# NAVAJO GALLUP WATER SUPPLY PROJECT

## APPRAISAL LEVEL DESIGNS AND COST ESTIMATES

## APPENDIX E

## INFILTRATION GALLERY

# SUPPLEMENTAL SUBMITTAL

**of**

# APPRAISAL LEVEL DESIGN DATA
# INFILTRATION GALLERY SYSTEM
**for the**
**SAN JUAN LATERAL**

**portion of the**

**SAN JUAN RIVER DIVERSION ALTERNATIVE**

**NAVAJO-GALLUP WATER SUPPLY PROJECT**
**NEW MEXICO**
**February 28, 2001**

FCO-203
PRJ-4.00

FEB 27 2001

**OVERNIGHT EXPRESS**

MEMORANDUM

To: Director, Technical Service Center
Attention: D-8140 (Richard Fuerst)

From: Arthur R. Valverde
Construction Manager

Subject: Supplemental Design Data for Appraisal Level Designs and Cost Estimates, Infiltration System, Navajo-Gallup Water Supply Project

Attached for your use in preparing appraisal level designs and cost estimates are seven copies of the subject design data. Please recognize this design data submission is a supplemental package to the previously submitted. A review of the introduction portion of the attached design data will provide an understanding of the Infiltration System and any changes made to the previous design data. We anticipate that this submittal will enable the Technical Service Center (TSC) to immediately start the Infiltration System evaluation.

This design data transmittal is an addition to the service agreement between WCAO and TSC entitled "Appraisal Level Designs and Cost Estimates, Navajo-Gallup Water Supply Project" dated December 1, 2000.

Funding to accomplish the requested work is available through Upper Colorado Region Cost Authority No. A10-1695-1695-100-00-0-0-4. Please provide us with a cost estimate for the additional cost and time required to accomplish this added work. We anticipate the costs and schedule change can be accommodated and an amendment made to the Dec. 1,2000 service agreement. We will review your estimate and prepare and amendment to the existing WOID.

Technical questions concerning this data should be directed to Leon Baros at the Farmington Construction Office at 505-325-1794, ext. 142.

[signature]

Attachments:

1) Design Data Packages including electronic data on disc (7)
2) Infiltration System Drawing (2) (Under separate cover)
3) Ranney Division Memorandum (2) (Under separate cover)
4) Report of the Hydrogeologic Survey for The Fluor Corp. Ltd., Western Gasification Co. San Juan River, NM (2) (Under separate cover)

cc: John Leeper
Navajo Nation
Department of Water Resources
PO Drawer 678
Fort Defiance AZ 86504 (w/o attach)

Stan Henderson
Public Works Director
110 W Aztec
Gallup NM 87301 (w/o attach)

Area Manager, Grand Junction CO
Attention: (Kevin Moran)
(w/ attach)

Four Corners Division Manager - Durango (Pat Schumacher)
(w/o attach)

bc: Director, Technical Service Center
Attention: D-8010 (Tom Mitchell), D-8140 (Leo Kinney)
(ea w/o attach)

WBR:LBaros:rs:02/27/10:505-325-1794
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**SUPPLEMENTAL SUBMITTAL**

**of**

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Table of Contents

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**of**

**APPRAISAL LEVEL DESIGN DATA**
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## A. Introduction

This appraisal level design data submittal is supplemental to an earlier submittal dated October 3, 2000 for San Juan River Diversion Alternative. In addition, this submittal documents refinements in the methodology and criteria for calculating demand flows of the proposed project alternatives.

An Infiltration Gallery System is proposed as an option of diversion from the San Juan River for the San Juan River Diversion Alternative of the Navajo Gallup Water Supply Project (NGWSP). NGWSP will supply water to the western portion of the Navajo Nation (NN). The Infiltration Gallery System will 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 will tie into the previously proposed pipeline alignment for the San Juan River Alternative at the most feasible point. The location where the infiltration system connects to the pipeline will become the delivery point for the Navajo Agricultural Products Industry (NAPI). The proposed Infiltration System components include: a series of infiltration galleries installed in the river alluvium, collection wells and pumps, collection manifold system , transmission pipeline, and a water treatment plant.

## B. Data, Design Plan and Purpose

Completion of the appraisal level designs and cost estimates for the NGWSP will be a combined effort of Technical Service Center(TSC) and field office personnel. An October 2000 costing level has been chosen to coincide with federal fiscal year needs. The purpose of this supplemental design data submission is to allow appraisal level design work to begin on the Infiltration System option.

Infiltration System - Water for the San Juan River Diversion Alternative, Infiltration System will come from the San Juan River between the Hogback and the confluence of the Chaco River and the San Juan River.

The Infiltration System will consist of numerous collector wells. Each collector well will have an infiltration gallery extending into the river alluvium. The infiltration galleries will consists of screens of continuous wire wound or perforated cylinders. Each collector will have a pump and valve assemblies that will discharge into a pipe manifold system. The manifold system will tie into a main pipeline which will convey water to the treatment plant. In lieu of a manifold system, designers should also consider pumping from each collector into a common and centrally located sump from which water could be pumped to the treatment plant.

A section of water transmission pipeline and transmission facilities will be required to convey water from the treatment plant to the existing San Juan River alignment along road N36.

Water Treatment Plant - The water treatment plant would be constructed on the bluff south of the collection system. TSC studies are underway to determine the most cost effective method for water treatment. The water treatment design should take advantage of the high quality water collected through the infiltration system. As required, supplemental treatment along the water transmission line should be designed and included to meet domestic water quality standards. This treatment plant shall have all the features previously submitted in the San Juan River Diversion Alternative, San Juan Lateral.

## C. Survey Control

Full survey control is not required for the appraisal level designs and cost estimates. The provided maps are USGS quadrangle 7.5 minute series topographic maps with UTM (meter) zone 12 and a 20' contour intervals, unless otherwise shown. Elevations at delivery points and along the pipeline alignment should be extrapolated from the topographic maps.

## D. Hydraulic Design Criteria and Operating Data

1. Infiltration System

Preliminary field studies have been conducted on the viability of the proposed Infiltration System. Appendix A has data pertaining to an infiltration system. This data is provided by, Ranney, a company that designs, constructs, and installs collection systems. A map with the location of the collector wells, the pipeline alignments, and the location of the water treatment plant is in Appendix A.

Required capacities of the Infiltration System options are as follows:

a. 45.52 cfs base with a 1.3 peaking factor = 59.18 cfs for year 2040
b. 28.44 cfs base with a 1.3 peaking factor = 36.97 cfs for year 2020

Estimates for capital, operations and maintenance, and replacement costs are also required.

Please note: These capacities are different from those previously submitted with the San Juan River Alternative design data package. **The demand for the NGWSP has increased due to refinements in the methodology for calculating peak capacity .** An addendum to the previous capacities and any previously submitted design data affected by the change are addressed later in this design data package.

2. Collector Wells

The appraisal level cost estimate for the collector wells has been prepared by Ranney and is attached in Appendix A. This estimate includes cost for the infiltration gallery and the well caisson. The estimate does not include other items such as well pumps, pump enclosures, electrical components, access roads, or collection manifold. Each collector well is estimated to produce 1.5 million gallons per day (mgd).

3. Collection Manifold

A method to convey the water from the individual gallery caissons to the treatment plant will be required. The gallery caissons are spaced approximately 500 feet apart along the San Juan River. A collection manifold will need to be part of the appraisal level design.

Estimates for capital, operations and maintenance, and replacement costs are also required.

4. Pumping Plant for Infiltration System

The appraisal level design should include well pumps, electrical equipment, and other appurtenances required to operate the collector wells.

Design considerations shall include:

a. Personnel safety devices
b. Surge protection
c. Pump redundancy for system reliability and flexibility

Electrical power shall be assumed to be within a 2 mile radius of the Infiltration System.

Estimates for capital, operations and maintenance, and replacement costs are required.

5. Water Treatment Plant

As indicated, a water treatment plant would be constructed on the bluff south of the infiltration system. Appendix A has a map showing the proposed location of the treatment plant. The capacities of the plants to be analyzed are 59.18 cfs( 38.25 mgd) and 36.97 cfs(23.89 mgd) for year 2040 and 2020 respectively. The type of treatment system should be determined by TSC studies.

Estimates for capital, operations and maintenance, and replacement costs are required.

6. Pipelines

A pipeline to convey water is required from the collection manifold/sump through the water treatment plant to the existing alignment for the San Juan Lateral. This location will become the NAPI delivery point.

Estimates for capital, operations and maintenance, and replacement costs are required.

7. Deliveries

The delivery locations for the San Juan Lateral alignment will remain the same as previously submitted except for the addition of the NAPI delivery point.

A spreadsheet, in Appendix A, has information showing the delivery points, flow rates, elevations, and required storage. The spreadsheet shows all the communities that will be serviced by the project. Pipeline sizes and types shall be based on hydraulic analysis. The spreadsheet column labeled "Required P.S.I." shows the minimum required delivery pressure.

In the spreadsheet, nodes in small text are communities to be serviced but will not have sublaterals (transmission pipeline) extended to them. These pipelines will be design and constructed by others.

The 2040 population (1990 population with 2.48 percent per annum growth rate) was used with an average water consumption of 160 gallons per capita per day (gpcd) to determine the average daily demand. Surface diversion required for NGWSP is the average demand minus other sources of water. Peak Daily Demand is derived from the surface diversion for NGWSP with a 1.3 peak factor. Storage capacity was based on the surface diversion for a length of five days.

Estimates for capital, operations and maintenance, and replacement costs are required.

## E. Refinements and New Criteria

Refinements

Refinements in determining ground water production have changed the surface diversion required (average demand minus ground water) for NGWSP. This has also changed the flow rate requirements for the various Navajo Communities. The methodology used for calculating the peak requirements on the system have also changed. The new methodology applies a peak factor to the surface diversion or demand met by NGWSP and not to the total demand. These refinements have a net effect of increasing the total peak demand from 62.62 $ft^3/s$ to 65.36 $ft^3/s$ and a total diversion of 34,000 to 36,564 acre feet per year for the San Juan River and NIIP alternative in year 2040. The net effect for year 2020 is a change of peak from 31.31 $ft^3/s$ to 40.61 $ft^3/s$ and a total San Juan River and NIIP Alternative diversion of 17,000 to 22,728 acre feet per year.

New Criteria

1. Average demand is equal to the population for a given year times 160 gallons per capita per day(gpcd) for Navajo Communities. Please note that the city of Gallup uses a different method to calculate average demand.

2. Population for a given year is based on 2.48 percent per annum growth rate from the 1990 population for Navajo Communities (Chapters). The city of Gallup's population growth rate is 1.82 percent. NAPI has no population.

3. Water supplied by NGWSP is equal to the average demand minus other sources of water for Navajo communities. The city of Gallup has 7,500 acre feet per year. NAPI has 500 acre feet per year in 2020 and 700 acre feet per year in 2040 of water available for use from NGWSP.

4. Storage is required in all Navajo communities that have existing water systems. The maps previously submitted do not show all existing community water systems. NAPI, Shiprock, Burnham, Lake Valley, White Rock, and White Horse Lake do not have storage . Required Storage capacity for Navajo communities is based on 5 days of the surface diversion or water available through the NGWSP . The city of Gallup will be responsible for the designs and estimates of storage for the city. Areas to receive storage will require storage tanks and the ability to deliver water to the community at a minimum pressure of 70 pounds per square inch.

5. Peak capacity is defined as the surface diversion times a 1.3 peaking factor. Peak capacity will be used for sizing all facilities. The peaking factor was derived from a 7 day average in mid July.

## F. Changes to San Juan River Alternative, San Juan Lateral

The increased diversion demand and new methodology for calculating peak has a net effect of increasing total peak demand from 56.47 $ft^3/s$ to 59.18 $ft^3/s$ for the San Juan Lateral year 2040 and for year 2020 a change of peak from 31.31 to 40.61 $ft^3/s$.

A new delivery point was created to provide industrial water to NAPI. The delivery tables show the location along the existing alignment where the new delivery point will be located. The delivery tables in Appendix B for the San Juan River Alternative San Juan Lateral also show the revised and current capacities and storage along the alignment. No alignment changes were made.

## G. Changes to San Juan River Alternative, Cutter Lateral

There were no alignment changes to the Cutter Lateral. The delivery spread sheet in Appendix C shows the current capacities and storage. The previously submitted delivery spreadsheet for the Cutter Lateral had incorrect lengths from the Cutter Treatment Plant to Huerfano. The lengths in the current delivery spreadsheet should be used. Peak demand changed from 6.05 $ft^3/s$ to 6.19 $ft^3/s$.

## H. Changes to NIIP Alternative

The increased diversion demand and new methodology for calculating peak has a net effect of increasing total peak demand from 62.62 $ft^3/s$ to 65.37 $ft^3/s$ in year 2040 and for year 2020 a change of peak from 31.31 $ft^3/s$ to 40.61 $ft^3/s$.

The NIIP alternative alignment has changed. There is also an addition of a reach from the Sanostee delivery point to the Shiprock delivery point. Previously the termination of the Tohatchi Junction lateral was at Sanostee which has been extended to the Shiprock delivery point to be consistent with the other alternative.

**Appendixes**

A. Ranney Inflitration System
B. San Juan Lateral Changes
C. Cutter Lateral Changes
D. NIIP Alternative Changes
E. Electronic Files

Items List for Appendix A

1. San Juan Alternative, San Juan Lateral, Infiltration Gallery Alternative, San Juan River to Sanostee Reach, 1695-406-42 **(As separate attachment)**
2. Infiltration System Delivery Data
3. Typical Collector Well(Ranney)
4. Typical Infiltration Gallery(Ranney)
5. Collector Well Description(Ranney)
6. Ranney, Appraisal Estimate and Site Visit Memorandum for San Juan River **(As separate attachment)**

| ch[illegible] | 1990 pop | 2020 pop | avgdmd(AF) | avgdmd(gpd) | 2020 GW(AF) | pkdmd(gpd) | [illegible]d(cfs) | diversion(AF) | storage(gal) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gallup | 19,154 | 32,904 | 8,459 | 6,695,577 | 1,439 | 8,704,215 | 13.47 | 7,500 | 0 | 13.47 |
| Burnham | 246 | 513 | 92 | 82,080 | 0 | 106,704 | 0.17 | 92 | 0 | 13.64 |
| Lake Valley | 436 | 909 | 163 | 145,440 | 34 | 149,613 | 0.23 | 129 | 0 | 13.87 |
| White Rock | 201 | 419 | 75 | 67,040 | 0 | 87,152 | 0.13 | 75 | 0 | 14.00 |
| White HorseLake | 610 | 1,272 | 228 | 203,520 | 18 | 243,686 | 0.38 | 210 | 0 | 14.38 |
| Becenti | 193 | 402 | 72 | 64,320 | 0 | 83,616 | 0.13 | 72 | 321,600 | 14.51 |
| Coyote Canyon | 1,234 | 2,573 | 461 | 411,680 | 47 | 480,638 | 0.74 | 414 | 1,848,606 | 15.25 |
| Crownpoint | 2,658 | 5,543 | 993 | 886,880 | 438 | 644,618 | 1.00 | 555 | 2,479,299 | 16.25 |
| Dalton Pass | 313 | 653 | 117 | 104,480 | 0 | 135,824 | 0.21 | 117 | 522,400 | 16.46 |
| Little Water | 638 | 1,330 | 238 | 212,800 | 0 | 276,640 | 0.43 | 238 | 1,064,000 | 16.89 |
| Standing Rock | 251 | 523 | 94 | 83,680 | 55 | 44,953 | 0.07 | 39 | 172,897 | 16.96 |
| Bread Springs | 1,219 | 2,542 | 456 | 406,720 | 60 | 459,102 | 0.71 | 396 | 1,765,778 | 17.67 |
| Chichilitah | 1,555 | 3,243 | 581 | 518,880 | 0 | 674,544 | 1.04 | 581 | 2,594,400 | 18.71 |
| Church Rock | 1,780 | 3,712 | 665 | 593,920 | 90 | 667,645 | 1.03 | 575 | 2,567,867 | 19.74 |
| Iyanbito | 974 | 2,031 | 364 | 324,960 | 77 | 333,085 | 0.52 | 287 | 1,281,095 | 20.26 |
| Marino Lake | 726 | 1,514 | 271 | 242,240 | 107 | 190,732 | 0.30 | 164 | 733,584 | 20.55 |
| Pinedale | 609 | 1,270 | 228 | 203,200 | 0 | 264,160 | 0.41 | 228 | 1,016,000 | 20.96 |
| Red Rock | 1,041 | 2,171 | 389 | 347,360 | 48 | 395,861 | 0.61 | 341 | 1,522,542 | 21.58 |
| Huerfano | 511 | 1,066 | 191 | 170,560 | 45 | 169,503 | 0.26 | 146 | 651,934 | 21.84 |
| Nageezi | 981 | 2,046 | 367 | 327,360 | 23 | 398,875 | 0.62 | 344 | 1,534,135 | 22.45 |
| Manuelito | 631 | 1,316 | 236 | 210,560 | 23 | 247,035 | 0.38 | 213 | 950,135 | 22.84 |
| Rock Springs | 1,685 | 3,514 | 630 | 562,240 | 58 | 663,599 | 1.03 | 572 | 2,552,305 | 23.86 |
| Tsayatoh | 1,433 | 2,988 | 536 | 478,080 | 32 | 584,366 | 0.90 | 504 | 2,247,562 | 24.77 |
| Mexican Springs | 711 | 1,483 | 266 | 237,280 | 0 | 308,464 | 0.48 | 266 | 1,186,400 | 25.25 |
| Naschitti | 1,539 | 3,209 | 575 | 513,440 | 79 | 575,788 | 0.89 | 496 | 2,214,568 | 26.14 |
| Newcomb | 651 | 1,358 | 243 | 217,280 | 12 | 268,537 | 0.42 | 231 | 1,032,836 | 26.55 |
| Sanostee | 2,081 | 4,340 | 778 | 694,400 | 121 | 762,292 | 1.18 | 657 | 2,931,892 | 27.73 |
| Sheep Springs | 660 | 1,376 | 247 | 220,160 | 14 | 269,960 | 0.42 | 233 | 1,038,308 | 28.15 |
| Tohatchi | 1,607 | 3,351 | 601 | 536,160 | 222 | 439,363 | 0.68 | 379 | 1,689,859 | 28.83 |
| Twin Lakes | 1,967 | 4,102 | 735 | 656,320 | 120 | 713,949 | 1.10 | 615 | 2,745,956 | 29.93 |
| Two Grey Hills | 883 | 1,841 | 330 | 294,560 | 66 | 306,331 | 0.47 | 264 | 1,178,196 | 30.41 |
| Counselor | 1,365 | 2,846 | 510 | 455,360 | 0 | 591,968 | 0.92 | 510 | 2,276,800 | 31.32 |
| Ojo Encino | 596 | 1,243 | 223 | 198,880 | 18 | 237,654 | 0.37 | 205 | 914,053 | 31.69 |
| Pueblo Pintado | 472 | 984 | 176 | 157,440 | 0 | 204,672 | 0.32 | 176 | 787,200 | 32.01 |
| Torreon | 1,364 | 2,844 | 510 | 455,040 | 77 | 502,189 | 0.78 | 433 | 1,931,495 | 32.78 |
| Fort Defiance | 6,187 | 12,902 | 2,312 | 2,064,320 | 905 | 1,633,307 | 2.53 | 1,407 | 6,281,952 | 35.31 |
| St Michaels | 5,580 | 11,638 | 2,086 | 1,862,080 | 0 | 2,420,704 | 3.75 | 2,086 | 9,310,400 | 39.06 |
| Shiprock | 13,804 | 28,786 | 5,159 | 4,605,760 | 4,680 | 556,058 | 0.86 | 479 | 0 | 39.92 |
| NAPI | | | 7,274 | | 500 | 446,370 | 0.69 | 500 | 0 | 40.61 |
| total | 78,546 | 156,757 | 37,930 | 26,512,057 | 9,408 | 26,243,771 | 40.61 | 22,728 | 61,346,053 | |

Note:

1990 pop = 1990 population from census data
2020 pop = 2020 population based on 2.48 % per annum growth rate for Navajo commuites
avgdmd(AF) = average daily demand(2020 population * 160 gallons per day) in acre feet
except for NAPI and Gallup which have a fixed diversion amount
avgdmd(gpd) = average daily demand(2020 population * 160 gallons per day)
except for NAPI and Gallup which have a fixed diversion amount
2020 GW(AF) = 2020 Ground Water Production in acre feet
pkdmd(gpd) = peak demand(average demand - Ground Water Production)*1.3 in gallons per day for Navajo Communities
pkdmd(cfs) = peak demand(average demand - Ground Water Production)*1.3
storage = (average demand - ground water Production)* 5 days

