APPENDIX B

Appraisal Level Designs and Cost Estimates (April 2002)

NAVAJO GALLUP WATER SUPPLY PROJECT

APPRAISAL LEVEL DESIGNS
AND COST ESTIMATES

Prepared for the Bureau of Reclamation - Western Colorado Area Office

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April 2002

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I. EXECUTIVE SUMMARY

The Navajo Gallup Water Supply Project would deliver treated municipal water to selected Navajo communities, the Jicarilla Apache Nation, and the City of Gallup, New Mexico. The project would serve approximately 124,000 people in 43 Navajo Chapters in the Navajo Nation, 500 people in the Jicarilla Apache Nation, and approximately 33,000 people in Gallup based on the future demands for the year 2020. Based on the expected populations in the year 2040, the project would serve approximately 203,000 people in 43 Chapters in the Navajo Nation, 1,300 people in the Jicarilla Apache Nation, and approximately 47,000 people in Gallup. The purpose of this document is to provide appraisal-level designs and cost estimates for six project alternatives at each of these demand levels.

This proposed Navajo Gallup Water Supply Project (NGWSP) would serve the New Mexico portion of the Navajo Nation south of the San Juan River, the Navajo Nation in the Window Rock area within Arizona, the Jicarilla Apache Nation, and the City of Gallup, New Mexico. A municipal water supply is needed in these areas to improve the standard of living for current and future populations and to support economic growth. The NGWSP has evolved as a major infrastructure initiative to meet these needs. To achieve this initiative, the following organizations are working closely in a cooperative effort: the Navajo Nation Department of Water Resources, the Jicarilla Apache Nation, the Northwest New Mexico Council of Governments, the New Mexico Office of The State Engineer, the City of Gallup, the Bureau of Indian Affairs, and the Bureau of Reclamation.

This appraisal-level study includes six alternatives with differing configurations. The Navajo Indian Irrigation Project (NIIP) Moncisco Alternative utilizes two connected laterals to deliver the required water (See NIIP Moncisco Alternative Map - Figure 1). The NIIP Cutter Alternative is similar to the NIIP Moncisco Alternative except that it would not require the construction of Moncisco Dam and Reservoir (See NIIP Cutter Lateral Alternative Map - Figure 2). The NIIP Coury Lateral Alternative is similar to the other two NIIP alternatives, but would utilize existing NIIP facilities to convey NGWSP water throughout the year (See NIIP Coury Lateral Alternative Map - Figure 3). The NIIP Amarillo Alternative also utilizes existing NIIP facilities to convey NGWSP water throughout the year, and is made up of two separate lateral systems. One lateral diverts water from the end of the NIIP facilities, and the Cutter Lateral diverts water from Cutter Reservoir (See NIIP Amarillo Alternative Map - Figure 4). The San Juan River, Public Service Company of New Mexico (SJR PNM) Alternative is also made up of two separate lateral systems, the San Juan Lateral and the Cutter Lateral (See SJR PNM Alternative Map - Figure 5), which deliver the same amounts of water to the same locations, but utilize different lateral alignments. Water for this alternative comes from both the NIIP facilities and from the San Juan River. The SJR Infiltration Alternative is similar to the SJR PNM Alternative except that water from the San Juan River would come from an infiltration gallery near the Hogback Irrigation Diversion rather than from a turnout on the river near the PNM facilities (See San Juan River Infiltration Alternative Map - Figure 6). Detailed descriptions for each of these six alternatives are provided later in this document.

Summaries of the total costs for the appraisal-level designs for the six alternatives, each including the City of Gallup, for the years 2020 and 2040 are shown in Tables 1 and 2. Tables 1a and 2a include annual operation, maintenance, and replacement (OM&R) costs, shown both as annual expenses and converted to present worth values. The present worth conversions assumed a 50 year project life and an interest rate of 6.375%.

TABLE 1: Project Construction Costs With Taxes Based on Year 2020 Demand

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Field Costs	$310,000,000	$300,000,000	$300,000,000	$270,000,000	$230,000,000	$250,000,000
Non-Contract Costs	$93,000,000	$90,000,000	$90,000,000	$81,000,000	$69,000,000	$75,000,000
Totals	$403,000,000	$390,000,000	$390,000,000	$351,000,000	$299,000,000	$325,000,000
Gallup Regional Field Cost	$16,500,000	$16,500,000	$16,500,000	$16,500,000	$16,500,000	$16,500,000
Non-Contract Costs	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000
Totals	$22,000,000	$22,000,000	$22,000,000	$22,000,000	$22,000,000	$22,000,000
Taxes on Field Costs (estimated at 6.0%)	$19,590,000	$18,990,000	$18,990,000	$17,190,000	$14,790,000	$15,990,000
Navajo Nation Tax - Includes Gallup (est. 3%)	$9,795,000	$9,495,000	$9,495,000	$8,595,000	$7,395,000	$7,995,000
Total Project Construction Costs Including Taxes*	$454,385,000	$440,485,000	$440,485,000	$398,785,000	$343,185,000	$370,985,000
Rounded Values	$450,000,000	$440,000,000	$440,000,000	$400,000,000	$340,000,000	$370,000,000

* Costs for Rights-of-way, Land, Environmental Mitigation, and Cultural Resources are not included.

TABLE 1a: Project Total Present Worth Costs Based on Year 2020 Demand (Values Rounded)

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Total Construction Cost With Taxes (From Table 1)	$450,000,000	$440,000,000	$440,000,000	$400,000,000	$340,000,000	$370,000,000
Treatment Plants annual OM&R (NTUA Rates)	$2,100,000	$2,100,000	$2,100,000	$2,900,000	$3,200,000	$2,600,000
Treatment Plants annual OM&R (CRSP Rates)	$1,900,000	$1,950,000	$1,900,000	$2,700,000	$2,900,000	$2,400,000
Pumping Plants and canal annual OM&R (NTUA Rates)	$3,900,000	$3,100,000	$3,900,000	$4,300,000	$5,800,000	$5,800,000
Pumping Plants and canal annual OM&R (CRSP Rates)	$2,400,000	$2,000,000	$2,200,000	$2,700,000	$3,400,000	$3,400,000
Pipelines annual OM&R	$500,000	$550,000	$610,000	$480,000	$380,000	$350,000
Gallup Regional System annual OM&R (NTUA Rates)	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000
Gallup Regional System annual OM&R (CRSP Rates)	$330,000	$330,000	$330,000	$330,000	$330,000	$330,000
Total annual OM&R Costs (NTUA Rates)	$6,900,000	$6,100,000	$7,000,000	$8,100,000	$9,800,000	$9,100,000
Present Worth (NTUA)	$103,000,000	$91,000,000	$105,000,000	$121,000,000	$147,000,000	$136,000,000
Total annual OM&R Costs (CRSP Rates)	$5,100,000	$4,800,000	$5,000,000	$6,200,000	$7,000,000	$6,500,000
Present Worth (CRSP)	$76,000,000	$72,000,000	$75,000,000	$93,000,000	$105,000,000	$97,000,000
Project Total Present Worth (NTUA Rates)	$550,000,000	$530,000,000	$550,000,000	$520,000,000	$490,000,000	$510,000,000
Project Total Present Worth (CRSP Rates)	$530,000,000	$510,000,000	$520,000,000	$490,000,000	$450,000,000	$470,000,000

TABLE 2: Project Construction Costs With Taxes Based on Year 2040 Demand

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Field Costs	$390,000,000	$380,000,000	$430,000,000	$320,000,000	$300,000,000	$320,000,000
Non-Contract Costs	$117,000,000	$114,000,000	$129,000,000	$96,000,000	$90,000,000	$96,000,000
Totals	$507,000,000	$494,000,000	$559,000,000	$416,000,000	$390,000,000	$416,000,000
Gallup Regional Field Cost	$16,500,000	$16,500,000	$16,500,000	$16,500,000	$16,500,000	$16,500,000
Non-Contract Costs	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000
Totals	$22,000,000	$22,000,000	$22,000,000	$22,000,000	$22,000,000	$22,000,000
Taxes on Field Costs (estimated at 6.0%)	$24,390,000	$23,790,000	$26,790,000	$20,190,000	$18,990,000	$20,190,000
Navajo Nation Tax - Includes Gallup (est. 3%)	$12,195,000	$11,895,000	$13,395,000	$10,095,000	$9,495,000	$10,095,000
Total Project Construction Costs Including Taxes*	$565,585,000	$551,685,000	$621,185,000	$468,285,000	$440,485,000	$468,285,000
Rounded Values	$570,000,000	$550,000,000	$620,000,000	$470,000,000	$440,000,000	$470,000,000

* Costs for Rights-of-way, Land, Environmental Mitigation, and Cultural Resources are not included.

TABLE 2a: Project Total Present Worth Costs Based on Year 2040 Demand (Values Rounded)

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Total Construction Cost With Taxes (From Table 2)	$570,000,000	$550,000,000	$620,000,000	$470,000,000	$440,000,000	$470,000,000
Treatment Plants annual OM&R (NTUA Rates)	$2,900,000	$2,900,000	$2,900,000	$3,700,000	$4,000,000	$3,200,000
Treatment Plants annual OM&R (CRSP Rates)	$2,600,000	$2,600,000	$2,600,000	$3,400,000	$3,600,000	$2,900,000
Pumping Plants and canal annual OM&R (NTUA Rates)	$5,000,000	$3,900,000	$5,200,000	$5,500,000	$7,700,000	$7,400,000
Pumping Plants and canal annual OM&R (CRSP Rates)	$2,800,000	$2,300,000	$2,600,000	$3,200,000	$4,100,000	$4,000,000
Pipelines annual OM&R	$640,000	$780,000	$1,000,000	$520,000	$450,000	$410,000
Gallup Regional System annual OM&R (NTUA Rates)	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000
Gallup Regional System annual OM&R (CRSP Rates)	$330,000	$330,000	$330,000	$330,000	$330,000	$330,000
Total annual OM&R Costs (NTUA Rates)	$8,900,000	$8,000,000	$9,500,000	$10,100,000	$12,500,000	$11,400,000
Present Worth (NTUA)	$133,300,000	$119,800,000	$142,200,000	$151,200,000	$187,200,000	$170,700,000
Total annual OM&R Costs (CRSP Rates)	$6,400,000	$6,000,000	$6,500,000	$7,500,000	$8,500,000	$7,600,000
Present Worth (CRSP)	$96,000,000	$90,000,000	$97,000,000	$112,000,000	$127,000,000	$114,000,000
Project Total Present Worth (NTUA Rates)	$700,000,000	$670,000,000	$760,000,000	$620,000,000	$630,000,000	$640,000,000
Project Total Present Worth (CRSP Rates)	$670,000,000	$640,000,000	$720,000,000	$580,000,000	$570,000,000	$580,000,000

II. PURPOSE AND OBJECTIVE

The purpose of this document is to provide the Navajo Nation, Jicarilla Apache Nation, and the City of Gallup, New Mexico, with appraisal-level designs and cost estimates for six alternatives with differing configurations. This document also provides the estimated operation, maintenance, and replacement costs for the project using two different power rates. The differences between the alternatives are also described. Costs for Rights-of-way, Land, Environmental Mitigation, and Cultural Resources are not included.

III. BACKGROUND AND SCOPE

Over the past 28 years several proposals have been studied to deliver water from the San Juan River and other sources of water to communities in the Navajo Nation and to the City of Gallup. Reclamation's first investigation for the "Gallup Project, New Mexico[1] " culminated in a reconnaissance report dated October 1973. A second study[2] was completed in January 1984 and included expanded service to Navajo communities as well as to the City of Gallup. An appraisal-level estimate[3] for a system having a main transmission line along Highway 371 was completed in September 1986. In November 1993, an appraisal-level study[4] was conducted to deliver water from Gallegos Reservoir, a planned feature of the Navajo Indian Irrigation Project (NIIP).

This proposal for the Navajo Gallup Water Supply Project (NGWSP) serves the New Mexico portion of the Navajo Nation south of the San Juan River, the Navajo Nation in the Window Rock area within Arizona, the Jicarilla Apache Nation, and the City of Gallup, New Mexico. A municipal water supply is needed in these areas to improve the standard of living for current and future populations and to support economic growth. The NGWSP has evolved as a major infrastructure initiative to supply approximately 23,900 acre-feet (2020) or approximately 37,800 acre-feet (2040) of municipal water annually to meet these needs. To achieve this initiative, the following organizations are working closely in a cooperative effort: the Navajo Nation Department of Water Resources, the Jicarilla Apache Nation, the Northwest New Mexico Council of Governments, the New Mexico Office of the State Engineer, the City of Gallup, and the Bureau of Indian Affairs,

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[1] Gallup Project Reconnaissance Report, U.S. Department of the Interior, Bureau of Reclamation, 1973.

[2] Gallup-Nation Indian Water Supply Project, Planning Report/Draft Environmental Statement, U.S. Department of the Interior, Bureau of Reclamation, Southwest Region, January 1984.

[3] Gallup-Navajo Indian Water Supply Project, New Mexico Arizona, Technical Report, U.S. Department of the Interior, Bureau of Reclamation, Southwest Region, September 1986.

[4] San Juan River Gallup/Navajo Water Supply Project, Engineering and Cost Estimates, Technical Appraisal Report, Bureau of Reclamation, November 1993.

and the Bureau of Reclamation. A detailed history and explanation of the project can be found in the final draft of "Technical Memorandum, The Navajo-Gallup Water Supply Project", March 16, 2001, prepared by the Navajo Nation Department of Water Resources.

Appraisal level analyses were conducted for six alternatives with differing configurations, each having two different flow capacities in cubic feet per second (cfs), or MGD as follows:

1. NIIP Moncisco Alternative at 67.52 cfs (43.6 MGD) for year 2040

1a. NIIP Moncisco Alternative at 42.75 cfs (27.6 MGD) for year 2020

2. NIIP Coury Lateral Alternative at 67.52 cfs (43.6 MGD) for year 2040

2a. NIIP Coury Lateral Alternative at 42.75 cfs (27.6 MGD) for year 2020

3. NIIP Cutter Alternative at 67.52 cfs (43.6 MGD) for year 2040

3a. NIIP Cutter Alternative at 42.75 cfs (27.6 MGD) for year 2020

4. NIIP Amarillo Alternative at 67.52 cfs (43.6 MGD) for year 2040
   a. Amarillo Canal Diversion at 59.18 cfs (38.2 MGD) for year 2040
   b. Cutter Lateral at 8.34 cfs (5.38 MGD) for year 2040

4a. NIIP Amarillo Alternative at 42.75 cfs (27.6 MGD) for year 2020
   a. Amarillo Canal Diversion at 36.97 cfs (23.9 MGD) for year 2020
   b. Cutter Lateral at 5.78 cfs (3.7 MGD) for year 2020

5. SJR PNM Alternative (Total Q = 67.52 cfs (43.6 MGD))
   a. PNM Diversion at 59.18 cfs (38.2 MGD) for year 2040
   b. Cutter Lateral at 8.34 cfs (5.38 MGD) for year 2040

5a. SJR PNM Alternative (Total Q = 42.75 cfs (27.6 MGD))
   a. PNM Diversion at 36.97 cfs (23.9 MGD) for year 2020
   b. Cutter Lateral at 5.78 cfs (3.7 MGD) for year 2020

6. SJR Infiltration Alternative (Total Q = 67.52 cfs (43.6 MGD))
   a. Infiltration Gallery System at 59.18 cfs (38.2 MGD) for year 2040
   b. Cutter Lateral at 8.34 cfs (5.38 MGD) for year 2040

6a. SJR Infiltration Alternative (Total Q = 42.75 cfs (27.6 MGD))
   a. Infiltration Gallery System at 36.97 cfs (23.9 MGD) for year 2020
   b. Cutter Lateral at 5.78 cfs (3.7 MGD) for year 2020

IV. DESCRIPTION OF ALTERNATIVES

A. Navajo Indian Irrigation Project (NIIP) Moncisco Alternative

The NIIP Moncisco Alternative would utilize two laterals to deliver water to different portions of the Navajo Nation but both would begin at one location, the proposed Moncisco Reservoir (See NIIP Moncisco Alternative Map - Figure 1). This alternative would use existing NIIP canals and features to convey water to the proposed Moncisco Reservoir during the irrigation season (see Appendix G). From the proposed water treatment plant near Moncisco Reservoir, the East Lateral would convey water south to communities in the eastern portion of the Navajo Nation and the Jicarilla Apache Nation. The West Lateral would convey water south to communities in the western portion of the Navajo Nation, and to the City of Gallup. Several sublaterals would convey water to the communities of Window Rock, Arizona and the Nahodishgish Chapter/Dalton Pass, New Mexico.

Water for the NIIP Moncisco Alternative would be conveyed from the existing Burnham Lateral to the proposed Moncisco Reservoir via a proposed stabilized channel. The NIIP system would convey water from Navajo Reservoir and through a series of canals, siphons, and tunnels to Gallegos Pumping Plant which conveys water to Burnham Lateral. An existing wasteway in Burnham Lateral would be used with the proposed stabilized channel to convey water to Moncisco Reservoir. Moncisco Dam and Reservoir would be constructed specifically for the NGWSP and would have an approximate capacity of 12,000 acre feet of active storage. This storage would be provided because the NIIP system would not operate during the winter months. Previous designs, estimates and quantities from two Bureau of Reclamation reports[5] were evaluated and refined, and the costs for these designs were indexed for this study.

A water treatment plant would be located immediately downstream of Moncisco Dam and Reservoir to treat the water before it is conveyed to the Navajo communities, the Jicarilla Apache Nation, and the City of Gallup. The treatment plant would utilize an enhanced coagulation and hollow fiber ultrafiltration treatment system. Treated water would be pumped into the West and East Laterals. The NIIP Moncisco Alternative would have the a capacity of 42.75 cfs (27.6 Million Gallons per Day (MGD)) for the expected flow requirements in year 2020 or 67.52 cfs (43.6 MGD) in year 2040.

B. NIIP Cutter Alternative

The NIIP Cutter Alternative would also be similar to the NIIP Moncisco Alternative, but would not require the construction of Moncisco Dam and Reservoir (See NIIP Cutter Alternative Map - Figure 2). Water would be released from Navajo Reservoir and conveyed through the existing

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[5] "Technical Memorandum No. GG-8311-2, Gallegos Dam, Reconnaissance Design Summary" and "Water Supply and Storage Options, Gallup Navajo Pipeline Project, Engineering and Cost Estimates Appraisal Level Report".

NIIP system to Cutter Reservoir throughout the year, requiring winterization of a portion of the existing NIIP facilities (see Appendix G). The treatment plant would be constructed at the base of Cutter Dam. Water would be pumped from the base of Cutter Dam through the Cutter Lateral to Highway 550, at which point the pipeline would serve the East and West Laterals following the same alignments as the NIIP Moncisco Alternative.

All flows for the project remain the same as described in Alternative A.

C. NIIP Coury Lateral Alternative

The NIIP Coury Lateral Alternative is similar to the NIIP Moncisco Alternative, but instead of constructing Moncisco Dam and Reservoir, the existing NIIP facilities would be winterized (see Appendix G) to convey NGWSP water throughout the year (See NIIP Coury Lateral Alternative Map - Figure 3). A turnout structure would divert water from the Coury Lateral and tie into the alignment proposed in the NIIP Moncisco Alternative. The turnout structure was sized based upon a standard canal turnout with a 48" diameter outlet pipe. This alternative requires a 4,500 acre foot lined storage pond located near the Coury Lateral, which would provide storage capacity for the summer months when NIIP facilities cannot provide both peak irrigation demand and NGWSP demands (see Appendix G). The pond was assumed to be square, with a 20 foot water depth, and 3 feet of freeboard. The pond was partially excavated below original ground, and a compacted embankment was assumed to be 5 feet above original ground, and 6 feet wide at the top. The interior was assumed to be lined with a 40 mil membrane liner and 6 inches of riprap.

The water treatment plant, as described in Alternative A, would be located near the storage pond and the Coury Lateral, and flows would be the same as discussed in Alternative A.

D. NIIP Amarillo Alternative

The NIIP Amarillo Alternative is similar to the NIIP Coury Lateral Alternative in that the existing NIIP facilities would be winterized (see Appendix G) to convey NGWSP water throughout the year (See NIIP Amarillo Alternative Map - Figure 4). However, this alternative diverts water from the end of the Amarillo Canal for one lateral, as well as from Cutter Reservoir for the Cutter Lateral. A turnout structure would divert water from the Amarillo Canal and tie into the alignment proposed in the SJR PNM Alternative (see below). The turnout structure was sized based upon a standard canal turnout with a 48" diameter outlet pipe. This alternative requires a 4,500 acre foot lined storage pond located near the canal, as described in Alternative C.

A water treatment plant would treat the water from the Amarillo Canal before the water is transmitted to the Navajo communities and the City of Gallup. Another treatment plant immediately downstream of Cutter Dam would provide treated water to the eastern portion of the Navajo Nation and the Jicarilla Apache Nation. Both treatment plants would utilize an enhanced coagulation and hollow fiber ultrafiltration treatment system. Flows would be divided between the Amarillo Canal and the Cutter Reservoir as described in Section III above.

E. San Juan River Public Service Company of New Mexico (SJR PNM) Alternative

The SJR PNM Alternative is made up of two separate lateral systems, the San Juan Lateral and the Cutter Lateral (See SJR PNM Alternative Map - Figure 5). The San Juan Lateral would divert water from the San Juan River downstream of Fruitland, New Mexico, and treat and deliver the water west along Highway N36 and south along US Highway 666 to communities in the western portion of the Navajo Nation and the City of Gallup. This Lateral utilizes several sublaterals to serve such communities as Window Rock, Arizona, and the Nahodishgish Chapter/Dalton Pass, New Mexico. The SJR PNM Alternative would divert water from the San Juan River just upstream from the existing Public Service Company of New Mexico (PNM) diversion structure. A side channel inlet structure would be designed with a sump, and water then pumped to settling basins and a treatment plant. The Cutter Lateral would obtain water from the NIIP system at the existing Cutter Reservoir and treat and deliver the water south to communities in the eastern portion of the Navajo Nation and the Jicarilla Apache Nation.

A water treatment plant would treat the water from the San Juan River before the water is transmitted to the Navajo communities and the City of Gallup. The treatment plant immediately downstream of Cutter Dam would provide treated water to the eastern portion of the Navajo Nation and the Jicarilla Apache Nation. Both treatment plants would utilize an enhanced coagulation and hollow fiber ultrafiltration treatment system. All flows would be the same as those discussed in Alternative D.

F. SJR Infiltration Alternative

The SJR Infiltration Alternative is the same as the SJR PNM Alternative except that the water would be diverted from the San Juan River through an infiltration gallery system downstream from the Hogback Irrigation Diversion (See SJR Infiltration Alternative Map - Figure 6). All other aspects would be the same as for the SJR PNM Alternative.

V. DELIVERY DATA

The Farmington Construction Office created delivery data spread sheets, which listed the delivery points, flow rates, elevations, and required storage for all the communities that would be served by the project. This delivery data was prepared for the water demand in year 2020 and year 2040, based on estimated population. The population and demand for each of the six alternatives was identical for each community for each year. At the delivery points, the project would connect to existing service connections.

The 2040 population of the Navajo Communities (1990 population with 2.48 percent annual growth rate) was used with an average daily water demand of 160 gallons per capita per day (gpcd) to determine the average daily demand. Surface diversion required for NGWSP was the average demand minus the available groundwater sources. Supporting information can be found in the "Technical Memorandum, The Navajo-Gallup Water Supply Project," prepared by The Navajo

Nation Department of Water Resources. Peak daily demand was computed by multiplying the surface diversion for NGWSP by a 1.3 peaking factor. The peaking factor was derived from a seven day average in mid July. The project would connect to approximately 31 existing Navajo municipal systems, and would provide 70 psi pressure at those locations. Storage capacity was based on the individual service area five day demand for the year 2020 for those communities with existing water distribution systems.

The City of Gallup and Jicarilla Apaches Nation surface diversion requirements are 7,500 and 1,200 acre feet per year respectively for all years in the project. An independent analysis (Appendix F) conducted by the City of Gallup identifies the system requirements for Gallup and the surrounding Navajo communities served by the Gallup system. No storage is required for the Jicarilla Apache Nation.

VI. BASIC DESIGN CONSIDERATIONS

Each of the alternatives for this project have very similar design considerations, but the components vary for each alternative.

All of the alternatives have one or more surface water diversion points. The two San Juan River Alternatives divert water from both the San Juan River and from Cutter Reservoir. Cutter Reservoir is an existing feature of the NIIP system which receives water from Navajo Reservoir.

The four NIIP Alternatives divert water entirely from the NIIP system originating at Navajo Reservoir. The difference between the NIIP Alternatives is where the water is diverted from prior to entering the NGWSP pipeline system. The NIIP Moncisco Alternative conveys water through the NIIP system and stores water in the proposed Moncisco Reservoir. The NIIP Coury Lateral Alternative requires construction of a smaller storage facility near the existing Coury Lateral. The NIIP Cutter Alternative diverts water from Cutter Reservoir, an existing NIIP feature. The NIIP Amarillo Alternative conveys water through the NIIP system and requires construction of a storage facility near the end of the Amarillo Canal, but also diverts water from Cutter Reservoir. The NIIP Coury Lateral, NIIP Cutter, and NIIP Amarillo Alternatives require winterization of NIIP facilities (see Appendix G).

In all alternatives, the surface water is treated to meet primary safe water drinking standards before entering the NGWSP conveyance system. Treatment plant designs are based on the quality of the water at the point of diversion. Treated water is then conveyed in pipelines toward points of use. When necessary, relift pumping plants are included to keep the water flowing in the pipeline. Navajo Communities that have an existing water distribution system would have a storage tank and a method to increase (by means of a turnout pumping plant) the pressure for proper distribution. Delivery locations in the transmission line that do not have an existing water distribution system would be provided with a tee and a blind flange for future use.

A typical relift pumping plant has a forebay tank, pumps and motors within an enclosed building, an air chamber, and re-chlorination equipment. The forebay tank provides an adequate supply of water to minimize the number of times the pumps cycle on and off. The air chamber provides protection of the pumping plant and pipeline when the pumps are started and stopped. Re-chlorination equipment provides the required chlorine residual in the treated water.

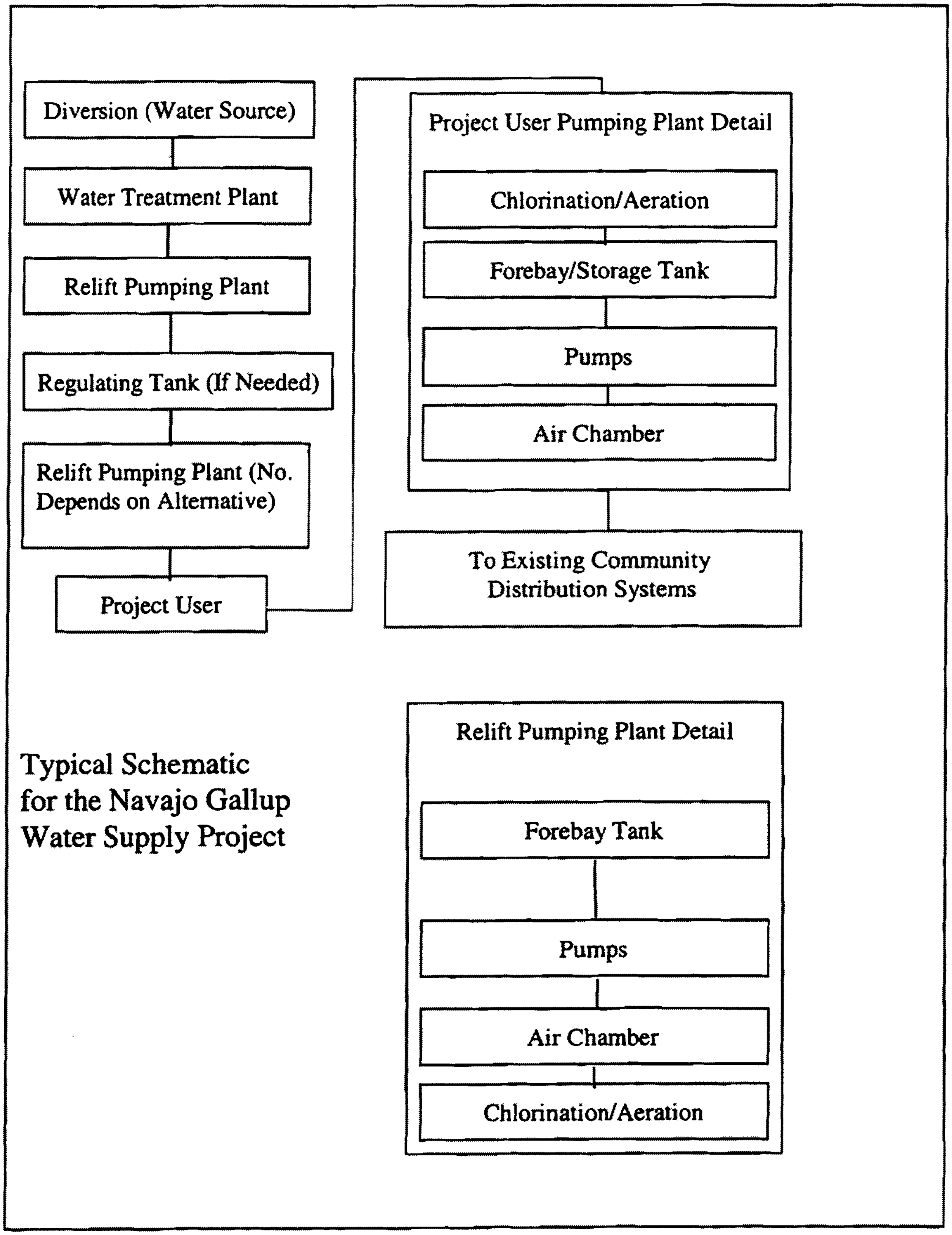
The turnout pumping plants have the same components as the relift pumping plants except a storage tank replaces the forebay tank. Re-chlorination equipment may not be necessary if chlorine residuals are adequate. Shown below is a summary of the major components required for each of the alternatives, followed by a typical schematic of the NGWSP system.

General Summary of Components

Component	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
River Intake					1	
Infiltration Wells						26 (Year 2040)
River Pumping Plant					1	
Treatment Plants	1	1	1	2	2	2
Forebay Tanks	12	8	11	17	19	20
Pumping Plants	12	8	11	17	20	20
Regulating Tanks	5	5	5	6	5	5
Community Storage Tanks	20	20	20	20	20	20
Feet of Pipeline	1,361,954	1,389,378	1,466,248	1,286,082	1,237,792	1,189,145
Miles of Pipeline	258	263	278	244	234	225

Gallup Regional System

Component	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Pumping Plants	4	4	4	4	4	4
Community Storage Tanks	5	5	5	5	5	5
Feet of Pipeline	171,923	171,923	171,923	171,923	171,923	171,923
Miles of Pipeline	32.6	32.6	32.6	32.6	32.6	32.6


Diversion (Water Source)
Water Treatment Plant
Relift Pumping Plant
Regulating Tank (If Needed)
Relift Pumping Plant (No. Depends on Alternative)
Project User
Project User Pumping Plant Detail
Chlorination/Aeration
Forebay/Storage Tank
Pumps
Air Chamber
To Existing Community Distribution Systems
Typical Schematic for the Navajo Gallup Water Supply Project
Relift Pumping Plant Detail
Forebay Tank
Pumps
Air Chamber
Chlorination/Aeration

A. Geology

No intensive geological investigations were conducted in the project area. Reclamation's Western Colorado Area Office identified reaches of pipe that may contain rock. These reaches were determined by comparing surface geology maps with the pipe alignments. Specific lengths of the alinement were identified, and rock excavation quantities were calculated based upon the pipe sizes in those areas. Drawings identifying the anticipated rock excavation areas are included in Appendix D.

