	282	287	290	292	295	296	298		
North Dakota	139	141	143	145	147	149	151	153	155	156	156	156	154	152		
Oklahoma	139	140	141	142	143	144	145	146	147	148	150	152	153	152		
Oregon	242	249	256	263	270	277	284	291	298	301	304	307	306	303		
South Dakota	157	158	160	162	164	166	168	170	171	171	174	178	183	183		
Texas	187	190	193	195	199	202	204	206	207	208	213	217	213	208		
Utah	240	247	255	260	266	272	278	280	282	283	285	288	290	290		
Washington	204	206	209	212	217	223	229	235	241	244	250	255	250	246		
Wyoming	181	183	185	188	192	195	198	200	203	205	207	208	206	204		
Other Indicators																
Machinery and equipment (BLS)	221	221	225	225	226	228	229	230	231	232	234	234	235	237		
Federal salary	207	207	207	207	212	212	212	212	217	217	217	217	225	225		

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