Year 2020
02/02/01

02/02/01

## Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
## San Juan Lateral, Infiltration System(main transmission pipeline)

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required Delivery(PSI) |
|---|---|---|---|---|---|---|---|---|---|
| Infiltration System | | 0 | 0 | 0 | 0 | 0.00 | 36.97 | | |
| Reservoir/WTP | 18,756 | 0 | 0 | 0 | 0 | 0.00 | 36.97 | 5,070 | |
| NAPI | 5,111 | 0 | 0 | 0 | 446,370 | 0.69 | 36.97 | 5,140 | |
| Shiprock | 16,844 | 28,786 | 0 | 4,605,760 | 556,058 | 0.86 | 36.28 | 5,160 | |
| Sanostee | 94,323 | 4,340 | 2,931,892 | 694,400 | 762,292 | 1.18 | 35.42 | 5,580 | 70 |
| Burnham | 51,075 | 513 | 0 | 82,080 | 106,704 | 0.17 | 34.24 | 5,590 | |
| Newcomb | 19,088 | 3,199 | 2,211,031 | 511,840 | 574,868 | 0.89 | 34.08 | 5,550 | 70 |
| Two Grey Hills | | 1,841 | 1,178,196 | 294,560 | 306,331 | 0.47 | | | |
| Newcomb | | 1,358 | 1,032,836 | 217,280 | 268,537 | 0.42 | | | |
| Sheepsprings | 51,174 | 1,376 | 1,038,308 | 220,160 | 269,960 | 0.42 | 33.19 | 5,890 | 70 |
| Naschitti | 29,635 | 3,209 | 2,214,568 | 513,440 | 575,788 | 0.89 | 32.77 | 5,890 | 70 |
| Tohatchi | 90,183 | 4,834 | 2,876,259 | 773,440 | 747,827 | 1.16 | 31.88 | 6,100 | |
| Tohatchi | | 3,351 | 1,689,859 | 536,160 | 439,363 | 0.68 | | | |
| Mexican Springs | | 1,483 | 1,186,400 | 237,280 | 308,464 | 0.48 | | | |
| Coyote Cyn. Jct | 34,954 | 12,352 | 0 | 1,976,320 | 1,903,053 | 2.94 | 30.72 | 6,250 | |
| Twin Lakes | 15,594 | 4,102 | 2,745,956 | 656,320 | 713,949 | 1.10 | 27.78 | 6,380 | 70 |
| Ya-ta-hey Jct. | 31,161 | 31,042 | 0 | 4,966,720 | 5,301,977 | 8.20 | 26.67 | 6,560 | |
| Gallup Jct. | 20,482 | 50,703 | 0 | 9,543,417 | 11,936,379 | 18.47 | 18.47 | 6,935 | 4.2 |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

## Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
## Coyote Canyon Junction

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Coyote Cyn. Jct | 34,954 | 12,352 | 0 | 1,976,320 | 1,903,053 | 2.94 | 2.94 | 6,250 | |
| Coyote Cyn. | 35,938 | 2,573 | 1,848,606 | 411,680 | 480,638 | 0.74 | 2.94 | 6,160 | 70 |
| Standing Rock | 81,321 | 523 | 172,897 | 83,680 | 44,953 | 0.07 | 2.20 | 6,280 | 70 |
| Dalton Pass | 37,998 | 9,256 | 4,387,299 | 1,480,960 | 1,377,463 | 2.13 | 2.13 | 6,740 | 70 |
| Dalton Pass | | 653 | 522,400 | 104,480 | 135,824 | 0.21 | | | |
| Crownpoint | | 5,543 | 2,479,299 | 886,880 | 644,618 | 1.00 | | | |
| Littlewater | | 1,330 | 1,064,000 | 212,800 | 276,640 | 0.43 | | | |
| Lake Valley | | 909 | 0 | 145,440 | 149,613 | 0.23 | | | |
| White Rock | | 419 | 0 | 67,040 | 87,152 | 0.13 | | | |
| Becenti | | 402 | 321,600 | 64,320 | 83,616 | 0.13 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
Yah-ta-hey Junction

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Ya-ta-hey Jct. | 31,161 | 31,042 | 0 | 4,966,720 | 5,301,977 | 8.20 | 8.20 | 6,560 | |
| Rock Springs | 29,439 | 6,502 | 4,799,867 | 1,040,320 | 1,247,965 | 1.93 | 8.20 | 6,760 | 70 |
| Rock Springs | | 3,514 | 2,552,305 | 562,240 | 663,599 | 1.03 | | | |
| Tsayatoh | | 2,988 | 2,247,562 | 478,080 | 584,366 | 0.90 | | | |
| Window Rock | 58,887 | 24,540 | 15,592,352 | 3,926,400 | 4,054,011 | 6.27 | 6.27 | 6,760 | 70 |
| Fort Defiance | | 12,902 | 6,281,952 | 2,064,320 | 1,633,307 | 2.53 | | | |
| St. Michaels | | 11,638 | 9,310,400 | 1,862,080 | 2,420,704 | 3.75 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
Gallup Junction

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Gallup Jct. | 20,482 | 50,703 | 0 | 9,543,417 | 11,936,379 | 18.47 | 18.47 | 6,935 | 4.2 |
| Gallup | | 32,904 | 0 | 6,695,577 | 8,704,215 | 13.47 | | | |
| Red Rock | | 2,171 | 1,522,542 | 347,360 | 395,861 | 0.61 | | | |
| Breadsprings | | 2,542 | 1,765,778 | 406,720 | 459,102 | 0.71 | | | |
| Chichiltah | | 3,243 | 2,594,400 | 518,880 | 674,544 | 1.04 | | | |
| Manuelito | | 1,316 | 950,135 | 210,560 | 247,035 | 0.38 | | | |
| Church Rock | | 3,712 | 2,567,867 | 593,920 | 667,645 | 1.03 | | | |
| Iyanbito | | 2,031 | 1,281,095 | 324,960 | 333,085 | 0.52 | | | |
| Pinedale | | 1,270 | 1,016,000 | 203,200 | 264,160 | 0.41 | | | |
| Mariano Lake | | 1,514 | 733,584 | 242,240 | 190,732 | 0.30 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.
8. Navajo communities in Gallup Jct. storage locations and capacity are in table 1
of the design data package.

| chap[illegible] | 1990 pop | 2040 pop | avgdmd(AF) | avgdmd(gpd) | 2040 GW(AF) | pkdmd(gpd) | p[illegible]s) | diversion(AF) | storage(gal) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gallup | 19,154 | 47,197 | 8,459 | 6,695,577 | 1,439 | 8,704,215 | 13.47 | 7,500 | 0 | 13.47 |
| Burnham | 246 | 837 | 150 | 133,920 | 0 | 174,096 | 0.27 | 150 | 0 | 13.74 |
| Lake Valley | 436 | 1,484 | 266 | 237,440 | 46 | 255,286 | 0.39 | 220 | 0 | 14.13 |
| White Rock | 201 | 684 | 123 | 109,440 | 0 | 142,272 | 0.22 | 123 | 0 | 14.35 |
| White HorseLake | 610 | 2,076 | 372 | 332,160 | 31 | 395,831 | 0.61 | 341 | 0 | 14.97 |
| Becenti | 193 | 657 | 118 | 105,120 | 0 | 136,656 | 0.21 | 118 | 525,600 | 15.18 |
| Coyote Canyon | 1,234 | 4,200 | 753 | 672,000 | 61 | 802,806 | 1.24 | 692 | 3,087,714 | 16.42 |
| Crownpoint | 2,658 | 9,047 | 1,621 | 1,447,520 | 614 | 1,169,191 | 1.81 | 1,007 | 4,496,888 | 18.23 |
| Dalton Pass | 313 | 1,065 | 191 | 170,400 | 0 | 221,520 | 0.34 | 191 | 852,000 | 18.57 |
| Little Water | 638 | 2,172 | 389 | 347,520 | 0 | 451,776 | 0.70 | 389 | 1,737,600 | 19.27 |
| Standing Rock | 251 | 854 | 153 | 136,640 | 77 | 88,269 | 0.14 | 76 | 339,495 | 19.41 |
| Bread Springs | 1,219 | 4,149 | 744 | 663,840 | 77 | 773,629 | 1.20 | 667 | 2,975,495 | 20.60 |
| Chichilitah | 1,555 | 5,293 | 949 | 846,880 | 0 | 1,100,944 | 1.70 | 949 | 4,234,400 | 22.31 |
| Church Rock | 1,780 | 6,059 | 1,086 | 969,440 | 123 | 1,117,523 | 1.73 | 963 | 4,298,165 | 24.04 |
| Iyanbito | 974 | 3,315 | 594 | 530,400 | 153 | 511,954 | 0.79 | 441 | 1,969,054 | 24.83 |
| Marino Lake | 726 | 2,471 | 443 | 395,360 | 92 | 407,196 | 0.63 | 351 | 1,566,140 | 25.46 |
| Pinedale | 609 | 2,073 | 372 | 331,680 | 0 | 431,184 | 0.67 | 372 | 1,658,400 | 26.13 |
| Red Rock | 1,041 | 3,543 | 635 | 566,880 | 61 | 666,150 | 1.03 | 574 | 2,562,114 | 27.16 |
| Huerfano | 511 | 1,739 | 312 | 278,240 | 31 | 325,735 | 0.50 | 281 | 1,252,825 | 27.66 |
| Nageezi | 981 | 3,339 | 598 | 534,240 | 15 | 677,104 | 1.05 | 583 | 2,604,245 | 28.71 |
| Manuelito | 631 | 2,148 | 385 | 343,680 | 46 | 393,398 | 0.61 | 339 | 1,513,070 | 29.32 |
| Rock Springs | 1,685 | 5,735 | 1,028 | 917,600 | 77 | 1,103,517 | 1.71 | 951 | 4,244,295 | 31.02 |
| Tsayatoh | 1,433 | 4,878 | 874 | 780,480 | 46 | 961,238 | 1.49 | 828 | 3,697,070 | 32.51 |
| Mexican Springs | 711 | 2,420 | 434 | 387,200 | 0 | 503,360 | 0.78 | 434 | 1,936,000 | 33.29 |
| Naschitti | 1,539 | 5,238 | 939 | 838,080 | 77 | 1,000,141 | 1.55 | 862 | 3,846,695 | 34.84 |
| Newcomb | 651 | 2,216 | 397 | 354,560 | 12 | 447,001 | 0.69 | 385 | 1,719,236 | 35.53 |
| Sanostee | 2,081 | 7,083 | 1,269 | 1,133,280 | 153 | 1,295,698 | 2.00 | 1,116 | 4,983,454 | 37.53 |
| Sheep Springs | 660 | 2,246 | 403 | 359,360 | 15 | 449,760 | 0.70 | 388 | 1,729,845 | 38.23 |
| Tohatchi | 1,607 | 5,470 | 980 | 875,200 | 307 | 781,467 | 1.21 | 673 | 3,005,644 | 39.44 |
| Twin Lakes | 1,967 | 6,695 | 1,200 | 1,071,200 | 153 | 1,214,994 | 1.88 | 1,047 | 4,673,054 | 41.32 |
| Two Grey Hills | 883 | 3,005 | 539 | 480,800 | 77 | 535,677 | 0.83 | 462 | 2,060,295 | 42.15 |
| Counselor | 1,365 | 4,646 | 833 | 743,360 | 0 | 966,368 | 1.50 | 833 | 3,716,800 | 43.64 |
| Ojo Encino | 596 | 2,029 | 364 | 324,640 | 16 | 403,463 | 0.62 | 348 | 1,551,781 | 44.27 |
| Pueblo Pintado | 472 | 1,607 | 288 | 257,120 | 0 | 334,256 | 0.52 | 288 | 1,285,600 | 44.79 |
| Torreon | 1,364 | 4,643 | 832 | 742,880 | 61 | 894,950 | 1.38 | 771 | 3,442,114 | 46.17 |
| Fort Defiance | 6,187 | 21,059 | 3,774 | 3,369,440 | 767 | 3,490,121 | 5.40 | 3,007 | 13,423,542 | 51.57 |
| St Michaels | 5,580 | 18,993 | 3,404 | 3,038,880 | 0 | 3,950,544 | 6.11 | 3,404 | 15,194,400 | 57.68 |
| Shiprock | 13,804 | 46,985 | 8,421 | 7,517,600 | 4,680 | 4,341,450 | 6.72 | 3,741 | 0 | 64.40 |
| NAPI | | | 7,274 | | 700 | 624,918 | 0.97 | 700 | 0 | 65.37 |
| total | 78,546 | 249,350 | 51,964 | 39,040,057 | 10,007 | 42,245,655 | 65.36 | 36,563 | 106,183,029 | |

Note:
1990 pop = 1990 population from census data
2040 pop = 2040 population based on 2.48 % per annum growth rate for Navajo commuites
avgdmd(AF) = average daily demand(2040 population * 160 gallons per day) in acre feet
except for NAPI and Gallup which have a fixed diversion amount
avgdmd(gpd) = average daily demand(2040 population * 160 gallons per day)
except for NAPI and Gallup which have a fixed diversion amount
2040 GW(AF) = 2040 Ground Water Production in acre feet
pkdmd(gpd) = peak demand(average demand - Ground Water Production)*1.3 in gallons per day for Navajo Communities
pkdmd(cfs) = peak demand(average demand - Ground Water Production)*1.3
storage = (average demand - ground water Production)* 5 days

Year 2040
02/02/01

02/26/01

Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
San Juan Lateral, Infiltration System(main transmission pipeline)

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required Delivery(PSI) |
|---|---|---|---|---|---|---|---|---|---|
| Infiltration System | | 0 | 0 | 0 | 0 | 0.00 | 59.18 | | |
| Reservoir/WTP | 18,756 | 0 | 0 | 0 | 0 | 0.00 | 59.18 | 5,070 | |
| NAPI | 5,111 | 0 | 0 | 0 | 624,918 | 0.97 | 59.18 | 5,140 | |
| Shiprock | 16,844 | 46,985 | 0 | 7,517,600 | 4,341,450 | 6.72 | 58.21 | 5,160 | |
| Sanostee | 94,323 | 7,083 | 4,983,454 | 1,133,280 | 1,295,698 | 2.00 | 51.49 | 5,580 | 70 |
| Burnham | 51,075 | 837 | 0 | 133,920 | 174,096 | 0.27 | 49.49 | 5,590 | |
| Newcomb | 19,088 | 5,221 | 3,779,531 | 835,360 | 982,678 | 1.52 | 49.22 | 5,550 | 70 |
| Two Grey Hills | | 3,005 | 2,060,295 | 480,800 | 535,677 | 0.83 | | | |
| Newcomb | | 2,216 | 1,719,236 | 354,560 | 447,001 | 0.69 | | | |
| Sheepsprings | 51,174 | 2,246 | 1,729,845 | 359,360 | 449,760 | 0.70 | 47.70 | 5,890 | 70 |
| Naschitti | 29,635 | 5,238 | 3,846,695 | 838,080 | 1,000,141 | 1.55 | 47.00 | 5,890 | 70 |
| Tohatchi | 90,183 | 7,890 | 4,941,644 | 1,262,400 | 1,284,827 | 1.99 | 45.46 | 6,100 | |
| Tohatchi | | 5,470 | 3,005,644 | 875,200 | 781,467 | 1.21 | | | |
| Mexican Springs | | 2,420 | 1,936,000 | 387,200 | 503,360 | 0.78 | | | |
| Coyote Cyn. Jct | 34,954 | 20,163 | 0 | 3,226,080 | 3,267,776 | 5.06 | 43.47 | 6,250 | |
| Twin Lakes | 15,594 | 6,695 | 4,673,054 | 1,071,200 | 1,214,994 | 1.88 | 38.41 | 6,380 | 70 |
| Ya-ta-hey Jct. | 31,161 | 50,665 | 0 | 8,106,400 | 9,505,420 | 14.71 | 36.53 | 6,560 | |
| Gallup Jct. | 20,482 | 76,248 | 0 | 11,343,737 | 14,106,193 | 21.83 | 21.83 | 6,935 | 4.2 |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San Jua[illegible]er Alternative): Project Node Assumptions
Coyote Canyon Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Coyote Cyn. Jct | 34,954 | 20,163 | 0 | 3,226,080 | 3,267,776 | 5.06 | 5.06 | 6,250 | |
| Coyote Cyn. | 35,938 | 4,200 | 3,087,714 | 672,000 | 802,806 | 1.24 | 5.06 | 6,160 | 70 |
| Standing Rock | 81,321 | 854 | 339,495 | 136,640 | 88,269 | 0.14 | 3.81 | 6,280 | 70 |
| Dalton Pass | 37,998 | 15,109 | 7,612,088 | 2,417,440 | 2,376,701 | 3.68 | 3.68 | 6,740 | 70 |
| Dalton Pass | | 1,065 | 852,000 | 170,400 | 221,520 | 0.34 | | | |
| Crownpoint | | 9,047 | 4,496,888 | 1,447,520 | 1,169,191 | 1.81 | | | |
| Littlewater | | 2,172 | 1,737,600 | 347,520 | 451,776 | 0.70 | | | |
| Lake Valley | | 1,484 | 0 | 237,440 | 255,286 | 0.39 | | | |
| White Rock | | 684 | 0 | 109,440 | 142,272 | 0.22 | | | |
| Becenti | | 657 | 525,600 | 105,120 | 136,656 | 0.21 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
Yah-ta-hey Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Ya-ta-hey Jct. | 31,161 | 50,665 | 0 | 8,106,400 | 9,505,420 | 14.71 | 14.71 | 6,560 | |
| Rock Springs | 29,439 | 10,613 | 7,941,365 | 1,698,080 | 2,064,755 | 3.19 | 14.71 | 6,760 | 70 |
| Rock Springs | | 5,735 | 4,244,295 | 917,600 | 1,103,517 | 1.71 | | | |
| Tsayatoh | | 4,878 | 3,697,070 | 780,480 | 961,238 | 1.49 | | | |
| Window Rock | 58,887 | 40,052 | 28,617,942 | 6,408,320 | 7,440,665 | 11.51 | 11.51 | 6,760 | 70 |
| Fort Defiance | | 21,059 | 13,423,542 | 3,369,440 | 3,490,121 | 5.40 | | | |
| St. Michaels | | 18,993 | 15,194,400 | 3,038,880 | 3,950,544 | 6.11 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

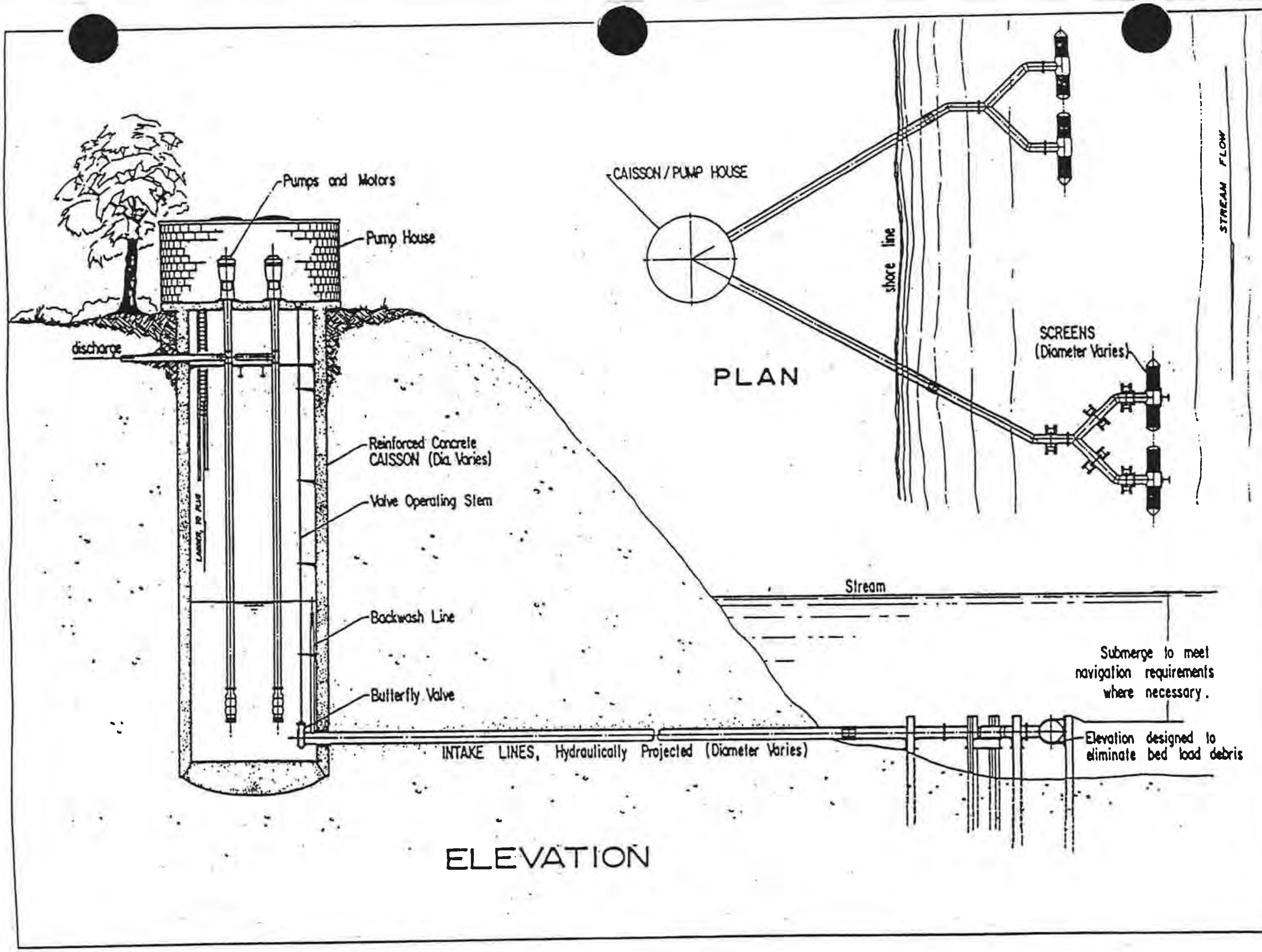
02/02/01

# Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
## Gallup Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Gallup Jct. | 20,482 | 76,248 | 0 | 11,343,737 | 14,106,193 | 21.83 | 21.83 | 6,935 | 4.2 |
| Gallup | | 47,197 | 0 | 6,695,577 | 8,704,215 | 13.47 | | | |
| Red Rock | | 3,543 | 2,562,114 | 566,880 | 666,150 | 1.03 | | | |
| Breadsprings | | 4,149 | 2,975,495 | 663,840 | 773,629 | 1.20 | | | |
| Chichiltah | | 5,293 | 4,234,400 | 846,880 | 1,100,944 | 1.70 | | | |
| Manuelito | | 2,148 | 1,513,070 | 343,680 | 393,398 | 0.61 | | | |
| Church Rock | | 6,059 | 4,298,165 | 969,440 | 1,117,523 | 1.73 | | | |
| Iyanbito | | 3,315 | 1,969,054 | 530,400 | 511,954 | 0.79 | | | |
| Pinedale | | 2,073 | 1,658,400 | 331,680 | 431,184 | 0.67 | | | |
| Mariano Lake | | 2,471 | 1,566,140 | 395,360 | 407,196 | 0.63 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.
8. Navajo communities in Gallup Jct. storage locations and capacity are in table 1 of the design data package.