B. Surface Water Diversions

1. PNM Diversion Structure

One of the options for diverting water from the San Juan River is to construct a new turnout structure just upstream from the existing Public Service Company of New Mexico (PNM) diversion structure, which is located about 1.5 miles northwest of Fruitland, New Mexico. The PNM diversion diverts water for a coal fired steam electric plant. A report was prepared for the Bureau of Reclamation by Tetra-Tech Inc. In this report, Tetra-Tech developed a simple HECRAS model of the PNM diversion and settling channel describing the hydraulics and theoretical settling characteristics of sediment in the PNM intake channel. The Bureau of Reclamation's Technical Service Center reviewed this report, and the review comments, as well as Tetra-Tech's report, are included in Appendix H.

The use of the existing PNM facilities was evaluated, but because of the potential impact on PNM's water quality, it was determined that the appraisal level study should proceed with the concept of constructing a water intake structure independent of the existing PNM intake facility, and to include independent sediment removal facilities. It was assumed that the new concrete structure would be located just upstream from the existing intake/turnout on the San Juan River, and would be similar to a side channel wasteway structure as shown in Bureau of Reclamation Design Standards 3, Chapter 7, Figure 5 (see Drawing 10). The structure would have a side intake with a trash rack and fish screen. The flow was assumed to be 0.5 feet per second through the trash rack. There would be a ramp at a 10:1 slope down which equipment would be driven to the pumping plant sump from which silt buildup would be removed. A pump would also be provided to remove sediment from the sump. The pumping plant would have a maximum capacity of 60 cfs. Each of the vertical turbine pumps would be rated at 100 horsepower. At the top of the ramp would be a 24 foot square parking/loading area. The entire site would be fenced with a 7-foot high chain link fence. The pumping units would pump from the sump to settling basins and the treatment plant.

Drawing 9 is a conceptual layout for the turnout structure and sump. Drawing 2 is a process flow diagram for the water treatment facility at this turnout. Drawing 8 is a conceptual layout for the water treatment plant, which is shown in more detail on Drawing 5. A site layout for both the turnout structure and the water treatment plant is shown on Drawing 11.

2. Infiltration Gallery System

An Infiltration Gallery System (IGS) was proposed as an option for the San Juan River diversion. The IGS would obtain water from the San Juan River downstream of the Hogback and upstream of the confluence of the Chaco River and the San Juan River. This diversion option would tie into the previously proposed alignment for the San Juan River PNM Alternative at the most feasible point. The proposed IGS components would include a series of infiltration galleries placed in the river alluvium, collection wells and pumps, a collection manifold system and tank, a pumping plant, and a pipeline to the proposed water treatment plant site (See Drawing 12). The location and cost estimate for the collection wells were prepared by Ranney, a company that specializes in the design and construction of infiltration gallery systems (See Appendix E). The gallery caissons were spaced approximately 500 feet apart along the San Juan River and were located with environmental considerations. For this study, the yield of each well was estimated at 1.5 million gallons per day (2.33 cfs).

A typical collector well is constructed of a concrete caisson typically ranging from 12 to 20 feet in diameter and approximately 20 feet deep. Each collector well would include a pump and a backup pump housed in a weather-proof enclosure. Numerous perforated infiltration pipes radiate out from the caisson into the river alluvium. The infiltration pipe would be perforated to allow water filtering through the alluvium to enter the pipe and be transported to the collector well, from which it is then pumped. The well pumps would convey water through a collection manifold that gathers the water from the entire infiltration gallery (well field) to a collection sump and pumping plant. The pumping plant would lift the water approximately 120 feet in elevation from the river elevation to the bluffs south of the San Juan River into the water treatment plant.

Drawing 3 is a process flow diagram for the infiltration gallery system. Drawing 12 is a conceptual layout of the proposed water treatment plant, which is shown in more detail on Drawing 7. Drawing 13 shows a plan view of the infiltration system and a section of a typical collection well.

3. Cutter Dam and Reservoir

The Cutter Lateral is part of the San Juan River Alternatives and serves communities in the eastern portion of the Navajo Nation and the Jicarilla Apache Nation. The Cutter Lateral would obtain water from the Cutter Reservoir via the river outlet works as shown on Drawing 14. Cutter Dam and Reservoir are existing features on the NIIP. The Cutter water treatment plant would deliver treated water to a pumping plant, which would then pump the water into Cutter Lateral for transmission to the various communities.

Drawing 1 includes a process flow diagram for the water treatment system at Cutter Reservoir, which is shown in more detail on Drawing 6.

For the NIIP Cutter Alternative, Cutter Reservoir would supply all of the water for the entire project, and there would be no diversion from the San Juan River. Drawing 15 is a conceptual layout of the treatment plant for this alternative, which is shown in more detail on Drawing 4. Additional information on the NIIP operations is included in Appendix G.

4. Moncisco Dam and Reservoir

Moncisco Dam and Reservoir would be constructed specifically for the NGWSP. Water would be delivered to Moncisco Reservoir from the Burnham Lateral. The designs for Moncisco Dam would include a river outlet works with a tee for diverting water into the water treatment plant (See Appendix G for additional information). The Moncisco Water Treatment Plant (See Drawing 15) would deliver treated water to a pumping plant, which would then pump water into the East and West Laterals for transmission to the various communities.

Drawing 1 includes a process flow diagram for this alternative. Drawing 15 is a conceptual layout of the proposed water treatment plant, which is shown in more detail on Drawing 4. Additional information on the NIIP operations is included in Appendix G.

5. Coury Lateral

A canal turnout structure would be constructed near the beginning of Coury Lateral for the NIIP Coury Lateral Alternative. Water from the Coury Lateral would be diverted into a 4500 acre-foot storage pond, and from that point would be pumped into a treatment plant.

Drawing 1 is a process flow diagram for the water treatment facility at this turnout. Drawing 16 is a conceptual layout for the water treatment plant, which is shown in more detail on Drawing 4. Additional information on the NIIP operations is included in Appendix G.

6. Amarillo Canal

A canal turnout structure would be constructed near the end of the Amarillo Canal for the NIIP Amarillo Alternative. Water from the Amarillo Canal would be diverted into a 4500 acre-foot storage pond, and from that point would be pumped into a treatment plant.

Drawing 1 is a process flow diagram for the water treatment facility at this turnout. Drawing 16 is a conceptual layout for the water treatment plant, which is shown in more detail on Drawing 5. Additional information on the NIIP operations is included in Appendix G.

VII. WATER TREATMENT CONSIDERATIONS

A. Water Quality

1. Alternatives and Diversions using Water from the Navajo Indian Irrigation Project (NIIP)

The water source for the NIIP Monsisco, NIIP Cutter, NIIP Coury Lateral, and NIIP Amarillo Alternatives, along with the Cutter Reservoir diversion portion of the SJR Alternatives and the NIIP Amarillo Alternative, is Navajo Reservoir. The water quality parameters, which are provided in Table 3, indicate that the only treatment requirements are filtration and disinfection as required under the Surface Water Treatment Rule (SWTR) which is part of the Safe Drinking Water Act. Further sampling and analysis will be required before final design and construction to verify the data presented in Table 3 is correct, especially during low and high precipitation years.

Table 3 - Water Quality - Navajo Indian Irrigation Project Source Water

Parameter	Average	Design Range	Secondary MCL
Electrical Conductivity, EC (umhos/cm)	195	205-187	
pH	7.72	7.75 - 7.71	
Temperature (of)	46.7	49.1 - 45.3	
Turbidity (NTU)	2.6	3.16 - 1.47	
Total Suspended Solids, TSS (mg/L)	1.15	1.3 - 1	
Total Dissolved Solids, TDS (mg/L)	154	181 - 140	500
Sulfates, SO_4 (mg/L)	32.5	38.2 - 2.29	250
Total Organic Carbon, TOC (mg/L)	4.47	8 - 2.29	
Chlorides (mg/L)	1.6	1.9 - 1.2	250

Notes:

1. Data from three samples collected from the Cutter Diversion April 2000 to June 2000.
2. Secondary standards or MCL's are established by EPA for control of aesthetic qualities relating to public acceptance and includes contaminants that may affect taste, color, odor and appearance.

2. San Juan River Diversions

a. San Juan River Alternatives During Non-Runoff Events

The San Juan River, upstream of the Public Service Company of New Mexico Diversion (PNM), would provide water to the SJR PNM Water Treatment Plant. The San Juan River downstream of the Hogback Diversion would supply water to the San Juan Water Treatment Plant utilizing a infiltration intake system. Table 4 provides water quality parameters for both of these sources during non-runoff events. As shown, the water quality meets all primary standards established by EPA for the parameters shown, resulting in the need for filtration and disinfection to meet the requirements of the SWTR which is discussed below. Further sampling and analysis will be required before final design and construction to verify the average concentration and ranges are correct, especially during low and high precipitation years.

Table 4 - Water Quality - San Juan Alternatives, Non Storm Event						
	Hogback		PNM Historic		Design	
Parameters	Averages	Ranges	Average	Range	Range	Secondary MCL
EC, umhos/cm	301.00	1155-203	446.7	632-214	632-214	
pH	7.99	8.66-7.53	8.1	8.6-7.6.	8.6-7.6.	
Temp (°F)	57.30	74.1-53.0			62.4-74.1	
Turbidity (NTU)	78.00	4266-5.41	506	6700-9	115-5.4	
TSS mg/L	170.00	15334-42	876.6	1080-21	262-21	
TDS mg/L	190.00	884-141	208	350-24	350-24	500
SO_4 mg/L	57.00	476.5-42.2	119	200-38	200 - 38	250
TOC mg/L	3.40	4.76-2.89			4.76-2.89	
Chloride mg/L	4.70	26.6-2.91			26.6-2.91	250.00
T. Hardness mg/L	107.00	1535-106	163	232-84	232-84	
Calcium +2			50.8	78-24	78-24	
Magnesium +2			10.1	54-1.9	54-1.9	
P Alkalinity			0.5	4.0-TRACE	4.0-TRACE	
M Alkalinity			99.3	123-4.5	123-4.5	
SiO_2			8.1	13.2-4.9	13.2-4.9	

Notes
1. Design value for TSS incorporates the reduction of turbidity and suspended solids by the pretreatment settling pond.
2. Data for PNM is based on 50 samples collected between January 5, 1999 and December 24, 1999.
3. Data for Hogback is based on 7 samples collected between April 14, 2000 and August 23, 2000.
4. Secondary standards or MCL's are established by EPA for control of aesthetic qualities relating to public acceptance and includes contaminants that may affect taste, color, odor and appearance.

b. San Juan River Alternatives During High Runoff Events

Table 5 shows the water quality in the San Juan River at the Hogback Canal taken from a sample collected on August 23, 2000 during a large storm event. Based on this data, it appears the water quality in the San Juan River at the Hogback exceeds secondary MCL's for Total Dissolved Solids (TDS) and sulfates. Sulfates and TDS are typically constituents of low quality water which cannot be substantially reduced by the infiltration gallery intake structure, traditional treatment or the proposed ultrafiltration system.

Further investigation is required to confirm the reduction of water quality due to the increase of TDS and sulfates associated with storm water runoff flows at both the SJR PNM and SJR Infiltration Alternative diversion points. Since this water cannot be treated by the proposed system, the following operation scenarios are suggested during major runoff events:

- Significant dilution may be provided in the SJR PNM settling ponds to reduce TDS and sulfate concentrations to below MCL limits.

- Storage capacity in the settling ponds, wastewater polishing ponds and the treated water distribution system may be adequate to temporarily stop diverting water from the San Juan River to the treatment plant during large storm events. Once the concentrations of water at the diversion intakes are below 500 ppm TDS and 250 parts per million sulfate, diversion of San Juan River water can resume.

If the San Juan River is selected as a water supply source, further sampling and analysis will be required to determine the potential impacts of storm water runoff in the water quality diverted from the river, potential impacts to the treatment equipment, and the resultant water quality produced by the proposed water treatment system. As a result of the analysis of this one sample, a review of the USGS water quality databases for Fruitland and Hogback diversion and the PNM diversion database was done. Sorted with respect to water quality during the summer and summer storms, the results of this review do not substantiate the values presented in Table 5. The analysis has confirmed the need for more data and reinforces the need for continued sampling of water at each of the proposed diversion points for total dissolved solids, dissolved sulfates and turbidity during runoff conditions. The results of this database analysis are provided in Appendix C.

Table 5 - Water Quality - Water Quality of the San Juan River at the Hogback Diversion During High Runoff Events

Parameter	Concentration	Secondary MCL
EC, umhos/cm	1,155	
pH	8	
Temp (°F)	62	
Turbidity (NTU)	23,460	
TSS (mg/L)	15,334	
TDS (mg/L)	**884***	500
T SO4 (mg/L)	**477***	250
TOC (mg/L)	4	
Chlorides (mg/L)	27	250

Notes
1. Data from sample collected August 23, 2000.
2. *** Exceeds secondary MCL.**
3. Secondary standards or MCL's are established by EPA for control of aesthetic qualities relating to public acceptance and includes contaminants that may affect taste, color, odor and appearance.

B. Treatment Requirements

The water source for all alternatives considered for the NGWSP use surface water from either the NIIP or the San Juan River. The treatment systems used to provide drinking water to the consumers must comply with the Surface Water Treatment Rule (SWTR). The SWTR was published in the Federal Register on June 29, 1989 and is promulgated by the Environmental

Protection Agency (EPA) as a National Primary Drinking Water Regulation for public water systems using surface water sources or ground water under the direct influence of surface water. The filtration and disinfection requirements under this rule protect consumers against the potential adverse effects of exposure to *Giardia lambia*, *Cryptosporidium*, viruses, Legionella, and heterotrophic bacteria by requiring the inactivation of 99.9% (3 log) for Giardia cysts and 99.99% (4 log) for viruses. The inactivation of potential pathogens, as required by the SWTR, is accomplished by the use of EPA approved technologies for filtration and disinfection methods. Newly adopted regulations to address the risk of disinfection by-products (DBP's) include: Disinfectants - Disinfection Byproducts Rule (D-DBP Rule) and the Interim Enhanced Surface Water Treatment Rule, which requires continual monitoring of filtered water turbidity and routine DBP's monitoring in the distribution system.

The D-DPB Rule is divided into two stages. Stage 1 of the Rule will be required for all community water systems and includes an MCL of 80 micrograms per liter (ug/l) for Total Trihalomenthanes (TTHMs), 60 ug/l for five haloacetric acids (HAA5), 10 ug/l for bromate and 1.0 ug/l for chlorite. Stage 2 of the D-DBP Rule will only pertain to surface water systems serving more than 10,000 people and will further reduce the MCL for TTHMS to 40 ug/l, and HAA5 to 30 ug/L. The proposed microbial/disinfection byproducts (M-DBP), if promulgated, will characterize the required treatment processes based on a "BIN" category as determined by average *Cryptosporidium* concentration in the source water. Sampling at the diversion point will be required to determine the BIN category of all the NIIP and San Juan River alternatives.

The relative high concentrations of total organic carbons (TOC) in samples from the NIIP and San Juan River water sources, as shown in Tables 3 and 4, in combination with the long detention times required to convey the treated water to some of the delivery points, indicate a potential for the production of DBP's that may exceed current and future regulatory limits at the treated water service points or within the domestic water storage and distributions systems used to distribute the water to consumers. In order to determine the expected reduction in TOC concentrations by the proposed treatment system and the potential of DBP's production over time, bench scale distribution simulation studies using chloramine and free chlorine disinfection should be done. If bench scale analysis indicates that the DBP limits are exceeded, additional treatment systems to remove the DBP's before consumption may be required in some locations.

C. Description of the Proposed Water Treatment System

Based on manufacturers data, the proposed treatment system should meet and exceed the requirements of the Surface Water Treatment Rule (SWTR). Long term pilot studies (minimum of 12 months) will be required to verify chemical types, chemical usage rates, and other parameters to optimize treatment and verify regulatory compliance before design and construction can begin. The proposed treatment system consists of enhanced coagulation, ultrafiltration and ultraviolet disinfection to provide multiple treatment barriers for removal of organic molecules, *Giardia*, *Cryptosporidium* and viruses. The use of chloramines to provide a disinfection residual during the conveyance of treated water from the treatment plant to the service areas will not only provide a treated water that is not conducive to the formation of disinfection by products, but will also provide an additional disinfection barrier. Drawings #1, #2 and #3 show the process flow diagrams of the proposed processes for each alternative. Table 7 provides an estimated land requirement for each alternative and Table 8 provides an overview of the main treatment process components for each alternative. Before final design and construction, a comprehensive pilot scale operation of each process will be required to verify the effectiveness and operation of each unit process and resultant water quality.

1. Sediment Removal Ponds (SJR PNM alternative only)

The settling basins considered in this alternative are required to reduce turbidity of the San Juan River water before treatment. Most of the sediment contained in the source water would be removed by the intake and the proposed settling ponds. Each pond is designed with a three hour detention time providing optimum conditions for the reduction of turbidity to acceptable limits before treatment by the enhanced coagulation and ultrafiltration systems. Settling tests using San Juan River water collected during a high turbidity of 4,266 NTU have verified that a two pond system with each pond to provide a detention time of 3 hours will be sufficient to reduce turbidity to acceptable limits before treatment. The settling basins will have minimal effects on the quality of the water, with the exception of some dilution of high TDS and sulfate concentrations occurring during high runoff conditions. The settling pond(s) are sized to meet the hydraulic requirements for the demand year 2040 as shown in Table 6. To reduce the impact of the ponds on regional groundwater through infiltration, and to avoid the need to replace the liner after each sediment removal event, each pond will be lined with six inches of reinforced concrete.

Table 6 Settling Pond Requirements at PNM site based on a 6 hour detention time

Year	Influent Flow Rate (MGD)	Required Volume of Settling Pond (gallons)	Surface Area of each pond with a 10 feet Depth and 1:1 side slopes (Acres)
2040	38.25	9,563,000	1.72

Source water from the NIIP alternatives and NIIP Cutter diversion in the SJR PNM alternative would not require settling basins since the water has already passed through a large surface impoundment which acts like a settling basin. As shown in Table 3, the water is characterized by having low but varying turbidity.

2. Enhanced Coagulation

In waters that have variable annual turbidity or moderate to high total organic carbon concentrations, ultrafiltration systems typically include an enhanced coagulation step prior to filtration to coagulate small suspended materials in the water and increase the filtration efficiency. This process will increase the removal of organic matter before disinfection to meet the requirements of the Stage 1 and Stage 2 D-DPB Rule. This pretreatment process uses aluminum sulfate or other coagulant such that the type and dosage can only be determined by laboratory and field tests. In this study, it will be assumed that aluminum sulfate is the coagulant of choice and that the required concentration is 30 mg/l.

Water generated by the SJR infiltration intake system is expected to drastically reduce turbidity and organic matter in the feed water to the treatment plant. It is expected that a decrease in suspended solids will reduce the coagulant dosage from 30 mg/L to 10 mg/L. This change, along with the no sediment reduction requirement, will decrease the land requirements, capital construction costs and operation and maintenance costs. These are the major benefits of an infiltration intake system. A pilot scale operation that simulates the use of an infiltration intake system will be required to verify that the decrease in coagulant dosage can be made without impacting the quality of the treated water.

3. Hollow Fiber Ultrafiltration Treatment System

Previous studies have evaluated the potential for using conventional, diatomaceous earth and microfiltration/ultrafiltration for the treatment of surface waters associated with this project. A discussion of these studies is included in Section 8.05 of the "Technical Memorandum, The Navajo-Gallup Water Supply Project," prepared by The Navajo Nation Department of Water Resources. Based on this analysis, ultrafiltration using hollow fiber membranes along with enhanced coagulation is the proposed method for filtration due to the system's ability to treat water with varying turbidity, ability to meet current and future regulatory standards, and the ease to operate and maintain.

The hollow fiber ultrafiltration treatment system physically removes suspended particles greater than 0.1 microns in diameter by having a nominal and absolute pore size of .035 and 0.1 microns respectively. Particles found in surface water that exceed this size range are easily filtered. They include Giardia (5-15 microns in size), Cryptosporidium (4-6 microns in size), large viruses and large organic molecules. The continuous hollow fiber ultrafiltration system manufactured by US Filter(CMF-S) or Zenon (ZeeWeed) are bundles or cassettes of tubular membranes that filters water through microscopic holes. Designed for large scale systems, the pre-engineered cassettes are submerged into open top concrete or steel tanks. The study will incorporate the ZeeWeed-500 (ZW-500) hollow tube membranes which are used for applications requiring enhanced coagulation.

a. The Ultrafiltration Filtration (UF) Process Using Hollow Fibers

The proposed ZeeWeed 500 system consists of a series of parallel concrete tanks, or trains, in which cassettes are immersed in modules consisting of four cassettes in the NIPP and San Juan plants and one cassette in the Cutter diversion plant in the SJR Alternative. UF feed water enters each tank from the bottom and flows upward through the cassettes. During the filtration cycle, a vacuum is applied to each hollow fiber to draw water into the tube leaving the flocculated and suspended solids greater than 0.1 micron on the outside of the tube. Untreated water is added to maintain a constant level in each concrete tank.

b. Recovery Rate and Wastewater Treatment

The estimated recovery of treated water is 90 percent of the inflow meaning that 10 percent of the inflow would be used for membrane cleaning and will be discharged as process wastewater. Design flows used in this section to determine size and costs for each alternative are based on the treated water requirements of the treatment system during peak demands. The actual discharge of the potable water from the treatment plant is approximately ten percent less than is shown, with the difference being supplied by treated water storage.

In the proposed concept of operation, the process wastewater will be diverted to two wastewater treatment ponds for treatment and then recycled through the treatment system. In some alternatives there will be zero discharge from the treatment plant for extended periods of time and for other alternatives water from these ponds will be discharged on a continual basis to surface waters. Further discussions on the discharge of treated water for each option is provided in section F.5. below.

c. Description of membrane cleaning techniques.

At the end of a filtration cycle, which is characterized by plugging enough holes in the hollow fiber with filtered material to increase suction pressure, a backwash is performed. During backwash, the membranes are simultaneously aerated and back pulsed with treated water to dislodge solids from the outside of each fiber. The water, which includes the backwashed solids, is routed into the backwash trough and out to the backwash water polishing ponds. The time for backwash varies from 15 minutes to 1 hour. The number of filtration cycles a day is directly related to the amount and type of contaminants or floc particles in the water.

On a daily basis, each process tank is emptied into the wastewater polishing ponds and an extended back pulse using chlorinated water from the clear well is performed. The length of this cleaning is between 10-15 minutes.

Recovery cleaning is performed as required, typically every 2-6 months, at which time the fibers are back pulsed with a cleaning solution followed by in-situ soaking for several hours. After cleaning, the tanks are emptied and the cleaning solution is pumped to a storage tank for future use.

d. Log Credits

According to information provided by ZENON, the enhanced coagulation and ultrafiltration treatment process is expected to provide a 6 log reduction in *Giardia* and *Cryptosporidium* and 2 log reduction in viruses in the source water, thus meeting all the SWTR removal requirements for *Giardia* and *Cryptosporidium* reduction, and half of the requirements for virus reduction.

4. Ultraviolet Disinfection Units

Disinfection after ultrafiltration is accomplished by state of the art "flow through" ultraviolet (UV) disinfection units which are located on the filtered water discharge line from each ultrafiltration treatment train. Each unit consists of a stainless steel chamber containing eight UV lamps, an automatic cleaning system, UV monitoring system and control cabinet. Each unit will provide a minimum UV dose of 40 mJ/cm^2 to the filtered water before being routed to the clear well. Manufacturers data is provided in the water treatment appendix (Appendix C) in the report.

According to the information provided by Aquionics, the proposed UV units will add an additional 3 log (99.9%) reduction of Giardia and Cryptosporidium an additional 4 log (99.99%) reduction in viruses to the water following the ultrafiltration process. Based on this information, the unit processes of ultrafiltration and UV disinfection will provide a reduction of 9 log for Giardia and Cryptosporidium and 6 log for viruses. This reduction far exceeds the SDWA requirements.

5. Chloramination

The mixing of filtered and disinfected water with ammonia gas followed by chlorine gas in the clearwell will provide a chloramine residual prior to being pumped by the service water pumping plant into the treated water mains leading to the service areas. This form of residual is being used to reduce the development of disinfection by-products that would be generated by extended contact times in the conveyance and storage facilities if a free chlorine residual was used. Other benefits of a chloramine residual include prevention of taste and odor problems and the fact that the chloramine residual will last longer in the treated water transmission line and storage system, thus eliminating the number of re-chloramination stations.

Detention times and dosage rates for a chloramination system can only be determined by laboratory and field testing. In this study, an estimated chloramine dosage of 1.00 ppm was used. This consists of a 0.5 ppm demand and 0.5 ppm residual. The ratio of 3 parts chlorine to 1 part ammonia was used to size the ammonia and chlorine gas storage area for the cost estimate. A detention time of 30 minutes was used to size the clearwell where mixing will occur.

Not having the same disinfection power as a free chlorine residual, chloramination will still provide additional disinfection log credit based on the contact time from the plant to the withdrawal point by individual communities. The water treatment appendix (Appendix C) provides an estimate of the contact times and additional log credit removals that occur during conveyance of the treated water.

D. Structures

Drawings 4 through 7 identify the features of each water treatment plant. All plant structures, except intakes, must be located above the 100 year flood plain.

1. Treatment Buildings

a. Treatment Plant Building Requirements for the NIIP and SJR Alternatives

The main treatment building for NIIP and SJR Alternative treatment plants would be approximately the same size with a first floor surface area of approximately 24,500 square feet and a second floor mezzanine that is approximately 22 feet wide and 122 feet long. The proposed floor plan of each treatment plant is shown on the attached drawings. The proposed building would be a pre-engineered, prefabricated structure with metal siding and suitable insulation and ventilation to meet the building code requirements of the State of New Mexico and all other applicable code requirements. The building would house the 10 foot tall flocculation basins, 10 foot tall concrete tanks containing the Ultrafiltration modules for each train, UV units, vacuum pumps and internal piping. The second floor mezzanine would contain the control room for the filters and UV units, air blowers used for module cleaning and the motor control center. The chlorine storage room and ammonia storage room are included in the main building but have outside entrances and separate HVAC systems to eliminate the risk to the operators if leakage occurs in any of the cylinders. The building is designed to house the treatment system required to meet 2040 demands requirement. Further details are shown in the drawing for each plant.

The chlorine and ammonia storage room would house the ton containers of each gas along with the chlorinators and ammoniators which will meter the gases into the clearwell for mixing. Trunnions are provided in the storage room to provide for the storage of full containers to meet two months demand along with spare trunnions for storage of an equal amount of empty or full containers.

b. Treatment Plant Building Requirements for the NIIP Cutter Diversion (SJR and NIIP Amarillo Alternatives) Treatment Plant

The Cutter diversion of the SJR and NIIP Amarillo Alternatives water treatment plant is a scaled down version of the other NIIP and SJR Alternative plants with a building area of approximately 4,600 square feet. Like the larger plants, the flocculation basins would be located inside the building to protect the water from windblown sand and freezing temperatures. Due to its reduced size all treatment components for the Cutter treatment plant would be located on a single floor as shown on the drawing.

2. Regional Operation and Maintenance Buildings

Each alternative includes a 2,500 square foot Regional operations and maintenance building located within the treatment plant "compound". Each building would be on a slab on grade with 15 feet eave heights. The facility would be used for spare equipment/parts storage and for maintenance areas relating to the treatment, conveyance and pumping of water for this project.

3. Clear Well

The below grade clear well will provide a detention time of 30 minutes and will include injection manifolds, baffles and mixers to properly mix ammonia and chlorine with treated water. After chloramination the treated water would be pumped by the service pumping station into the distribution system.

4. Wastewater Storage/Treatment Ponds

Water generated during the routine cleaning of the filters will flow into one of two passive treatment ponds. In these ponds, fine suspended solids filtered by the hollow fiber system will be settled out and removed from the site. After passive treatment, the water can be conveyed back into the treatment plant, discharged back into the source, or discharged to surface waters. The useful life of a pond is estimated to be between 10 to 15 years before settled sediment will need to be removed and conveyed to the sediment drying beds. Each pond will be lined with a 45 mil geomembrane system to reduce the impact on regional groundwater.

5. Sediment Drying Beds for Wastewater Ponds

Sediment drying beds are provided to dry sediment taken from the wastewater polishing ponds for all the alternatives except the SJR PNM. Excavated material will be placed on six-inches of sand. Evaporation along with draining of water into the sand will dry the sediment before it is hauled away for disposal in a sanitary landfill, open pit or abandoned mine shaft. Operation and maintenance costs, associated with excavation and transport of sediment collected from the wastewater ponds, will occur every 15 years.

6. Sediment Drying Beds for ~~SJR PNM Alternative~~

With the construction of a new diversion upstream of the PNM site, all sediment that is removed by the intake structure and settling ponds must be retained and ultimately disposed of off site. The determination on the frequency of pond cleaning, volume of sediment, volume of dried sediment, size of required sediment drying beds and resulting operation and maintenance costs in this report are based on one water quality sample taken during one storm event. This event occurred on August 23, 2000 and analysis indicated a Turbidity reading over 23,000 NTU units and a suspended solids loading of over 15,000 mg/Liter. The drying bed size and costs should be taken as preliminary as additional sampling and analysis is required prior to design and construction. Using this data point the lead pond will need to be "dredged" of sediment after every 10 days of storm runoff and two sediment drying beds with a surface area of approximately 6 acres each will be required. When the sediment in the 10 foot deep lead pond becomes 2 feet deep, approximately 130,000 cubic feet of sediment will need to be removed and placed on one of the drying beds. The excavated sediment is applied at an approximate depth of 6-inches on the surface of each bed. Beds consist of perforated PVC pipes located in a gravel under drain system followed by sand. The system will remove water from the sediment by drainage and evaporation, reducing the water content by approximately 50% with a dried sediment depth of 2.5 to 3-inches. Once dried, the sludge will be removed from the top of each bed and transported to a nearby abandoned open pit coal mine for final disposal. Operation and maintenance costs, associated with excavation and transport of sediment collected from the settling ponds are based on two "cleaning cycles" per year.

7. Land Requirements

Table 7 provides the approximate land requirement for each alternative. This information is provided for comparing alternatives only and does not represent the actual requirements determined after final design.