# RANNEY RAW WATER INTAKE

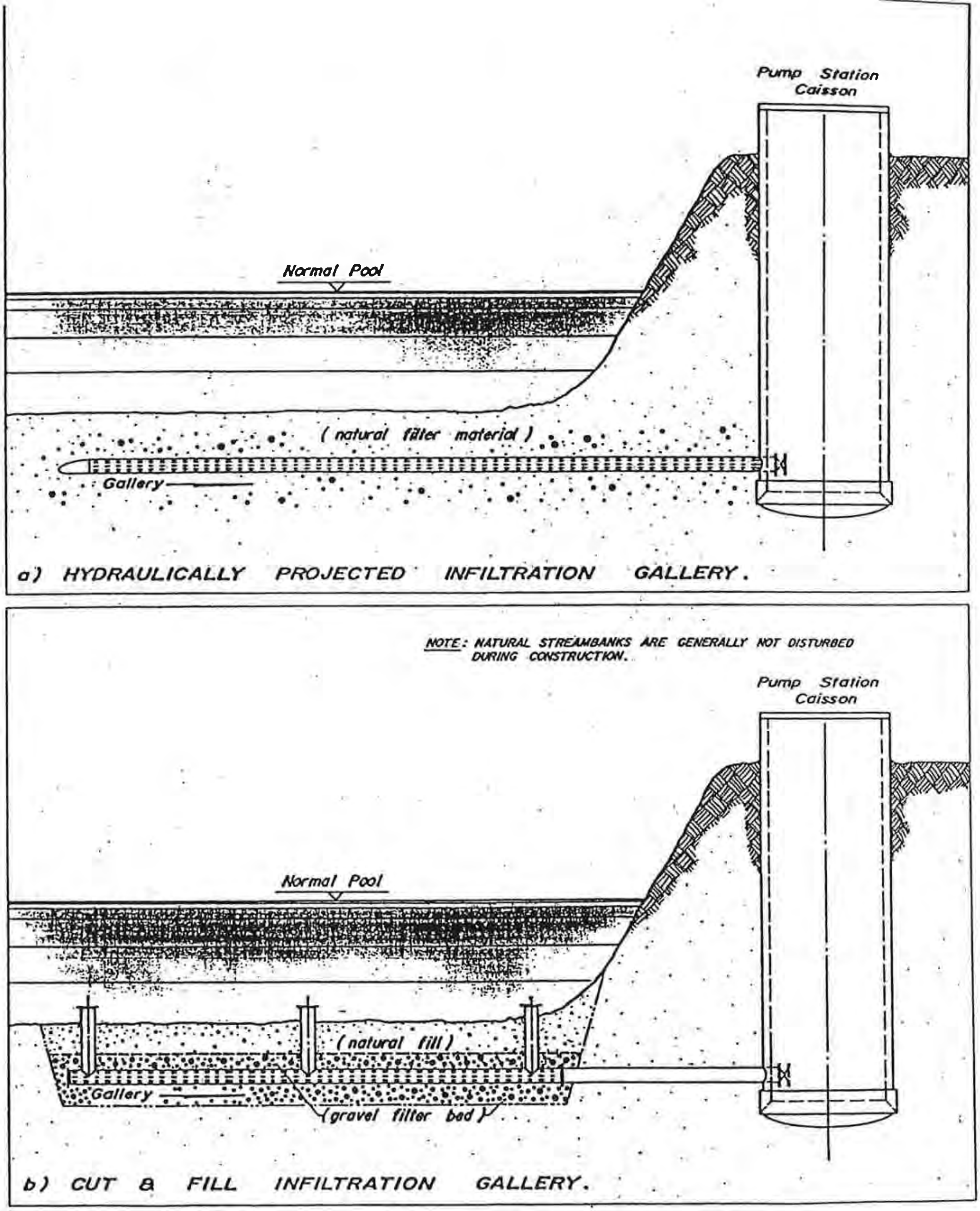



Fig. I - TYPICAL INFILTRATION GALLERY.

# Ranney Collector Wells

A Ranney Collector Well is designed to operate on induced infiltration from a nearby surface source and combines the desirable features of both a groundwater and surface water supply. This unique design results in an abundant, dependable supply of high quality, reasonably constant temperature water.

Ranney, a name synonymous with collector wells, invented this superior method to supply water to industry and municipalities.

Ranney Collector wells deliver billions of Gallons of water to a wide variety of industrial facilities.

- Cooling Water for Power Generation Facilities
- Process Water for Pulp and Paper Mills, Chemical, Steel and Other Manufacturing Facilities
- Once-Through Cooling Water Supplies
- Potable Water Supplies
- Sea Water Supplies

## Environmental Advantages

Ranney Collectors utilizing induced supply infiltration from a surface water source offer the best available technology for minimal environmental impact. The US EPA in it's "Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact" states: "This is an intake which has been frequently used for obtaining highly filtered industrial and municipal water. It provides a degree of screening which far exceeds the requirements for cooling water supplies. It has the advantage of being the most environmentally sound intake system because it does not have any direct impact on the waterway."

## Well Construction

A reinforced concrete caisson serves as the well or pumping station. First, the caisson is constructed using the open-end caisson sinking method. A bottom-sealing plug is poured to make the caisson watertight. Next, a series of lateral well screens are projected out horizontally from the caisson, into the aquifer formation at one or more elevations. These screens may be placed in a variety of patterns and varying lengths. They can also be equipped with an artificial gravel-pack filter, if required. Finally, the caisson is extended above known or anticipated flood elevations. The well is typically completed with a pump house and controls.

## Operational Advantages

Utilizing the natural process of riverbank filtration results in superior water quality.

- Low Turbidity, typically <1.0 NTU
- Zebra Mussel Elimination
- Surface Water-Borne Microorganism Reduction
- Optimization of Pumping Efficiency
- Low Maintenance
- Lower Land Acquisition Costs
- Ranney Wells Remain Operational During Extreme High and Low River Levels.
- A Single Ranney Well Exceeds the Yield of Several Vertical Wells.
- Provides Temperature Attenuation

Items List for Appendix B

1. San Juan River Alternative, San Juan Lateral, Delivery Data
2. Table 1. Storage Tank Capacities for Gallup area.

02/02/01

## Navajo - Gallup Water Supply Project (San Juan River Alt[illegible]ve): Project Node Assumptions
San Juan Lateral, PNM Diversion(main transmission pipeline)

| Nodes | Length | 2020 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | Delivery(PSI) |
| PNMDiversion | | 0 | 0 | 0 | 0 | 0.00 | 36.97 | | |
| Reservoir/WTP | | 0 | 0 | 0 | 0 | 0.00 | 36.97 | | |
| NAPI | 8,100 | 0 | 0 | 0 | 446,370 | 0.69 | 36.97 | 5,250 | |
| Shiprock | 91,042 | 28,786 | 0 | 4,605,760 | 556,058 | 0.86 | 36.28 | 5,160 | |
| Sanostee | 94,323 | 4,340 | 2,931,892 | 694,400 | 762,292 | 1.18 | 35.42 | 5,580 | 70 |
| Burnham | 51,075 | 513 | 0 | 82,080 | 106,704 | 0.17 | 34.24 | 5,590 | |
| Newcomb | 19,088 | 3,199 | 2,211,031 | 511,840 | 574,868 | 0.89 | 34.08 | 5,550 | 70 |
| Two Grey Hills | | 1,841 | 1,178,196 | 294,560 | 306,331 | 0.47 | | | |
| Newcomb | | 1,358 | 1,032,836 | 217,280 | 268,537 | 0.42 | | | |
| Sheepsprings | 51,174 | 1,376 | 1,038,308 | 220,160 | 269,960 | 0.42 | 33.19 | 5,890 | 70 |
| Naschitti | 29,635 | 3,209 | 2,214,568 | 513,440 | 575,788 | 0.89 | 32.77 | 5,890 | 70 |
| Tohatchi | 90,183 | 4,834 | 2,876,259 | 773,440 | 747,827 | 1.16 | 31.88 | 6,100 | |
| Tohatchi | | 3,351 | 1,689,859 | 536,160 | 439,363 | 0.68 | | | |
| Mexican Springs | | 1,483 | 1,186,400 | 237,280 | 308,464 | 0.48 | | | |
| Coyote Cyn. Jct | 34,954 | 12,352 | 0 | 1,976,320 | 1,903,053 | 2.94 | 30.72 | 6,250 | |
| Twin Lakes | 15,594 | 4,102 | 2,745,956 | 656,320 | 713,949 | 1.10 | 27.78 | 6,380 | 70 |
| Ya-ta-hey Jct. | 31,161 | 31,042 | 0 | 4,966,720 | 5,301,977 | 8.20 | 26.67 | 6,560 | |
| Gallup Jct. | 20,482 | 50,703 | 0 | 9,543,417 | 11,936,379 | 18.47 | 18.47 | 6,935 | 4.2 |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

## Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
### Coyote Canyon Junction

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Coyote Cyn. Jct | 34,954 | 12,352 | 0 | 1,976,320 | 1,903,053 | 2.94 | 2.94 | 6,250 | |
| Coyote Cyn. | 35,938 | 2,573 | 1,848,606 | 411,680 | 480,638 | 0.74 | 2.94 | 6,160 | 70 |
| Standing Rock | 81,321 | 523 | 172,897 | 83,680 | 44,953 | 0.07 | 2.20 | 6,280 | 70 |
| Dalton Pass | 37,998 | 9,256 | 4,387,299 | 1,480,960 | 1,377,463 | 2.13 | 2.13 | 6,740 | 70 |
| Dalton Pass | | 653 | 522,400 | 104,480 | 135,824 | 0.21 | | | |
| Crownpoint | | 5,543 | 2,479,299 | 886,880 | 644,618 | 1.00 | | | |
| Littlewater | | 1,330 | 1,064,000 | 212,800 | 276,640 | 0.43 | | | |
| Lake Valley | | 909 | 0 | 145,440 | 149,613 | 0.23 | | | |
| White Rock | | 419 | 0 | 67,040 | 87,152 | 0.13 | | | |
| Becenti | | 402 | 321,600 | 64,320 | 83,616 | 0.13 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

## Navajo - Gallup Water Supply Project (San [illegible]n River Alternative): Project Node Assumptions
## Yah-ta-hey Junction

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Ya-ta-hey Jct. | 31,161 | 31,042 | 0 | 4,966,720 | 5,301,977 | 8.20 | 8.20 | 6,560 | |
| Rock Springs | 29,439 | 6,502 | 4,799,867 | 1,040,320 | 1,247,965 | 1.93 | 8.20 | 6,760 | 70 |
| Rock Springs | | 3,514 | 2,552,305 | 562,240 | 663,599 | 1.03 | | | |
| Tsayatoh | | 2,988 | 2,247,562 | 478,080 | 584,366 | 0.90 | | | |
| Window Rock | 58,887 | 24,540 | 15,592,352 | 3,926,400 | 4,054,011 | 6.27 | 6.27 | 6,760 | 70 |
| Fort Defiance | | 12,902 | 6,281,952 | 2,064,320 | 1,633,307 | 2.53 | | | |
| St. Michaels | | 11,638 | 9,310,400 | 1,862,080 | 2,420,704 | 3.75 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

# Navajo - Gallup Water Supply Project (San [illegible]n River Alternative): Project Node Assumptions
## Gallup Junction

| Nodes | Length | 2020 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| | | | | | | | | | |
| Gallup Jct. | 20,482 | 50,703 | 0 | 9,543,417 | 11,936,379 | 18.47 | 18.47 | 6,935 | 4.2 |
| Gallup | | 32,904 | 0 | 6,695,577 | 8,704,215 | 13.47 | | | |
| Red Rock | | 2,171 | 1,522,542 | 347,360 | 395,861 | 0.61 | | | |
| Breadsprings | | 2,542 | 1,765,778 | 406,720 | 459,102 | 0.71 | | | |
| Chichiltah | | 3,243 | 2,594,400 | 518,880 | 674,544 | 1.04 | | | |
| Manuelito | | 1,316 | 950,135 | 210,560 | 247,035 | 0.38 | | | |
| Church Rock | | 3,712 | 2,567,867 | 593,920 | 667,645 | 1.03 | | | |
| Iyanbito | | 2,031 | 1,281,095 | 324,960 | 333,085 | 0.52 | | | |
| Pinedale | | 1,270 | 1,016,000 | 203,200 | 264,160 | 0.41 | | | |
| Mariano Lake | | 1,514 | 733,584 | 242,240 | 190,732 | 0.30 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.
8. Navajo communities in Gallup Jct. storage locations and capacity are in table 1 of the design data package.

02/02/01

# Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
## San Juan Lateral, PNM Diversion(main transmission pipeline)

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required Delivery(PSI) |
|---|---|---|---|---|---|---|---|---|---|
| PNMDiversion | | 0 | 0 | 0 | 0 | 0.00 | 59.18 | | |
| Reservoir/WTP | | 0 | 0 | 0 | 0 | 0.00 | 59.18 | | |
| NAPI | 8,100 | 0 | 0 | 0 | 624,918 | 0.97 | 59.18 | 5,250 | |
| Shiprock | 91,042 | 46,985 | 0 | 7,517,600 | 4,341,450 | 6.72 | 58.21 | 5,160 | |
| Sanostee | 94,323 | 7,083 | 4,983,454 | 1,133,280 | 1,295,698 | 2.00 | 51.49 | 5,580 | 70 |
| Burnham | 51,075 | 837 | 0 | 133,920 | 174,096 | 0.27 | 49.49 | 5,590 | |
| Newcomb | 19,088 | 5,221 | 3,779,531 | 835,360 | 982,678 | 1.52 | 49.22 | 5,550 | 70 |
| Two Grey Hills | | 3,005 | 2,060,295 | 480,800 | 535,677 | 0.83 | | | |
| Newcomb | | 2,216 | 1,719,236 | 354,560 | 447,001 | 0.69 | | | |
| Sheepsprings | 51,174 | 2,246 | 1,729,845 | 359,360 | 449,760 | 0.70 | 47.70 | 5,890 | 70 |
| Naschitti | 29,635 | 5,238 | 3,846,695 | 838,080 | 1,000,141 | 1.55 | 47.00 | 5,890 | 70 |
| Tohatchi | 90,183 | 7,890 | 4,941,644 | 1,262,400 | 1,284,827 | 1.99 | 45.46 | 6,100 | |
| Tohatchi | | 5,470 | 3,005,644 | 875,200 | 781,467 | 1.21 | | | |
| Mexican Springs | | 2,420 | 1,936,000 | 387,200 | 503,360 | 0.78 | | | |
| Coyote Cyn. Jct | 34,954 | 20,163 | 0 | 3,226,080 | 3,267,776 | 5.06 | 43.47 | 6,250 | |
| Twin Lakes | 15,594 | 6,695 | 4,673,054 | 1,071,200 | 1,214,994 | 1.88 | 38.41 | 6,380 | 70 |
| Ya-ta-hey Jct. | 31,161 | 50,665 | 0 | 8,106,400 | 9,505,420 | 14.71 | 36.53 | 6,560 | |
| Gallup Jct. | 20,482 | 76,248 | 0 | 11,343,737 | 14,106,193 | 21.83 | 21.83 | 6,935 | 4.2 |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
Coyote Canyon Junction

| Nodes | Length | 2040 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| | | | | | | | | | |
| Coyote Cyn. Jct | 34,954 | 20,163 | 0 | 3,226,080 | 3,267,776 | 5.06 | 5.06 | 6,250 | |
| Coyote Cyn. | 35,938 | 4,200 | 3,087,714 | 672,000 | 802,806 | 1.24 | 5.06 | 6,160 | 70 |
| Standing Rock | 81,321 | 854 | 339,495 | 136,640 | 88,269 | 0.14 | 3.81 | 6,280 | 70 |
| Dalton Pass | 37,998 | 15,109 | 7,612,088 | 2,417,440 | 2,376,701 | 3.68 | 3.68 | 6,740 | 70 |
| Dalton Pass | | 1,065 | 852,000 | 170,400 | 221,520 | 0.34 | | | |
| Crownpoint | | 9,047 | 4,496,888 | 1,447,520 | 1,169,191 | 1.81 | | | |
| Littlewater | | 2,172 | 1,737,600 | 347,520 | 451,776 | 0.70 | | | |
| Lake Valley | | 1,484 | 0 | 237,440 | 255,286 | 0.39 | | | |
| White Rock | | 684 | 0 | 109,440 | 142,272 | 0.22 | | | |
| Becenti | | 657 | 525,600 | 105,120 | 136,656 | 0.21 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
Yah-ta-hey Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Ya-ta-hey Jct. | 31,161 | 50,665 | 0 | 8,106,400 | 9,505,420 | 14.71 | 14.71 | 6,560 | |
| Rock Springs | 29,439 | 10,613 | 7,941,365 | 1,698,080 | 2,064,755 | 3.19 | 14.71 | 6,760 | 70 |
| Rock Springs | | 5,735 | 4,244,295 | 917,600 | 1,103,517 | 1.71 | | | |
| Tsayatoh | | 4,878 | 3,697,070 | 780,480 | 961,238 | 1.49 | | | |
| Window Rock | 58,887 | 40,052 | 28,617,942 | 6,408,320 | 7,440,665 | 11.51 | 11.51 | 6,760 | 70 |
| Fort Defiance | | 21,059 | 13,423,542 | 3,369,440 | 3,490,121 | 5.40 | | | |
| St. Michaels | | 18,993 | 15,194,400 | 3,038,880 | 3,950,544 | 6.11 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San [illegible]n River Alternative): Project Node Assumptions
Gallup Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Gallup Jct. | 20,482 | 76,248 | 0 | 11,343,737 | 14,106,193 | 21.83 | 21.83 | 6,935 | 4.2 |
| Gallup | | 47,197 | 0 | 6,695,577 | 8,704,215 | 13.47 | | | |
| Red Rock | | 3,543 | 2,562,114 | 566,880 | 666,150 | 1.03 | | | |
| Breadsprings | | 4,149 | 2,975,495 | 663,840 | 773,629 | 1.20 | | | |
| Chichiltah | | 5,293 | 4,234,400 | 846,880 | 1,100,944 | 1.70 | | | |
| Manuelito | | 2,148 | 1,513,070 | 343,680 | 393,398 | 0.61 | | | |
| Church Rock | | 6,059 | 4,298,165 | 969,440 | 1,117,523 | 1.73 | | | |
| Iyanbito | | 3,315 | 1,969,054 | 530,400 | 511,954 | 0.79 | | | |
| Pinedale | | 2,073 | 1,658,400 | 331,680 | 431,184 | 0.67 | | | |
| Mariano Lake | | 2,471 | 1,566,140 | 395,360 | 407,196 | 0.63 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.
8. Navajo communities in Gallup Jct. storage locations and capacity are in table 1 of the design data package.

Table 1. Storage tank capacities for Navajo communities served through the City of Gallup municipal system.

| Storage Tank Location | Community Served | 2020 Storage(gal) | 2040 Storage(gal) |
|---|---|---|---|
| NW Torrivio Mesa | Manuelito | 950,135 | 1,513,070 |
| Breadsprings Wash | Redrock, Breadsprings, Chichiltah | 5,882,720 | 9,772,009 |
| Perriti Canyon | Iyanbito | 1,281,095 | 1,969,054 |
| S Interstate 40 & E Rehoboth | Church Rock | 2,567,867 | 4,298,165 |
| S Red Rock State Park | Pinedale, Mariano Lake | 1,749,584 | 3,224,540 |

Note:
Storage tank locations are found on drawing "Navajo Gallup Water Supply Project, NIIP Alternative, Gallup Municipal System, Navajo Community Storage Locations". UTM coordinates for these location can be extracted from electronic data provided on compact disc.

Items List for Appendix C

1. San Juan River Alternative, Cutter Lateral, Delivery Data

02/02/01

Navajo - Gallup Water Supply Project (San Juan River Alternative): Project Node Assumptions
Cutter Lateral(Main transmission pipeline)

| Nodes | Length | 2020 | Storage | Average Daily | Peak Daily | | ummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| Cutter Reservoir | | 0 | 0 | 0 | 0 | 0.00 | | | |
| Cutter WTP | | | | | | 3.63 | 3.63 | | |
| Huerfano | 136,961 | 1,066 | 651,934 | 170,560 | 169,503 | 0.26 | 3.63 | 6,850 | 70 |
| Nageezi | 61,308 | 2,046 | 1,534,135 | 327,360 | 398,875 | 0.62 | 3.37 | 6,950 | 70 |
| Counselor | 105,773 | 5,102 | 3,064,000 | 816,320 | 1,040,326 | 1.61 | 2.75 | 6,860 | 70 |
| Counselor | | 2,846 | 2,276,800 | 455,360 | 591,968 | 0.92 | | | |
| Pueblo Pintado | | 984 | 787,200 | 157,440 | 204,672 | 0.32 | | | |
| Whitehorse Lake | | 1,272 | 0 | 203,520 | 243,686 | 0.38 | | | |
| Torreon | 85,396 | 4,087 | 2,845,549 | 653,920 | 739,843 | 1.14 | 1.14 | 6,600 | 70 |
| Ojo Encino | | 1,243 | 914,053 | 198,880 | 237,654 | 0.37 | | | |
| Torreon | | 2,844 | 1,931,495 | 455,040 | 502,189 | 0.78 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (San [illegible] River Alternative): Project Node Assumptions
Cutter Lateral(Main transmission pipeline)

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | ummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Cutter Reservoir | | 0 | 0 | 0 | 0 | 0.00 | | | |
| Cutter WTP | | | | | | 6.19 | 6.19 | | |
| Huerfano | 136,961 | 1,739 | 1,252,825 | 278,240 | 325,735 | 0.50 | 6.19 | 6,850 | 70 |
| Nageezi | 61,308 | 3,339 | 2,604,245 | 534,240 | 677,104 | 1.05 | 5.68 | 6,950 | 70 |
| Counselor | 105,773 | 8,329 | 5,002,400 | 1,332,640 | 1,696,455 | 2.62 | 4.63 | 6,860 | 70 |
| Counselor | | 4,646 | 3,716,800 | 743,360 | 966,368 | 1.50 | | | |
| Pueblo Pintado | | 1,607 | 1,285,600 | 257,120 | 334,256 | 0.52 | | | |
| Whitehorse Lake | | 2,076 | 0 | 332,160 | 395,831 | 0.61 | | | |
| Torreon | 85,396 | 6,672 | 4,993,895 | 1,067,520 | 1,298,413 | 2.01 | 2.01 | 6,600 | 70 |
| Ojo Encino | | 2,029 | 1,551,781 | 324,640 | 403,463 | 0.62 | | | |
| Torreon | | 4,643 | 3,442,114 | 742,880 | 894,950 | 1.38 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

Items List for Appendix D

1. NIIP Alternative, Delivery Data
2. Table 1. Storage Tank Capacities for Gallup area

02/02/01

# Navajo - Gallup Water Supply Project (NIIP Alternative): Project Node Assumptions
## West Lateral(main transmission pipeline)

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | ummulative CFS | Node Elevation | Required storage(PSI) |
|---|---|---|---|---|---|---|---|---|---|
| Moncisco | | 0 | 0 | 0 | 0 | 0.00 | 40.61 | | |
| Reservoir/WTP | | 0 | 0 | 0 | 0 | 0.00 | 40.61 | 6,030 | |
| NAPI | 100 | 0 | 0 | 0 | 446,370 | 0.69 | 40.61 | 6,030 | |
| East/West Tee | 4,478 | 0 | 0 | 0 | 0 | 3.63 | 39.91 | 5,990 | |
| Burnham | 56,732 | 513 | 0 | 82,080 | 106,704 | 0.17 | 36.28 | 6,190 | |
| Lake Valley Jct | 72,046 | 1,328 | 0 | 212,480 | 236,765 | 0.37 | 36.12 | 5,660 | |
| Lake Valley | | 909 | 0 | 145,440 | 149,613 | 0.23 | | | |
| White Rock | | 419 | 0 | 67,040 | 87,152 | 0.13 | | | |
| Tohatchi Jct. | 76,272 | 0 | 0 | 0 | 0 | 4.24 | 35.75 | 5,700 | |
| Tohatchi | 82,686 | 4,834 | 2,876,259 | 773,440 | 747,827 | 1.16 | 31.51 | 6,100 | 70 |
| Tohatchi | | 3,351 | 1,689,859 | 536,160 | 439,363 | 0.68 | | | |
| Mexican Springs | | 1,483 | 1,186,400 | 237,280 | 308,464 | 0.48 | | | |
| Coyote Cyn. Jct | 34,954 | 11,024 | 0 | 1,763,840 | 661,415 | 2.58 | 30.35 | 6,250 | |
| Twin Lakes | 15,594 | 4,102 | 2,745,956 | 656,320 | 713,949 | 1.10 | 27.78 | 6,380 | 70 |
| Ya-ta-hey Jct. | 31,161 | 31,042 | 0 | 4,966,720 | 5,301,977 | 8.20 | 26.67 | 6,560 | |
| Gallup Jct. | 20,482 | 50,703 | 0 | 9,543,417 | 11,936,379 | 18.47 | 18.47 | 6,935 | 4.2 |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

## Navajo - Gallup Water Supply Project (N[illegible]lternative): Project Node Assumptions
### East Lateral(Main transmission pipeline)

| Nodes | Length | 2020 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| East/West Tee | 4478 | 0 | 0 | 0 | 0 | 3.63 | 3.63 | | |
| Huerfano | 98,788 | 1,066 | 651,934 | 170,560 | 169,503 | 0.26 | 3.63 | 6,850 | 70 |
| Nageezi | 61,308 | 2,046 | 1,534,135 | 327,360 | 398,875 | 0.62 | 3.37 | 6,950 | 70 |
| Counselor | 105,773 | 5,102 | 3,064,000 | 816,320 | 1,040,326 | 1.61 | 2.75 | 6,860 | 70 |
| Counselor | | 2,846 | 2,276,800 | 455,360 | 591,968 | 0.92 | | | |
| Pueblo Pintado | | 984 | 787,200 | 157,440 | 204,672 | 0.32 | | | |
| Whitehorse Lake | | 1,272 | 0 | 203,520 | 243,686 | 0.38 | | | |
| Torreon | 85,396 | 4,087 | 2,845,549 | 653,920 | 739,843 | 1.14 | 1.14 | 6,600 | 70 |
| Ojo Encino | | 1,243 | 914,053 | 198,880 | 237,654 | 0.37 | | | |
| Torreon | | 2,844 | 1,931,495 | 455,040 | 502,189 | 0.78 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (NIIP [illegible]rnative): Delivery Assumptions
Tohatchi Junction

| Nodes | Length | 2020 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| | | | | | | | | | |
| Tohatchii Jct. | 76,272 | 0 | 0 | 0 | 0 | 4.24 | 4.24 | 5,700 | |
| Naschitti | 51,679 | 3,209 | 2,214,568 | 513,440 | 575,788 | 0.89 | 4.24 | 5,890 | 70 |
| Sheepsprings | 29,635 | 1,376 | 1,038,308 | 220,160 | 269,960 | 0.42 | 3.35 | 5,890 | 70 |
| Newcomb | 51,174 | 3,199 | 2,211,031 | 511,840 | 574,868 | 0.89 | 2.93 | 5,550 | 70 |
| Two Grey Hills | | 1,841 | 1,178,196 | 294,560 | 306,331 | 0.47 | | | |
| Newcomb | | 1,358 | 1,032,836 | 217,280 | 268,537 | 0.42 | | | |
| Sanostee | 70,163 | 4,340 | 2,931,892 | 694,400 | 762,292 | 1.18 | 2.04 | 5,580 | 70 |
| Shiprock Jct.* | 94,323 | 28,786 | 0 | 4,605,760 | 556,058 | 0.86 | 0.86 | 5,160 | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (NI[illegible]ernative): Delivery Assumptions
Coyote Canyon Junction

| Nodes | Length | 2020 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| | | | | | | | | | |
| Coyote Cyn. Jct. | 34,954 | 11,024 | 0 | 1,763,840 | 661,415 | 2.58 | 2.58 | 6,250 | |
| Coyote Cyn. | 35,938 | 2,573 | 1,848,606 | 411,680 | 480,638 | 0.74 | 2.58 | 6,160 | 70 |
| Standing Rock | 81,321 | 523 | 172,897 | 83,680 | 44,953 | 0.07 | 1.83 | 6,280 | 70 |
| Dalton Pass | 37,998 | 7,928 | 4,387,299 | 1,268,480 | 1,140,698 | 1.76 | 1.76 | 6,740 | 70 |
| Dalton Pass | | 653 | 522,400 | 104,480 | 135,824 | 0.21 | | | |
| Crownpoint | | 5,543 | 2,479,299 | 886,880 | 644,618 | 1.00 | | | |
| Littlewater | | 1,330 | 1,064,000 | 212,800 | 276,640 | 0.43 | | | |
| Becenti | | 402 | 321,600 | 64,320 | 83,616 | 0.13 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

# Navajo - Gallup Water Supply Project (NIIP Alternative): Delivery Assumptions
## Yah-ta-hey Junction

| Nodes | Length | 2020 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| Ya-ta-hey Jct. | 31,161 | 31,042 | 0 | 4,966,720 | 5,301,977 | 8.20 | 8.20 | 6,560 | |
| Rock Springs | 29,439 | 6,502 | 4,799,867 | 1,040,320 | 1,247,965 | 1.93 | 8.20 | 6,760 | 70 |
| Rock Springs | | 3,514 | 2,552,305 | 562,240 | 663,599 | 1.03 | | | |
| Tsayatoh | | 2,988 | 2,247,562 | 478,080 | 584,366 | 0.90 | | | |
| Window Rock | 58,887 | 24,540 | 15,592,352 | 3,926,400 | 4,054,011 | 6.27 | 6.27 | 6,760 | 70 |
| Fort Defiance | | 12,902 | 6,281,952 | 2,064,320 | 1,633,307 | 2.53 | | | |
| St. Michaels | | 11,638 | 9,310,400 | 1,862,080 | 2,420,704 | 3.75 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor.
peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day.
except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data
except for Gallup which has 1.48% growth rate.
4. Storage criteria based on Average Daily Demand * 5 days.
Only those Navajo communities that have existing NTUA lines will have storage.
4. Storage criteria based on average demand minus ground water for 5 days.
cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

# Navajo - Gallup Water Supply Project (NIIP Alternative): Project Node Assumptions
## Gallup Junction

| Nodes | Length (ft) | 2020 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Gallup Jct. | 20,482 | 50,703 | 0 | 9,543,417 | 11,936,379 | 18.47 | 18.47 | 6,935 | 4.2 |
| Gallup | | 32,904 | 0 | 6,695,577 | 8,704,215 | 13.47 | | | |
| Red Rock | | 2,171 | 1,522,542 | 347,360 | 395,861 | 0.61 | | | |
| Breadsprings | | 2,542 | 1,765,778 | 406,720 | 459,102 | 0.71 | | | |
| Chichiltah | | 3,243 | 2,594,400 | 518,880 | 674,544 | 1.04 | | | |
| Manuelito | | 1,316 | 950,135 | 210,560 | 247,035 | 0.38 | | | |
| Church Rock | | 3,712 | 2,567,867 | 593,920 | 667,645 | 1.03 | | | |
| Iyanbito | | 2,031 | 1,281,095 | 324,960 | 333,085 | 0.52 | | | |
| Pinedale | | 1,270 | 1,016,000 | 203,200 | 264,160 | 0.41 | | | |
| Mariano Lake | | 1,514 | 733,584 | 242,240 | 190,732 | 0.30 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.
8. Navajo communities in Gallup Jct. storage locations and capacities are in table 1 of the design data package.

02/02/01

# Navajo - Gallup Water Supply Project (NIIP Alternative): Project Node Assumptions
West Lateral(main transmission pipeline)

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | ummulative CFS | Node Elevation | Required storage(PSI) |
|---|---|---|---|---|---|---|---|---|---|
| Moncisco | | 0 | 0 | 0 | 0 | 0.00 | 65.36 | | |
| Reservoir/WTP | | 0 | 0 | 0 | 0 | 0.00 | 65.36 | 6,030 | |
| NAPI | 100 | 0 | 0 | 0 | 624,918 | 0.97 | 65.36 | 6,030 | |
| East/West Tee | 4,478 | 0 | 0 | 0 | 0 | 6.19 | 64.40 | 5,990 | |
| Burnham | 56,732 | 837 | 0 | 133,920 | 174,096 | 0.27 | 58.21 | 6,190 | |
| Lake Valley Jct | 72,046 | 2,168 | 0 | 346,880 | 397,558 | 0.62 | 57.94 | 5,660 | |
| Lake Valley | | 1,484 | 0 | 237,440 | 255,286 | 0.39 | | | |
| White Rock | | 684 | 0 | 109,440 | 142,272 | 0.22 | | | |
| Tohatchi Jct. | 76,272 | 0 | 0 | 0 | 0 | 12.49 | 57.33 | 5,700 | |
| Tohatchi | 82,686 | 7,890 | 4,941,644 | 1,262,400 | 1,284,827 | 1.99 | 44.84 | 6,100 | 70 |
| Tohatchi | | 5,470 | 3,005,644 | 875,200 | 781,467 | 1.21 | | | |
| Mexican Springs | | 2,420 | 1,936,000 | .387,200 | 503,360 | 0.78 | | | |
| Coyote Cyn. Jct | 34,954 | 17,995 | 0 | 2,879,200 | 1,112,594 | 4.44 | 42.85 | 6,250 | |
| Twin Lakes | 15,594 | 6,695 | 4,673,054 | 1,071,200 | 1,214,994 | 1.88 | 38.41 | 6,380 | 70 |
| Ya-ta-hey Jct. | 31,161 | 50,665 | 0 | 8,106,400 | 9,505,420 | 14.71 | 36.53 | 6,560 | |
| Gallup Jct. | 20,482 | 76,248 | 0 | 11,343,737 | 14,106,193 | 21.83 | 21.83 | 6,935 | 4.2 |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (N[illegible]lternative); Project Node Assumptions
East Lateral(Main transmission pipeline)

| Nodes | Length | 2040 | Storage | Average Daily | Peak Daily | | Cummulative | Node | Required |
|---|---|---|---|---|---|---|---|---|---|
| | (ft) | Population | | Demand(Gal.) | Demand(Gal.) | CFS | CFS | Elevation | P.S.I. |
| East/West Tee | 4478 | 0 | 0 | 0 | 0 | 6.19 | 6.19 | | |
| Huerfano | 98,788 | 1,739 | 1,252,825 | 278,240 | 325,735 | 0.50 | 6.19 | 6,850 | 70 |
| Nageezi | 61,308 | 3,339 | 2,604,245 | 534,240 | 677,104 | 1.05 | 5.68 | 6,950 | 70 |
| Counselor | 105,773 | 8,329 | 5,002,400 | 1,332,640 | 1,696,455 | 2.62 | 4.63 | 6,860 | 70 |
| Counselor | | 4,646 | 3,716,800 | 743,360 | 966,368 | 1.50 | | | |
| Pueblo Pintado | | 1,607 | 1,285,600 | 257,120 | 334,256 | 0.52 | | | |
| Whitehorse Lake | | 2,076 | 0 | 332,160 | 395,831 | 0.61 | | | |
| Torreon | 85,396 | 6,672 | 4,993,895 | 1,067,520 | 1,298,413 | 2.01 | 2.01 | 6,600 | 70 |
| Ojo Encino | | 2,029 | 1,551,781 | 324,640 | 403,463 | 0.62 | | | |
| Torreon | | 4,643 | 3,442,114 | 742,880 | 894,950 | 1.38 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

## Navajo - Gallup Water Supply Project (NIIP Alternative): Delivery Assumptions
## Tohatchi Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Tohatchii Jct. | 76272 | 0 | 0 | 0 | 0 | 12.49 | 12.49 | 5,700 | |
| Naschitti | 51,679 | 5,238 | 3,846,695 | 838,080 | 1,000,141 | 1.55 | 12.49 | 5,890 | 70 |
| Sheepsprings | 29,635 | 2,246 | 1,729,845 | 359,360 | 449,760 | 0.70 | 10.94 | 5,890 | 70 |
| Newcomb | 51,174 | 5,221 | 3,779,531 | 835,360 | 982,678 | 1.52 | 10.24 | 5,550 | 70 |
| Two Grey Hills | | 3,005 | 2,060,295 | 480,800 | 535,677 | 0.83 | | | |
| Newcomb | | 2,216 | 1,719,236 | 354,560 | 447,001 | 0.69 | | | |
| Sanostee | 70,163 | 7,083 | 4,983,454 | 1,133,280 | 1,295,698 | 2.00 | 8.72 | 5,580 | 70 |
| Shiprock Jct.* | 94,323 | 46,985 | 0 | 7,517,600 | 4,341,450 | 6.72 | 6.72 | 5,160 | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (NI[illegible]ernative): Delivery Assumptions
Coyote Canyon Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | Peak Daily CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Coyote Cyn. Jct. | 34,954 | 17,995 | 0 | 2,879,200 | 1,112,594 | 4.44 | 4.44 | 6,250 | |
| Coyote Cyn. | 35,938 | 4,200 | 3,087,714 | 672,000 | 802,806 | 1.24 | 4.44 | 6,160 | 70 |
| Standing Rock | 81,321 | 854 | 339,495 | 136,640 | 88,269 | 0.14 | 3.20 | 6,280 | 70 |
| Dalton Pass | 37,998 | 12,941 | 7,612,088 | 2,070,560 | 1,979,143 | 3.06 | 3.06 | 6,740 | 70 |
| Dalton Pass | | 1,065 | 852,000 | 170,400 | 221,520 | 0.34 | | | |
| Crownpoint | | 9,047 | 4,496,888 | 1,447,520 | 1,169,191 | 1.81 | | | |
| Littlewater | | 2,172 | 1,737,600 | 347,520 | 451,776 | 0.70 | | | |
| Becenti | | 657 | 525,600 | 105,120 | 136,656 | 0.21 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (NIIP Alternative): Delivery Assumptions
Yah-ta-hey Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| Ya-ta-hey Jct. | 31,161 | 50,665 | 0 | 8,106,400 | 9,505,420 | 14.71 | 14.71 | 6,560 | |
| Rock Springs | 29,439 | 10,613 | 7,941,365 | 1,698,080 | 2,064,755 | 3.19 | 14.71 | 6,760 | 70 |
| Rock Springs | | 5,735 | 4,244,295 | 917,600 | 1,103,517 | 1.71 | | | |
| Tsayatoh | | 4,878 | 3,697,070 | 780,480 | 961,238 | 1.49 | | | |
| Window Rock | 58,887 | 40,052 | 28,617,942 | 6,408,320 | 7,440,665 | 11.51 | 11.51 | 6,760 | 70 |
| Fort Defiance | | 21,059 | 13,423,542 | 3,369,440 | 3,490,121 | 5.40 | | | |
| St. Michaels | | 18,993 | 15,194,400 | 3,038,880 | 3,950,544 | 6.11 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
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6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.