Table 7 Estimated Land Requirements for Treatment Systems in the Year 2040

Alterative	Building (Acres)	Clearwell (Acres)	WW Ponds (Acres)	WW Ponds Drying Beds (Acres)	Sediment Settling Ponds (Acres)	Sediment Drying Beds (Acres)	Total (Acres)
NIIP Moncisco	0.56	0.28	0.33	0.16	NR	NR	1.33
NIIP Cutter	0.56	0.28	0.33	0.16	NR	NR	1.33
NIIP Coury Lateral	0.56	0.28	0.33	0.16	NR	NR	1.33
NIIP Amarillo	0.56	0.28	0.30	0.15	NR	NR	1.29
NIIP Cutter Diversion of SJR Alt.	0.11	0.03	0.09	0.03	NR	NR	0.26
SJR PNM	0.56	0.28	0.30	See notes	3.6	12	16.7
SJR Infiltration	0.56	0.28	0.30	0.15	NR	NR	1.29

Notes:
Total land area estimates do not include the diversion structures or the storage ponds for the NIIP Coury Lateral or NIIP Amarillo Alternatives.
Total land area estimate does not include the infiltration system for the SJR infiltration alternative.
Total land area estimate does not include diversion structure for the SJR PNM alternative.
SRJ PNM sediment drying beds would also be used for dewatering wastewater pond sediment.
NR: Not Required

Table 8 Overview of Treatment System Components

System Characteristics	NIIP Alternatives	NIIP Amarillo	SJR PNM Alternative	Cutter Diversions	SJR Infiltration
Design Flows 2020 Demand (MGD) 2040 Demand (MGD)	 27.64 43.63	 23.89 38.25	 23.89 38.25	 3.74 5.39	 23.89 38.25
Rapid Mix Tank (gallons)	21,000	19,600	19,600	6,200	19,600
Splitter Tank (gallons)	21,000	19,600	19,600	6,200	19,600
Flocculation Tanks (gallons)	303,000	266,000	266,000	26,000	266,000
Hollow Fiber Ultrafiltration Number of trains (size) Modules (2020/2040) Cassettes (2020/2040) Flux per Cassette (GPD) Spare Modules (cassettes)	 7 35/55 138/218 200,000 1	 7 30/48 120/192 200,000 7	 7 30/48 120/192 200,000 7	 3 19/27 200,000 0	 7 30/48 120/192 200,000 7
UV Disinfection Units	7	7	7	3	7
Clearwell (L'xW') Volume (gallons) Detention Time (min) Mixers	60 x 205 909,000 30 6	60 x 180 797,000 30 6	60 x 180 797,000 30 6	60 x 25 112,000 30 2	60 x 180 797,000 30 6
Chlorine Room Active Ton Cylinders Spare Capacity	 6 6 24	 6 6 24	 6 6 24	 1 1 4	 6 6 24
Ammonia Room Active Ton Cylinders Spare Capacity	 2 2 8	 2 2 8	 2 2 8	 1 1 4	 2 2 8
Building (square feet) Mezzanine (square feet)	24,500 Yes -2,700	24,500 Yes, 2,700	24,500 Yes-2,700	4,600 No	24,500 Yes, 2,700
Settling Pond (acres)	not required	not required	2@1.8	not required	not required
Wastewater Polishing Ponds Number Surface Area Each, acres (L'xW') Detention Time Per Pond hrs	 2 0.33 (180x80) 3	 2 0.30 (175x80) 3	 2 0.30 (175x80) 3	 2 0.09 (100x40) 3	 2 0.30 (175x80) 3
Drying Beds L' x W' For Sediment (2 of each) Polishing Ponds (2 of each)	 not required 170 x 40	 not required 160 x 40	 721x361 not required	 not required 60 x 20	 not required 160 x 40

Notes: Depth of wastewater polishing ponds is 10 feet, length to width ratio is approximately 2 to 1. Side slopes 1 horizontal to 1 vertical. Surface area provided is top of bank. Maximum level would be with 1 foot of freeboard.

E. Operation and Maintenance Requirements

Annual and annualized operations and maintenance cost estimates with electrical power costs based on the NTUA rates are provided in Table 10. Annual and annualized operations and maintenance cost estimates with electrical power costs based on the CRSP rates are provided in Table 11. Descriptions of each are provided below.

1. Operation

The overall operational system would monitor the demands in the treated water distribution system and activate/deactivate the treatment system as required to maintain required water levels or pressures in the treated water storage tanks. When in operation the water treatment system master control panel would control the local control panels (LCP) for each treatment process. During automatic operation, the water treatment master control system monitors all LCP's and provides inputs for adjustments for optimal treatment efficiency. Operators would be required to monitor operations 24 hours a day along with routine duties such as calibrations of turbidity meters, chemical injection equipment, residual monitors, inventory control, monthly reports, etc.

This control system would be integrated into the overall project control system.

2. Plant Operators

Plant operation for all treatment plants and all demands would require a total staff of six personnel, (four operators, one maintenance and one supervisor). This staff would ensure that a least one operator is at the plant during operation with suitable maintenance and supervisory support. Estimated staffing time and labor costs are provided in Appendix C.

3. Chemicals

Annual costs for chemicals include those required for routine cleaning of the hollow fiber membranes, aluminum sulfate to flocculate the small suspended particles in the source water and chlorine and ammonia gas to form a chloramine residual to keep the water disinfected during its transport from the treatment plants to service.

A reduction in chemical costs is predicted for the San Juan River plant using a infiltration collector since filtration is provided by this type of collector before treatment. It is expected to reduce the required aluminum sulfate dosage from 30 mg/L to 10 mg/L.

4. Power

Annual cost for power to operate each plant includes power to operate vacuum pumps, air compressors, UV disinfection units, low head lift pumps, lights, HVAC units and a percentage increase for other loads required for operation of a large water treatment facility. For the NIIP

Moncisco and NIIP Cutter Alternatives and the Cutter diversion in the SRJ and NIIP Amarillo Alternatives treatment plants, a low lift pump will divert water from the wastewater polishing ponds to the plant influent for recycling. For the NIIP Coury Lateral and NIIP Amarillo Alternatives, two low lift pump stations will be required, one to transfer water from the off-channel storage pond to the water treatment plant and one to recycle water from the wastewater ponds to the water treatment plant. For the SJR PNM Alternative three low head lift stations will be required, one to transfer water from the river diversion to the settling ponds, one to transfer water from the settling ponds to the water treatment plant and one to recycle water from the wastewater ponds to the water treatment plant. Electrical costs for the San Juan plant using infiltration collectors includes one low lift pumping station used to transfer water from the wastewater treatment ponds back into the plant for reuse. The power required to convey water from the infiltration caissons to the treatment plant is not included in the costs provided in Table 10 or Table 11.

To provide uninterrupted treated water, the New Mexico Environmental Department requires backup generators to be provided for all potable water treatment plants. These generators need to be rated to meet the power requirements during the average daily flow or 70 percent of the design flow.

5. Replacement of Equipment

Annualized equipment replacement costs include annual replacement of ultraviolet light bulbs, the replacement of all hollow fiber cassettes every 10 years and the replacement of mechanical equipment every 15 years. Details on the annualized cost of each are provided in Appendix C.

6. Dredging and Disposing of Sediment

When the settling and wastewater polishing ponds contain a maximum of 2 to 3 feet of sediment, a dragline would be used to remove the sediment in the PNM settling pond and each of the wastewater polishing ponds. The sediment would be dried on the sand drying beds and when dry, would be transported off site for disposal. The estimated frequency for dredging and disposing of sediment is every 10 days of storm runoff for the SRJ PNM lead settling pond and every 15 years for the wastewater polishing pond.

F. Miscellaneous

1. Chloramine Booster Stations

Each pumping plant would contain a chloramine booster station that would monitor the chloramine residual of the incoming water and automatically add, as required, additional chlorine to maintain the 0.5 ppm residual to the water being pumped by the plant. The capital and operation and maintenance costs of these re-chloramination systems are included as part of the unlisted items in the water treatment estimate.

2. Blending of Water

Blending of good water quality produced by the proposed surface water treatment plants with low quality ground water presently used by the City of Gallup and many of the Navajo Communities may increase turbidity in the mixed water. Increased turbidity, a secondary MCL, in the blended water will decrease the aesthetic quality of the water. In order to predict and compensate for any reactions, a detailed water quality analysis for each well system is required. This data will then be used in the "Rothberg, Tamburnini & Windsor Model for Corrosion Control and Process Chemistry" to predict turbidity formation. If the modeling determines chemical addition(s) are required to eliminate the formation of turbidity, follow up laboratory verification is required. A copy of a report that models the blending of Colorado River Water with well water for the city of Somerton is provided in Appendix C.

In order to provide funding for modeling and potential chemical injection systems, a 10 percent unlisted additive is included in the capital cost for each treatment system and each demand. To account for potential O&M costs of these systems, a 10 percent miscellaneous additive is provided.

3. Disinfection By-Product Treatment

Included in the unlisted percentage in the capital cost for each alternative is funding for the installation of aeration systems and rechlorination systems at each service point to remove DBP's that may be created during conveyance

4. Pilot Plant Operation

Prior to final design of the selected alternative, a pilot study using the proposed treatment system will be required to optimize each treatment process and collect design data. The pilot plant should operate 24 hours a day over a minimum of 12 consecutive months to determine treatment requirements with changing water conditions. The study will determine the most efficient chemical to use for coagulation, determine chemical injection rates based on changing water quality, determine backwash requirements and membrane cleaning requirements, determine wastewater quality and production rates, verify the ability of the treatment system to meet current and future regulatory standards, determine the potential for DBP formation during conveyance, provide data to update capital and operation and maintenance costs, determine operation requirements, and provide training for future operators of the full scale treatment system. A line item providing a sum of $200,000 to fund the pilot study is included in the capital cost of each alternative.

5. Wastewater Discharges from the Water Treatment Plants

Water generated from cleaning the filters will be discharged to the wastewater treatment ponds for treatment before being recycled or discharged. Domestic wastewater generated by the various restrooms located around each site and "spent" citric acid from filter cleaning will be routed to properly designed septic tanks and leach fields. Citric acid will be reused as much as possible.

The wastewater treatment ponds as proposed in the study will have a minimum detention time of six hours and are intended to settle out suspended solids and treat the water using naturally occurring microorganisms. Depending on the location and operation of each treatment plant, the discharge from the treatment ponds can be completely mixed with plant influent and re-treated, a portion can be retreated with the rest being discharged, or all of the water from the wastewater ponds can be discharged to supplement the source water or surface waters.

When the treated water is recycled back into the plant, the process of dissolved solids accumulation due to chemical additions and evaporation will increase the total dissolved solids in the wastewater pond as well as the TDS in the combined feed to the water treatment plant.

In an attempt to quantify the accumulation of TDS and potential discharge options from the wastewater ponds, a modeling program was developed. The results of the program for the year 2020 is provided in Appendix C. For this report all treated wastewater will be discharged either back to the source water or to natural drainages. With discharge after the ponds the expected increase of TDS and biological oxygen demand over the source water is from 10 to 15 percent and 5 to 10 percent respectively. Actual increases are subject to weather conditions and can only be determined by pilot plant and actual plant operation.

G. Appraisal Level Cost Estimates

1. Capital Costs

Estimated capital cost for each treatment plant and each demand alternative are provided in Table 9. Details of the estimated costs for each of the major components in each plant are provided in Appendix C.

Table 9 Water Treatment Plant Capital Costs[1]

Alternative	Capital Cost to meet year 2020 demands	Additional Capital Cost to upgrade to 2040 demands
NIIP Moncisco, Cutter, and Coury Lateral	$24,478,100	$7,933,400
NIIP Amarillo	$21,746,800	$7,145,600
SJR Infiltration[2]	$21,748,700	$7,145,600
SJR PNM	$22,689,800	$7,145,600
Cutter Diversion	$5,963,700	$1,213,000

[1] Taxes and land costs are not included

[2] Does not include the capital cost of the infiltration system, which is included as a separate item.

2. Annual Operation and Maintenance Costs

The estimated annual operation and maintenance requirement for each plant is summarized in Table 10, using NTUA power rates, and Table 11, using CRSP power rates. Detailed spreadsheets of each annual cost are presented in Appendix C.

Table 10 Estimated Annual Operation and Maintenance Costs using NTUA Rates.

Operation and Maintenance Tasks	NIIP Moncisco & NIIP Cutter	NIIP Coury Lateral	NIIP Amarillo	SJR PNM Alternative	Cutter Diversions	SJR Infiltration
Plant operators (Requires 6 personnel)	$ 695,000	$ 695,000	$ 695,000	$ 695,000	$ 695,000	$ 695,000
Chemicals Year 2020 Year 2040	 $ 592,000 $ 935,000	 $ 592,000 $ 935,000	 $ 512,000 $ 820,000	 $ 512,000 $ 820,000	 $ 80,000 $ 116,000	 $ 232,000 $ 371,000
Power Costs @ $.0185KW-hr Year 2020 Year 2040	 $ 253,000 $ 399,000	 $ 274,000 $ 433,000	 $ 219,000 $ 350,000	 $ 297,000 $ 476,000	 $ 34,000 $ 59,000	Note 2 $ 219,000 $ 350,000
Annualize Equipment Replacement Costs. Year 2020 Year 2040	 $ 380,000 $ 600,000	 $ 380,000 $ 600,000	 $ 329,000 $ 526,000	 $ 329,000 $ 526,000	 $ 52,000 $ 74,000	 $329,000 $526,000
Annualize Costs to Remove/dispose of Sediment in Settling Pond Year 2020 Year 2040	Not Required	Not Required	Not Required	 $173,000 $173,000	Not Required	Not Required
Annualize Costs for Cleaning WW Treatment Ponds Year 2020 Year 2040	 $ 4,000 $ 4,000	 $ 4,000 $ 4,000	 $ 3,000 $ 3,000	 $ 3,000 $ 3,000	 $ 1,000 $ 1,000	 $3,000 $3,000
Subtotal Year 2020 Year 2040	 $1,924,000 $2,633,000	 $1,945,000 $2,667,000	 $1,758,000 $2,394,000	 $2,009,000 $2,693,000	 $ 862,000 $ 945,000	 $1,478,000 $1,945,000
Miscellaneous 10% Year 2020 Year 2040	 $ 192,000 $ 263,000	 $ 195,000 $ 267,000	 $ 176,000 $ 239,000	 $ 201,000 $ 269,000	 $ 86,000 $ 95,000	 $ 148,000 $ 195,000
Total Annual O&M Cost Year 2020 Year 2040	 $2,117,000 $2,896,000	 $2,140,000 $2,934,000	 $1,934,000 $2,633,000	 $2,210,000 $2,962,000	 $ 948,000 $1,040,000	 $1,626,000 $2,140,000

Notes

1. All operation and maintenance costs are based on 24 hour a day operation at the average daily demand (design demand divided by 1.3).
2. Does not include power costs for the infiltration intake system.
3. Costs rounded off to the nearest thousand dollars.
4. Costs include a monthly demand charge of $15.40 per KW or an annual demand charge of $184.80 per KW.

Table 11 Estimated Annual Operation and Maintenance Costs using CRSP Rates.

Operation and Maintenance Tasks	NIIP Moncisco & NIIP Cutter	NIIP Coury Lateral	NIIP Amarillo	SJR PNM Alternative	Cutter Diversion of SJR Alt	SJR Infiltration
Plant operators (Requires 6 personnel)	$ 695,000	$ 695,000	$ 695,000	$ 695,000	$ 695,000	$ 695,000
Chemicals Year 2020 Year 2040	 $ 592,000 $ 935,000	 $ 592,000 $ 935,000	 $ 512,000 $ 820,000	 $ 512,000 $ 820,000	 $ 80,000 $ 116,000	 $ 232,000 $ 371,000
Power Costs @ $.0081 KW-hr Year 2020 Year 2040	 $ 76,000 $ 119,000	 $ 84,000 $ 134,000	 $ 73,000 $ 117,000	 $ 91,000 $ 145,000	 $ 10,000 $ 17,000	Note 2 $ 65,000 $ 105,000
Annualize Equipment Replacement Costs. Year 2020 Year 2040	 $ 380,000 $ 600,000	 $ 380,000 $ 600,000	 $ 329,000 $ 526,000	 $ 329,000 $ 526,000	 $ 51,500 $ 74,000	 $ 329,000 $ 526,000
Annualize Costs to Remove/dispose of Sediment in Settling Pond Year 2020 Year 2040	Not Required	Not Required	Not Required	$173,000 $173,000	Not Required	Not Required
Annualize Costs for cleaning WW Treatment Ponds Year 2020 Year 2040	 $ 4,000 $ 4,000	 $ 4,000 $ 4,000	 $ 3,000 $ 3,000	 $ 3,000 $ 3,000	 $ 1,000 $ 1,000	 $ 3,000 $ 3,000
Subtotal Estimated annual cost Year 2020 Year 2040	 $1,747,000 $2,353,000	 $1,755,000 $2,368,000	 $1,612,000 $2,161,000	 $1,803,000 $2,362,000	 $ 838,000 $ 903,000	 $1,324,000 $1,700,000
Miscellaneous 10% Year 2020 Year 2040	 $ 175,000 $ 235,000	 $ 176,000 $ 237,000	 $ 161,000 $ 216,000	 $ 180,000 $ 236,000	 $ 84,000 $ 90,000	 $ 170,000 $ 192,000
Total Annual O&M Cost Year 2020 Year 2040	 $1,922,000 $2,588,000	 $1,931,000 $2,605,000	 $1,773,000 $2,377,000	 $1,983,000 $2,598,000	 $ 922,000 $ 993,000	 $1,456,000 $1,870,000

Notes

1. All operation and maintenance costs are based on 24 hour a day operation at the average daily demand (design demand divided by 1.3).
2. Does not include power costs for the infiltration intake system.
3. Costs rounded off to the nearest thousand dollars.
4. Costs include a monthly demand charge of $3.44 per KW or an annual demand charge of $41.28 per KW.

VIII. OVERALL OPERATIONAL CONFIGURATION

Each of the proposed Alternatives would be fully automated systems. The main water treatment plants would operate automatically to maintain availability of treated water. The system downstream of the treatment plants is a series of pumping plants, regulating or forebay tanks, and community storage tanks. Each pumping plant operation along the main water transmission line is controlled by float level switches in the forebay or regulating tank downstream from that plant. During periods of low water demand from a local community, water altitude valves in the community storage tanks would reduce flow into the storage tank at predetermined elevations by shutting down pumps as demand decreases. As demand increases, staged pumps (one pump for each increment of 10 ft^3/s) would start. The pumping plants would not need to be attended on a full time basis, but would require physical inspection on a daily basis. Each pumping plant would have one back-up pump and an emergency generator capable of meeting full load power requirements for that plant in the event of a power outage.

A. Pumping Plants

There are four basic versions of pumping plants located throughout the NGWSP.

• The first group of pumping plants would include the pumping plants at the PNM and infiltration gallery system San Juan River sites (See Drawings 9 and 12).

• The second group of plants would generally be downstream of the water treatment plants to pump treated water into the lateral systems (See drawings 14, 15, and 16).

• The numerous relift pumping plants are the third group and are needed to lift the water from lower to higher elevations along the lateral and to overcome the frictional resistance lost in the pipe lateral (See drawing 17, Typical Relift Pumping Plant).

• The last group of pumping plants are part of the delivery turnout and would provide 70 psi of pressure to the community (See drawing 18, Typical Turnout Pumping Plant) .

The TSC used the Bureau of Reclamation computer program, **"PUMPLT"**, to estimate the field costs of the pumping plants. This program estimates costs of pumping plant construction based upon historical data for plants with similar flows, heads, and number of pumping units. The program output includes structural improvements, including the structure itself and civil site work, waterways, pumps, motors, electrical access, and miscellaneous equipment.

B. Pumps

The pumps at the pumping plants were assumed to be equal size units with a maximum capacity of 10 cfs each. There is one standby pump unit at each pumping plant. The majority of the pumps would be the horizontal split case type. Each pump would have a suction and discharge valve with an electric or hydraulic operator. The pumps in the relift pumping plants and the turnout deliveries all would require a minimum of 15 feet of head on the suction side. Pumps would be controlled by level switches that sense the water levels in the regulating, forebay, and storage tanks. Pumping plant locations are shown in Appendix D. There are also two pumps (one plus standby) rated at 2.32 cfs at each infiltration well (Infiltration Gallery) system.

C. Air Chambers

A few waterhammer computer runs were made for typical size pumping plants and pipe systems, and it was determined that a typical air chamber size would be a 20 foot diameter sphere. We assumed that this would be an average size air chamber and used this size at all locations where an air chamber would be needed.

D. Tanks

Forebay tanks would be required upstream of almost every pumping plant to supply water during startup of the pumps and during shutdown to reduce waterhammer effects. Altitude valves would be installed at most sites to prevent the forebay tanks from over topping. For this appraisal level study, all of the forebay tanks were estimated to be 8-foot in diameter and 40-foot tall. In the next level of study, each of these tanks would be sized on an individual basis.

Where possible, regulating tanks were placed at high points and gravity flow could then be used to deliver water to lower points in the system. By assuming that the pumps in the pumping plants would be 10 cfs or less and that the minimum run time was 15 minutes, the regulating tank diameters were found to be 40 feet. Then depending on the number of pumps, the heights of the tanks were computed. Tank heights ranged from 9 feet to 22 feet. The height included two feet for bottom dead space and five feet for overflow and top freeboard space. Tank water surfaces would be the primary control for automatically stopping and starting the pumps.

Storage tanks were provided at the delivery turnouts for the communities that had existing water distribution systems. These tanks store a five-day water supply for the community, which is then boosted by the pumping plant to a pressure of 70 psi into the community water system.

It was assumed that the height of the storage tanks would be 20 feet, and the diameters were computed based on the values for the five-day storage for the year 2020 demands.

Tank locations are shown on the drawings in Appendix D.

IX. ELECTRICAL

1. There are several locations that would be tapped to provide power for the pumping plants and miscellaneous equipment. The NTUA is installing a 115kV line (energized at 69-kV) from Tohatchi to Newcomb. This proposed powerline was assumed to be constructed by the time

NGWSP begins construction. The NGWSP would extend this NTUA powerline along highway 666 north to Shiprock and south along the pipeline alignment to Window Rock and Nahodishgish Chapter/Dalton Pass, New Mexico.

The pumping plants located in the eastern portion of the Navajo Nation would obtain power from and existing 230-kV powerline owned by PNM. There are two locations where this powerline could be tapped to provide power depending on the alternative and the distance of new transmission line construction. The transmission line would include one overhead optical ground wire for T1 fiber optic communications. A small switchyard with at least one circuit breaker would be required to provide electrical protection for the downstream facilities.

2. Assumptions:

a. Taps would be made on the powerline for pumping plants, turnouts, and the infiltration gallery.

b. Security systems, including video cameras, would be provided at each pumping plant.

c. Control and monitoring hardware at each site, including pumping plants, turnouts, and the infiltration gallery, would include an Allen-Bradley SLIC-500 controller, or equal.

d. The infiltration system would require at least a transducer to monitor the condition at each location. Cabling would be required to bring this information to a central point for transmission to the master station.

3. A SCADA system would be provided and installed in the existing NTUA facilities in Fort Defiance.

4. Each plant would have a backup engine-generator to provide full plant operation in the event of a power failure.

The Bureau of Reclamation Farmington Construction Office provided additional information on transmission line lengths and substations as stated below:

The following are the length of miles and substations for each alternative:

San Juan River Alternative - 107 miles and 1 substation near Nageezi
Infiltration System Alternative - 107 miles and 1 substation near Nageezi
NIIP Moncisco Alternative - 73 miles and 1 substation near Moncisco
NIIP Coury Lateral Alternative - 74 miles 1 substation near Nageezi
NIIP Cutter Alternative - 93 miles and 1 substation near Nageezi
NIIP Amarillo Alternative - 107 miles and 1 substation near Nageezi

The substations would tap power from a 230 kV line owned by PNM and would convert to 69kV. Kutz substation would be used to serve the pumping plant near the Coury Lateral on the NIIP Coury Lateral Alternative. Transmission line lengths may change due to pumping plant location changes.

Transmission line locations to be constructed are shown on drawings 19 through 24.

X. PIPELINES

A. General

The Farmington Construction Office created electronic files which contained the pipe alignments and topographic information for all of the pipe laterals. The TSC combined these files and created AutoCAD (Release 15.0) drawings for the general plans for each alternative and profiles for each of the laterals. These drawings were then used to determine pipe lengths and head classes. These drawings are included in Appendix D.

B. Hydraulics

The Hazen-Williams equation was used to compute the loss due to friction in the pipe laterals. The TSC used as a guideline that the design velocity should be about 5 feet per second or less and the maximum pump lift would be about 400 feet. The minimum system pressure along the pipe laterals was 15 feet. Pipe friction losses were limited to about 25 percent of the total dynamic head for the pumps.

C. Pipe Types

When computing the hydraulics, it was assumed that all of the lateral pipe would be mortar lined steel pipe with full inside diameters. In using a Hazen-Williams Coefficient of 140 and steel pipe with full inside diameters, it is felt that the resulting friction losses are conservative. By limiting the pump lift to about 400 feet of head and adding 30 percent for an upsurge allowance, the head class (pressure class) for the pipe was generally limited to 525 feet (235 psi). However, in areas where the topography results in large decreases in the ground surface elevations, pipe head classes often reach values much higher than 525 feet. The pipe head classes, pumping plant locations, pump heads, and pipeline alinements will be more precisely defined in the next level of study.

Steel pipe can be manufactured in all of the pipe diameters and head class increments that have been estimated for this project. At the present time, some of the newer pipe types are not available in the larger diameters and higher pressure ratings. Polyvinyl Chloride (PVC) pipe is currently limited to 48-inch diameter with a 125 psi pressure rating and 42-inch diameter with a 165 psi pressure rating. Polyethylene (PE) pipe is currently limited to 42-inch, 48-inch, and 54-inch diameters, each with a 64 psi pressure rating. Fiberglass pipe is currently limited to 54-inch diameter with a 200 psi pressure rating and 30-inch diameter with a 250-psi pressure rating. In some instances, pipe manufactures may have the capability to make larger diameters with higher pressure ratings.

Since cathodic protection is not required for these non metallic type pipes, they should be considered as at least an option in most of the pipe diameters in the next level of design for this project. Also, every year pipe manufacturers are making larger diameter pipes with higher pressure ratings. These non metallic type pipes generally have a lower coefficient of friction, but in some instances do not have full inside diameters. When more precise design data is available in the next level of design, all of these factors should be considered when computing the hydraulics. Because the pipe types cannot be predicted at this time, no costs were included for cathodic protection. Any costs for cathodic protection of steel pipe were assumed to be included in the 10% allowance for unlisted items.

Since PE pipe is currently available in the higher pressures in 24-inch diameter and smaller sizes, PE pipe costs were used for 24-inch pipe and smaller for this level of study. Steel pipe prices were used for all pipe greater than 24-inch in diameter. The appurtenant structures and mechanical equipment associated with the pipeline are covered under unlisted items in the cost estimates. These would include such items as air valves, blowoffs, drains, flow meters, pressure reducing valves, altitude valves, and sectionalizing valves.

D. Earthwork

Quantities for pipe earthwork, including rock excavation, were based on a typical trench section with an average depth of cover of 5 feet.

E. Operation and Maintenance

Annual operation and maintenance costs for pipelines were estimated to be 0.5 percent of the initial pipe cost. These costs are include in Tables 1a and 2a.

XI. GALLUP REGIONAL SYSTEM, TRANSMISSION AND STORAGE FACILITIES

The Northwest New Mexico Council of Governments (NWNMCOG) secured a USDA Rural Business Enterprise Grant for planning and preliminary design work associated with delivery and distribution of treated NGWSP water to areas within the City of Gallup and adjacent NTUA systems. DePauli Engineering & Surveying Co. of Gallup, NM produced a report entitled "Preliminary Design and Report For The Navajo-Gallup Water Supply Project, City of Gallup Transmission and Storage Facilities", dated January, 2002 (DePauli Report). The DePauli Report can be found in Appendix F.

The DePauli Report's preliminary designs and cost estimates begin near Gamerco Townsite at the Yah-ta-hey Junction and go through the City of Gallup to the NTUA systems located in Churchrock on the east, Manuelito and Spencer Valley on the west, and Redrock on the south. Figure 1 from the DePauli Report shows the Gallup Regional system and the five delivery locations for the Navajo Communities. The following are the Navajo Communities served through the Gallup Regional system: Manuelito, Redrock, Breadsprings, Chichiltah, Iyanbito, Church Rock, Pinedale, and Mariano Lake. The Gallup Regional System's demand is based on delivering 7500 acre-feet of water per year to the City of Gallup, and the Navajo Community deliveries were based on year 2040 demands. The Navajo Communities have a peak demand of 8.36 cubic feet per second and the City of Gallup has a peak demand of 13.47 cubic feet per second. In this report, the DePauli Report flow values were used for both years 2020 and 2040.

A summary for the Gallup Regional System's costs is shown Table 5 of the DePauli Report. For the most part, Reclamation used the quantities contained in the DePauli Report. However the following refinements were made to the DePauli Report's construction cost estimate to be consistent with the Reclamation cost estimates for the other parts of the NGWSP:

- DePauli Report unit prices included New Mexico State Gross Receipt Taxes of 6.4 percent. This tax was backed out of the unit prices to allow taxes to be added for the entire project as one lump sum.

- When the DePauli Report's unit costs are used, they were indexed from December 2000 to October 2001.

- The DePauli Report's unit cost for pipelines included earthwork and furnishing and installing ductile-iron pipe. Reclamation used the diameters and lengths provided and applied unit costs for furnishing and installing pipe with an assumed head class of 275 feet with 10 feet of cover. Earthwork quantities for the pipeline were computed as separate items. An estimate of 15% rock excavation was also assumed.

- The DePauli Report's estimate for crossings and bores were used with the exception of backing out the taxes and indexing.

- The number of water storage tanks and their capacities were used. Reclamation computed the size (diameters and heights) of the tanks based on the reported volumes and applied the applicable unit costs.

- The DePauli Report's estimates for pumping plant construction and upgrading existing pumping plants were used with the exception of backing out the taxes and indexing.

- The DePauli Report's estimates for valve and metering stations and surge control station were used with the exception of backing out the taxes and indexing.

- The cost of the Gallup SCADA system was not used because it is assumed to be included in the total project SCADA system estimated by Reclamation.

Reclamation's estimated cost of constructing the Gallup Regional System, Transmission and Storage Facilities is as follows:

Excavation, common	$271,200
Excavation, rock	$192,000
Backfill, common	$219,000
Furnish and install pipe	$3,468,762
Crossings and Borings	$684,400
Tanks (Reservoirs)	$5,990,000
Pump Stations	$670,240
Valves and Metering Stations	$542,800
Surge Control Station (T1-T2) (24")	$84,960
SCADA System (included in BOR SCADA)	$0
Subtotal Field Cost	$12,123,362
Rounded Total	$12,000,000
Mobilization (± 5%)	$600,000
Unlisted Items (± 10%)	$1,400,000
Contingencies (± 20%)	$2,500,000
Rounded Pre-tax Field Cost	$16,500,000
Non-Contract Costs (± 30%)	$5,000,000
Pre-tax Total	$22,000,000

The DePauli Report also had estimates for annual operation, maintenance and replacement (OM&R) expenses for the transmission and storage facilities within the City of Gallup. These OM&R estimates were not used by Reclamation, but were instead estimated in a different manner, as described later in this report. To be consistent with the entire project, Reclamation calculated annual OM&R cost from pumping plant data presented in the DePauli Report, but again used calculation methods described later in this report.