02/02/01

Navajo - Gallup Water Supply Project (NIIP Alternative): Project Node Assumptions
Gallup Junction

| Nodes | Length (ft) | 2040 Population | Storage | Average Daily Demand(Gal.) | Peak Daily Demand(Gal.) | CFS | Cummulative CFS | Node Elevation | Required P.S.I. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Gallup Jct. | 20,482 | 76,248 | 0 | 11,343,737 | 14,106,193 | 21.83 | 21.83 | 6,935 | 4.2 |
| Gallup | | 47,197 | 0 | 6,695,577 | 8,704,215 | 13.47 | | | |
| Red Rock | | 3,543 | 2,562,114 | 566,880 | 666,150 | 1.03 | | | |
| Breadsprings | | 4,149 | 2,975,495 | 663,840 | 773,629 | 1.20 | | | |
| Chichiltah | | 5,293 | 4,234,400 | 846,880 | 1,100,944 | 1.70 | | | |
| Manuelito | | 2,148 | 1,513,070 | 343,680 | 393,398 | 0.61 | | | |
| Church Rock | | 6,059 | 4,298,165 | 969,440 | 1,117,523 | 1.73 | | | |
| Iyanbito | | 3,315 | 1,969,054 | 530,400 | 511,954 | 0.79 | | | |
| Pinedale | | 2,073 | 1,658,400 | 331,680 | 431,184 | 0.67 | | | |
| Mariano Lake | | 2,471 | 1,566,140 | 395,360 | 407,196 | 0.63 | | | |

Notes:

1. Peaking Factor is 1.30 while Peak demand is surface diversion with the peak factor. peak demand=(average demand - ground water)*1.3.
2. Average Daily Demand is based on 2040 population * 160 gallon per capita day. except for NAPI and Gallup which have a fixed diversion amount
3. 2040 population is based on 2.48% growth rate from 1990 Census data except for Gallup which has 1.48% growth rate.
4. Storage criteria based on average demand minus ground water for 5 days. Only those Navajo communities that have existing NTUA lines will have storage.
5. City of Gallup will service all areas below Gallup Jct. No design or cost estimate required for these communities except for storage purposes.
6. City of Gallup has a total of 7500 AF/YR.
7. Rounding errors may cause subtotals to be off by .01.
8. Navajo communities in Gallup Jct. storage locations and capacity are in table 1 of the design data package.

Table 1. Storage tank capacities for Navajo communities served through the City of Gallup municipal system.

| Storage Tank Location | Community Served | 2020 Storage(gal) | 2040 Storage(gal) |
|---|---|---|---|
| NW Torrivio Mesa | Manuelito | 950,135 | 1,513,070 |
| Breadsprings Wash | Redrock, Breadsprings, Chichiltah | 5,882,720 | 9,772,009 |
| Perriti Canyon | Iyanbito | 1,281,095 | 1,969,054 |
| S Interstate 40 & E Rehoboth | Church Rock | 2,567,867 | 4,298,165 |
| S Red Rock State Park | Pinedale, Mariano Lake | 1,749,584 | 3,224,540 |

Note:
Storage tank locations are found on drawing "Navajo Gallup Water Supply Project, NIIP Alternative, Gallup Municipal System, Navajo Community Storage Locations". UTM coordinates for these location can be extracted from electronic data provided on compact disc.

Items List for Appendix E

1. Electronic Files

# REPORT ON HYDROGEOLOGICAL SURVEY FOR THE FLUOR CORPORATION LTD. WESTERN GASIFICATION CO. SAN JUAN RIVER, NEW MEXICO

September 27, 1973

SW-61

## TABLE OF CONTENTS



## LIST OF ILLUSTRATIONS

REPORT ON

HYDROGEOLOGICAL SURVEY

FOR

THE FLUOR CORPORATION LTD.

WESTERN GASIFICATION CO.

SAN JUAN RIVER, NEW MEXICO

## I PURPOSE OF SURVEY:

This report presents the results of a hydrogeological survey conducted to determine the feasibility of developing a naturally-filtered water supply of 44,000 acre-feet per year (39.2 MGD) by means of Ranney Collectors constructed adjacent to the San Juan River.

This work was carried out under Fluor Engineers and Constructors, Inc. Purchase Order No. 4416-0-003 dated February 14, 1973.

## II ACKNOWLEDGEMENTS:

The assistance and cooperation of the following individuals and firms, which aided materially during this investigation, is gratefully acknowledged: Mr. Dan Cook, Western Gasification Company; Mssrs. Paul Michalko and Joe Fiebig, The Fluor Corporation Ltd.; Mr. John Gilbert, Gilbert Drilling Company; and Mssrs. Jim Cooper and J. P. Borland, U. S. Geological Survey.

## III LOCATION AND HYDROGEOLOGY:

The area covered by this investigation is located in the flood plain of the San Juan River about midway between the cities of Shiprock and Farmington, New Mexico, as more specifically shown on the Location Map in Figure SW-61-1. A total of nine preliminary exploratory test holes were drilled to determine the character and thickness of the underlying unconsolidated alluvial deposits. The locations of the test holes are shown in Figure SW-61-1 and their logs in Figure SW-61-2.

Test Holes 1, 6, 2, 3 and 9 were drilled along the south bank of the San Juan River in an area commencing at the Hogback and extending a distance of 3,200 feet upstream. These test holes showed the existence of permeable sand and gravel deposits extending from ground surface to depths of 18.5 to 22.5 feet, where bedrock was encountered. The materials consist predominately of clean sand, pea to medium gravel, and occasional boulders, having a saturated thickness below low river stage varying from 14.5 to 19 feet. The observed static water levels were at or near the elevation of the river water surface indicating that the aquifer is hydraulically connected with the river and therefore an infiltrated water supply can be developed. In view of favorable indications, it was decided to conduct a series of five pumping tests in this area.

Test Holes 4 and 5 were drilled along the south bank of the river at distances of 2,000 and 1,450 feet, respectively, downstream from Test Hole 1. Both of these test holes showed a depth of sand and gravel of only 14.5 feet and a saturated thickness below low river stage of only 10.5 feet. Because of the shallow depth of materials and because of the fact that these sites are downstream from the Hogback Canal Diversion and consequently in an area where the river flow may be reduced by 220 cubic feet per second due to diversions during the irrigation season, this area is not considered suitable for a major water supply development.

Test Hole 7, located on the south bank of the river about 4 1/2 miles upstream from the Hogback and about 2,000 feet upstream from the Arizona Public Service Company river intake, encountered alluvial sands and gravels from ground surface to a depth of 19 feet, where bedrock was encountered, indicating a saturated thickness below low river stage of 12.5 feet. Since more favorable conditions appear to exist in that area between Test Holes 1 and 9, no further testing was carried out on this site at this time. However, it is felt that the results of this single test hole should not rule out the possibilities for future development of this large alluvial flat, which is over 2 1/2 miles in length.

Test Hole 8, located on the north bank of the river about 1 1/2 miles upstream from the Hogback, encountered bedrock at a depth of 18.5 feet. The alluvial materials overlying the bedrock consist largely of impermeable clays and gravels and the saturated thickness of permeable sands and gravels is only 8 feet below low river. However, as was the case at Test Hole 7, it is felt that the unfavorable results of this single test hole should not eliminate this alluvial flat from consideration for future development.

## IV PUMPING TESTS:

A series of detailed pumping tests were carried out in the area between Test Holes 1 and 9 to determine the permeability of the aquifer, the infiltration rate of the river bed and other data necessary to the design of a Ranney Collector System. These pumping tests are described as follows:

### Pumping Test - T.H.1:

For this test, a pumping well and four observation wells were drilled. The locations of the wells are shown in Figure SW-61-3 and their logs in Figure SW-61-5. The pumping well, 1PW, was pumped continuously, at a constant rate of 151 gallons per minute, from 7:00 a.m. on April 13 until 2:00 p.m. on April 15, 1973, a total of 55 hours. The temperature of the discharge water was 50°F. and that of the river varied from 49 - 54°F. The flow of the San Juan River, as measured at the Farmington gage, was 2,645 cfs. Water levels in observation wells and changes in river stage were recorded continuously and are shown on the hydrographs in Figure SW-61-7.

Pumping Test - T.H.2:

For this test, a pumping well and a single observation well were used. The locations of the wells are shown in Figure SW-61-3 and their logs in Figure SW-61-5. The pumping well, 2PW, was pumped continuously, at a constant rate of 197 gallons per minute, from 9:00 a.m. on April 30 until 8:00 p.m. on May 3, 1973, a total of 83 hours. The temperature of the discharge water was 52°F. and that of the river varied from 45 - 50 1/2°F. The flow of the San Juan River was 4,070 cfs. Water levels in observation wells and changes in river stage were recorded continuously and are shown on the hydrographs in Figure SW-61-8.

Pumping Test - T.H.3:

For this test, a pumping well, three observation wells and two shallow pits were constructed. The locations of wells are shown in Figure SW-61-3 and their logs in Figure SW-61-5. The pumping well, 3PW, was pumped continuously, at a constant rate of 178 gallons per minute, from 7:00 a.m. on April 26 until 2:00 p.m. on April 28, 1973, a total of 55 hours. The temperature of the discharge water was 52°F. and that of the river varied from 50 - 54°F. The flow of the San Juan River varied from 2,480 to 3,120 cfs. Water levels in observation wells and changes in river stage were recorded continuously and are shown on the hydrographs in Figure SW-61-9.

Pumping Test - T.H.6:

For this test, a pumping well and three observation wells were drilled. The locations of the wells are shown in Figure SW-61-4 and their logs in Figure SW-61-6. The pumping well, 6PW, was pumped continuously, at a constant rate of 128 gallons per minute, from 1:00 p.m. on September 1 until 8:00 a.m. on September 4, 1973, a total of 67 hours. The temperature of the discharge water was 60°F. and that of the river varied from 54 to 62°F. The flow of the San Juan River varied from 4,140 to 3,970 cfs. Water levels in observation wells and changes in river stage were recorded continuously and are shown on the hydrographs in Figure SW-61-10.

Pumping Test - T.H.9:

For this test, a pumping well and three observation wells were used. The locations of the wells are shown in Figure SW-61-4 and their logs in Figure SW-61-6. The pumping well, 9PW, was pumped continuously, at a constant rate of 164 gallons per minute, from 12:00 noon on September 5, until 11:00 a.m. on September 9, 1973, a total of 95 hours. The temperature of the discharge water was 59°F. and that of the river varied from 56 to 61°F. The flow of the San Juan River varied from 3,800 to 3,480 cfs. Water levels in observation wells and changes in river stage were recorded continuously and are shown on the hydrographs in Figure SW-61-11.

## V PERMEABILITY COMPUTATIONS:

The observed drawdowns for the various pumping tests, corrected for changes in river stage and aquifer dewatering, are shown on the distance-drawdown graphs in Figures SW-61-12 and SW-61-13. Also shown are the computations of transmissibility, permeability, effective distance to the line of infiltration, and the river bed infiltration rate(1). These results have been adjusted to a water temperature of 60°F., using the water temperature-viscosity relationship, and are summarized in the table below:

Water Temperature 60°F.

| Site | Transmissibility (GPD/ft.) | Permeability (GPD/sq.ft.) | Effective Distance to Line of Infiltration (ft.) | River bed Infiltration Rate (GPD/sq.ft./ft.) |
|---|---|---|---|---|
| T.H.1 | 20,220 | 1,155 | 140 | 9.3 |
| T.H.6 | 17,080 | 923 | 48.5 | 155 |
| T.H.2 | 23,060 | 1,154 | -- | -- |
| T.H.3 | 32,880 | 1,777 | 151 | 168 |
| T.H.9 | 22,020 | 1,377 | 45.5 | 167 |
| Average | (Excluding T.H.1) | 1,308 | -- | 163 |

(Note: Results for T.H.2 determined by a direct comparison with the results at T.H.3).

The foregoing table shows that permeabilities range from 923 to 1,777 and average 1,308 gallons per day per square foot. This is considered a moderately low permeability and probably is the result of the presence of a small amount of fine sand in the aquifer. The effective distances to the line of infiltration clearly reflect the fact that the pumping wells at T.H.1 and T.H.3 were much further from the river's edge than those at T.H.6 and T.H.9.

(1) For further discussions of this type of analysis see: WALTON, W.C. "Estimating the Infiltration Rates of a Streambed by Aquifer-Test Analysis" Inter. Assoc. Sci, Hydrology. Genl. Assembly of Berkeley (1963) and MIKELS, F. C. and KLAER, F. H. "Application of Ground Water Hydraulics to the Development of Water Supplies by Induced Infiltration," Symposia Darcy, Dijon, Sept. 1956, Pub. No. 41, Association Internationale d'Hydrologie.

With the exception of the T.H.1 site, the river bed infiltration rate is fairly uniform, ranging from 155 to 168 and averaging 163 gallons per day per square foot per foot of head. This corresponds to an infiltration rate of 7.1 MGD per acre per foot, which, as would be expected, is within the range of a slow sand filter. Fair and Geyer(2) give infiltration rates for slow sand filters ranging from 5 to 50 MGD per acre per foot.

Because of the very low apparent river bed infiltration rate at the site of T.H.1 and because T.H.1 is located downstream from the Hogback Canal Diversion, this site is not considered suitable for development and therefore is not included in the yield computations in this report.

## VI FLOW CHARACTERISTICS - SAN JUAN RIVER:

Water profiles of the San Juan River at the test site are shown in Figure SW-61-14. The profile for the river flow of 7,100 cfs at Farmington was determined by a field survey on May 15, 1973. The profile for the 50-year flood flow of 40,000 cfs is based upon data furnished by the Sacramento District - Corps of Engineers.

The profiles for the maximum observed flood of 68,000 cfs and low river stage of 300 cfs were determined by correlation of observed river stages at the test site with the rating curve for the San Juan River at Farmington. The river flow of 300 cfs has been conservatively taken as low river stage at the test site based upon a study of stream flow records at Farmington for the period 1962-1972, i.e., the period of record since partial control of the river has been in effect by the operation of Navajo Reservoir. These records show that the minimum mean monthly flow has ranged from 329 to 1,159 cfs generally being in excess of 400 cfs, and the extreme minimum daily flow has ranged from 200 to 729 cfs, generally being in excess of 300 cfs.

The records show further that the low water periods normally occur during the fall and winter months of September through March, with most of the low water periods being in January and March.

## VII RANNEY COLLECTOR YIELD:

Because of the moderately low permeability and limited amount of head available for development, a Ranney Collector System, having an "infiltration gallery-type" rather than a "conventional radial-type" development has been selected for maximum aquifer development. Bennett(3)

(2) FAIR, G.M. AND GEYER, J.C. "Water Supply and Waste-water Disposal." John Wiley and Sons, Inc. New York. 1954

(3) BENNETT, TRUMAN W. "On the Design and Construction of Infiltration Galleries" Groundwater, 1970.

and others have given the following equation for an infiltration gallery constructed parallel to a recharge boundary:

$$Q = \left( \frac{PmsL}{D} + \frac{2 \pi Pms}{2.3 \log \frac{2D}{r_e}} \right) \frac{V_1}{V_2}$$

in which,

- Q = Gallery Yield, in gallons per day.
- P = Permeability of the aquifer for a water temperature of 60°F, in gallons per day per square foot.
- m = Average saturated thickness, in feet.
- s = Drawdown below river level, in feet.
- D = Effective distance to the line of infiltration, in feet.
- L = Effective gallery length, in feet.
- $r_e$ = Effective radius of the gallery ends, in feet.
- $V_1$ = Viscosity correction factor for a water temperature of 60°F.
- $V_2$ = Viscosity correction factor for the water temperature for which the yield is being computed.

In the foregoing expression, the first term represents direct linear flow to the gallery, as determined by Darcy's Law, and the second term represents radial flow to the gallery ends.

The extreme minimum yield of the Ranney Collector System will occur when low river stage conditions and low water temperatures coincide. A review of water temperature records for the San Juan River shows a seasonal variation ranging from a low of 36°F. in January to a high of 77°F. in July. It is anticipated that the temperature of the water produced from the Ranney Collector System will range from 40 to 73°F. Since low river stages normally occur in January and will coincide with low water temperatures, this period can be expected to be the period of extreme minimum yield.

The proposed design for the Ranney Collector System is shown in Figure SW-61-15. The proposed system will result in an infiltration gallery having an effective length of 2,750 feet. The pertinent design elevations for the Ranney Collectors are given in the following table:

| Collector No. | GROUND ELEV. (MSL) | LOW WATER ELEV. (MSL) | BEDROCK ELEV. (MSL) | MINIMUM AQUIFER THICKNESS (ft.) |
|---|---|---|---|---|
| 1 | 5001.5 | 4999 | 4981.5 | 17.5 |
| 2 | 5003 | 4999.5 | 4980.5 | 19.0 |
| 3 | 5004 | 5001 | 4983.5 | 17.5 |
| 4 | 5005 | 5002 | 4985.0 | 17.0 |
| 5 | 5006 | 5002.5 | 4988.0 | 14.5 |
| | | | Average | 17 |

The effective distance to the line of infiltration will be a function of the amount of water pumped and can be determined from the following expression:

$$D = \frac{Q\ V_2}{IhLV_1}$$

in which,

D = Effective distance to the line of infiltration, in feet.
Q = Gallery yield, in gallons per day.
I = River bed infiltration rate at 60°F., in gallons per day per square foot per foot.
h = Average river depth, in feet.
L = Effective gallery length, in feet.
$V_1$ = Viscosity correction factor for a water temperature of 60°F.
$V_2$ = Viscosity correction factor for the water temperature for which the yield is being determined.

For a design yield of 9.8 MGD, the water requirement for one plant, and conservatively using an average low water depth of one foot and a minimum water temperature of 36°F., the effective distance to the line of infiltration is computed as:

$$D = \frac{(9,800,000)(1.48)}{(163)(1)(2,750)(1.00)} = 32.4 \text{ feet}$$

Using an average drawdown of 10 feet below low river stage and a minimum water temperature of 40°F., the yield of the Ranney Collector System will be:

$$Q_{min.} = \left(\frac{(1,308)(12)(10)(2,750)}{32.4} + \frac{2\pi(1,308)(12)(10)}{2.3 \log\frac{2(32.4)}{25}}\right)\frac{1.00}{1.37}$$

$Q_{min.}$ = 10.5 million gallons per day

= 11,800 acre-feet per year

The above computation shows that the proposed Ranney Collector System will be capable of providing a minimum yield slightly in excess of the water requirements for one plant. It is pointed out that this computation is considered conservative, since it does not include the direct vertical infiltration that will occur to the horizontal laterals directly underlying the river bed.

The foregoing computation has been based upon average conditions throughout the proposed area of development. The yields of individual Ranney Collectors will vary due to the varying permeability and saturated depth. The yield computations have been adjusted for these variations and are tabulated as follows:

| COLLECTOR NUMBER | MINIMUM YIELD (MGD) |
|---|---|
| 1 | 1.8 |
| 2 | 2.2 |
| 3 | 2.8 |
| 4 | 1.9 |
| 5 | 1.8 |
| TOTAL | 10.5 |

## VIII WATER QUALITY AND TEMPERATURE:

The chemical analyses of water samples collected during the tests are given in Table A at the end of the report. These analyses show that the water pumped during the pumping test is much higher in mineralization than that of the San Juan River. This is to be expected, since the water produced during the tests represents the relatively stagnant ground water in the area rather than infiltrated water from the river, the pumping test rates being too small and the duration of the tests too short to induce water into the aquifer from the river. This is further evidenced by the fact that the water produced at the tests of Test Holes 6 and 9 is substantially less mineralized than that at the tests of Test Hole 1, 2, and 3, by virtue of the fact that Test Holes 6 and 9 are much closer to the river's edge than Test Holes 1, 2 and 3.