XII. FIELD COSTS

Summaries of the field costs for the years 2020 and 2040, excluding the Gallup Regional System, are shown in Tables 12 and 13 for each of the six alternatives.

XIII. NON-CONTRACT COSTS

Non-contract costs, include costs for items such as facilitating services, investigations, preparation of designs and specifications and construction supervision. To determine a realistic value for non-contract costs for NGWSP, the Western Colorado Area Office reviewed non-contract costs resulting from the construction of the Dolores Project. The Dolores Project was a large project in Southwestern Colorado constructed in the 1980's and early 1990's. Individual features of Dolores Project had non-contract costs ranging from as low as 16.5% to as high as 82.6% of the feature's field costs. The later features such as the Dove Creek Pumping Plant and associated laterals and Towaoc Laterals (gravity pipelines) are considered similar to the proposed construction of NGWSP. These later Dolores Project features had non-contract costs of approximately 30% of the field costs.

For the purposes of this study, the non-contract costs were assumed to be 30% of the field costs. This value was also applied to the City of Gallup field costs (see Tables 1 and 2).

TABLE 12 SUMMARY OF FIELD COSTS BASED ON YEAR 2020 DEMAND*

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Pipelines	$100,745,160	$109,386,620	$122,079,120	$96,050,930	$76,168,350	$69,725,300
Pumping Plants	$9,910,000	$7,750,000	$10,960,000	$9,770,000	$15,890,000	$15,250,000
Water Treatment Plants	$24,478,100	$24,478,100	$24,478,100	$27,710,510	$28,653,500	$27,712,400
Tanks and Air Chambers	$32,675,000	$41,775,000	$41,660,000	$24,690,000	$30,720,000	$30,875,000
Infiltration Well System						$18,268,500
Transmission Lines	$12,103,800	$13,579,400	$14,444,400	$16,524,200	$16,524,200	$18,139,400
Moncisco Dam Storage Pond	$44,942,000	 $20,422,700		 $20,422,700		
Turnout Structure					$852,400	
Winterization		$240,000	$48,000	$600,000		
Unlisted Items (±10%)	$24,145,985	$21,608,225	$25,878,425	$25,031,660	$17,791,530	$21,029,025
Mobilization (±5%)	$11,000,000	$11,000,000	$10,500,000	$9,800,000	$8,400,000	$9,000,000
Contract Cost	$260,000,000	$250,000,000	$250,000,000	$230,000,000	$195,000,000	$210,000,000
Contingencies (±20%)	$50,000,000	$50,000,000	$50,000,000	$40,000,000	$35,000,000	$40,000,000
Total Field Cost	$310,000,000	$300,000,000	$300,000,000	$270,000,000	$230,000,000	$250,000,000

* DOES NOT INCLUDE GALLUP REGIONAL FIELD COSTS (SEE TABLES 1 AND 2)

TABLE 13 SUMMARY OF FIELD COSTS BASED ON YEAR 2040 DEMAND*

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Pipelines	$128,332,550	$155,156,930	$199,767,570	$103,145,230	$90,515,700	$81,958,850
Pumping Plants	$13,230,000	$10,570,000	$15,765,000	$13,760,000	$21,840,000	$20,750,000
Water Treatment Plants	$32,411,500	$32,411,500	$32,411,500	$36,069,110	$37,012,100	$36,071,000
Tanks and Air Chambers	$45,275,000	$44,805,000	$44,835,000	$37,300,000	$46,330,000	$46,485,000
Infiltration Well System						$29,807,150
Transmission Lines	$12,103,800	$13,579,400	$14,444,400	$16,524,200	$16,524,200	$18,139,400
Moncisco Dam Storage Pond	$50,679,500	 $20,422,700		 $20,422,700		
Turnout Structure					$852,400	
Winterization		$240,000	$48,000	$600,000		
Unlisted Items (±10%)	$33,967,695	$29,054,515	$27,276,575	$21,278,760	$26,429,170	$24,656,815
Mobilization (±5%)	$14,000,000	$14,000,000	$15,500,000	$11,500,000	$10,500,000	$11,500,000
Contract Cost	$330,000,000	$320,000,000	$350,000,000	$260,000,000	$250,000,000	$270,000,000
Contingencies (±20%)	$60,000,000	$60,000,000	$80,000,000	$60,000,000	$50,000,000	$50,000,000
Total Field Cost	$390,000,000	$380,000,000	$430,000,000	$320,000,000	$300,000,000	$320,000,000

* DOES NOT INCLUDE GALLUP REGIONAL FIELD COSTS (SEE TABLES 1 AND 2)

XIV. ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT COSTS

Annual operation, maintenance, and replacement (OM&R) costs for pumping plants were generated by the Bureau of Reclamation computer program called PMPOM. The computer program is derived from information in "Guidelines for Estimating Pumping Plant Operation and Maintenance Costs", by John Eyer; 1965, Bureau of Reclamation. Estimates of annual OM&R costs were derived from records of 174 existing electric and hydro-powered pumping plants. The procedures cover direct OM&R costs for pumps, motors, accessory electrical equipment, and plant structures for plants up through 15,000 total horsepower, and consider wage rates and price levels. Price levels were updated from 1965 to 2001 levels. For the NIIP Alternatives, annual OM&R costs were calculated for the additional costs to be incurred by year round operations of the existing NIIP conveyance facilities. For additional details, see Appendix G. Energy costs for the existing NIIP facilities were calculated based on CRSP rates only. For all other parts of the system, energy costs were calculated using both CRSP and NTUA rates. The costs are for the maximum pump discharge using the peak pumping rate, except for the power costs, which were determined as outlined below.

XV. POWER COSTS

It was necessary to determine the fraction of pumping at peak demand that would be necessary to deliver the annual Diversion.

The fraction of pumping at peak demand is given by the following equation:

$$P_k = \frac{Q_{AD}}{Q_{peak\_acft}}$$

Where: P_k is the fraction of peak pumping.
Q_{AD} is the annual diversion in acre-ft/year.
Q_{peak_acft} is the peak pumping rate in acre-ft/year.

The cost of power consists of two components. The first cost is the cost of power based on the rate charged per kilowatt-hour of usage. The second is the demand charge that is charged on a per kilowatt per month basis.

A. The Peak Power Demand

The Peak Power demand is given by the following equation:

$$P_{pwd\_ft-lbs/s} = \frac{\gamma_w Q_{pk\_cfs} H}{e}$$

Where: $P_{pwd\_ft\text{-}lbs/s}$ is the peak power demand in: ft-lbs/sec
γ_w is the unit weight of water in lbs/ft^3 (62.4)
Q_{pk_cfs} is the peak pumping discharge in ft^3/sec

H is the pumping head in feet..
e is the efficiency.

Since 1 horsepower (HP) is equal to 550 ft-lbs/sec.

$$P_{pwd\_HP} = \frac{P_{pwd\_ft-lbs/s}}{550}$$

Where : P_{pwd_HP} is the peak power demand in Horse Power.

Since: 1 HP = 0.746 KW (KW is kilowatts), then:

$$P_{pwd\_KW} = 0.746 P_{pwd\_HP}$$

Where: P_{pwd_KW} is the peak power demand in Kilowatts.

B. Kilowatt-Hours of Energy Consumption per Year

The kilowatt Hours of consumption is given by the following equation:

$$E_{kwhrs} = 8760 P_K P_{pwd\_KW}$$

Where: E_{kwhrs} is the energy consumption per year in kilowatt hours
P_k is the fraction of pumping at Peak Demand (as determined previously).
P_{pwd_KW} is the peak power demand in kilowatts.

C. Cost of Power (Based on Charge per kilowatt-hour)

The Cost of Power (Based on the rate per kilowatt hour) is given by the following equation:

$$C_{p\_kwhr} = R_{kwhr} E_{kwhrs}$$

Where: C_{p_kwhr} is the cost of power based on the rate per kilowatt Hour.
R_{kwhr} is the rate per kilowatt hour.

D. Demand Charge (Yearly)

The yearly demand charge is given by the following equation:

$$C_D = 12 P_{pwd\_KW} R_D$$

Where: C_D is the yearly demand charge
R_D is the monthly demand charge in dollars per kilowatt.

The total yearly power costs (C_T) are given by the flowing equation:

$$C_T = C_{p\_kwhr} + C_D$$

Example:

The annual power costs for both CRSP and NTUA rates were computed for the San Juan River Pumping Plant (Pumping Plant 01) for the year 2040.

The following values were used:

Rate	Power Cost (Dollars per Kilowatt Hour)	Demand Charge (Dollars per Kilowatt per month)
CRSP	0.0081	3.44
NTUA	0.0185	15.40

Peak Flow Rate = 59.18 ft^3/s
Efficiency (e) = 80% (combined for both pumps and motors)
Pumping Head (H) = 442 ft.
Annual Diversion (Q_{AD}) = 33,118 Acre-ft.

Q_{peak_acft} = (peak flow rate in acre-ft/year) = (59.18*86,400*365)/43,560= 42,844 acre-ft/year

Therefore P_k(fraction of peak pumping) = 33,118/42,844=0.773

Peak Power Demand= (62.4*59.18*442)/0.8 = 2,040,290 ft-lbs/sec

Peak Power Demand = 2,040,290/550 = 3,710 horsepower

Peak Power Demand = 3,710*0.746= 2,767 kilowatts

Kilowatt hours of consumption (per year) = 8,760*0.773*2767= 18,738,830 kw-hours

Power Cost based on charge per kilowatt Hour (C_{kwhr}):

CRSP Rate: 0.0081*18,738,830 = $151,785

NTUA Rate: 0.0185*18,738,830 = $346,668

Demand Charge (C_D) : **CRSP rate:** 12*3.44*2767= $114,237

NTUA rate: 12*15.40*2767 = $511,411

Total Yearly Power Costs: **CRSP rate:** $151,785 + $114,237 = $266,022
(PP01, Year 2040) **NTUA rate:** $346,668 + $511,411 = $858,079

The pipe diameters, pumping plant locations, pump heads, and monthly energy requirements will be more precisely defined in the next level of study. The summations for all of the pumping plants, as well as the costs associated with winterization of the existing NIIP facilities, are shown below for both 2020 and 2040 demands in Tables 14 and 15.

TABLE 14 SUMMARY OF ANNUAL OM&R COSTS FOR YEAR 2020 DEMAND

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Annual OM&R	$1,365,800	$991,900	$1,095,200	$1,710,300	$1,979,800	$2,042,900
Energy (NTUA)	$2,102,100	$1,700,500	$2,442,400	$2,170,000	$3,479,600	$3,333,800
Energy (CRSP)	$711,300	$691,100	$756,700	$672,000	$1,078,000	$1,032,900
City of Gallup Annual OM&R	$306,200	$306,200	$306,200	$306,200	$306,200	$306,200
Energy (NTUA)	$76,600	$76,600	$76,600	$76,600	$76,600	$76,600
Energy (CRSP)	$23,800	$23,800	$23,800	$23,800	$23,800	$23,800
Total (NTUA)	$3,850,700	$3,075,200	$3,920,400	$4,263,100	$5,842,200	$5,759,500
Total (CRSP)	$2,407,100	$2,013,000	$2,181,900	$2,712,300	$3,387,800	$3,405,800

TABLE 15 SUMMARY OF ANNUAL OM&R COSTS FOR YEAR 2040 DEMAND

Item	NIIP Moncisco Alternative	NIIP Coury Lateral Alternative	NIIP Cutter Alternative	NIIP Amarillo Alternative	SJR PNM Alternative	SJR Infiltration Alternative
Annual OM&R	$1,449,500	$1,053,500	$1,157,100	$1,828,300	$2,120,800	$2,183,500
Energy (NTUA)	$3,118,300	$2,453,100	$3,657,800	$3,303,000	$5,169,200	$4,874,600
Energy (CRSP)	$1,060,700	$962,700	$1,133,300	$1,023,000	$1,601,500	$1,510,200
City of Gallup Annual OM&R	$306,200	$306,200	$306,200	$306,200	$306,200	$306,200
Energy (NTUA)	$76,600	$76,600	$76,600	$76,600	$76,600	$76,600
Energy (CRSP)	$23,800	$23,800	$23,800	$23,800	$23,800	$23,800
Total (NTUA)	$4,950,600	$3,889,400	$5,197,700	$5,514,100	$7,672,800	$7,440,900
Total (CRSP)	$2,840,200	$2,346,200	$2,620,400	$3,181,300	$4,052,300	$4,023,700

XVI. FUTURE REFINEMENTS IN DESIGNS AND COST ESTIMATES

When the preferred Alternative has been identified, the designs and cost estimates for that option will be performed in greater detail. The following are some of the items to be included in that effort:

Update costs to reflect the most recent interest rates, tax information, power costs, and flow rates.

Refinement of hydraulic analyses (including an economic analysis of pumping costs vs. initial cost of pipe). This could impact both the number and size of the pumping plants.

Refinement of OM&R costs for pumping plants, treatment plants, etc.

Additional water quality data for the San Juan River will be available. Water treatment plant sediment handling costs will be reevaluated based on the results of the new data.

The pipeline alinement will be refined based upon possible impacts from cultural resources, endangered species, and existing facilities.

Refinement of pipe unit costs, including revisions to installation (earthwork) costs.

Refinement of rock excavation areas based upon more detailed information

XVII. LIST OF APPENDICES

Appendix A - Figures and Drawings

Appendix B - Cost Estimate Worksheets (Bound as a separate document)

Appendix C - Water Treatment (Bound as a separate document)

Appendix D - Engineering (Bound as a separate document)

Appendix E - Infiltration Gallery (Bound as a separate document)

Appendix F - City of Gallup Transmission and Storage Facilities, Revised January, 2002, by DePauli Engineering and Surveying Co. (Bound as a separate document)

Appendix G - Moncisco Reservoir and NIIP Operations (Bound as a separate document)

Appendix H - Evaluation of Existing PNM Diversion and Sedimentation Facility (Bound as a separate document)

NAVAJO GALLUP WATER SUPPLY PROJECT

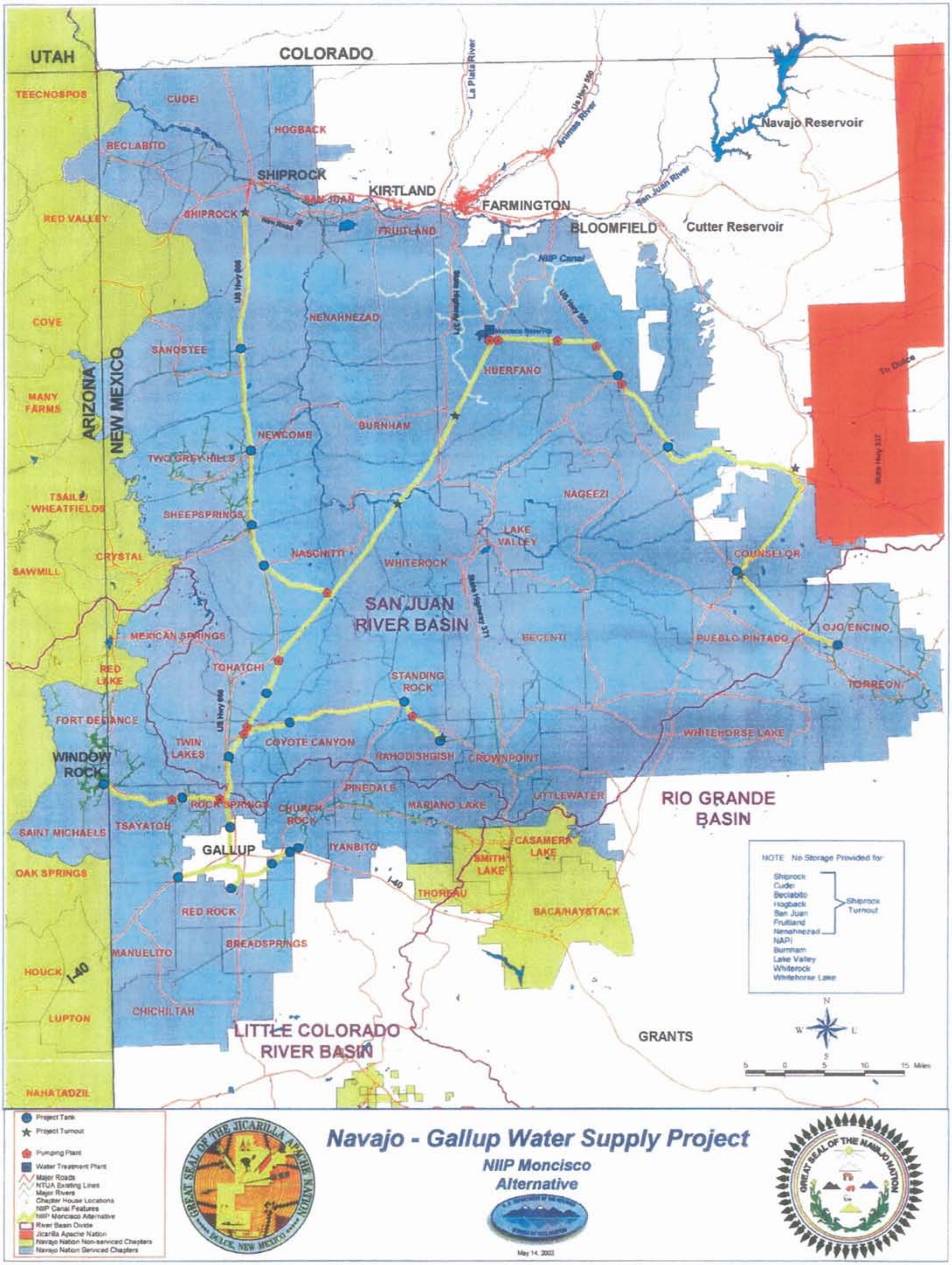
APPRAISAL LEVEL DESIGNS AND COST ESTIMATES

APPENDIX A

FIGURES AND DRAWINGS

FIGURE LIST

DRAWING LIST



UTAH
COLORADO
ARIZONA
NEW MEXICO
La Plata River
Animas River
San Juan River
Navajo Reservoir
Cutter Reservoir
NIIP Canal
SHIPROCK
KIRTLAND
FARMINGTON
BLOOMFIELD
TEECNOSPOS
CUDEI
HOGBACK
BECLABITO
RED VALLEY
SHIPROCK
SAN JUAN
FRUITLAND
COVE
NENAHNEZAD
SANOSTEE
HUERFANO
MANY FARMS
NEWCOMB
BURNHAM
TWO GREY HILLS
TSAILE/ WHEATFIELDS
SHEEPSPRINGS
NAGEEZI
LAKE VALLEY
CRYSTAL
SAWMILL
NASCHITTI
WHITEROCK
COUNSELOR
SAN JUAN RIVER BASIN
MEXICAN SPRINGS
BECENTI
PUEBLO PINTADO
OJO ENCINO
RED LAKE
TOHATCHI
STANDING ROCK
TORREON
FORT DEFIANCE
TWIN LAKES
COYOTE CANYON
NAHODISHGISH
CROWNPOINT
WHITEHORSE LAKE
WINDOW ROCK
ROCK SPRINGS
CHURCH ROCK
PINEDALE
MARIANO LAKE
LITTLEWATER
RIO GRANDE BASIN
SAINT MICHAELS
TSAYATOH
GALLUP
IYANBITO
CASAMERO LAKE
SMITH LAKE
OAK SPRINGS
THOREAU
I-40
RED ROCK
BACA/HAYSTACK
BREADSPRINGS
MANUELITO
HOUCK
I-40
CHICHILTAH
LUPTON
LITTLE COLORADO RIVER BASIN
GRANTS
NAHATADZIL
NOTE: No Storage Provided for:
Shiprock
Cudei
Beclabito
Hogback
San Juan
Fruitland
Nenahnezad
Shiprock Turnout
NAPI
Burnham
Lake Valley
Whiterock
Whitehorse Lake
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W
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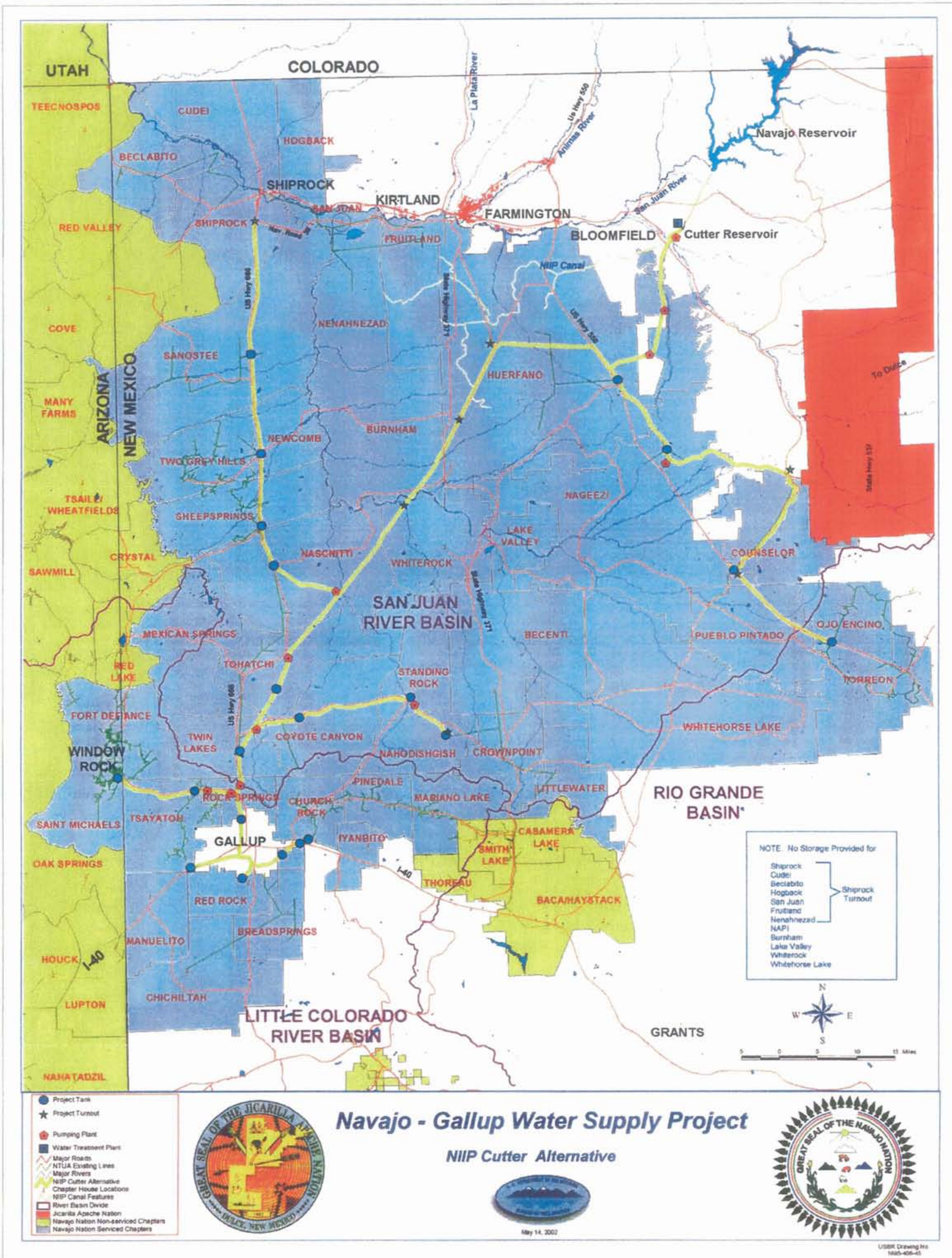
S
5 0 5 10 15 Miles
Project Tank
Project Turnout
Pumping Plant
Water Treatment Plant
Major Roads
NTUA Existing Lines
Major Rivers
Chapter House Locations
NIIP Canal Features
NIIP Moncisco Alternative
River Basin Divide
Jicarilla Apache Nation
Navajo Nation Non-serviced Chapters
Navajo Nation Serviced Chapters
GREAT SEAL OF THE JICARILLA APACHE NATION
DULCE, NEW MEXICO
Navajo - Gallup Water Supply Project
NIIP Moncisco
Alternative
May 14, 2003
GREAT SEAL OF THE NAVAJO NATION
USBR Drawing No
1695-400-46

Figure 1


Navajo - Gallup Water Supply Project
NIIP Cutter Alternative
UTAH
COLORADO
ARIZONA
NEW MEXICO
Navajo Reservoir
Cutter Reservoir
SHIPROCK
KIRTLAND
FARMINGTON
BLOOMFIELD
GALLUP
WINDOW ROCK
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SAN JUAN RIVER BASIN
RIO GRANDE BASIN
LITTLE COLORADO RIVER BASIN
San Juan River
Animas River
La Plata River
NIIP Canal
US Hwy 550
US Hwy 666
State Highway 371
State Hwy 537
I-40
To Dulce
TEECNOSPOS
CUDEI
HOGBACK
BECLABITO
SAN JUAN
FRUITLAND
RED VALLEY
COVE
MANY FARMS
SANOSTEE
NENAHNEZAD
HUERFANO
NEWCOMB
BURNHAM
TWO GREY HILLS
TSAILE/ WHEATFIELDS
SHEEPSPRINGS
NAGEEZI
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CRYSTAL
SAWMILL
NASCHITTI
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PUEBLO PINTADO
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CHURCH ROCK
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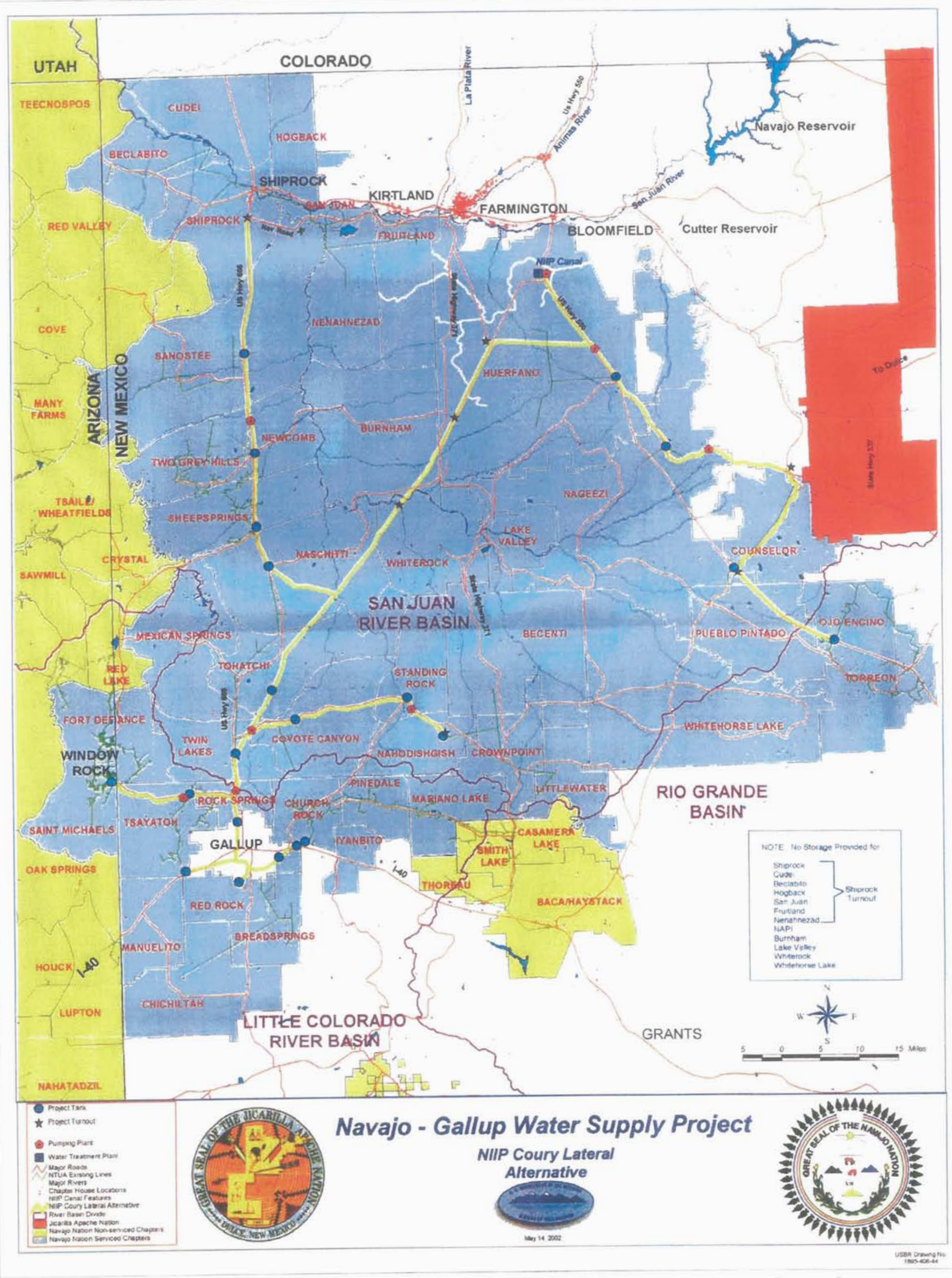
SAINT MICHAELS
TSAYATOH
IYANBITO
CASAMERA LAKE
SMITH LAKE
OAK SPRINGS
THOREAU
RED ROCK
BACA/HAYSTACK
MANUELITO
BREADSPRINGS
HOUCK
LUPTON
CHICHILTAH
NAHATADZIL
NOTE: No Storage Provided for
Shiprock
Cudei
Beclabito
Hogback
San Juan
Fruitland
Nenahnezad
Shiprock Turnout
NAPI
Burnham
Lake Valley
Whiterock
Whitehorse Lake
N
S
E
W
Miles
Project Tank
Project Turnout
Pumping Plant
Water Treatment Plant
Major Roads
NTUA Existing Lines
Major Rivers
NIIP Cutter Alternative
Chapter House Locations
NIIP Canal Features
River Basin Divide
Jicarilla Apache Nation
Navajo Nation Non-serviced Chapters
Navajo Nation Serviced Chapters
GREAT SEAL OF THE JICARILLA APACHE NATION
DULCE, NEW MEXICO
GREAT SEAL OF THE NAVAJO NATION
May 14, 2002
USBR Drawing No