A further indication of this is shown by the field tests of hardness at Well 9PW taken at several intervals during the pumping test:

| | Hardness as $CaCO_3$ (ppm) | |
|---|---|---|
| Pumping Hours | Well 9PW | San Juan River |
| 1 | 1666 | -- |
| 48 | 1026 | -- |
| 71 | 850 | -- |
| 95 | 731 | 154 |

The reduction in hardness, as pumping progressed, clearly shows the beginning effects of induced infiltration from the river.

Since most of the water produced from the Ranney Collector System will be infiltrated from the river, the dissolved inorganic chemical quality of the water produced will approach that of the river, once continuous pumping has started. However, because of the high mineralization of the normal ground water in the area, it is anticipated that individual mineral constituents may range from 10 to 20 percent higher than those of the river.

Being naturally filtered, the water produced will be clear and free of silt, sand, turbidity, organic matter and pathogenic bacteria. The temperature of the water produced will have a seasonal temperature variation similar to that of the river except that it will be less in magnitude. It is estimated that the temperature of the water produced will range from 40 to 73$^{o}$F.

## IX COST OF RANNEY COLLECTOR SYSTEM:

The proposed design for a Ranney Collector System capable of supplying 9.8 MGD, i.e., the water requirements for one plant, is shown in Figure SW-61-15. The Collector caissons have been designed to extend two feet above the maximum observed flow of 68,000 cfs.

We estimate the cost to construct a Ranney Collector System, designed for a minimum yield of 9.8 MGD and as set forth in Figure SW-61-15, will not exceed

THE LUMP SUM OF. . . . . . . . . . . . . . . .$575,000.00
(Five Hundred Seventy-Five Thousand and no/100 Dollars)

This cost estimate is for the Ranney Collectors only, fully-developed, tested and ready for operation, but exclusive of superstructures, slabs, pumps, discharge piping, electrical and accessory equipment. Sales tax, access roads and temporary construction power are not included in the cost estimate. Furthermore, this cost estimate is based upon present day labor and materials costs. Extension of the costs to future construction dates should be based upon the Engineering News Record Construction Cost Index.

## X FUTURE DEVELOPMENT:

Based upon the results of the present study, it is considered reasonable to assume that the water requirement of 9.8 MGD for each additional plant expansion will require approximately 3000 feet of river front property and a development similar to that proposed in this report for the initial water requirement. On this basis, several areas have been selected for future development and are shown in Figure SW-61-16.

These areas have been selected from a field reconnaissance of the river valley and are based upon topographical features and the appearance of sands and gravels along the river bank. The areas have been numbered in the order of preference with the thought in mind of keeping the entire water supply development within one general area, i.e., Areas 5 and 6 will not be used unless one of the Areas 2, 3 and 4 is found to be unsuitable.

A detailed testing program, similar to that carried out in this study, will be required in each area to determine the suitability of the area for the future water supply development. Initially, the testing will consist of the drilling of five exploratory test holes, spaced at 600-foot intervals, to determine the character and thickness of the underlying unconsolidated alluvial deposits. If favorable conditions are found to exist, detailed pumping tests will be required to determine the permeability of the aquifer, the river bed infiltration rate, and other data necessary to the design of a Ranney Collector System. It is anticipated that three pumping tests will be required in each area - one in the middle of the area and one at each end of the area. Each pumping test will consist of the drilling of a pumping well, two observation wells (the test hole will be used as a third observation well) and the conducting of a continuous, constant rate pumping test of at least 48 hours duration.

We estimate the cost to conduct such a testing program, for each area, as follows:

| | | |
|---|---|---|
| Five (5) Exploratory Test Holes @ $2,000.00/each | = | $10,000.00 |
| Three (3) Detailed Pumping Tests @ $5,000.00/each | = | 15,000.00 |
| Total (Excluding New Mexico Gross Receipt Tax) | | $25,000.00 |

We estimate the time required to conduct the testing program, for each area, will be 9 weeks.

## XI SUMMARY AND CONCLUSIONS:

The hydrogeological survey consisted of drilling nine preliminary exploratory test holes and the conducting of five detailed pumping tests in the flood plain valley of the San Juan River about midway between the cities of Shiprock and Farmington, New Mexico, as more specifically shown on the Location Map in Figure SW-61-1.

The exploratory test holes show that the valley is underlain by permeable sand and gravel deposits, with the most favorable conditions occurring in the stretch of river between Test Holes 6 and 9. In this area, the sand and gravel deposits extend from ground surface to depths of 18.5 to 22.5 feet, where bedrock was encountered.

Pumping tests in this area show that the aquifer has a moderately low permeability, averaging 1,308 gallons per day per square foot at 60°F.

The tests further show that the aquifer is hydraulically connected with the river and therefore an infiltrated water supply can be developed. The average infiltration rate of the river bed is determined as 163 gallons per day per square foot at 60°F. This corresponds to an infiltration rate of 7.1 MGD per acre per foot, which, as would be expected, is within the range of a slow sand filter.

The extreme minimum yield of a Ranney Collector System, designed and constructed as shown in Figure SW-61-15, is computed as 10.5 MGD (11,800 acre-feet per year), which is slightly in excess of the water requirements for one plant. It is pointed out that this computation is considered conservative, since it does not include the direct vertical infiltration that will occur to the horizontal laterals directly underlying the river bed.

Since most of the water produced from the Ranney Collector System will be infiltrated from the river, the dissolved inorganic chemical quality of the water produced will approach that of the river, once continuous pumping has started. However, because of the high mineralization of the normal ground water in the area, it is anticipated that individual mineral constituents may range from 10 to 20 percent higher than those of the river.

Being naturally filtered, the water produced will be clear and free of silt, sand, turbidity, organic matter and pathogenic bacteria. The temperature of the water produced will have a seasonal temperature variation similar to that of the river except that it will be less in magnitude. It is estimated that the temperature of the water produced will range from 40 to 73°F.

We estimate the cost to construct a Ranney Collector System, designed for a minimum yield of 9.8 MGD and as set forth in Figure SW-61-15, will not exceed

THE LUMP SUM OF. . . . . . . . . . . . . . . . .$575,000.00
(Five Hundred Seventy-Five Thousand and no/100 Dollars)

This cost estimate is for the Ranney Collectors only, fully-developed, tested and ready for operation, but exclusive of superstructures, slabs, pumps, discharge piping, electrical and accessory equipment. Sales tax, access roads and temporary construction power are not included in the cost estimate. Furthermore, this cost estimate is based upon present day labor and materials costs. Extension of the costs to future construction dates should be based upon the Engineering News Record Construction Cost Index.

Based upon the results of the present study, it is considered reasonable to assume that the water requirement of 9.8 MGD for each additional plant expansion will require approximately 3000 feet of river front property and a development similar to that proposed in this report for the initial water requirement. On this basis, several areas have been selected for future development and are shown in Figure SW-61-16.

A detailed testing program, similar to that carried out in this study, will be required in each area to determine the suitability of the area for future water supply development. We estimate the cost to conduct such a testing program, for each area, will be $25,000.00 and will require nine weeks to complete.

Respectfully submitted,

RANNEY METHOD WESTERN CORPORATION

Frederick C. Mikels

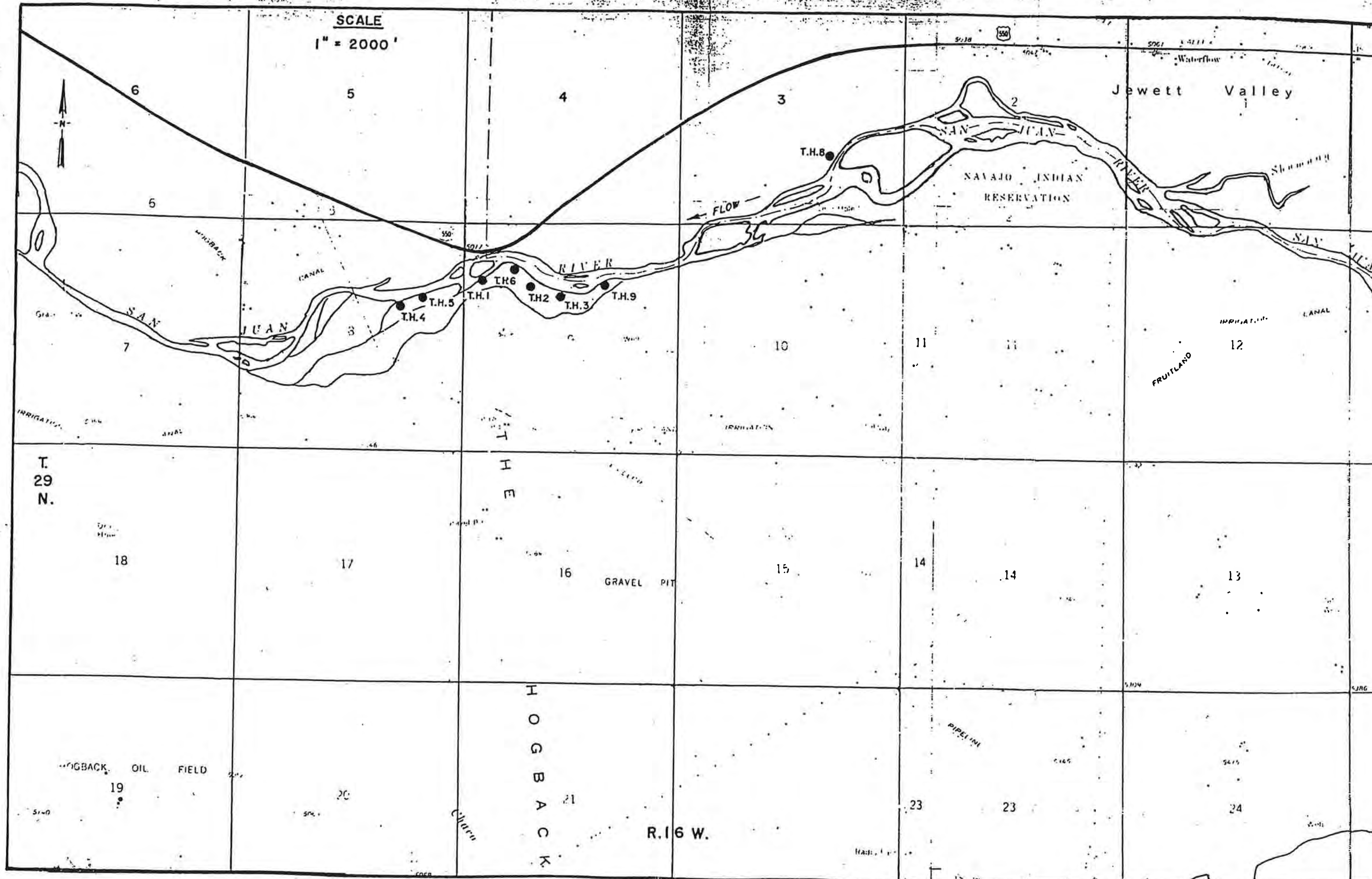
Frederick C. Mikels, P.E.
President & Chief Engineer

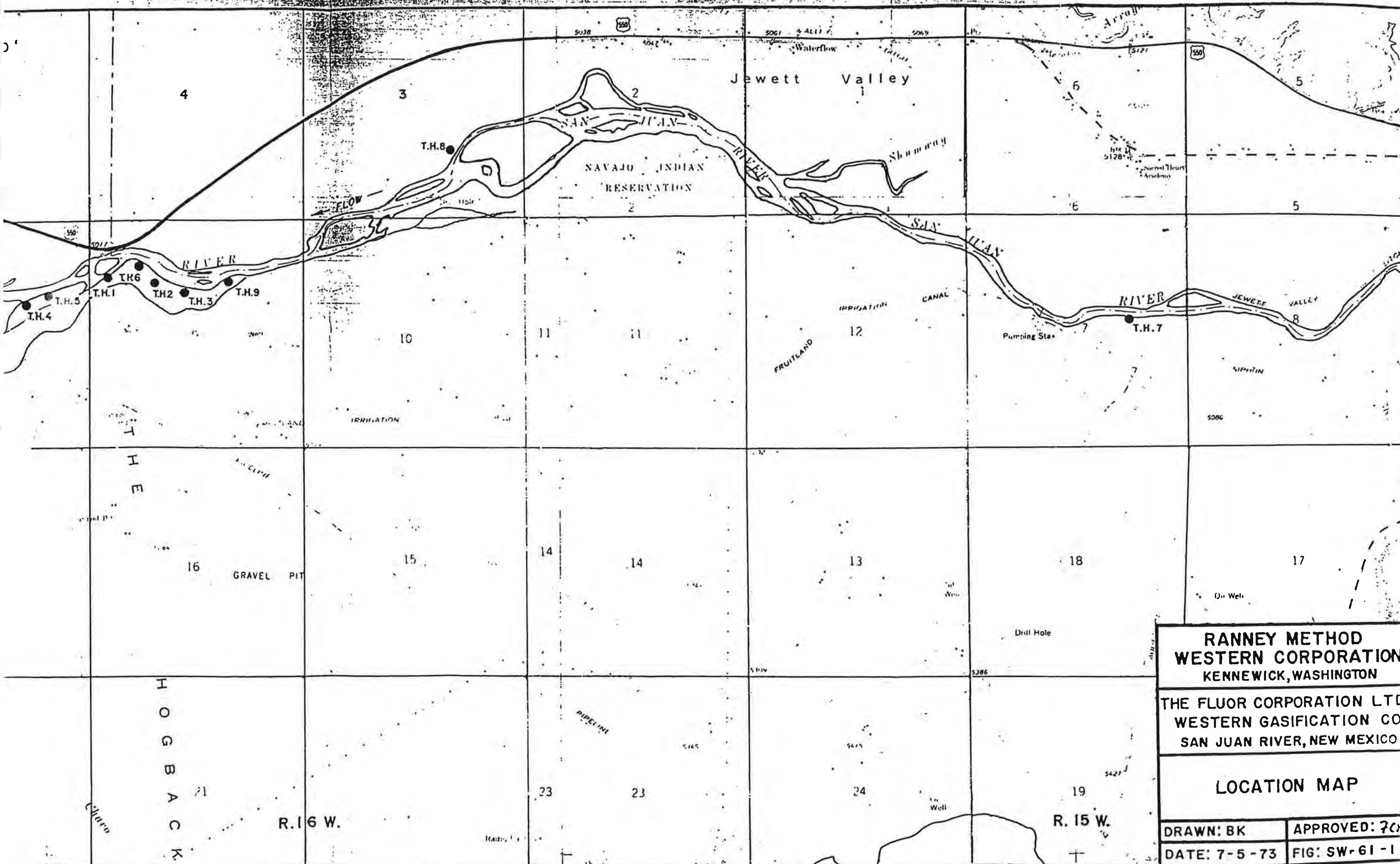
September 27, 1973

TABLE A - CHEMICAL ANALYSES OF WATER SAMPLES(1)

| | PARTS PER MILLION EXCEPT pH VALUE | | | | | | |
|---|---|---|---|---|---|---|---|
| )NSTITUENT | San Juan River 4-15-73 | 1PW 4-15-73 | T.H.2 5-3-73 | 3PW 4-28-73 | 6PW 9-4-73 | 9PW 9-9-73 | San Juan River 9-9-73 |
| ırbonate Alkalinity ($C_aCO_3$) | 18. | 0 | 0 | 0 | 18. | 0 | 0 |
| icarbonate Alkalinity ($C_aCO_3$) | 127. | 483. | 270. | 310. | 177. | 243. | 86. |
| ardness ($CaCO_3$) | 206. | 1035. | 1142. | 695. | 178. | 344. | 154. |
| odium (Na) | 35. | 238. | 415. | 59. | 160. | 100. | 25. |
| alcium (Ca) | 60. | 275. | 260. | 155. | 48. | 105. | 50. |
| agnesium (Mg) | 14. | 85. | 120. | 75. | 14. | 20. | 7.5 |
| ron (Fe) | < 0.04 | < 0.04 | 0.05 | 0.04 | < 0.08 | < 0.08 | 0.54 |
| anganese (Mn) | < 0.02 | 0.80 | 3.7 | 1.5 | < 0.02 | 0.60 | < 0.02 |
| rsenic (As) | 0.002 | 0.005 | < 0.005 | 0.002 | 0.002 | 0.002 | 0.002 |
| ilica ($SiO_2$) | 17. | 23. | 16. | 16. | 6. | 9. | 8. |
| loride (Cl) | 17. | 210. | 350. | 89. | 100. | 8.7 | 39. |
| ılfate ($SO_4$) | 166. | 772. | 1470. | 380. | 180. | 300. | 70. |
| luoride (F) | 0.74 | 1.0 | 0.53 | 0.37 | 0.33 | 0.40 | 0.37 |
| itrate Nitrogen (N) | 0.45 | 0.02 | 0.04 | 0.24 | 0.26 | 0.36 | 0.37 |
| itrate Nitrogen (N) | 0.01 | 0.002 | < 0.001 | < 0.002 | 0.01 | 0.007 | 0.007 |
| otal Solids | 1672. | 3756. | 3644. | 2164. | 640. | 784. | 360. |
| issolved Solids | 422. | 3741. | 3644. | 2164. | 625. | 699. | 260. |
| uspended Solids | 1250. | 15. | 0 | 0 | 15. | 85. | 100. |
| ırbidity (JTU) | 3000. | < 1. | 0.6 | 0.24 | 2. | < 1. | 21. |
| olor | 20. | < 5. | < 5. | < 5. | < 5. | < 5. | 5. |
| I Value | 8.1 | 7.2 | 7.0 | 7.5 | 8.4 | 7.4 | 7.45 |

I) Analyses by MEI CHARLTON LABORATORIES, Portland, Oregon


SCALE
1" = 2000'
N
6
5
4
3
2
Jewett Valley
Waterflow
T.H.8
SAN JUAN RIVER
NAVAJO INDIAN RESERVATION
FLOW
T.H.1
T.H.2
T.H.3
T.H.4
T.H.5
T.H.6
T.H.9
SAN JUAN
CANAL
7
8
10
11
12
FRUITLAND
T. 29 N.
18
17
16
GRAVEL PIT
15
14
13
THE HOGBACK
HOGBACK OIL FIELD
19
21
23
24
R.16 W.