Figure 2


Navajo - Gallup Water Supply Project
NIIP Coury Lateral
Alternative
May 14 2002
USBR Drawing No. 1885-406-44
UTAH
COLORADO
ARIZONA
NEW MEXICO
Navajo Reservoir
Cutter Reservoir
SHIPROCK
KIRTLAND
FARMINGTON
BLOOMFIELD
GALLUP
GRANTS
WINDOW ROCK
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CHURCH ROCK
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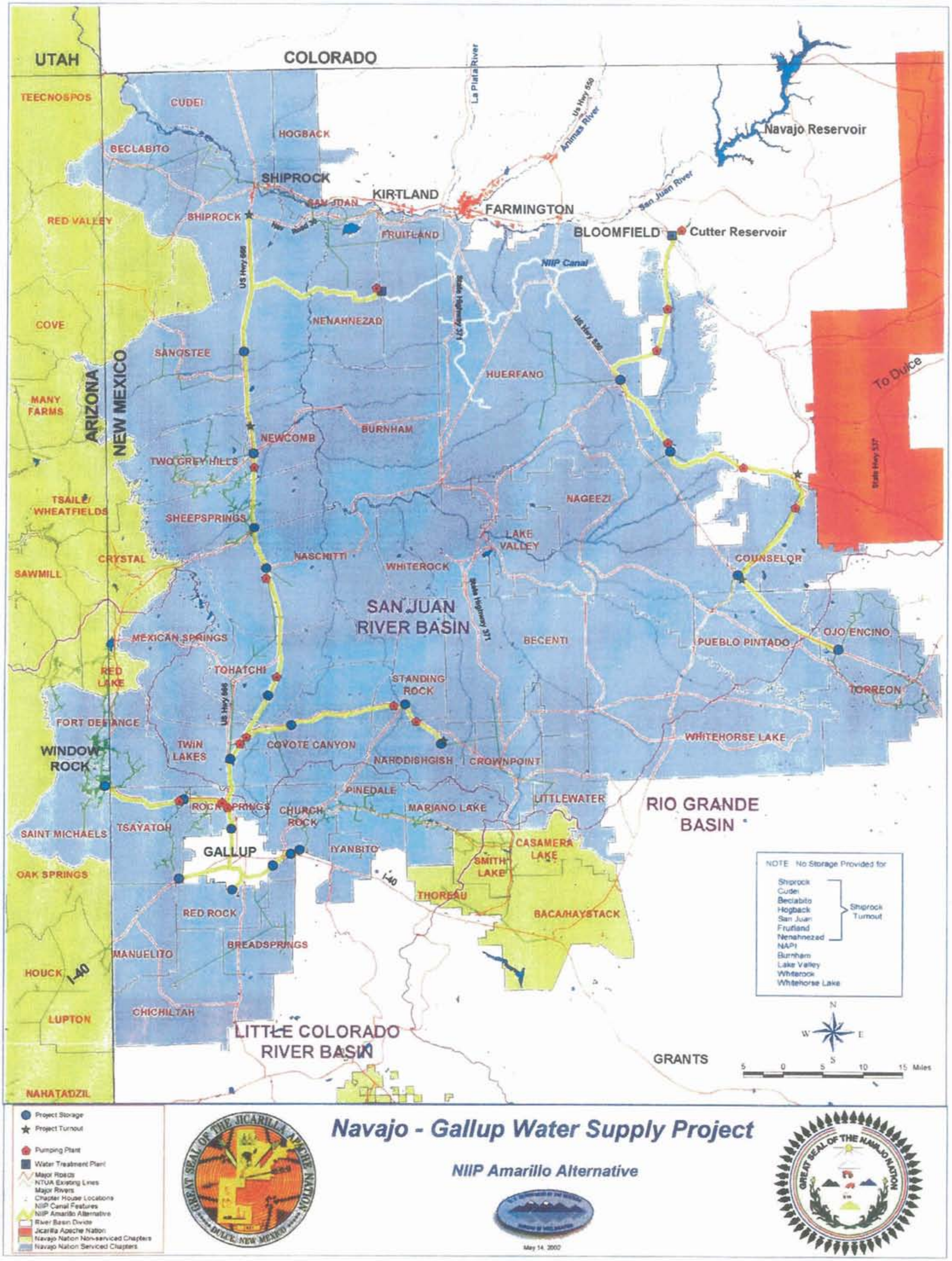
BACA/HAYSTACK
BREADSPRINGS
MANUELITO
HOUCK
CHICHILTAH
LUPTON
NAHATADZIL
NOTE: No Storage Provided for
Shiprock
Cudei
Beclabito
Hogback
San Juan
Fruitland
Nenahnezad
Shiprock Turnout
NAPI
Burnham
Lake Valley
Whiterock
Whitehorse Lake
N
S
W
E
5 0 5 10 15 Miles
Project Tank
Project Turnout
Pumping Plant
Water Treatment Plant
Major Roads
NTUA Existing Lines
Major Rivers
Chapter House Locations
NIIP Canal Features
NIIP Coury Lateral Alternative
River Basin Divide
Jicarilla Apache Nation
Navajo Nation Non-serviced Chapters
Navajo Nation Serviced Chapters
GREAT SEAL OF THE JICARILLA APACHE NATION
DULCE, NEW MEXICO
GREAT SEAL OF THE NAVAJO NATION

Figure 3



UTAH
COLORADO
ARIZONA
NEW MEXICO
La Plata River
US Hwy 550
Animas River
Navajo Reservoir
San Juan River
SHIPROCK
KIRTLAND
FARMINGTON
BLOOMFIELD
Cutter Reservoir
NIIP Canal
TEECNOSPOS
CUDEI
HOGBACK
BECLABITO
SAN JUAN
FRUITLAND
RED VALLEY
COVE
SANOSTEE
NENAHNEZAD
HUERFANO
MANY FARMS
NEWCOMB
BURNHAM
TWO GREY HILLS
TSAILE/ WHEATFIELDS
SHEEPSPRINGS
NAGEEZI
LAKE VALLEY
CRYSTAL
SAWMILL
NASCHITTI
WHITEROCK
COUNSELOR
SAN JUAN RIVER BASIN
MEXICAN SPRINGS
BECENTI
PUEBLO PINTADO
OJO ENCINO
RED LAKE
TOHATCHI
STANDING ROCK
TORREON
FORT DEFIANCE
WINDOW ROCK
TWIN LAKES
COYOTE CANYON
NAHODISHGISH
CROWNPOINT
WHITEHORSE LAKE
PINEDALE
LITTLEWATER
ROCK SPRINGS
CHURCH ROCK
MARIANO LAKE
RIO GRANDE BASIN
SAINT MICHAELS
TSAYATOH
GALLUP
IYANBITO
CASAMERA LAKE
SMITH LAKE
OAK SPRINGS
I-40
THOREAU
BACA/HAYSTACK
RED ROCK
BREADSPRINGS
MANUELITO
HOUCK
LUPTON
CHICHILTAH
LITTLE COLORADO RIVER BASIN
GRANTS
NAHATADZIL
To Dulce
State Hwy 537
US Hwy 666
State Highway 371
US Hwy 550
NOTE No Storage Provided for
Shiprock
Cudei
Beclabito
Hogback
San Juan
Fruitland
Nenahnezad
Shiprock Turnout
NAPI
Burnham
Lake Valley
Whiterock
Whitehorse Lake
N
W
E
S
5 0 5 10 15 Miles
Project Storage
Project Turnout
Pumping Plant
Water Treatment Plant
Major Roads
NTUA Existing Lines
Major Rivers
Chapter House Locations
NIIP Canal Features
NIIP Amarillo Alternative
River Basin Divide
Jicarilla Apache Nation
Navajo Nation Nonserviced Chapters
Navajo Nation Serviced Chapters
GREAT SEAL OF THE JICARILLA APACHE NATION
DULCE, NEW MEXICO
Navajo - Gallup Water Supply Project
NIIP Amarillo Alternative
May 14, 2002
GREAT SEAL OF THE NAVAJO NATION
USBR Drawing No. 1695-406-47

Figure 4

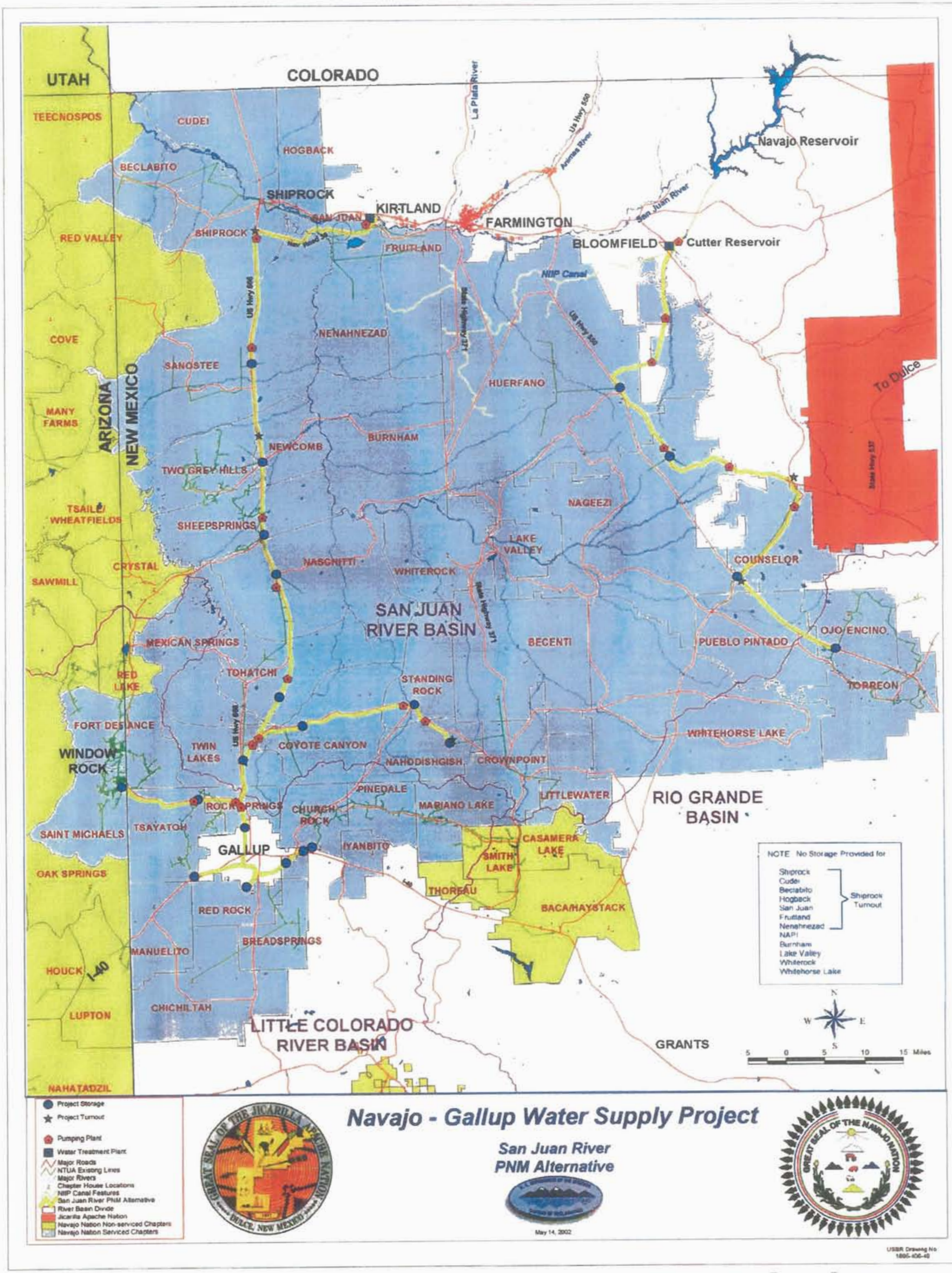

UTAH
COLORADO
ARIZONA
NEW MEXICO
Navajo Reservoir
SHIPROCK
KIRTLAND
FARMINGTON
BLOOMFIELD
Cutter Reservoir
SAN JUAN RIVER BASIN
RIO GRANDE BASIN
LITTLE COLORADO RIVER BASIN
GALLUP
WINDOW ROCK
GRANTS
To Dulce
NOTE No Storage Provided for
Shiprock
Cudei
Beclabito
Hogback
San Juan
Fruitland
Nenahnezad
Shiprock Turnout
NAPI
Burnham
Lake Valley
Whiterock
Whitehorse Lake
Project Storage
Project Turnout
Pumping Plant
Water Treatment Plant
Navajo - Gallup Water Supply Project
San Juan River
PNM Alternative
May 14, 2002
USBR Drawing No. 1886-406-48

Figure 5

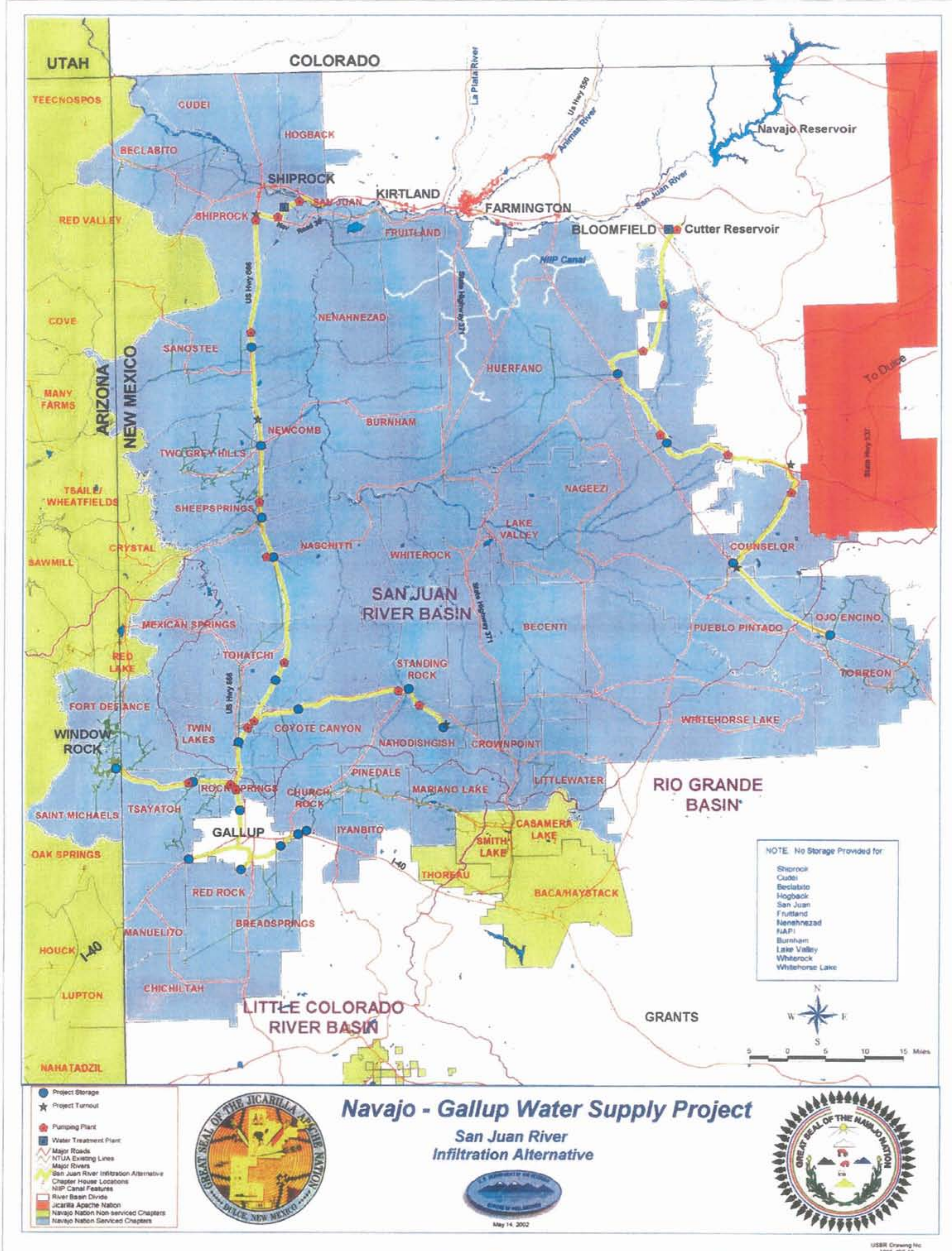
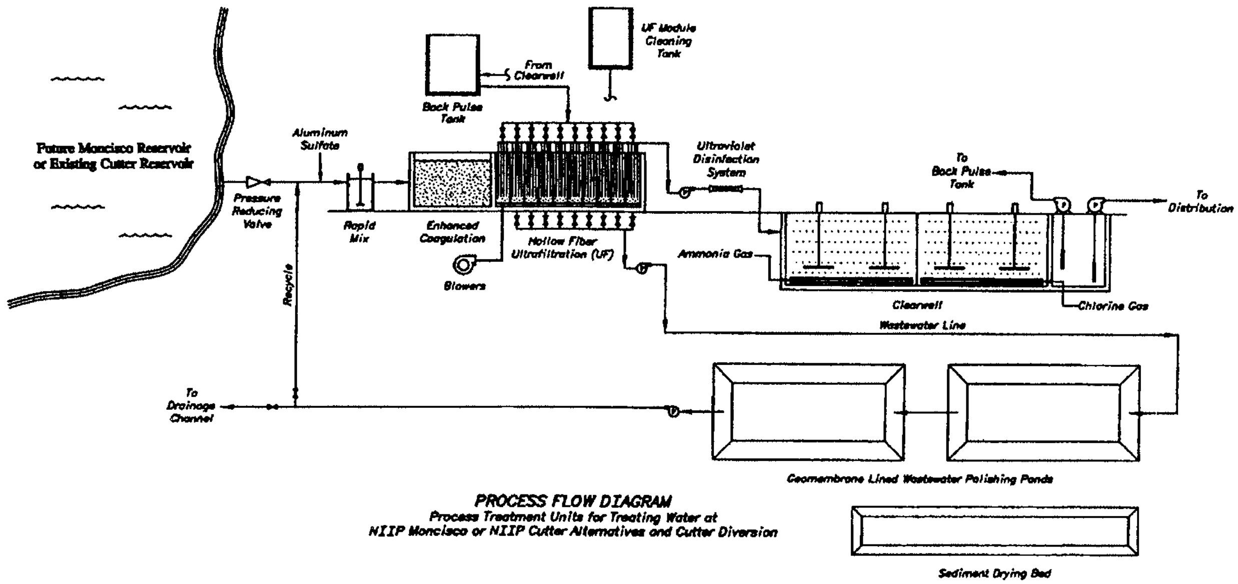
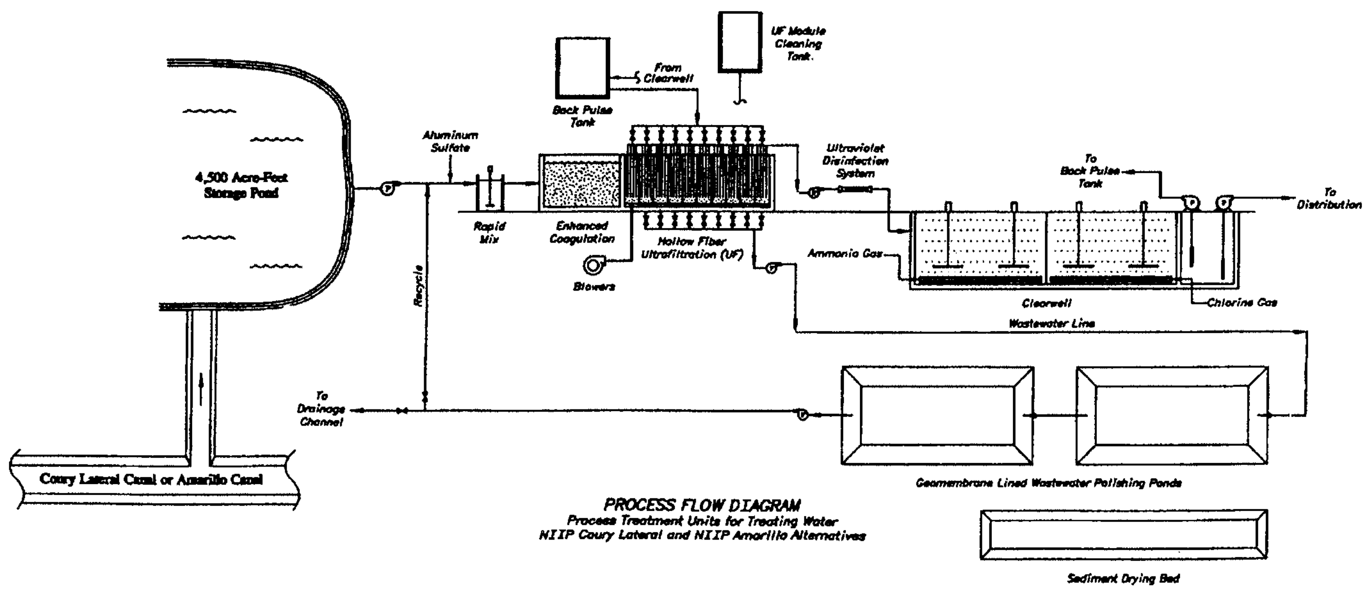

UTAH
COLORADO
ARIZONA
NEW MEXICO
TEECNOSPOS
CUDEI
HOGBACK
BECLABITO
SHIPROCK
KIRTLAND
FARMINGTON
SAN JUAN
RED VALLEY
FRUITLAND
BLOOMFIELD
Cutter Reservoir
Navajo Reservoir
La Plata River
Animas River
San Juan River
Us Hwy 550
NIIP Canal
US Hwy 666
State Highway 371
COVE
NENAHNEZAD
SANOSTEE
HUERFANO
To Dulce
MANY FARMS
NEWCOMB
BURNHAM
TWO GREY HILLS
State Hwy 537
TSAILE/ WHEATFIELDS
SHEEPSPRINGS
NAGEEZI
LAKE VALLEY
CRYSTAL
NASCHITTI
WHITEROCK
COUNSELOR
SAWMILL
SAN JUAN RIVER BASIN
MEXICAN SPRINGS
BECENTI
PUEBLO PINTADO
OJO ENCINO
RED LAKE
TOHATCHI
STANDING ROCK
TORREON
FORT DEFIANCE
WINDOW ROCK
TWIN LAKES
COYOTE CANYON
WHITEHORSE LAKE
NAHODISHGISH
CROWNPOINT
PINEDALE
ROCK SPRINGS
CHURCH ROCK
MARIANO LAKE
LITTLEWATER
RIO GRANDE BASIN
SAINT MICHAELS
TSAYATOH
GALLUP
IYANBITO
CASAMERA LAKE
SMITH LAKE
OAK SPRINGS
I-40
THOREAU
RED ROCK
BACA/HAYSTACK
BREADSPRINGS
MANUELITO
HOUCK
I-40
CHICHILTAH
LUPTON
LITTLE COLORADO RIVER BASIN
GRANTS
NAHATADZIL
NOTE: No Storage Provided for:
Shiprock
Cudei
Beclabito
Hogback
San Juan
Fruitland
Nenahnezad
NAPI
Burnham
Lake Valley
Whiterock
Whitehorse Lake
N
W
E
S
5 0 5 10 15 Miles
Project Storage
Project Turnout
Pumping Plant
Water Treatment Plant
Major Roads
NTUA Existing Lines
Major Rivers
San Juan River Infiltration Alternative
Chapter House Locations
NIIP Canal Features
River Basin Divide
Jicarilla Apache Nation
Navajo Nation Non-serviced Chapters
Navajo Nation Serviced Chapters
GREAT SEAL OF THE JICARILLA APACHE NATION
DULCE, NEW MEXICO
Navajo - Gallup Water Supply Project
San Juan River
Infiltration Alternative
May 14, 2002
GREAT SEAL OF THE NAVAJO NATION
USBR Drawing No.
1665-400-48

Figure 6

DRAWING 1



PROCESS FLOW DIAGRAM
Process Treatment Units for Treating Water at
NIIP Moncisco or NIIP Cutter Alternatives and Cutter Diversion



PROCESS FLOW DIAGRAM
Process Treatment Units for Treating Water
NIIP Coury Lateral and NIIP Amarillo Alternatives

11-27-01 — REVISED TITLE, ADDED NIIP AMARILLO AND CHANGED ACRE-FEET IN STORAGE POND.

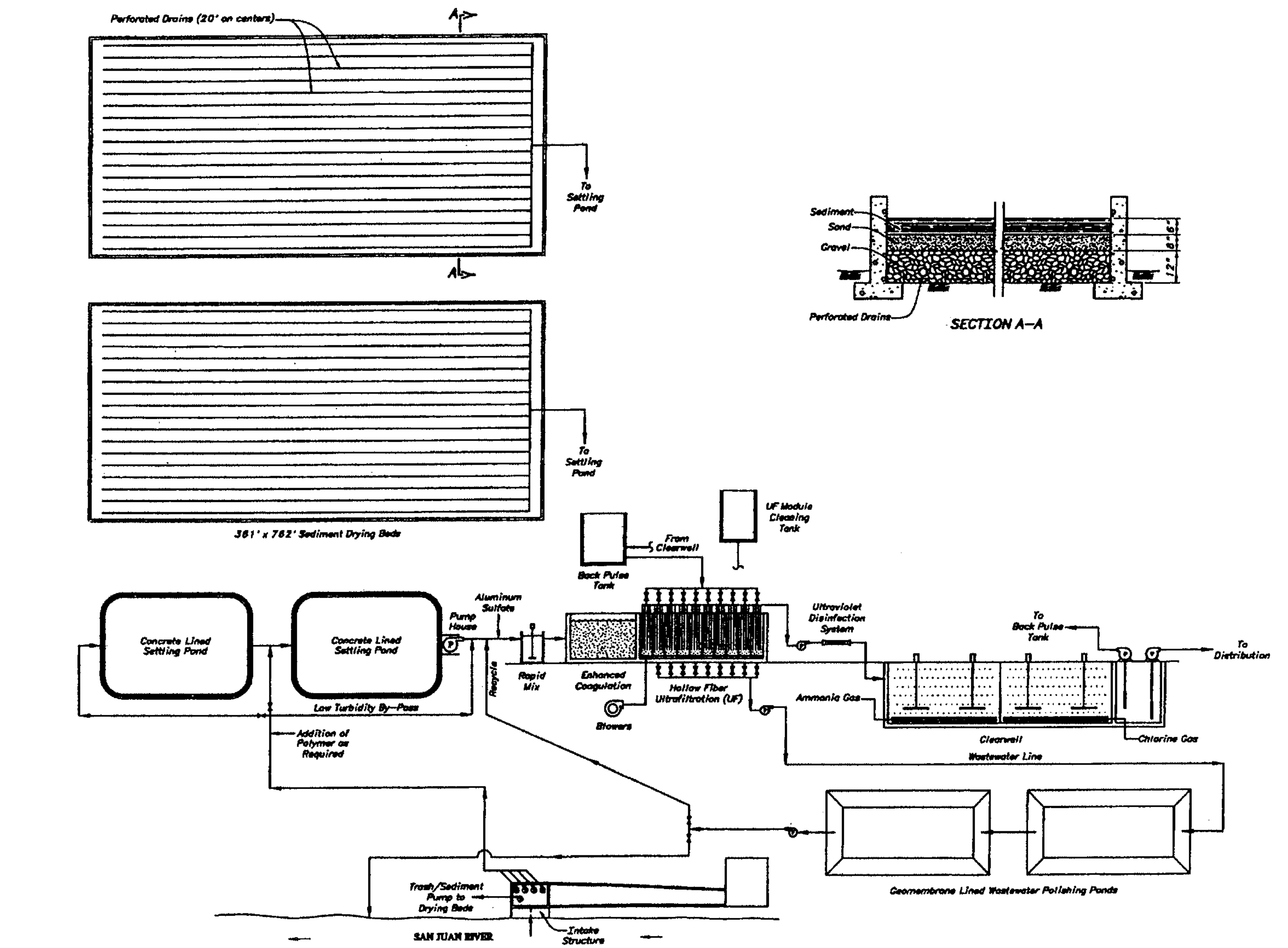
ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

NAVAJO GALLUP WATER SUPPLY PROJECT
WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAMS

DRAWING 1

DRAWING 2



PROCESS FLOW DIAGRAM
Process Treatment Units for Treating Water
San Juan River PNM Alternative

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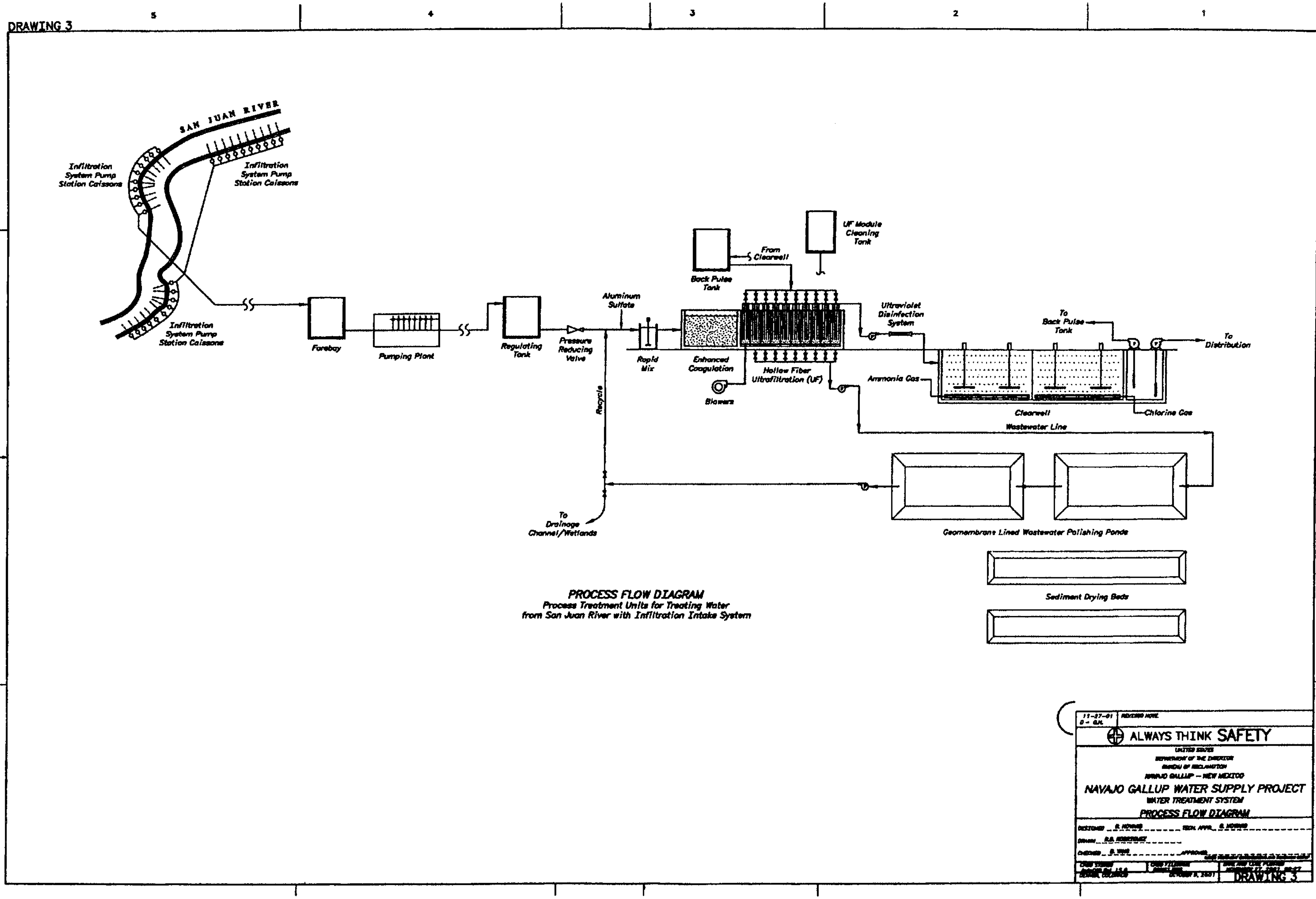
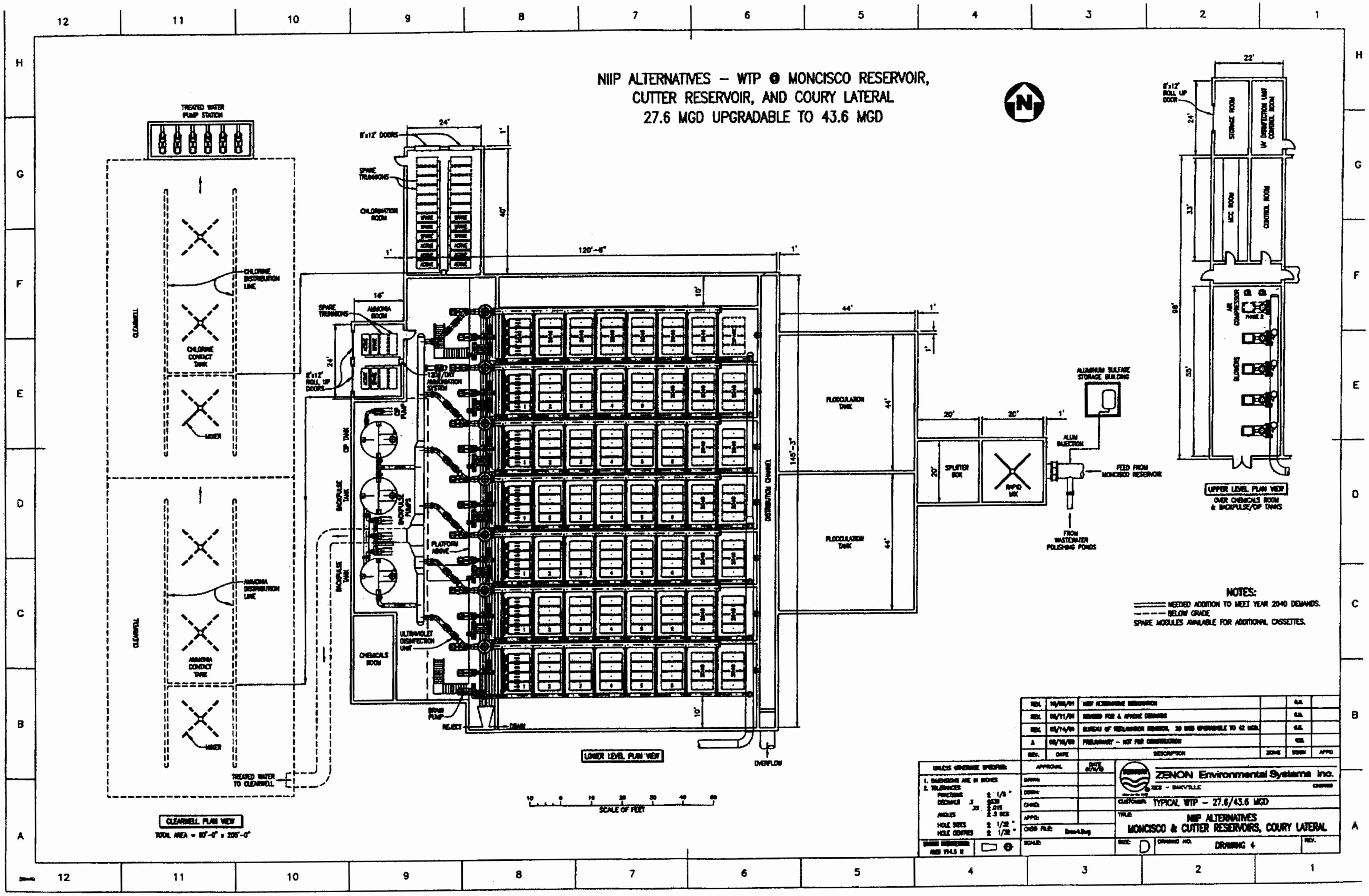
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

NAVAJO GALLUP WATER SUPPLY PROJECT
WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAMS

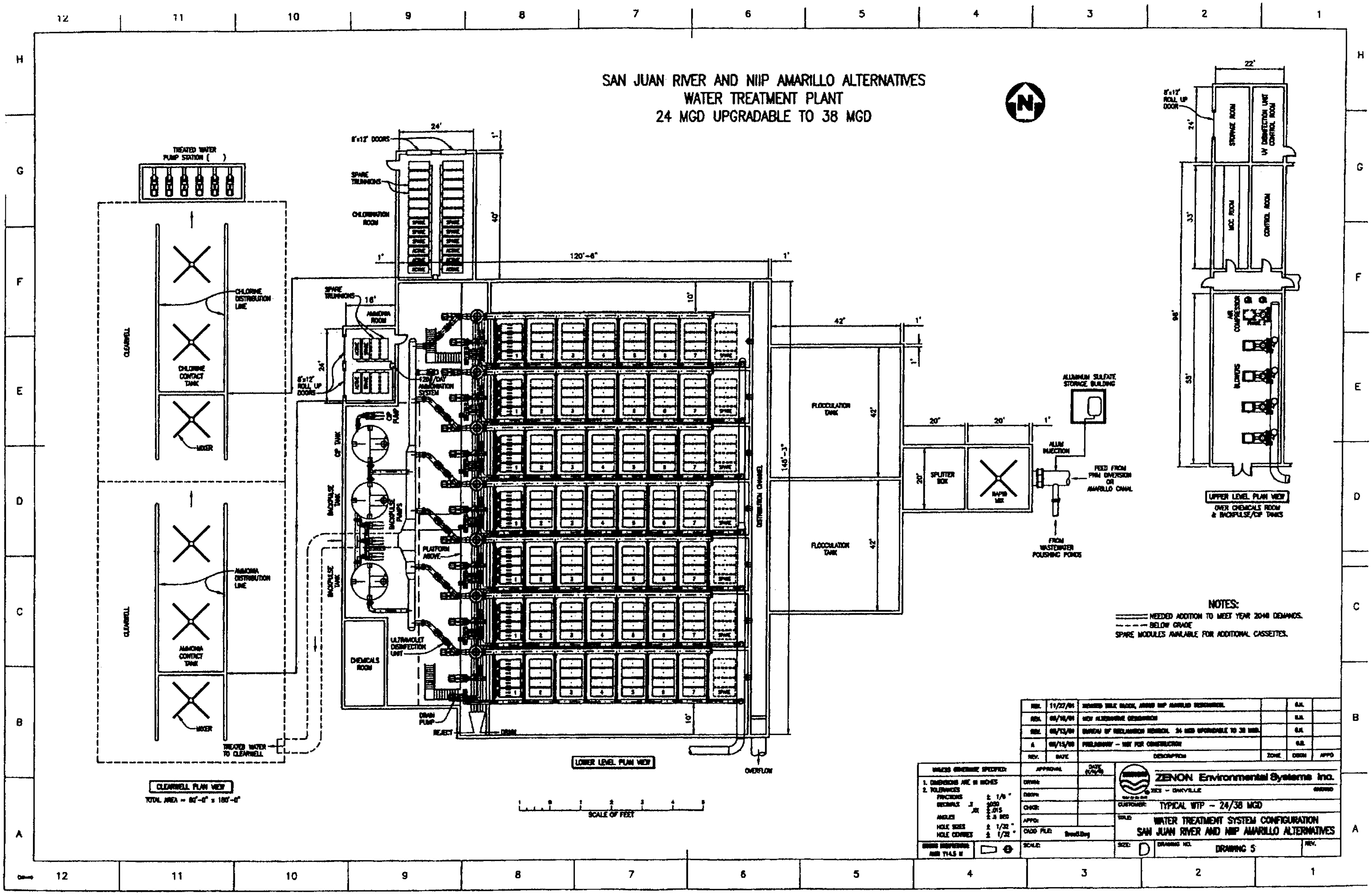
DRAWING 2

DRAWING 3


SAN JUAN RIVER
Infiltration System Pump Station Caissons
Infiltration System Pump Station Caissons
Infiltration System Pump Station Caissons
Forebay
Pumping Plant
Regulating Tank
Pressure Reducing Valve
Aluminum Sulfate
Rapid Mix
Enhanced Coagulation
Back Pulse Tank
From Clearwell
UF Module Cleaning Tank
Hollow Fiber Ultrafiltration (UF)
Blowers
Ultraviolet Disinfection System
To Back Pulse Tank
To Distribution
Ammonia Gas
Clearwell
Chlorine Gas
Wastewater Line
Recycle
To Drainage Channel/Wetlands
Geomembrane Lined Wastewater Polishing Ponds
Sediment Drying Beds
PROCESS FLOW DIAGRAM
Process Treatment Units for Treating Water
from San Juan River with Infiltration Intake System
11-27-01
ALWAYS THINK SAFETY
NAVAJO GALLUP — NEW MEXICO
NAVAJO GALLUP WATER SUPPLY PROJECT
WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAM
DRAWING 3

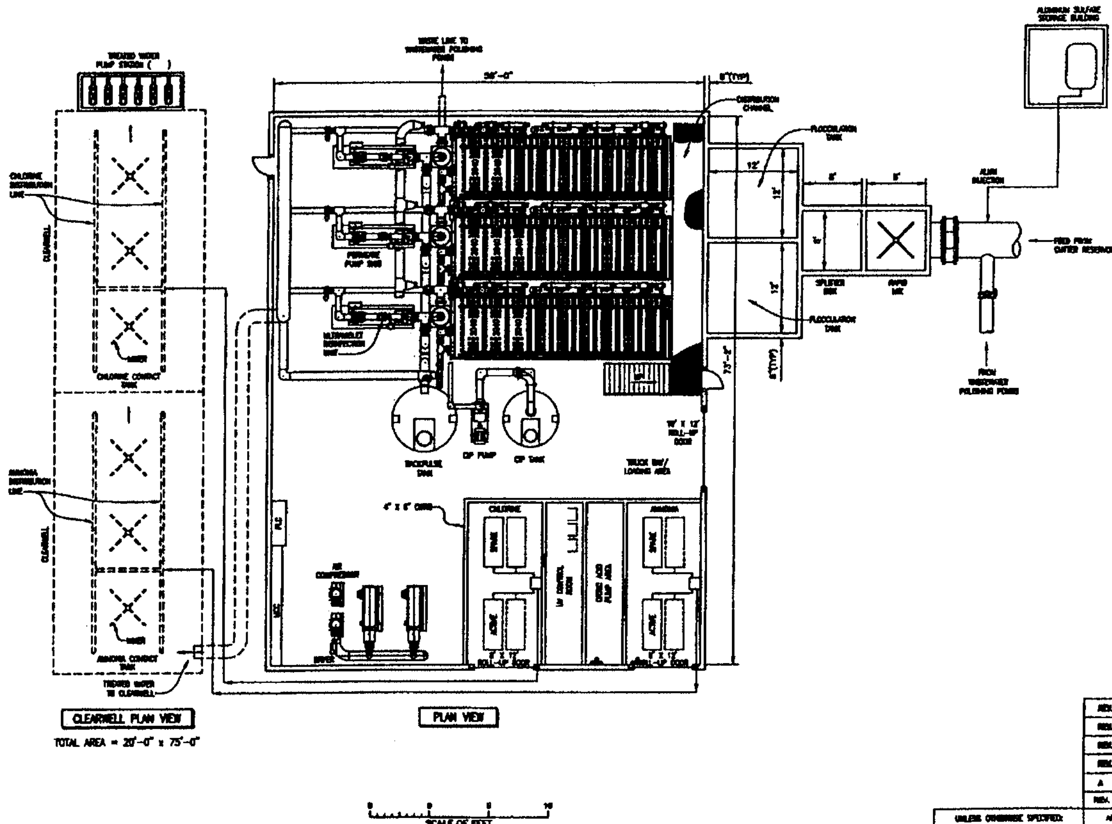


NIIP ALTERNATIVES – WTP @ MONCISCO RESERVOIR,
CUTTER RESERVOIR, AND COURY LATERAL
27.6 MGD UPGRADABLE TO 43.6 MGD
TREATED WATER PUMP STATION
CLEARWELL
CHLORINE DISTRIBUTION LINE
CHLORINE CONTACT TANK
MIXER
AMMONIA DISTRIBUTION LINE
AMMONIA CONTACT TANK
TREATED WATER TO CLEARWELL
CLEARWELL PLAN VIEW
TOTAL AREA = 80'-0" x 205'-0"
8'x12' DOORS
SPARE TRUNNIONS
CHLORINATION ROOM
AMMONIA ROOM
8'x12' ROLL UP DOORS
CIP TANK
CIP PUMP
BACKPULSE TANK
BACKPULSE PUMPS
PLATFORM ABOVE
ULTRAVIOLET DISINFECTION UNIT
CHEMICALS ROOM
DRAIN PUMP
REJECT
DRAIN
DISTRIBUTION CHANNEL
OVERFLOW
LOWER LEVEL PLAN VIEW
120'-8"
145'-3"
FLOCCULATION TANK
SPLITTER BOX
RAPID MIX
ALUMINUM SULFATE STORAGE BUILDING
ALUM INJECTION
FEED FROM MONCISCO RESERVOIR
FROM WASTEWATER POLISHING PONDS
SCALE OF FEET
8'x12' ROLL UP DOOR
STORAGE ROOM
UV DISINFECTION UNIT CONTROL ROOM
MCC ROOM
CONTROL ROOM
AIR COMPRESSOR
BLOWERS
UPPER LEVEL PLAN VIEW
OVER CHEMICALS ROOM & BACKPULSE/CIP TANKS
NOTES:
NEEDED ADDITION TO MEET YEAR 2040 DEMANDS.
BELOW GRADE
SPARE MODULES AVAILABLE FOR ADDITIONAL CASSETTES.
A PRELIMINARY – NOT FOR CONSTRUCTION
REV. DATE DESCRIPTION ZONE APPD
UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES
FRACTIONS ± 1/8"
HOLE SIZES ± 1/32"
HOLE CENTRES ± 1/32"
APPROVAL
DRAWN:
DSGN:
CHKD:
APPD:
CADD FILE:
SCALE:
ZENON Environmental Systems Inc.
CUSTOMER: TYPICAL WTP – 27.6/43.6 MGD
TITLE: NIIP ALTERNATIVES
MONCISCO & CUTTER RESERVOIRS, COURY LATERAL
SIZE: D
DRAWING NO. DRAWING 4
REV.



SAN JUAN RIVER AND NIIP AMARILLO ALTERNATIVES
WATER TREATMENT PLANT
24 MGD UPGRADABLE TO 38 MGD
TREATED WATER PUMP STATION
CLEARWELL
CHLORINE DISTRIBUTION LINE
CHLORINE CONTACT TANK
MIXER
AMMONIA DISTRIBUTION LINE
AMMONIA CONTACT TANK
TREATED WATER TO CLEARWELL
CLEARWELL PLAN VIEW
8'x12' DOORS
SPARE TRUNNIONS
CHLORINATION ROOM
AMMONIA ROOM
8'x12' ROLL UP DOORS
CIP TANK
CIP PUMP
BACKPULSE TANK
BACKPULSE PUMPS
PLATFORM ABOVE
ULTRAVIOLET DISINFECTION UNIT
CHEMICALS ROOM
DRAIN PUMP
REJECT
DRAIN
120'-6"
DISTRIBUTION CHANNEL
OVERFLOW
LOWER LEVEL PLAN VIEW
SCALE OF FEET
FLOCCULATION TANK
SPLITTER BOX
RAPID MIX
ALUM INJECTION
ALUMINUM SULFATE STORAGE BUILDING
FEED FROM PNM DIVERSION OR AMARILLO CANAL
FROM WASTEWATER POLISHING PONDS
8'x12' ROLL UP DOOR
STORAGE ROOM
UV DISINFECTION UNIT CONTROL ROOM
MCC ROOM
CONTROL ROOM
AIR COMPRESSOR
BLOWERS
UPPER LEVEL PLAN VIEW
OVER CHEMICALS ROOM & BACKPULSE/CIP TANKS
NOTES:
NEEDED ADDITION TO MEET YEAR 2040 DEMANDS.
BELOW GRADE
SPARE MODULES AVAILABLE FOR ADDITIONAL CASSETTES.
REV. DATE DESCRIPTION ZONE DSGN APPD
A PRELIMINARY – NOT FOR CONSTRUCTION
APPROVAL
DRAWN:
DSGN:
CHKD:
APPD:
SCALE:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES
ZENON Environmental Systems Inc.
OAKVILLE
CUSTOMER: TYPICAL WTP – 24/38 MGD
TITLE: WATER TREATMENT SYSTEM CONFIGURATION
SAN JUAN RIVER AND NIIP AMARILLO ALTERNATIVES
SIZE: D
DRAWING NO. DRAWING 5
REV.

SAN JUAN RIVER AND NIIP AMARILLO ALTERNATIVES
WTP @ CUTTER RESERVOIR DIVERSION
3.7 MGD UPGRADABLE TO 5.4 MGD



NOTES:

═══ NEEDED ADDITION TO MEET YEAR 2040 DEMANDS.
– – – BELOW GRADE

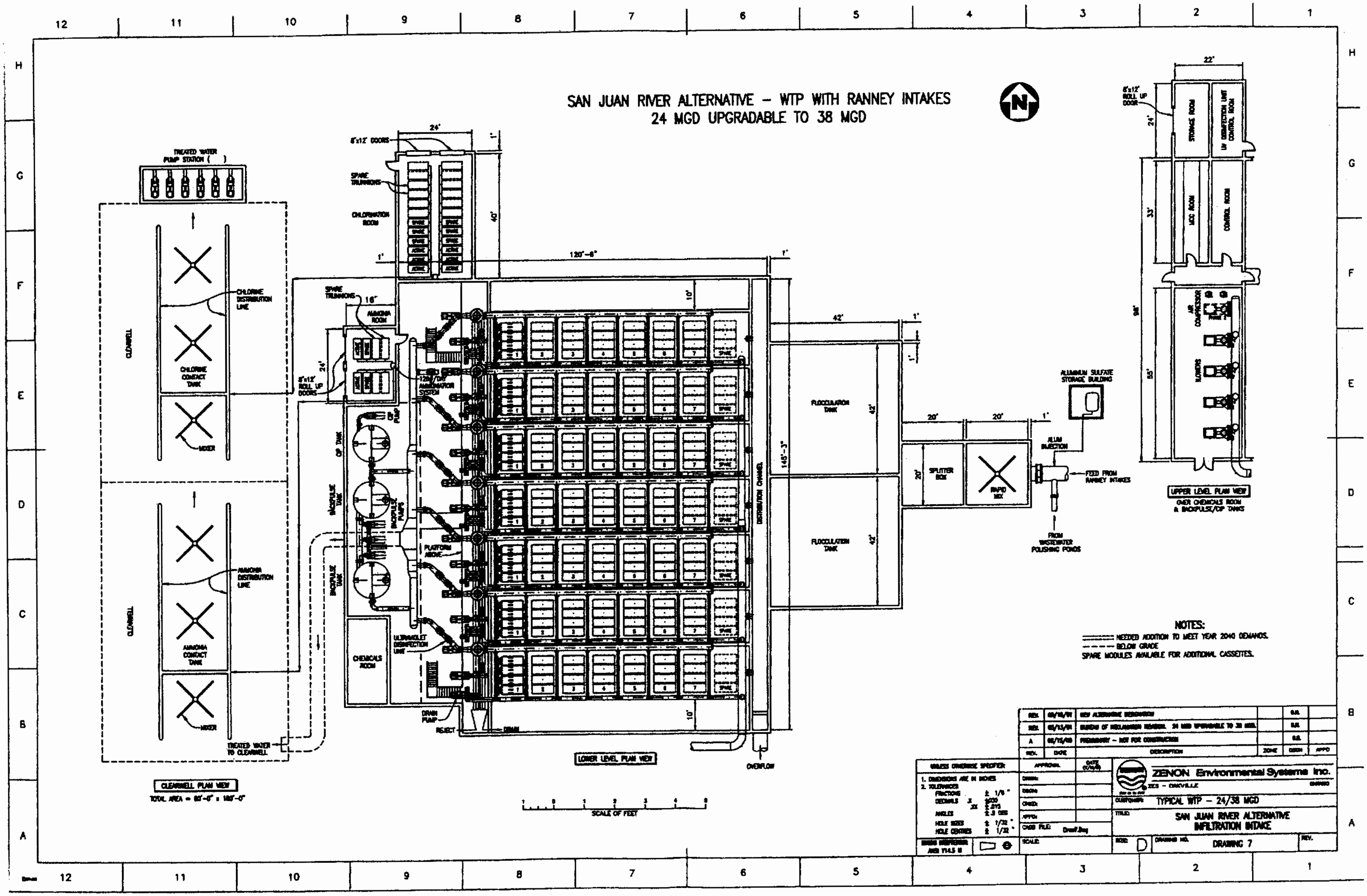
REV.	DATE	DESCRIPTION	ZONE	DSGN	APPD
[illegible]	11/[illegible]/[illegible]	[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]	
[illegible]	[illegible]/11/[illegible]	[illegible]		[illegible]	
[illegible]	[illegible]/13/[illegible]	[illegible] 2.3[illegible] MGD UPGRADABLE TO 4 MGD		[illegible]	
A	07/[illegible]/[illegible]	PRELIMINARY – NOT FOR CONSTRUCTION		[illegible]	

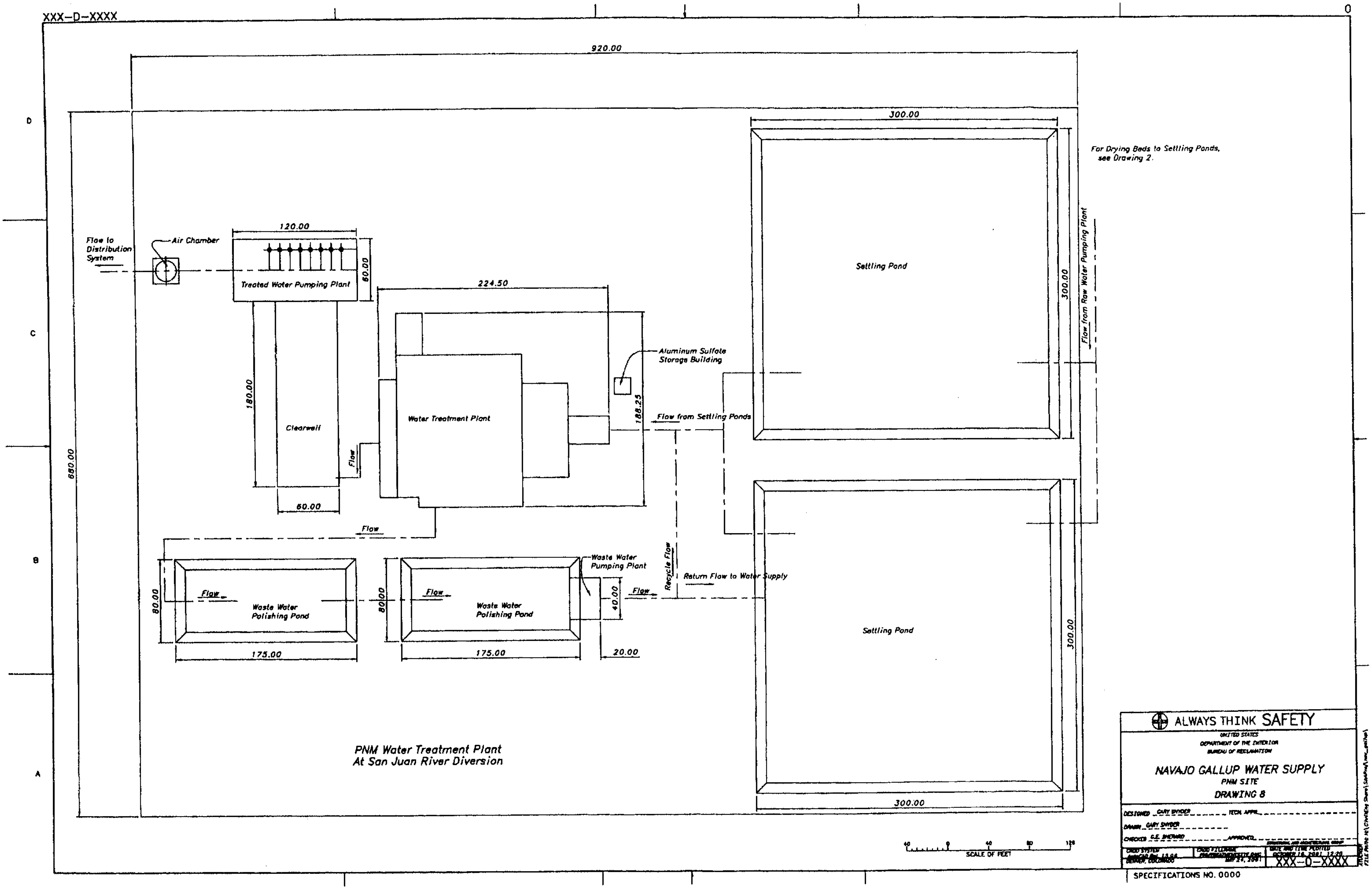
UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES
FRACTIONS ± 1/8"
DECIMALS .X ±.030 .XX ±.015
ANGLES ±.5 DEG
HOLE SIZES ± 1/32"
HOLE CENTRES ± 1/32"

APPROVAL | DATE
DRWN:
DSGN:
CHKD:
APPD:
CADD FILE:
SCALE:

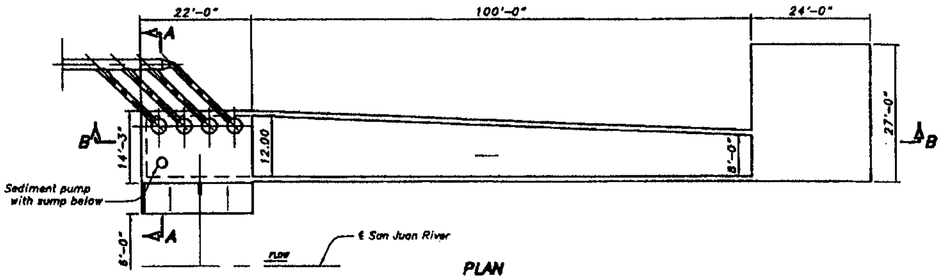
ZENON Environmental Systems inc.
ZES – OAKVILLE

CUSTOMER: TYPICAL WTP – 3.7/5.4 MGD
TITLE: CUTTER RESERVOIR DIVERSION
SAN JUAN RIVER AND NIIP AMARILLO ALTERNATIVES
SIZE: D
DRAWING NO. DRAWING 6
REV.

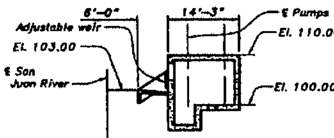

SAN JUAN RIVER ALTERNATIVE – WTP WITH RANNEY INTAKES
24 MGD UPGRADABLE TO 38 MGD
TREATED WATER PUMP STATION
CLEARWELL
CHLORINE DISTRIBUTION LINE
CHLORINE CONTACT TANK
MIXER
AMMONIA DISTRIBUTION LINE
AMMONIA CONTACT TANK
TREATED WATER TO CLEARWELL
CLEARWELL PLAN VIEW
8'x12' DOORS
SPARE TRUNNIONS
CHLORINATION ROOM
AMMONIA ROOM
8'x12' ROLL UP DOORS
CIP TANK
BACKPULSE TANK
BACKPULSE PUMPS
PLATFORM ABOVE
ULTRAVIOLET DISINFECTION UNIT
CHEMICALS ROOM
DRAIN PUMP
REJECT
DRAIN
DISTRIBUTION CHANNEL
OVERFLOW
LOWER LEVEL PLAN VIEW
FLOCCULATION TANK
SPLITTER BOX
RAPID MIX
ALUM INJECTION
ALUMINUM SULFATE STORAGE BUILDING
FEED FROM RANNEY INTAKES
FROM WASTEWATER POLISHING PONDS
STORAGE ROOM
MCC ROOM
CONTROL ROOM
AIR COMPRESSOR
BLOWERS
UPPER LEVEL PLAN VIEW
OVER CHEMICALS ROOM & BACKPULSE/CIP TANKS
NOTES:
NEEDED ADDITION TO MEET YEAR 2040 DEMANDS.
BELOW GRADE
SPARE MODULES AVAILABLE FOR ADDITIONAL CASSETTES.
SCALE OF FEET
ZENON Environmental Systems Inc.
TYPICAL WTP – 24/38 MGD
SAN JUAN RIVER ALTERNATIVE INFILTRATION INTAKE
DRAWING 7



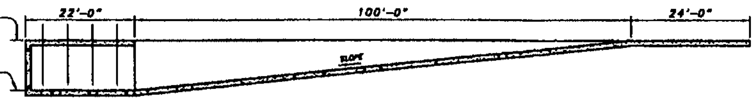
XXX-D-XXXX
920.00
680.00
300.00
For Drying Beds to Settling Ponds, see Drawing 2.
Settling Pond
Flow from Raw Water Pumping Plant
Flow to Distribution System
Air Chamber
120.00
60.00
Treated Water Pumping Plant
224.50
Aluminum Sulfate Storage Building
180.00
Clearwell
Water Treatment Plant
188.25
Flow from Settling Ponds
Flow
60.00
Waste Water Pumping Plant
Recycle Flow
Return Flow to Water Supply
80.00
Waste Water Polishing Pond
175.00
40.00
20.00
PNM Water Treatment Plant
At San Juan River Diversion
SCALE OF FEET
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY
PNM SITE
DRAWING 8
DESIGNED GARY SNYDER
TECH. APPR.
DRAWN GARY SNYDER
CHECKED
APPROVED
XXX-D-XXXX
SPECIFICATIONS NO. 0000



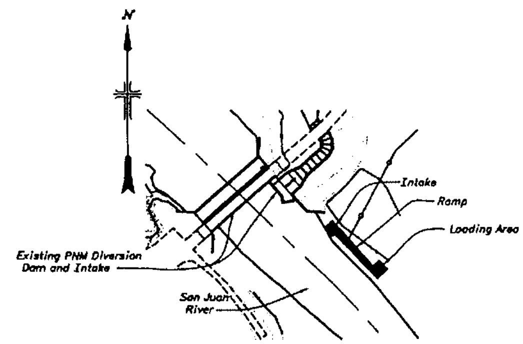
PLAN



SECTION A–A



SECTION B–B



LOCATION

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DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

NAVAJO GALLUP WATER SUPPLY

TURNOUT STRUCTURE – SJR PNM ALTERNATIVE

DRAWING 9

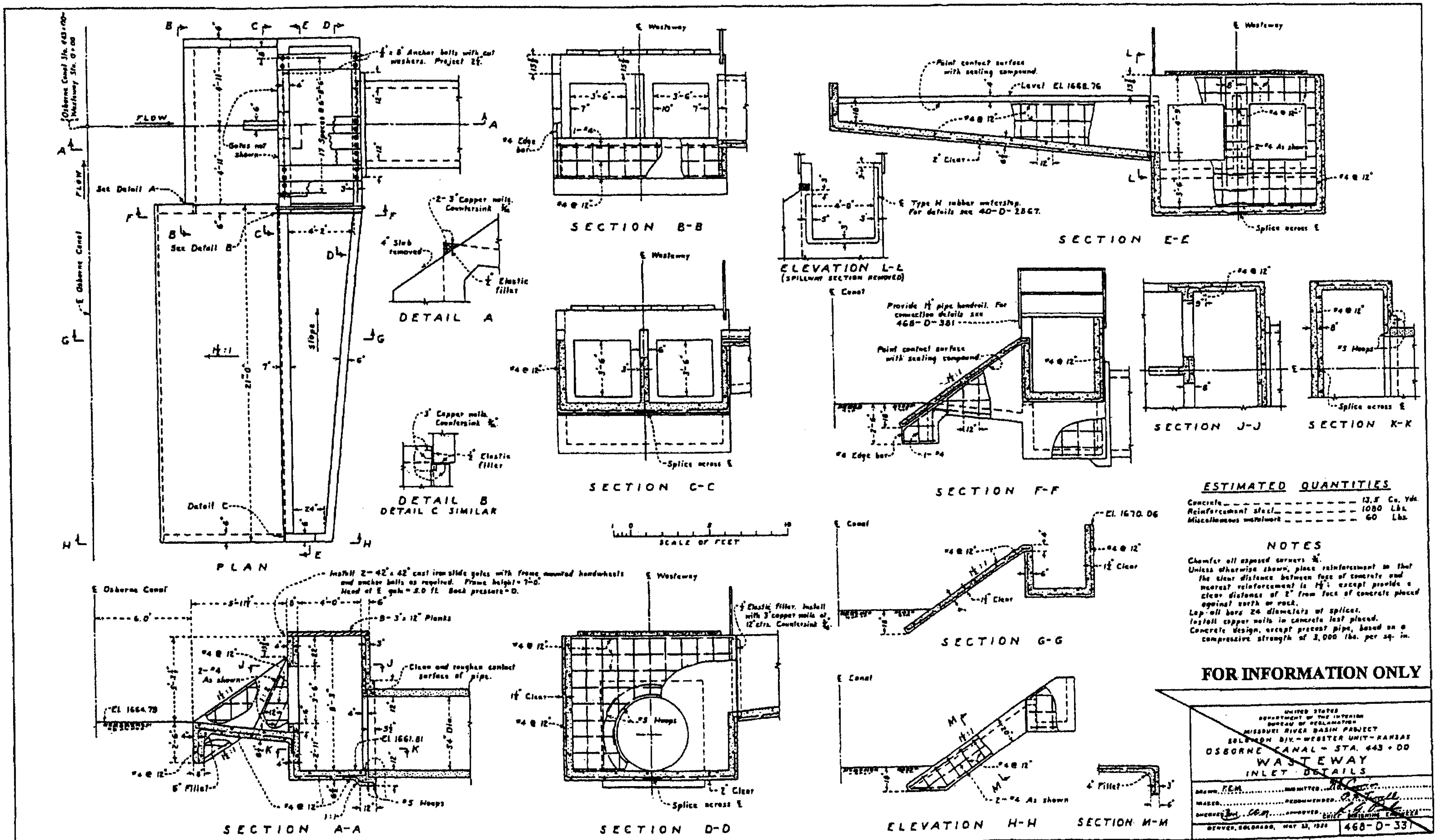
DESIGNED G.E. SHEPARD TECH. APPR.