Jewett Valley
Waterflow
SAN JUAN RIVER
NAVAJO INDIAN RESERVATION
FLOW
Shumway
T.H.8
T.H.6
T.H.1
T.H.5
T.H.4
T.H2
T.H.3
T.H.9
T.H.7
IRRIGATION CANAL
FRUITLAND
JEWETT VALLEY
SIPHON
Pumping Sta.
Drill Hole
GRAVEL PIT
IRRIGATION
PIPELINE
THE HOGBACK
R.16 W.
R. 15 W.
4
3
2
1
6
5
10
11
12
7
8
16
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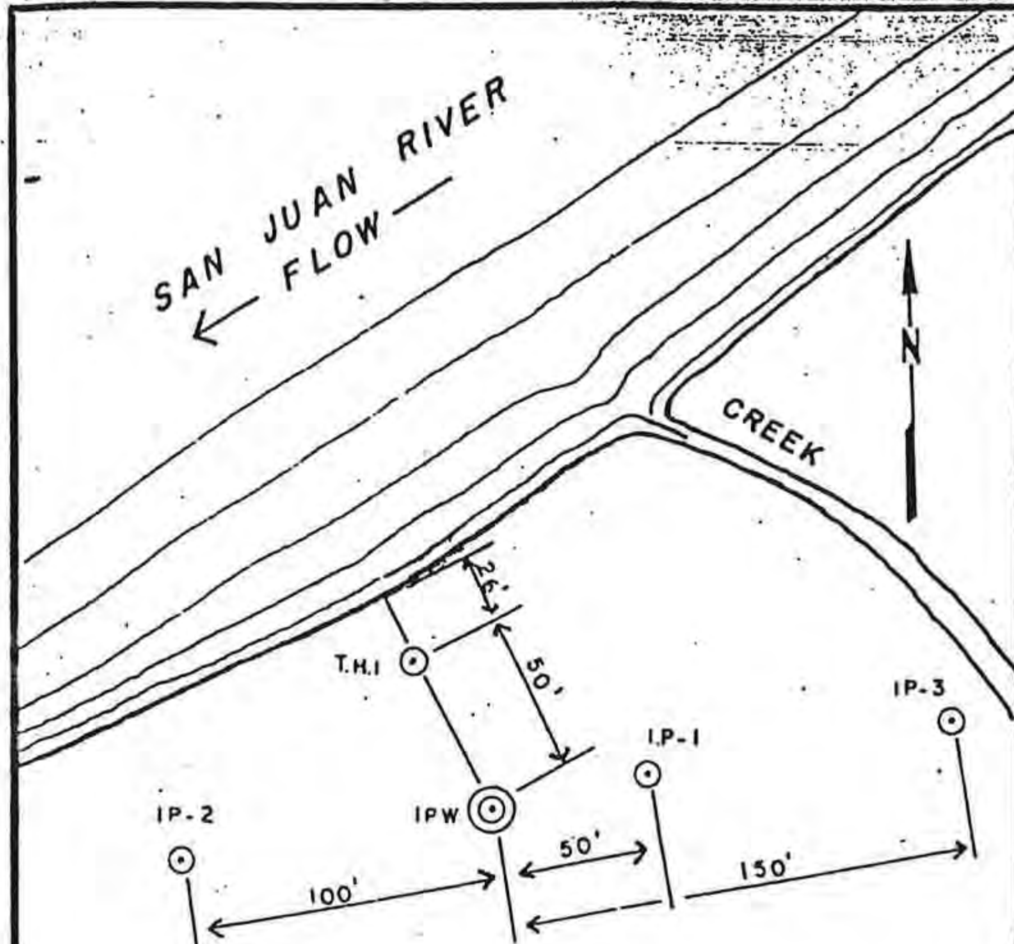
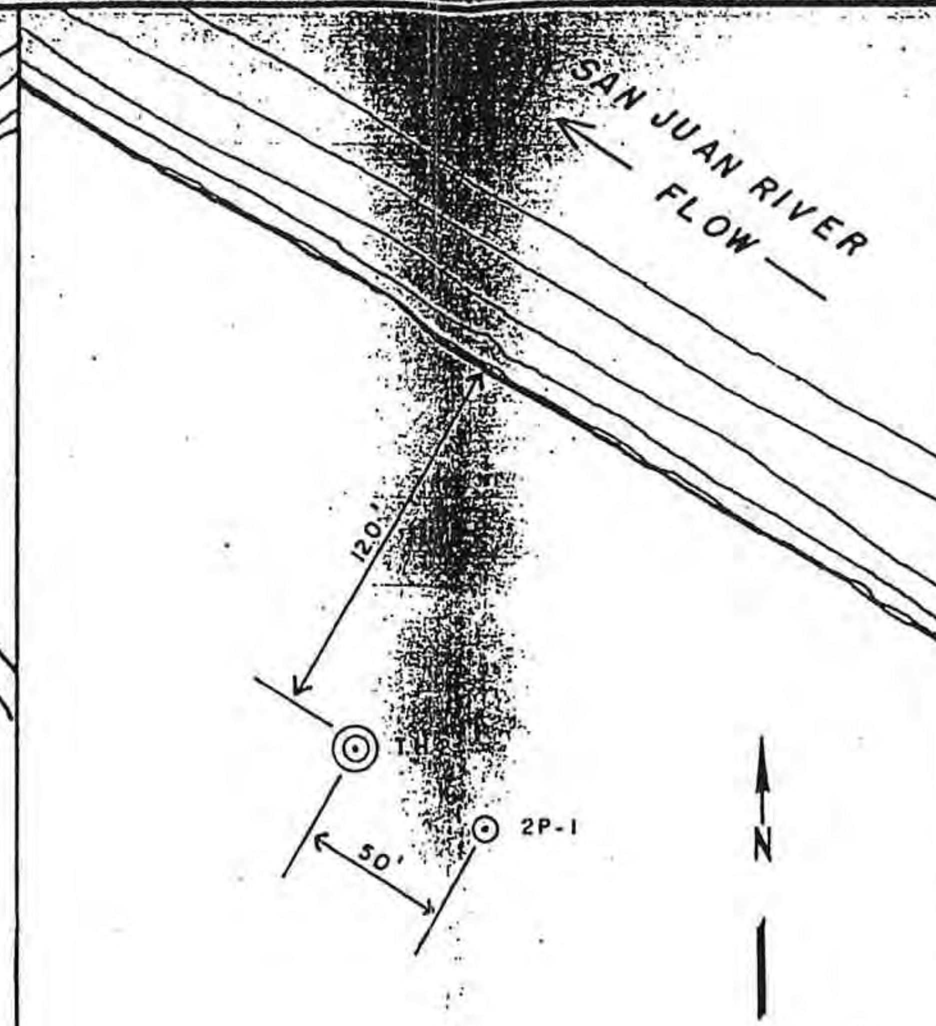
19
RANNEY METHOD WESTERN CORPORATION
KENNEWICK, WASHINGTON
THE FLUOR CORPORATION LTD.
WESTERN GASIFICATION CO.
SAN JUAN RIVER, NEW MEXICO
LOCATION MAP
DRAWN: BK
APPROVED:
DATE: 7-5-73
FIG: SW-61-1



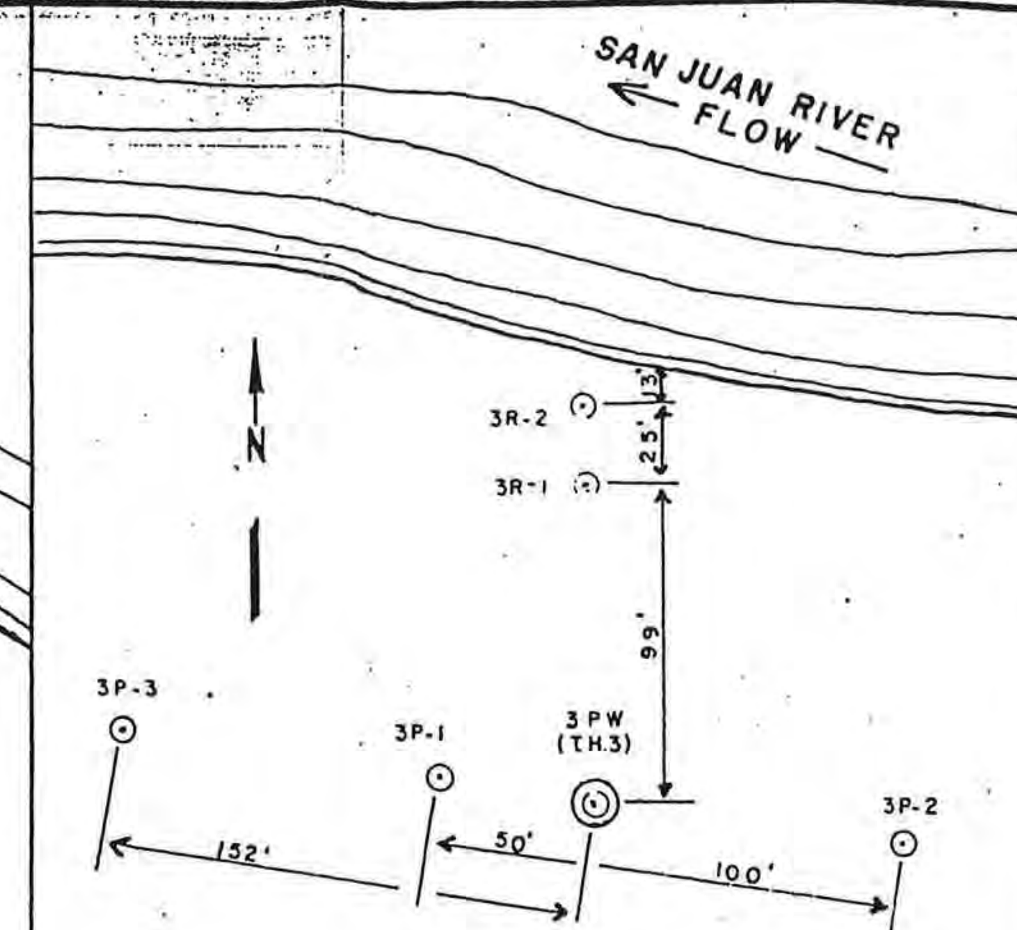

PUMPING TEST – T.H. I

SCALE
1" = 60'




PUMPING TEST – T. H. 2

SCALE
1" = 60'




PUMPING TEST – T.H. 3

SCALE
1" = 60'

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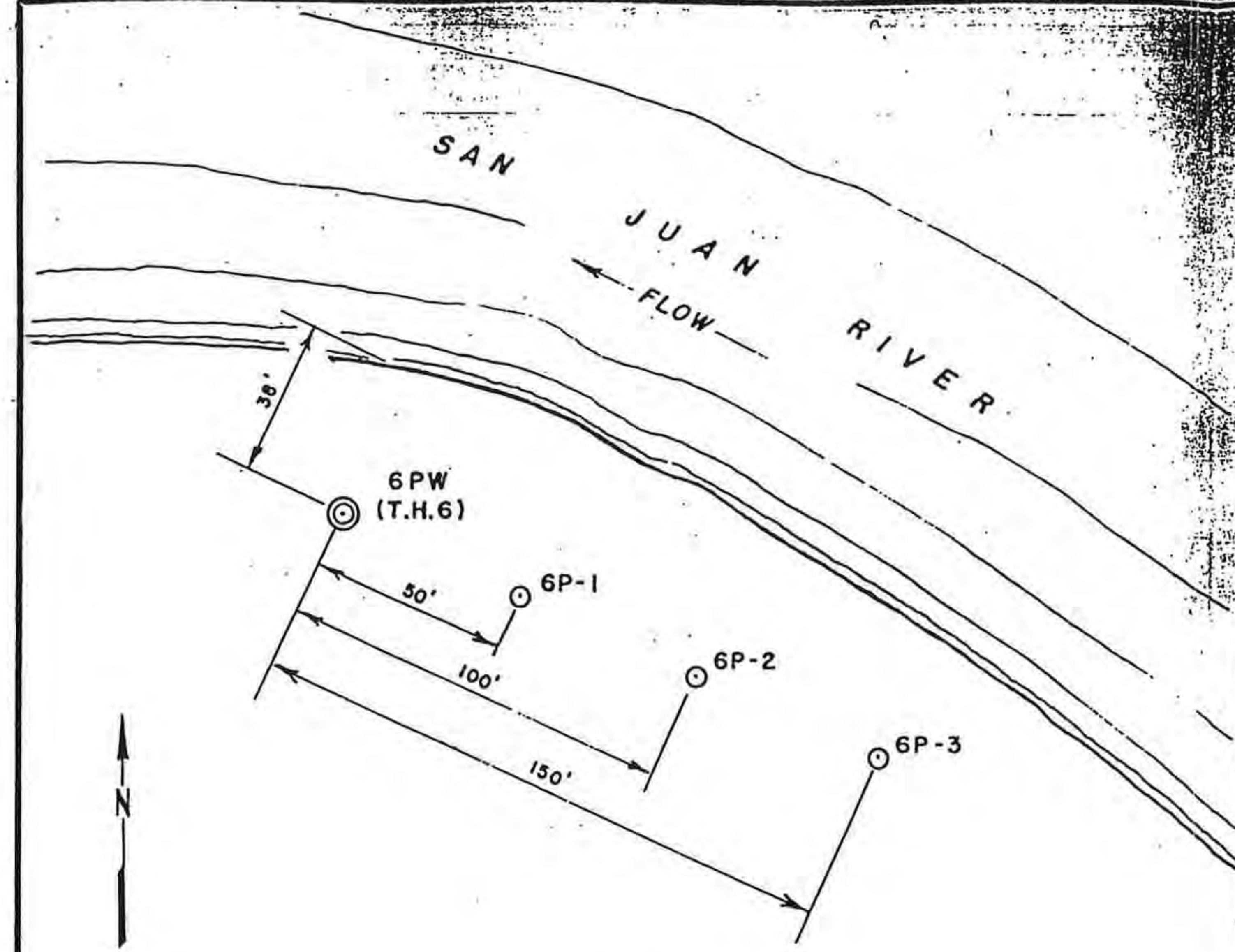
THE FLUOR CORPORATION LTD.
WESTERN GASIFICATION CO.
SAN JUAN RIVER, NEW MEXICO

LOCATIONS OF WELLS
PUMPING TESTS
T.H.1, T.H.2 & T.H.3

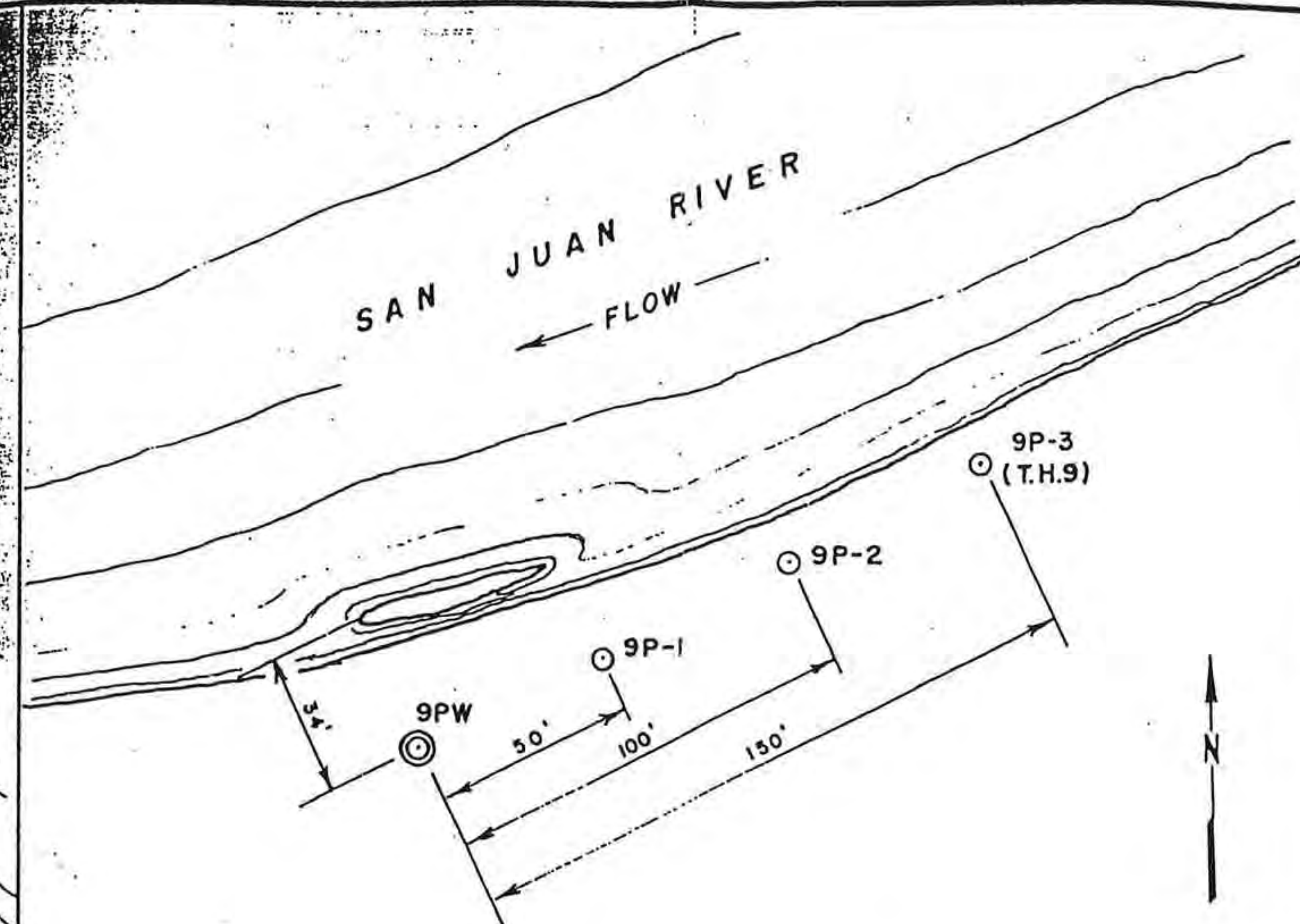
| | |
|---|---|
| DRAWN: GEH | APP: |
| DATE: 8-8-73 | FI. |




PUMPING TEST - T.H. 6

SCALE

1" = 40'




PUMPING TEST - T.H. 9

SCALE

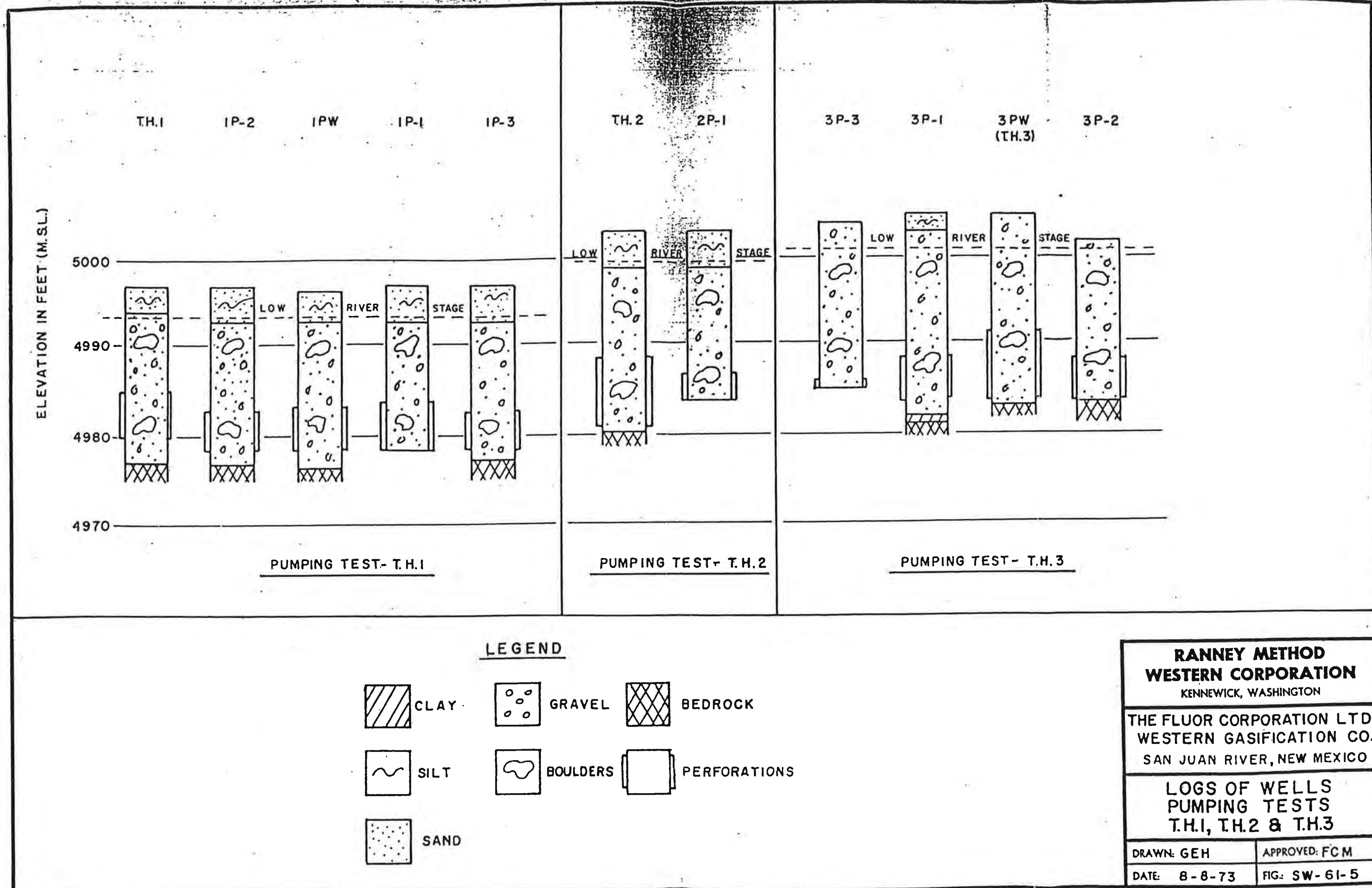
1" = 40'