DRAWN A.M. TUCKER

CHECKED APPROVED

DENVER, COLORADO

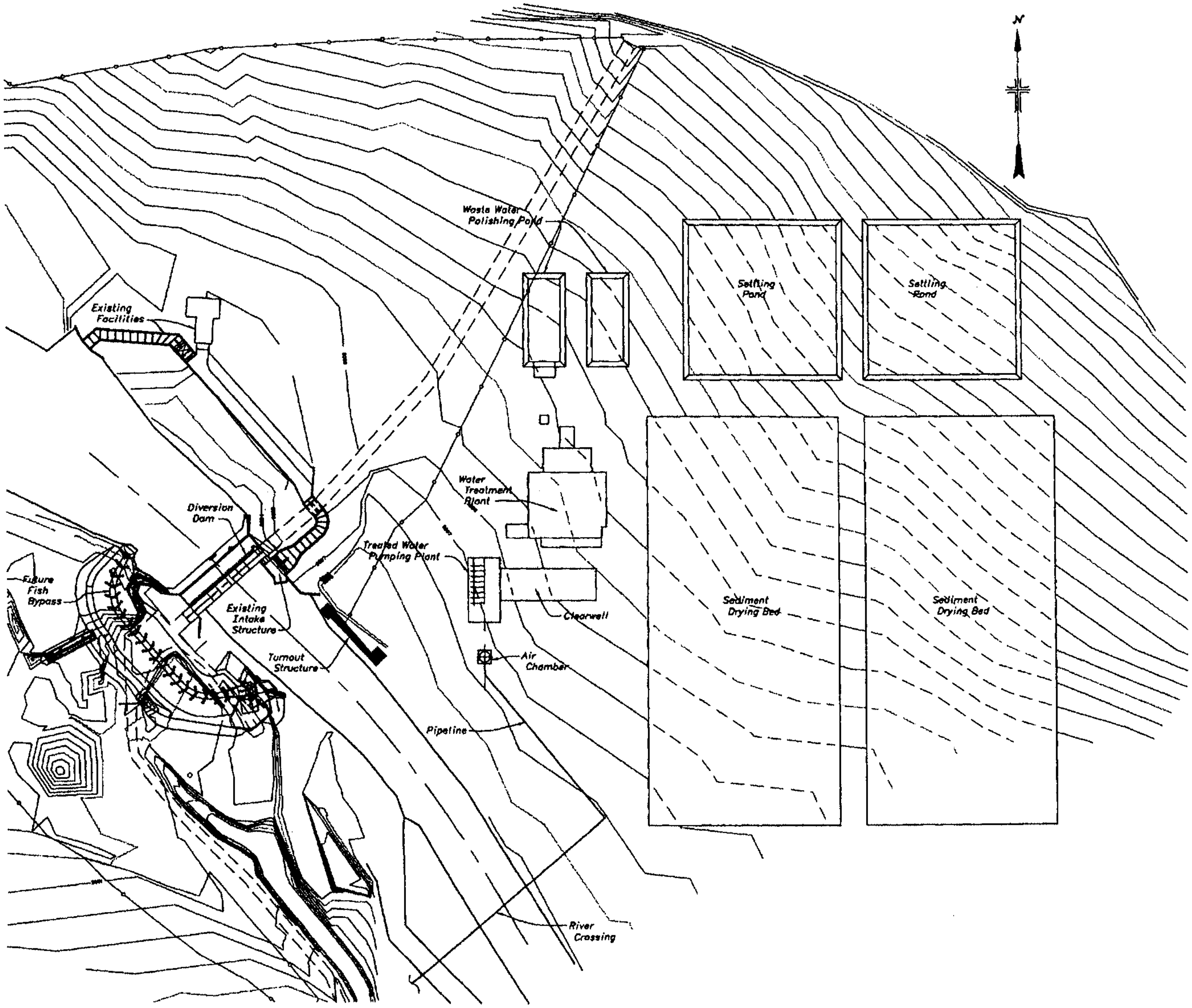
XXX-D-XXXX



PLAN
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
SECTION G-G
SECTION J-J
SECTION K-K
SECTION M-M
ELEVATION L-L
(SPILLWAY SECTION REMOVED)
ELEVATION H-H
DETAIL A
DETAIL B
DETAIL C SIMILAR
SCALE OF FEET
FLOW
℄ Osborne Canal
℄ Wasteway
Install 2 - 42" x 42" cast iron slide gates with frame mounted handwheels and anchor bolts as required. Frame height = 7'-0". Head of ℄ gate = 5.0 ft. Back pressure = 0.
ESTIMATED QUANTITIES
Concrete 13.5 Cu. Yds.
Reinforcement steel 1080 Lbs.
Miscellaneous metalwork 60 Lbs.
NOTES
Chamfer all exposed corners ¾".
Unless otherwise shown, place reinforcement so that the clear distance between face of concrete and nearest reinforcement is 1½"; except provide a clear distance of 2" from face of concrete placed against earth or rock.
Lap all bars 24 diameters at splices.
Install copper nails in concrete last placed.
Concrete design, except precast pipe, based on a compressive strength of 3,000 lbs. per sq. in.
FOR INFORMATION ONLY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
SOLOMON DIV. - WEBSTER UNIT - KANSAS
OSBORNE CANAL - STA. 443 + 00
WASTEWAY
INLET DETAILS
DENVER, COLORADO
468-D-331

DRAWING 10

XXX-D-XXXX



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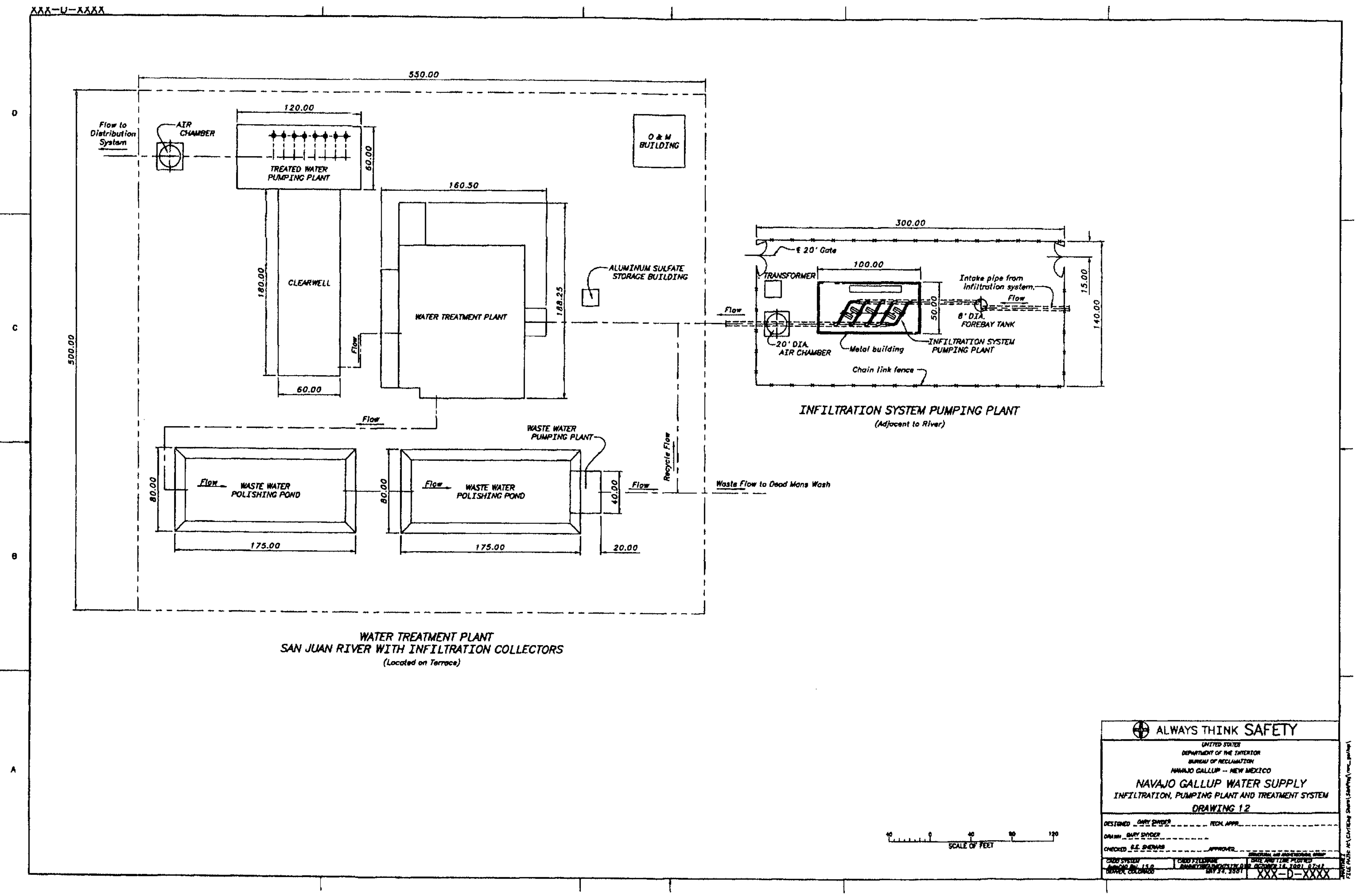
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

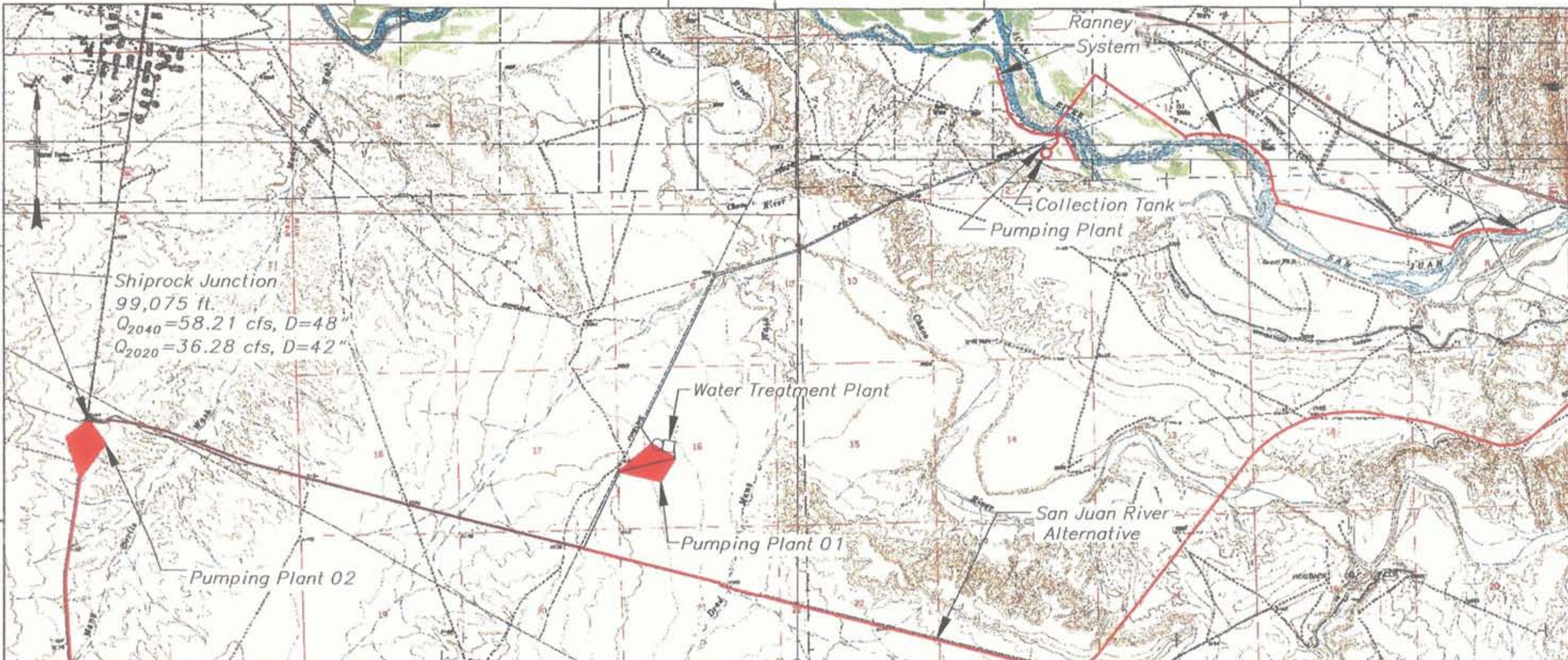
NAVAJO GALLUP WATER SUPPLY
PNM SITE LAYOUT
DRAWING 11

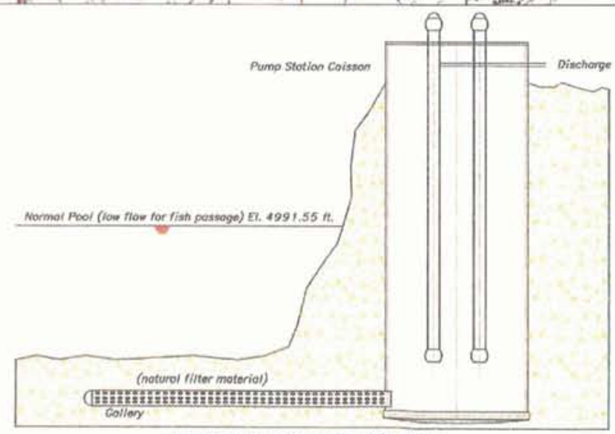
DESIGNED GARY SNYDER TECH. APPR.
DRAWN GARY SNYDER
CHECKED G.E. SHEPARD APPROVED

XXX-D-XXXX

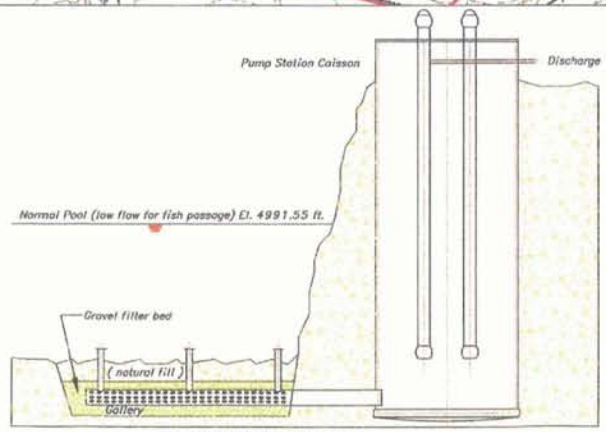
SPECIFICATIONS NO. 0000


XXX-D-XXXX
550.00
120.00
Flow to Distribution System
AIR CHAMBER
TREATED WATER PUMPING PLANT
60.00
O & M BUILDING
160.50
180.00
CLEARWELL
WATER TREATMENT PLANT
188.25
ALUMINUM SULFATE STORAGE BUILDING
500.00
Flow
60.00
Flow
WASTE WATER PUMPING PLANT
Recycle Flow
80.00
Flow
WASTE WATER POLISHING POND
80.00
Flow
WASTE WATER POLISHING POND
40.00
Flow
Waste Flow to Dead Mans Wash
175.00
175.00
20.00
WATER TREATMENT PLANT
SAN JUAN RIVER WITH INFILTRATION COLLECTORS
(Located on Terrace)
300.00
℄ 20' Gate
100.00
TRANSFORMER
Intake pipe from infiltration system
Flow
15.00
Flow
50.00
8' DIA. FOREBAY TANK
140.00
20' DIA. AIR CHAMBER
Metal building
INFILTRATION SYSTEM PUMPING PLANT
Chain link fence
INFILTRATION SYSTEM PUMPING PLANT
(Adjacent to River)
SCALE OF FEET
40
0
40
80
120
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO
NAVAJO GALLUP WATER SUPPLY
INFILTRATION, PUMPING PLANT AND TREATMENT SYSTEM
DRAWING 12
DESIGNED GARY SNYDER
TECH. APPR.
DRAWN GARY SNYDER
CHECKED R.E. SHERMAN
APPROVED
XXX-D-XXXX





Hydraulically Projected Infiltration Gallery



Cut and Fill Infiltration Gallery

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY PROJECT – NEW MEXICO
SJR INFILTRATION ALTERNATIVE

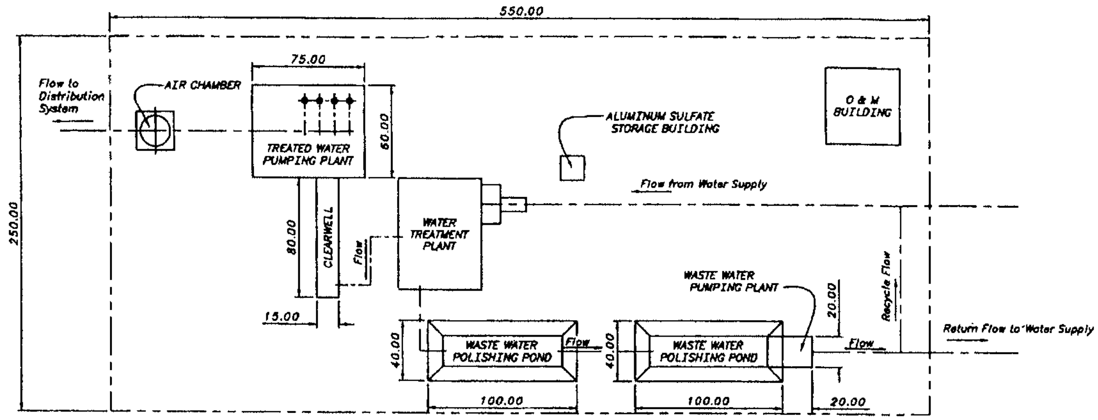
SAN JUAN LATERAL
PLAN

DESIGNED Art Strelitz — TECH. APPR. Lee Kinney
DRAWN Art Strelitz
CHECKED CHECKER — APPROVED Richard Forest

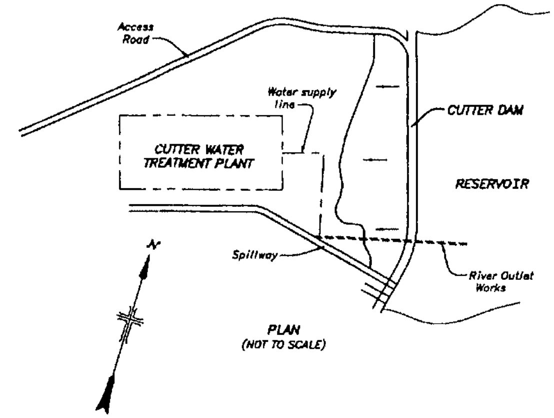
DENVER, COLORADO — MARCH 23, 2001 — DATE AND TIME PLOTTED OCTOBER 15, 2001 — Drawing No. 13

SPECIFICATIONS NO. 0000

XXX-D-XXXX



CUTTER WATER TREATMENT PLANT
AT CUTTER RESERVOIR



PLAN
(NOT TO SCALE)

40 0 40 80 120
SCALE OF FEET

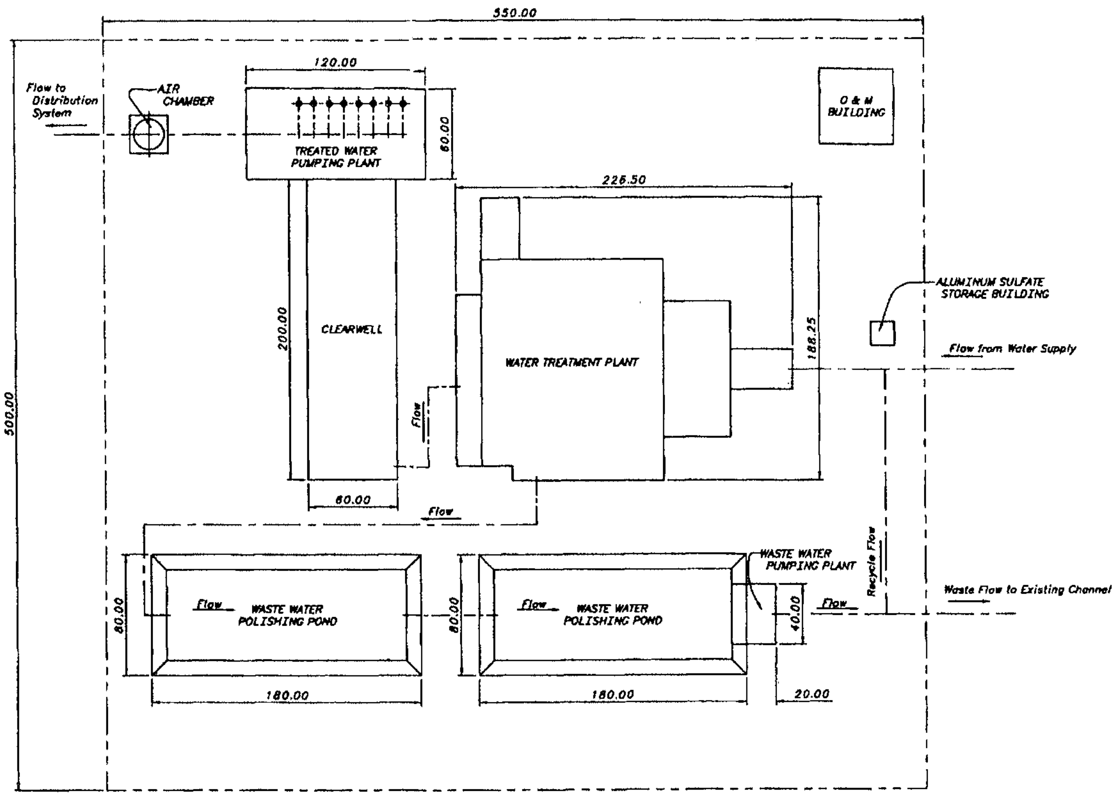
ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

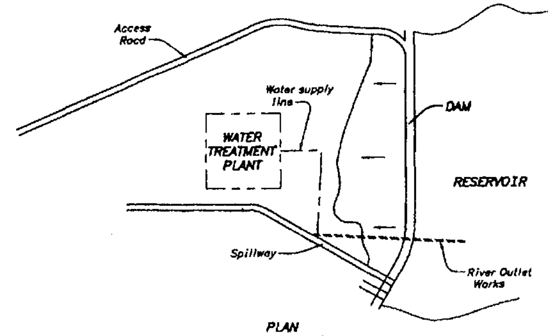
NAVAJO GALLUP WATER SUPPLY
SAN JUAN RIVER ALTERNATIVE
CUTTER WATER TREATMENT PLANT
DRAWING 14

DESIGNED GARY SNYDER TECH. APPR.
DRAWN GARY SNYDER
CHECKED R.E. SHEWARD APPROVED
STRUCTURAL AND ARCHITECTURAL GROUP
CADD SYSTEM AutoCAD Rel. 13.0
DENVER, COLORADO
MAY 24, 2001
DATE AND TIME PLOTTED OCTOBER 16, 2001 07:45
XXX-D-XXXX

XXX-D-XXXX



WATER TREATMENT PLANT



PLAN
(NOT TO SCALE)

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

NAVAJO GALLUP WATER SUPPLY
TYPICAL WATER TREATMENT PLANT
FOR NIIP MONCISCO/CUTTER ALTERNATIVES
DRAWING 15

DESIGNED GARY SNYDER TECH. APPR.
DRAWN GARY SNYDER
CHECKED R.E. SHEPARD APPROVED

XXX-D-XXXX

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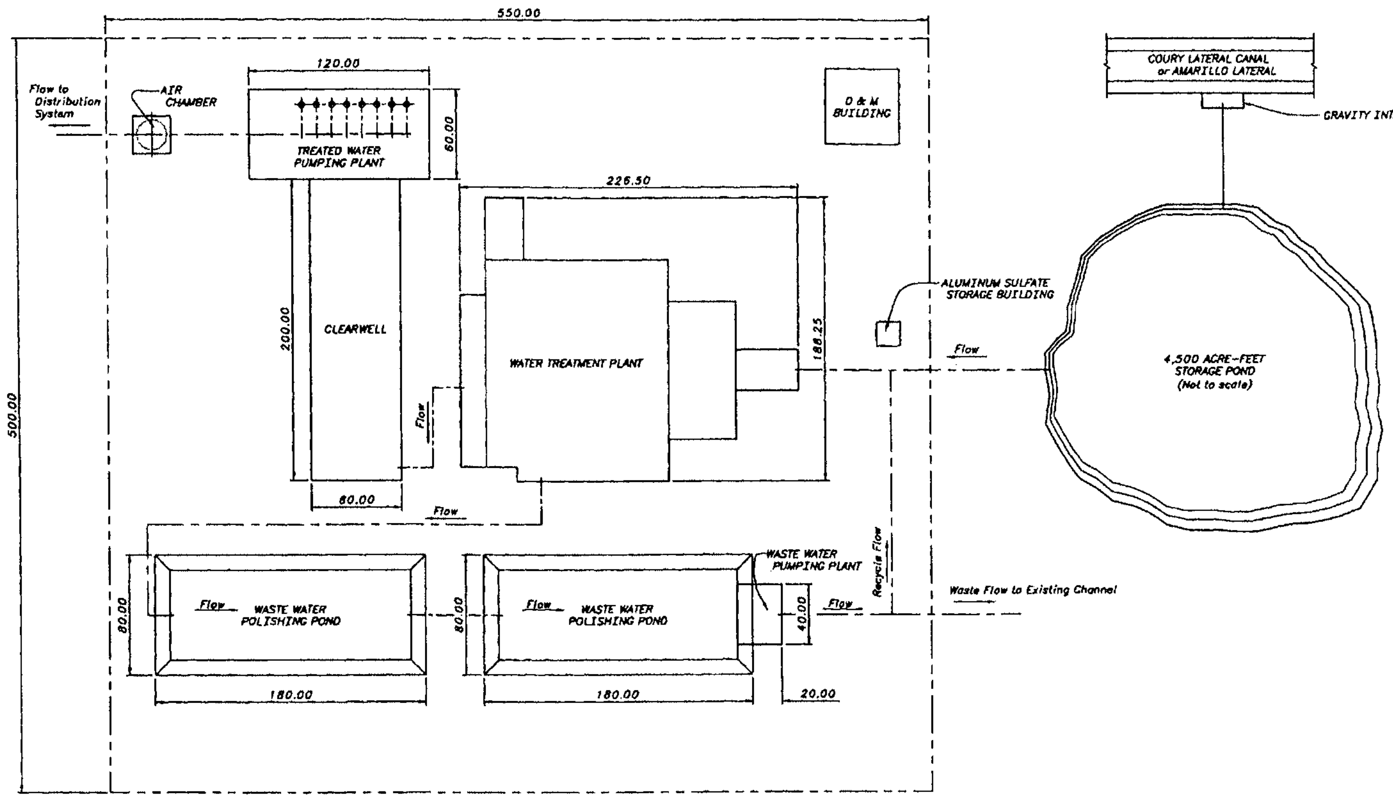


WATER TREATMENT PLANT

NOTE

Dimensions are approximate.

40 0 40 80 120
SCALE OF FEET

ALWAYS THINK SAFETY

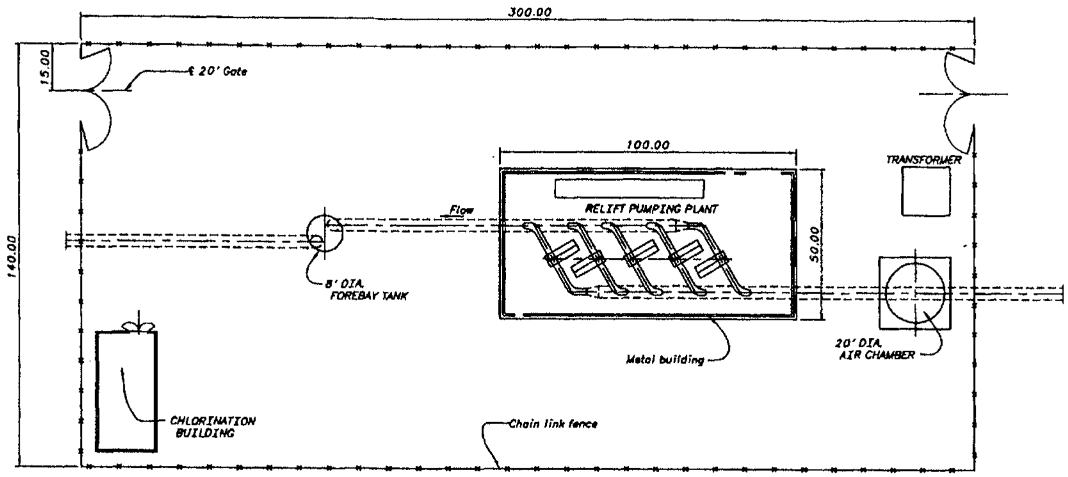
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

NAVAJO GALLUP WATER SUPPLY

TYPICAL WATER TREATMENT PLANT
FOR NIIP COURY LATERAL/AMARILLO ALTERNATIVES
DRAWING 16

DESIGNED GARY SNYDER TECH. APPR.
DRAWN GARY SNYDER
CHECKED G.E. SHERARD APPROVED
STRUCTURAL AND ARCHITECTURAL GROUP
CADD SYSTEM AutoCAD Rel. 15.05 | CADD FILENAME NIIP_DWG_16.DWG | DATE AND TIME PLOTTED NOVEMBER 28, 2001 14:16
DENVER, COLORADO MAY 24, 2001 XXX-D-XXXX

XXX-D-XXXX



TYPICAL RELIEF PUMPING PLANT

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

NAVAJO GALLUP WATER SUPPLY
TYPICAL RELIFT PUMPING PLANT
DRAWING 17

DESIGNED GARY SNYDER TECH. APPR.
DRAWN GARY SNYDER
CHECKED G.E. SHOWARD APPROVED

XXX-D-XXXX

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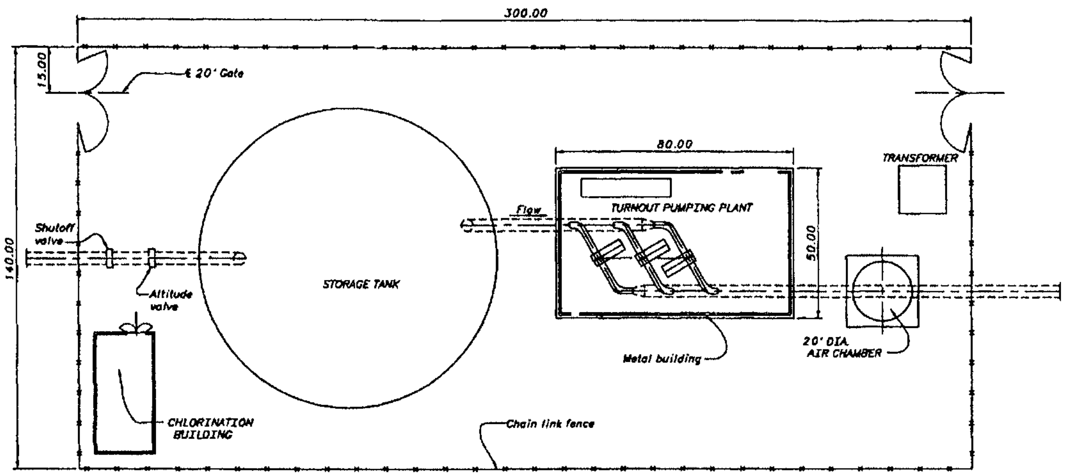

TYPICAL TURNOUT PUMPING PLANT

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP – NEW MEXICO

NAVAJO GALLUP WATER SUPPLY
TYPICAL TURNOUT PUMPING PLANT
DRAWING 18

DESIGNED GARY SNYDER TECH. APPR.
DRAWN GARY SNYDER
CHECKED R.E. SHERARD APPROVED

MAY 24, 2001

XXX-D-XXXX

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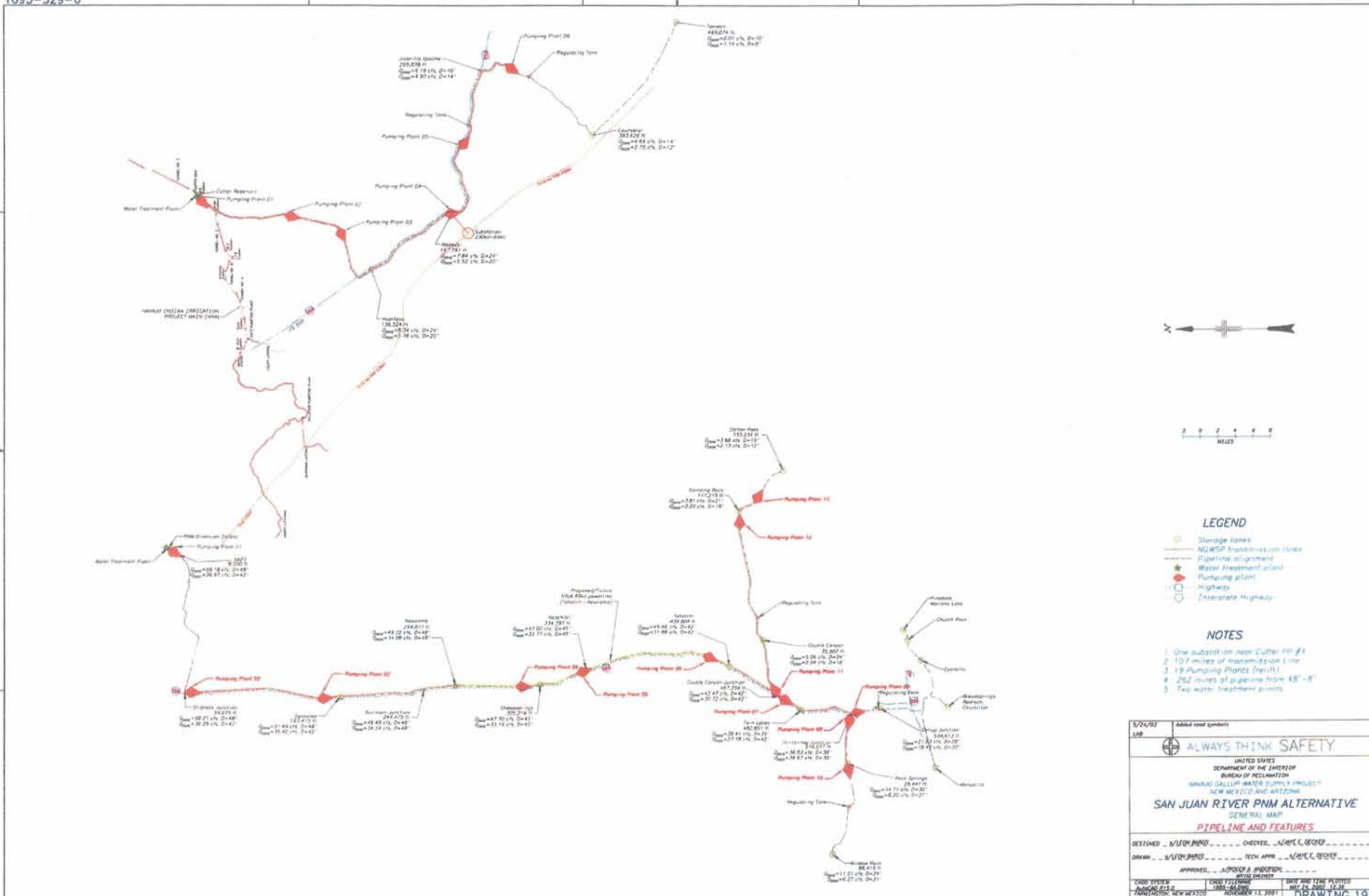
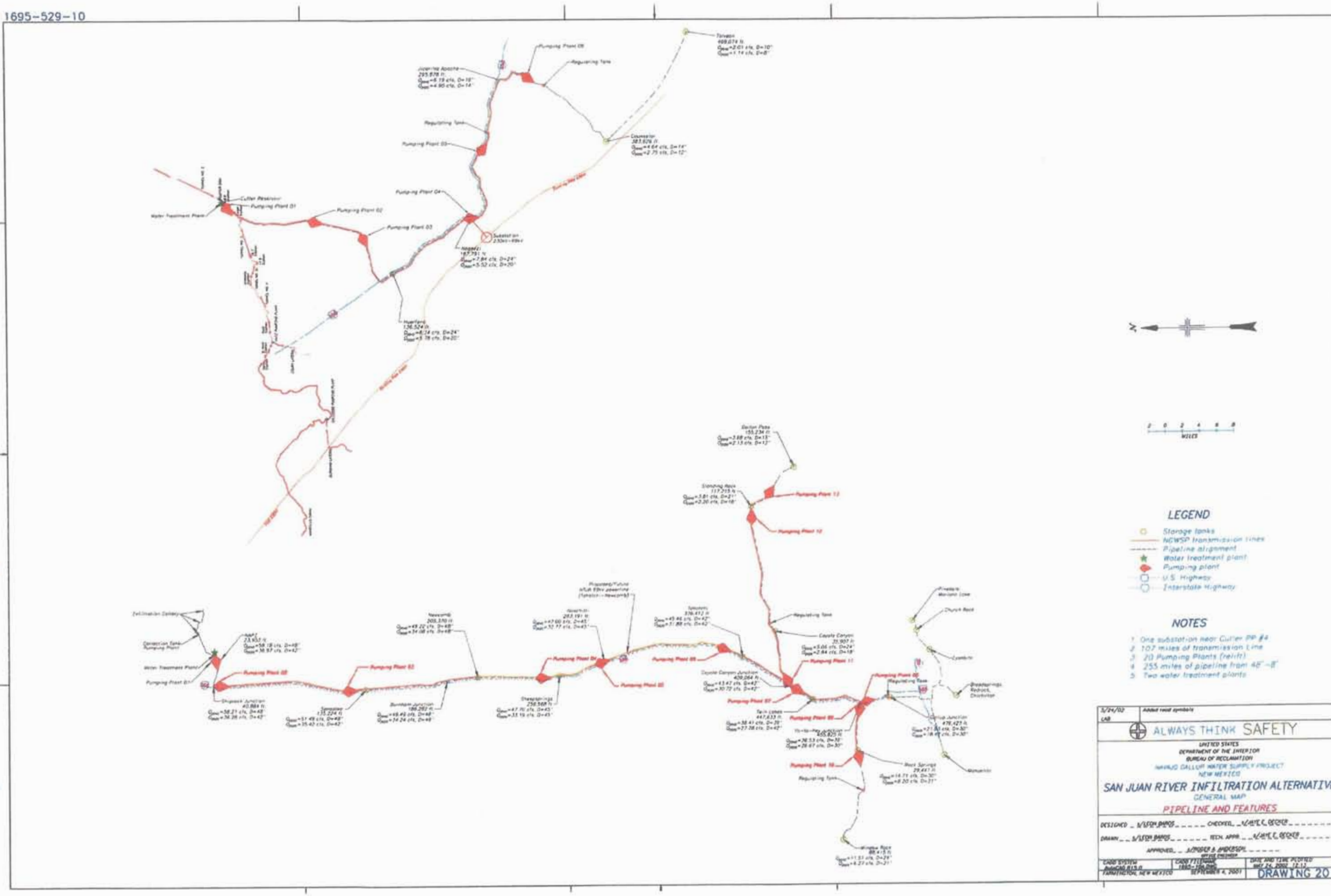


LEGEND
Storage tanks
NGWSP transmission lines
Pipeline alignment
Water treatment plant
Pumping plant
Highway
Interstate Highway
NOTES
1. One substation near Cutter PP #1
2. 107 miles of transmission line
3. 19 Pumping Plants (relift)
4. 262 miles of pipeline from 48"-8"
5. Two water treatment plants
5/24/02 LAB Added road symbols
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY PROJECT
NEW MEXICO AND ARIZONA
SAN JUAN RIVER PNM ALTERNATIVE
GENERAL MAP
PIPELINE AND FEATURES
DRAWING 19

1695-529-10



LEGEND
Storage tanks
NGWSP transmission lines
Pipeline alignment
Water treatment plant
Pumping plant
U.S. Highway
Interstate Highway
NOTES
1 One substation near Cutter PP #4
2 107 miles of transmission Line
3 20 Pumping Plants (relift)
4 255 miles of pipeline from 48"-8"
5 Two water treatment plants
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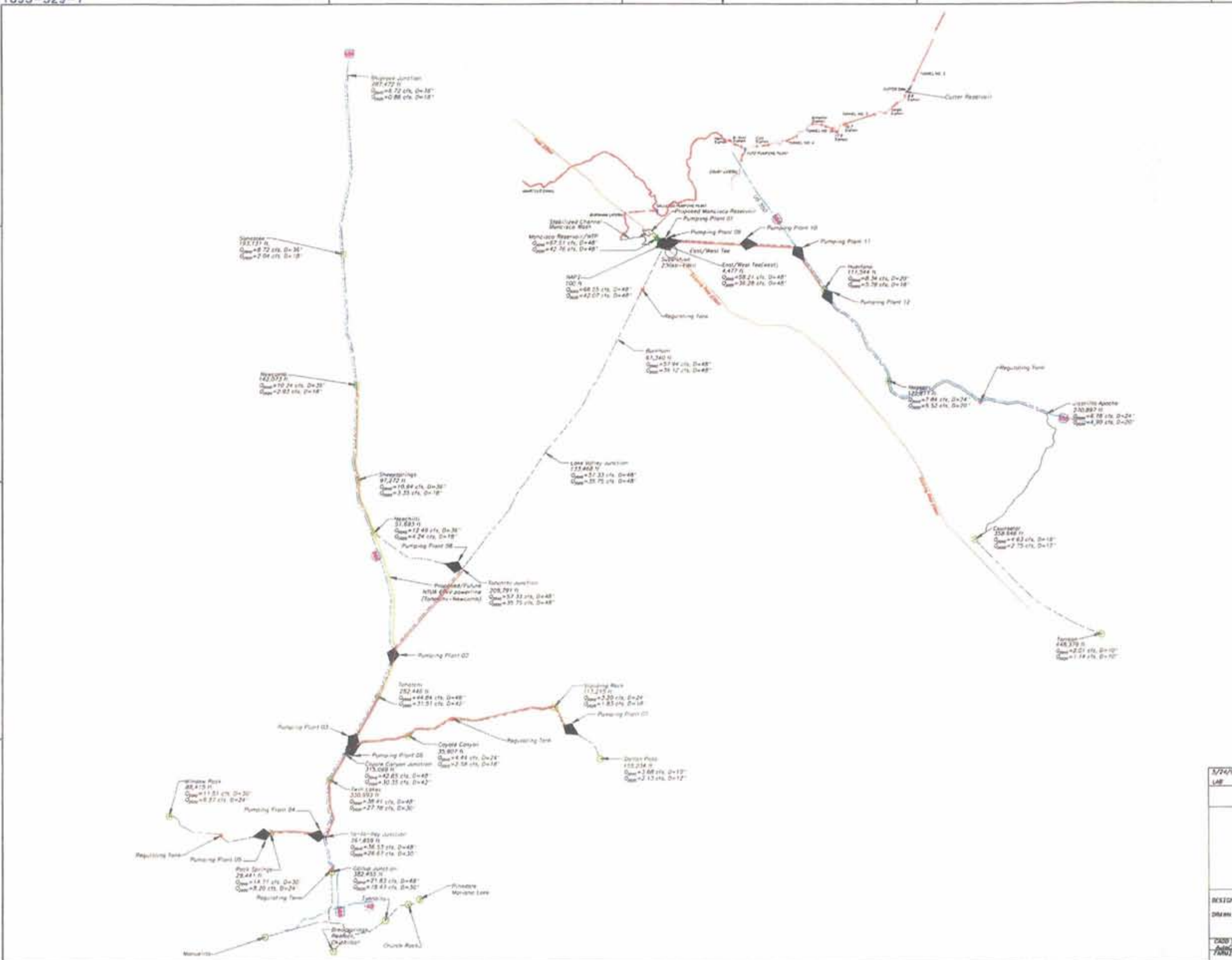
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY PROJECT
NEW MEXICO
SAN JUAN RIVER INFILTRATION ALTERNATIVE
GENERAL MAP
PIPELINE AND FEATURES
DRAWING 20

1695-529-7



LEGEND

- Storage tanks
- NGWSP transmission lines
- Pipeline alignment
- Water treatment plant
- Pumping plant
- Highway
- Interstate highway

NOTES

1. One Substation Near Moncisco
2. 74 miles of transmission Line
3. 12 Pumping Plants (w/lift)
4. 283 miles of pipeline from 48"–8"
5. One water treatment plant

5/24/02 LAB	Added road symbols

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY PROJECT
NEW MEXICO AND ARIZONA

NIIP MONCISCO ALTERNATIVE

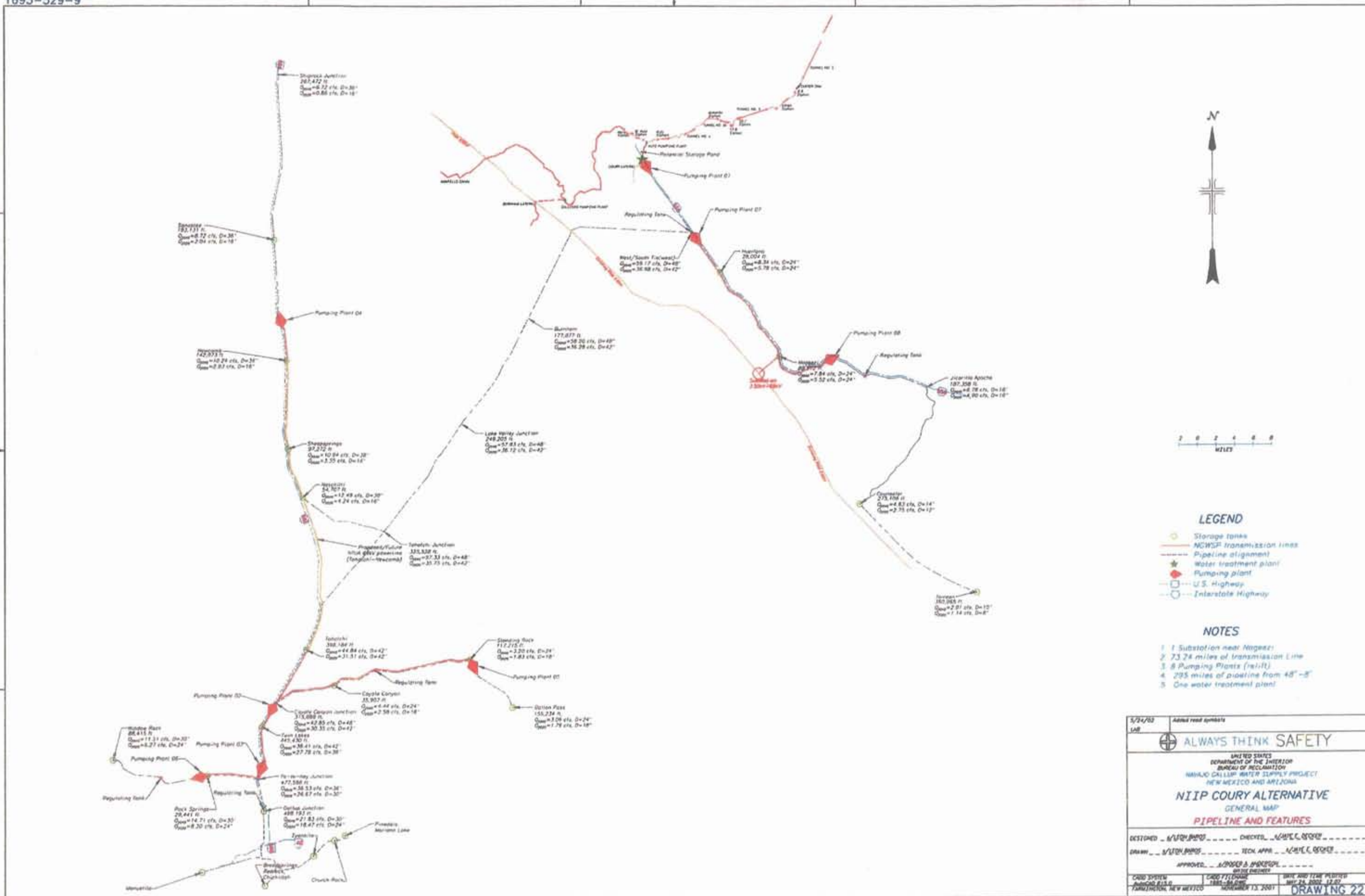
GENERAL MAP

PIPELINE AND FEATURES

DESIGNED s/LEON BAROS CHECKED s/JAYE C. DECKER
DRAWN s/LEON BAROS TECH. APPR. s/JAYE C. DECKER
APPROVED s/ROGER A. ANDERSON
AREA ENGINEER

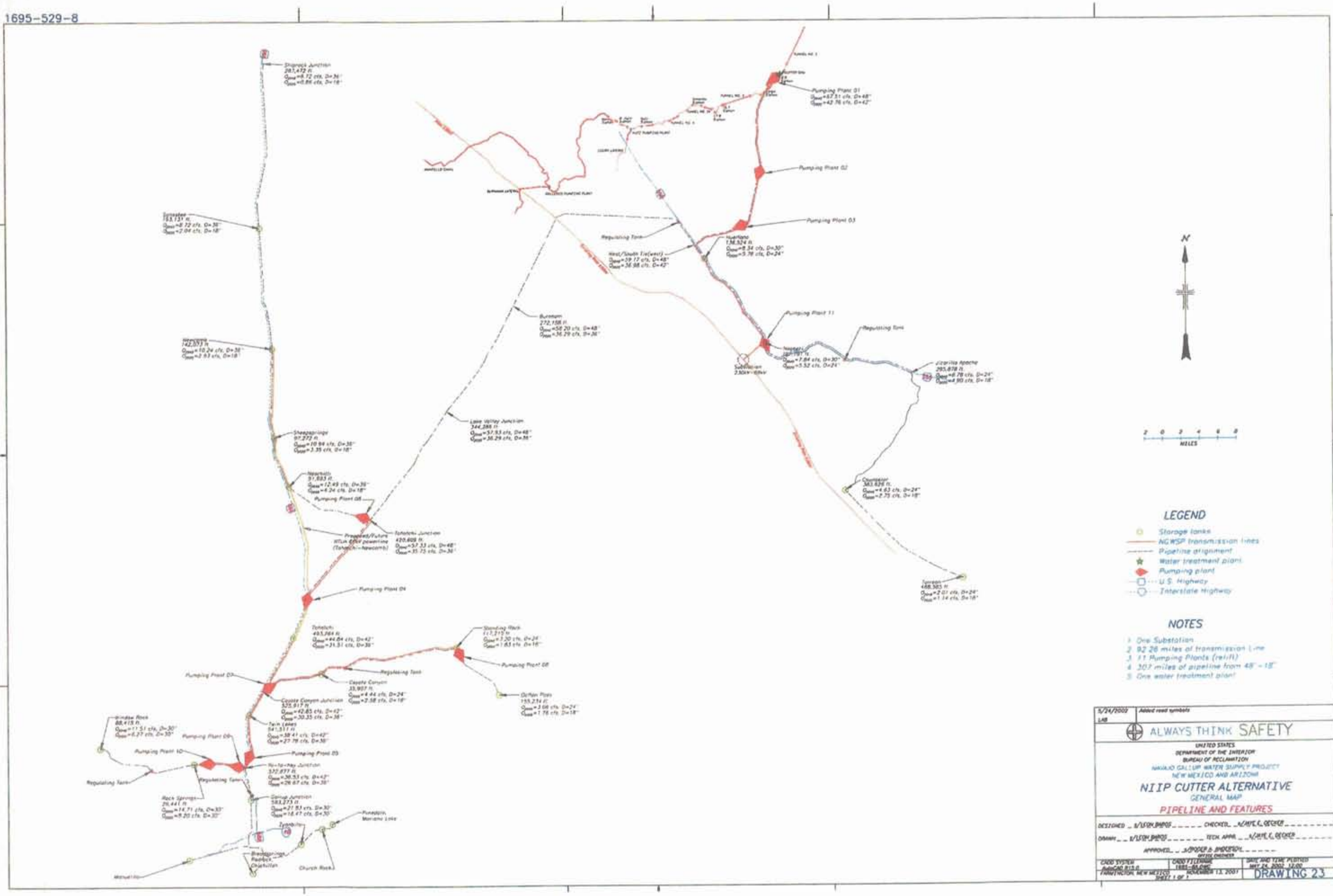
CADD SYSTEM AutoCAD R15.0	CADD FILENAME 1695-28.DWG	DATE AND TIME PLOTTED MAY 28, 2002 11:29
FARMINGTON, NEW MEXICO	NOVEMBER 13, 2001	DRAWING 21

1695-529-9



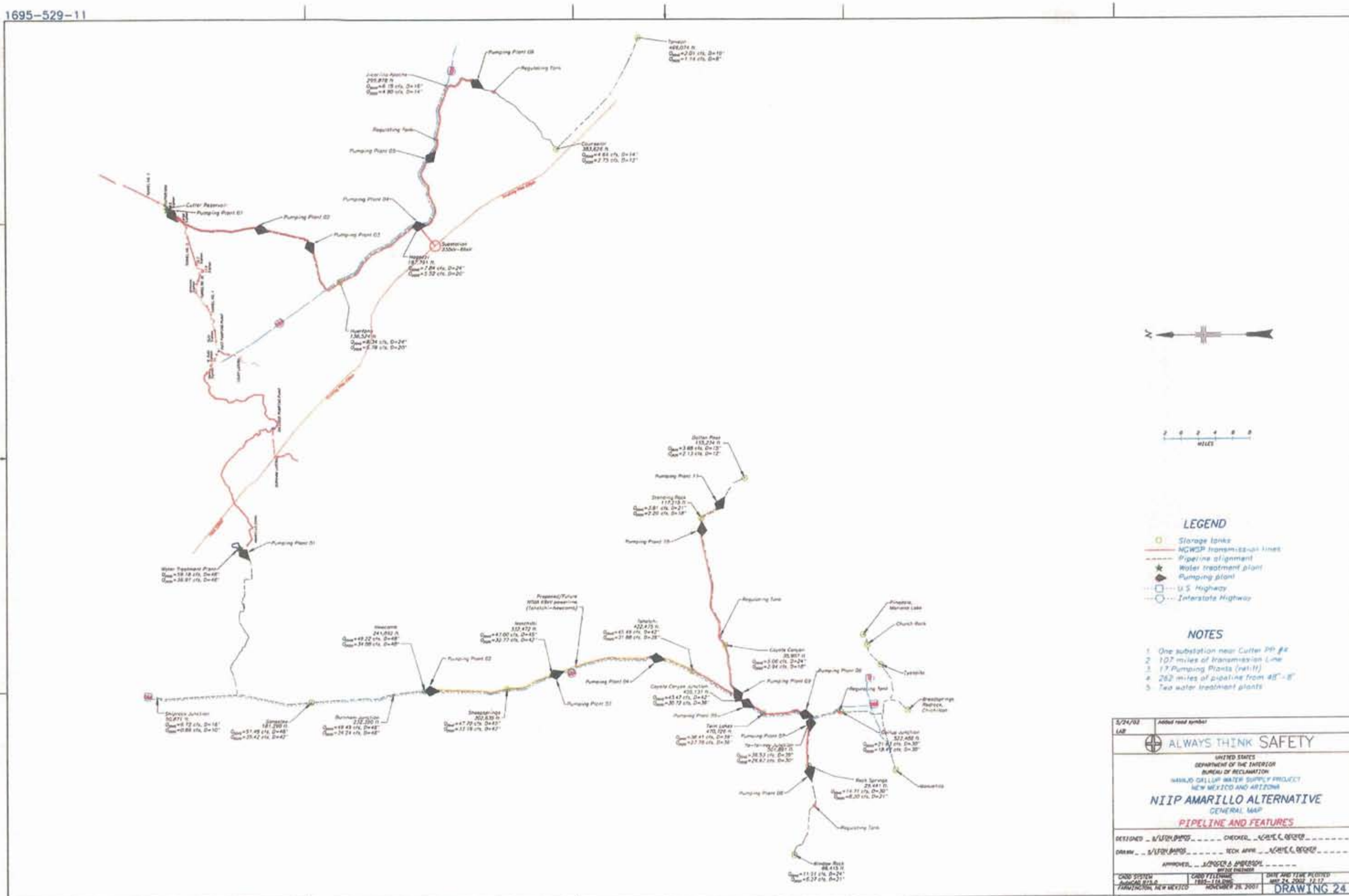
LEGEND
Storage tanks
NGWSP transmission lines
Pipeline alignment
Water treatment plant
Pumping plant
U.S. Highway
Interstate Highway
NOTES
1. 1 Substation near Nageezi
2. 73.24 miles of transmission Line
3. 8 Pumping Plants (relift)
4. 295 miles of pipeline from 48"–8"
5. One water treatment plant
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY PROJECT
NEW MEXICO AND ARIZONA
NIIP COURY ALTERNATIVE
GENERAL MAP
PIPELINE AND FEATURES
DESIGNED
CHECKED
DRAWN
TECH. APPR.
APPROVED
FARMINGTON, NEW MEXICO
NOVEMBER 13, 2001
DRAWING 22

1695-529-8



LEGEND
Storage tanks
NGWSP transmission lines
Pipeline alignment
Water treatment plant
Pumping plant
U.S. Highway
Interstate Highway
NOTES
1 One Substation
2 92.26 miles of transmission Line
3 11 Pumping Plants (relift)
4 307 miles of pipeline from 48" - 18"
5 One water treatment plant
MILES
Pumping Plant 01
Pumping Plant 02
Pumping Plant 03
Pumping Plant 04
Pumping Plant 05
Pumping Plant 07
Pumping Plant 08
Pumping Plant 09
Pumping Plant 10
Pumping Plant 11
Regulating Tank
Substation
5/24/2002
LAB
Added road symbols
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY PROJECT
NEW MEXICO AND ARIZONA
NIIP CUTTER ALTERNATIVE
GENERAL MAP
PIPELINE AND FEATURES
DESIGNED
CHECKED
DRAWN
TECH. APPR.
APPROVED
CADD SYSTEM
CADD FILENAME
DATE AND TIME PLOTTED
FARMINGTON, NEW MEXICO
NOVEMBER 13, 2001
SHEET 1 OF 1
DRAWING 23

1695-529-11



Cutter Reservoir
Pumping Plant 01
Pumping Plant 02
Pumping Plant 03
Pumping Plant 04
Pumping Plant 05
Pumping Plant 06
Regulating Tank
Substation
Huerfano
Counselor
Pumping Plant 51
Water Treatment Plant
Shiprock Junction
Newcomb
Pumping Plant 52
Sheepsprings
Naschitti
Pumping Plant 54
Pumping Plant 53
Tohatchi
Coyote Canyon
Twin Lakes
Standing Rock
Pumping Plant 11
Rock Springs
Window Rock
Gallup Junction
Church Rock
Navajo
LEGEND
Storage tanks
NGWSP transmission lines
Pipeline alignment
Water treatment plant
Pumping plant
U.S. Highway
Interstate Highway
NOTES
1 One substation near Cutter PP #X
2 107 miles of transmission Line
3 17 Pumping Plants (retilt)
4 262 miles of pipeline from 48"-8"
5 Two water treatment plants
5/24/02
LAB
Added road symbol
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NAVAJO GALLUP WATER SUPPLY PROJECT
NEW MEXICO AND ARIZONA
NIIP AMARILLO ALTERNATIVE
GENERAL MAP
PIPELINE AND FEATURES
DESIGNED
CHECKED
DRAWN
TECH APPR
APPROVED
CADD SYSTEM
FARMINGTON, NEW MEXICO
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NOVEMBER 29, 2001
DATE AND TIME PLOTTED
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