**RANNEY METHOD WESTERN CORPORATION**
KENNEWICK, WASHINGTON

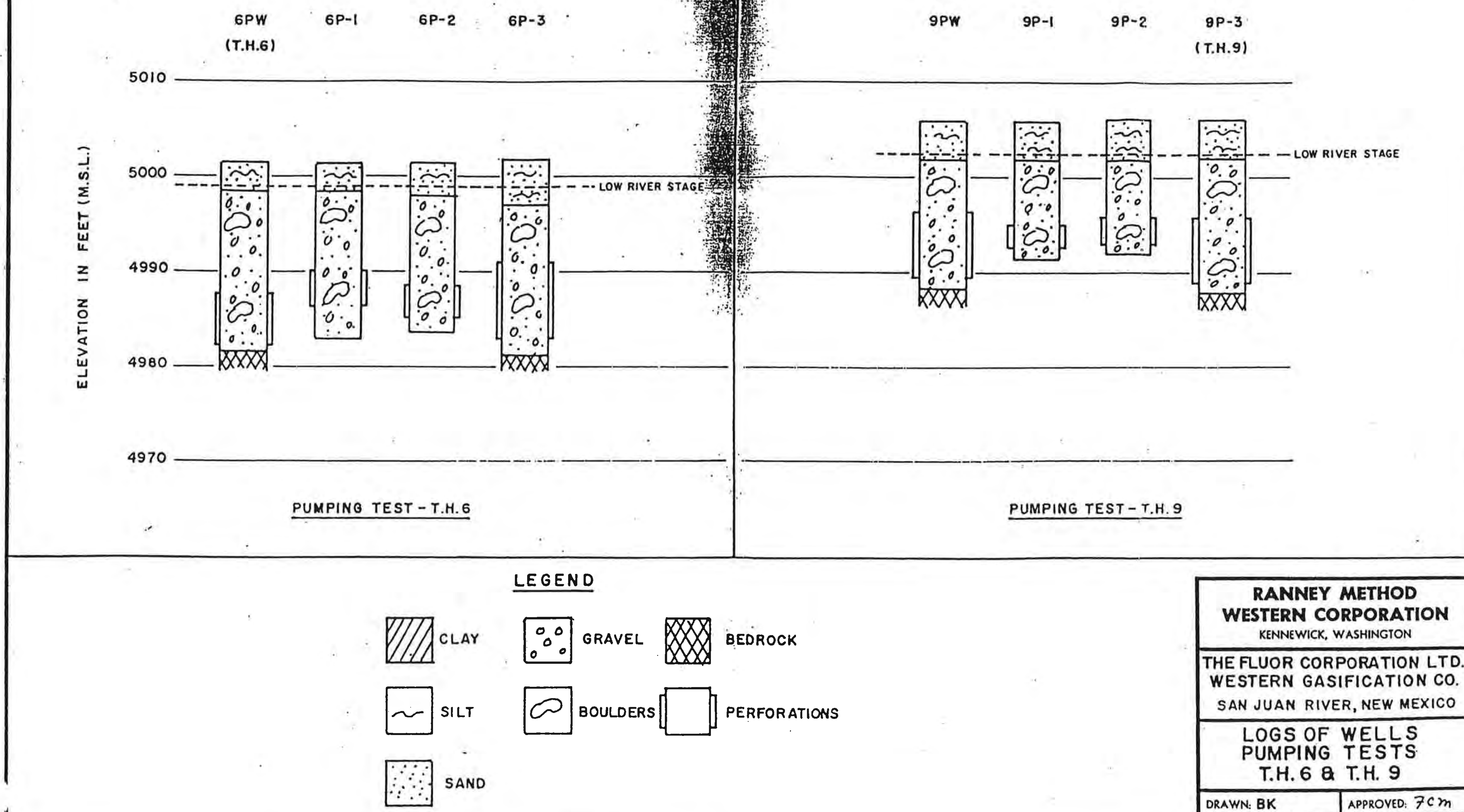
THE FLUOR CORPORATION LTD.
WESTERN GASIFICATION CO.
SAN JUAN RIVER, NEW MEXICO

LOCATIONS OF WELLS
PUMPING TESTS
T.H. 6 & T.H. 9

| | |
|---|---|
| DRAWN: BK | APPROVED: F.C.M. |
| DATE: 9-14-73 | FIG.: SW-61-4 |



T.H.1
1P-2
1PW
1P-1
1P-3
T.H.2
2P-1
3P-3
3P-1
3PW (T.H.3)
3P-2
ELEVATION IN FEET (M.S.L.)
5000
4990
4980
4970
LOW
RIVER
STAGE
PUMPING TEST- T.H.1
PUMPING TEST- T.H.2
PUMPING TEST- T.H.3
LEGEND
CLAY
GRAVEL
BEDROCK
SILT
BOULDERS
PERFORATIONS
SAND
RANNEY METHOD WESTERN CORPORATION
KENNEWICK, WASHINGTON
THE FLUOR CORPORATION LTD
WESTERN GASIFICATION CO.
SAN JUAN RIVER, NEW MEXICO
LOGS OF WELLS
PUMPING TESTS
T.H.1, T.H.2 & T.H.3
DRAWN: GEH
APPROVED: FCM
DATE: 8-8-73
FIG.: SW-61-5

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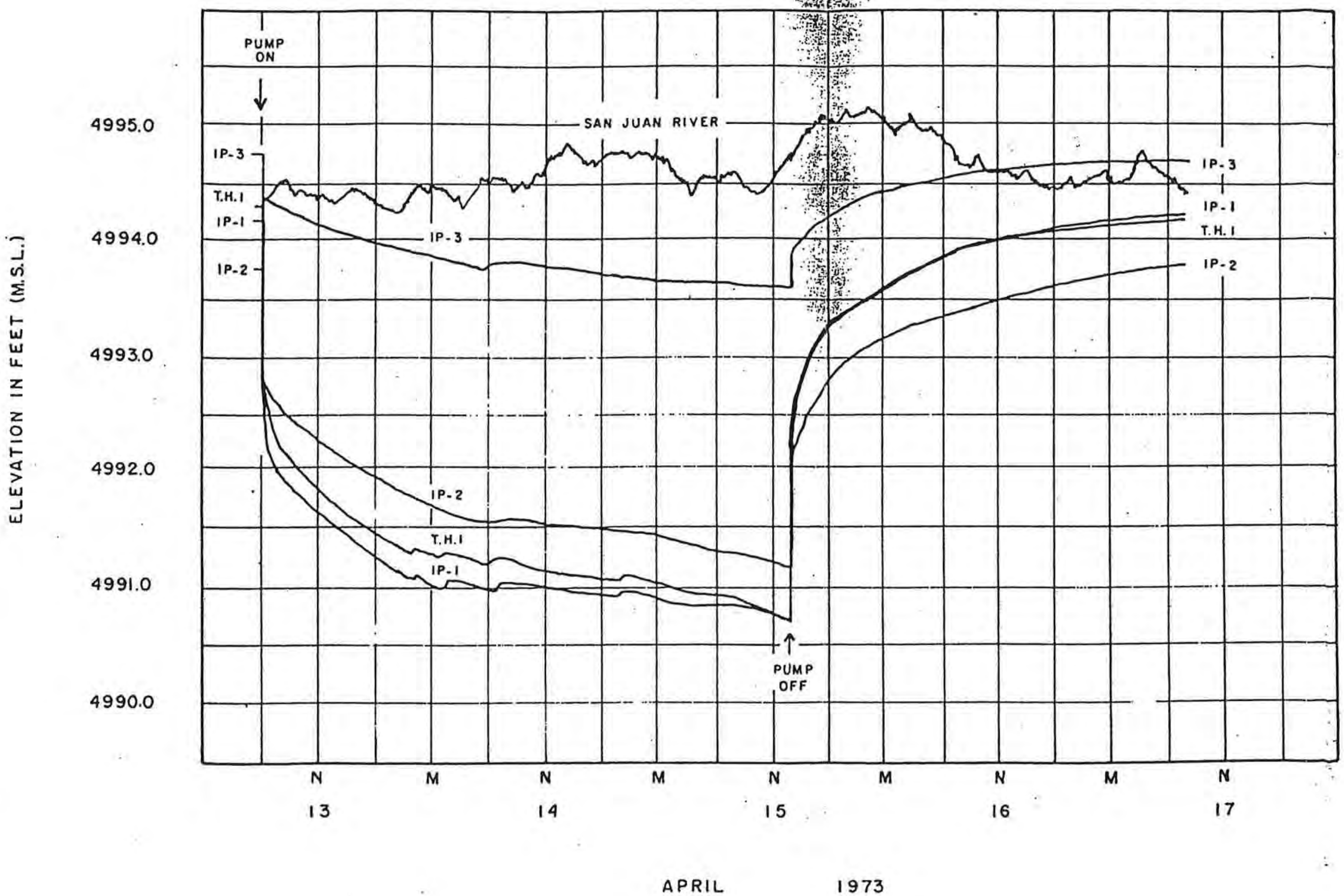
SAN JUAN RIVER, NEW MEXICO

LOGS OF WELLS
PUMPING TESTS
T.H. 6 & T.H. 9

| | |
|---|---|
| DRAWN: BK | APPROVED: FCM |
| DATE: 9-14-73 | FIG.: SW-61-6 |




| | |
|---|---|
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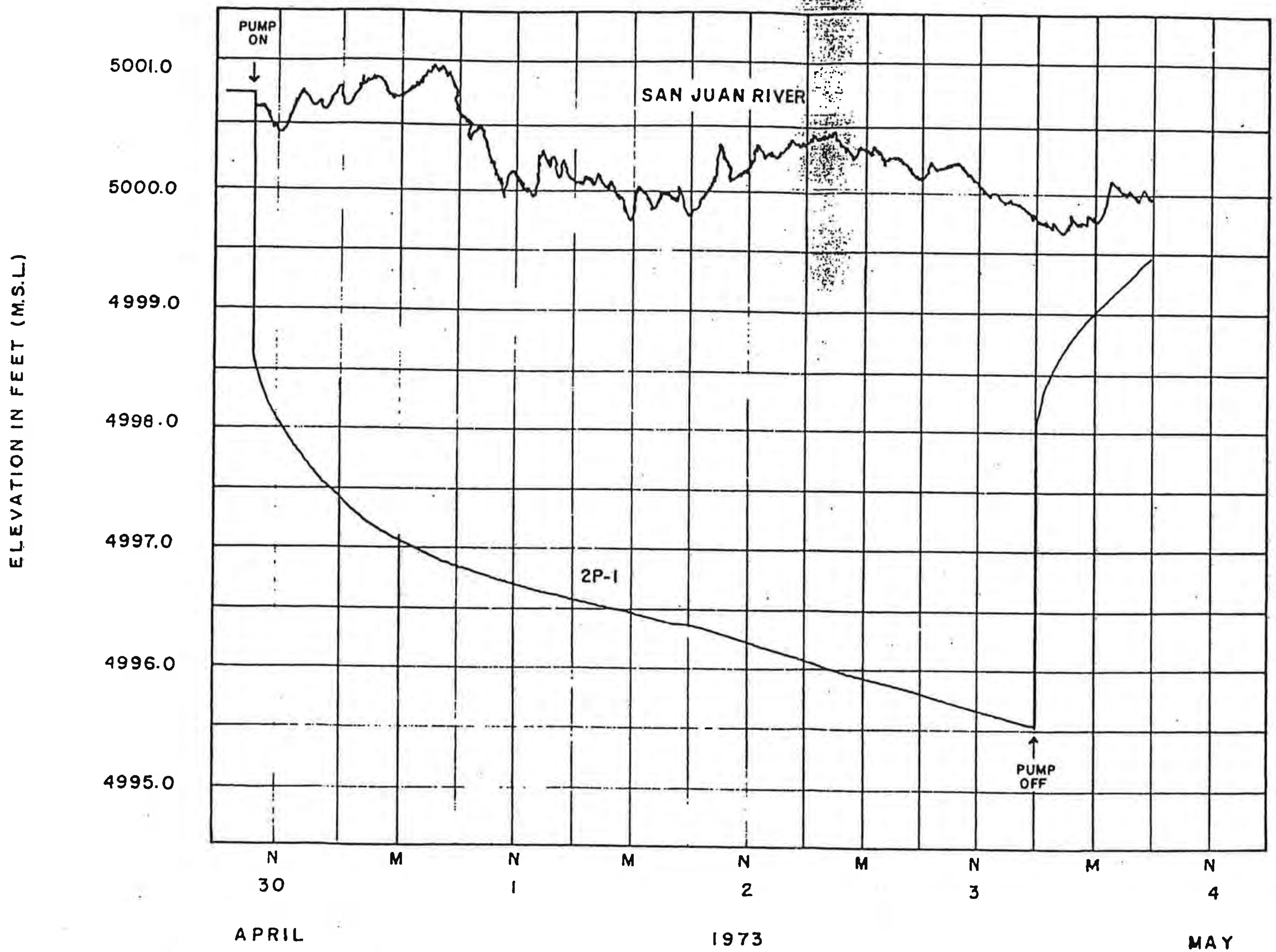
| THE FLUOR CORPORATION LTD.<br>WESTERN GASIFICATION CO.<br>SAN JUAN RIVER, NEW MEXICO | |
| HYDROGRAPHS<br>PUMPING TEST T.H.-I | |
| DRAWN: GEH | APPROVED: FCM |
| DATE: 8-8-73 | FIG.: SW-61-7 |

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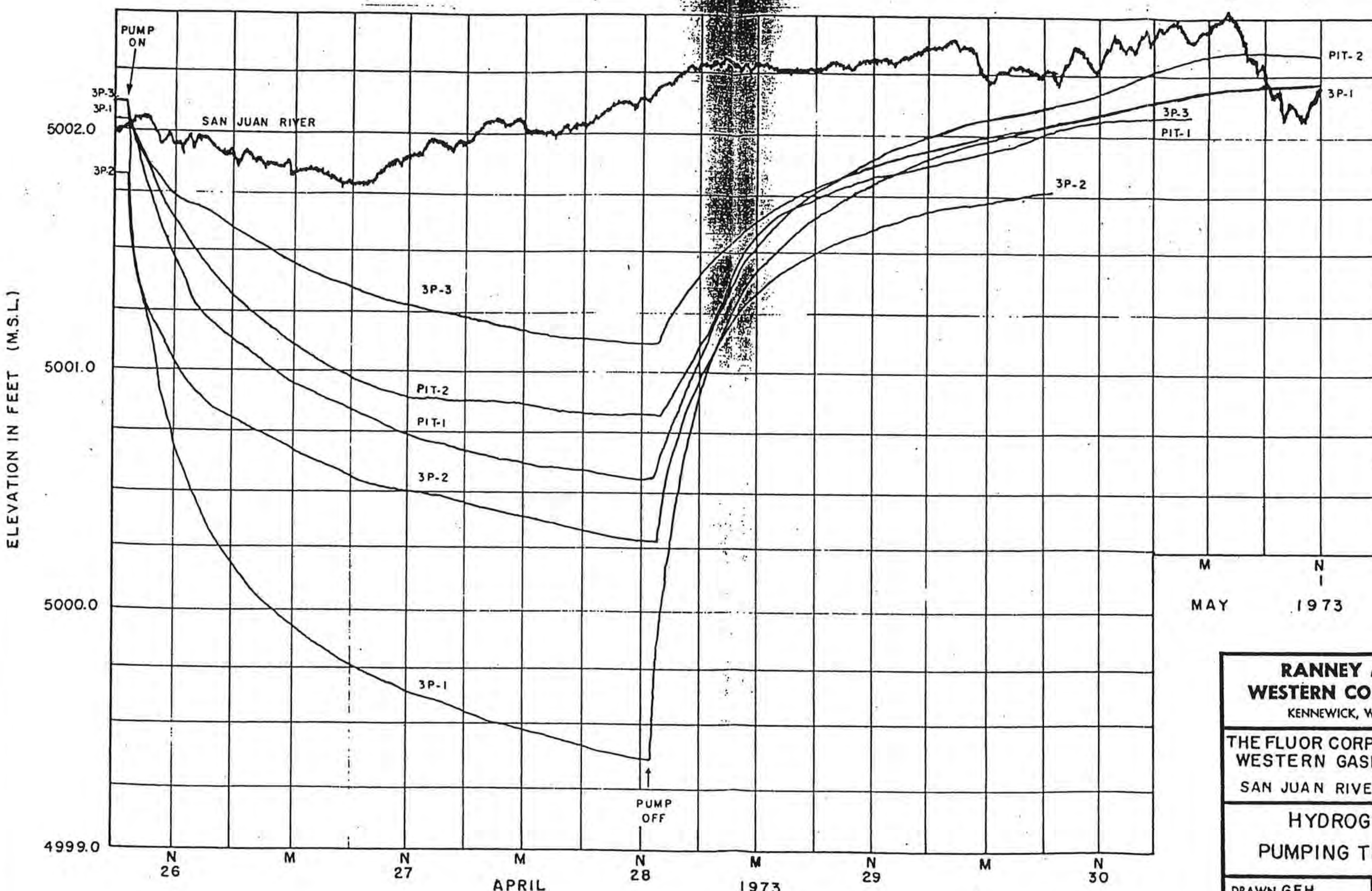
HYDROGRAPHS
PUMPING TEST T.H.-2

| | |
|---|---|
| DRAWN: GEH | APPROVED: FCM |
| DATE: 8-8-73 | FIG.: SW-61-8 |

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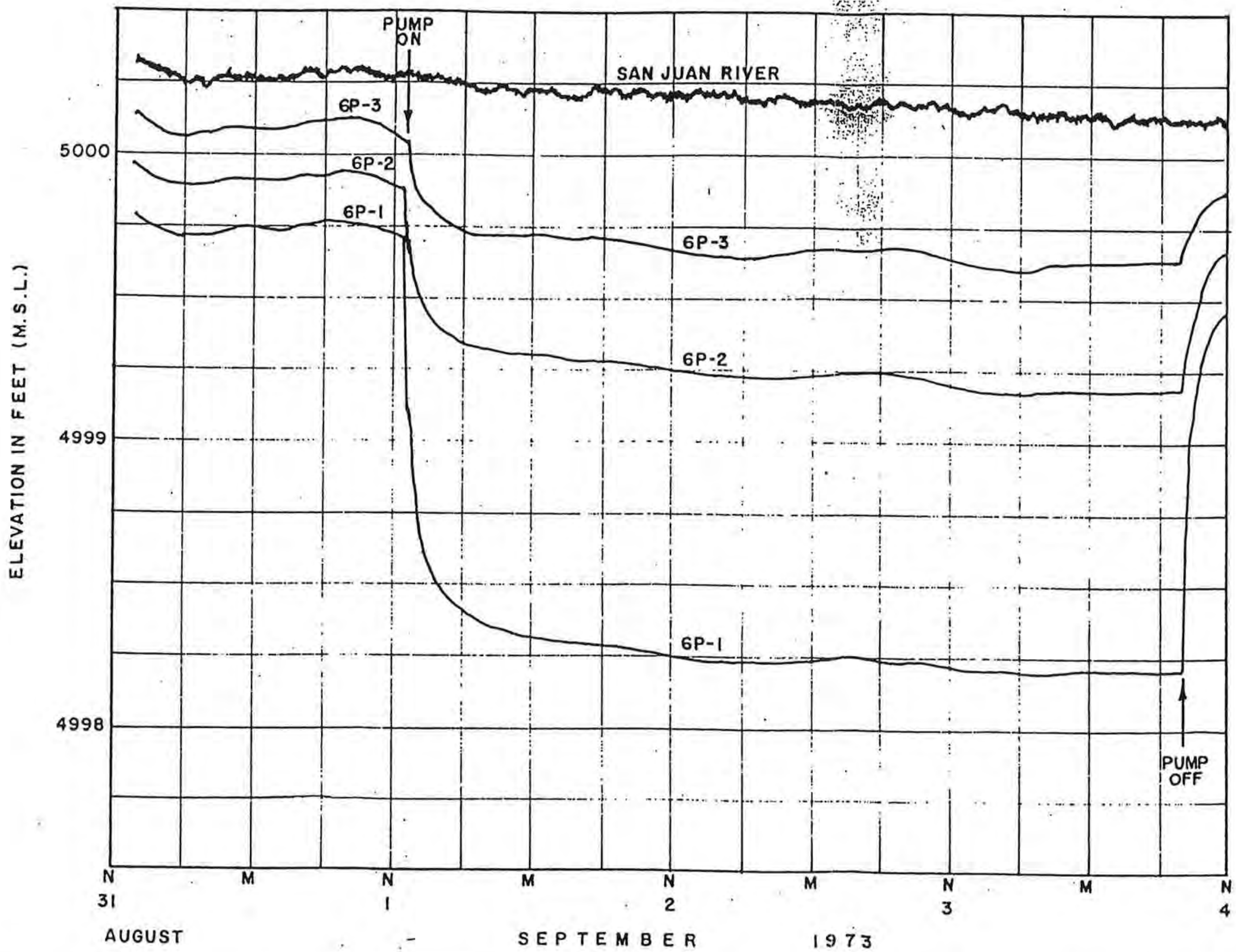
HYDROGRAPHS
PUMPING TEST T.H. 3

| | |
|---|---|
| DRAWN: GEH | APPROVED: FCM |
| DATE: 8-8-73 | FIG.: SW-61-9 |

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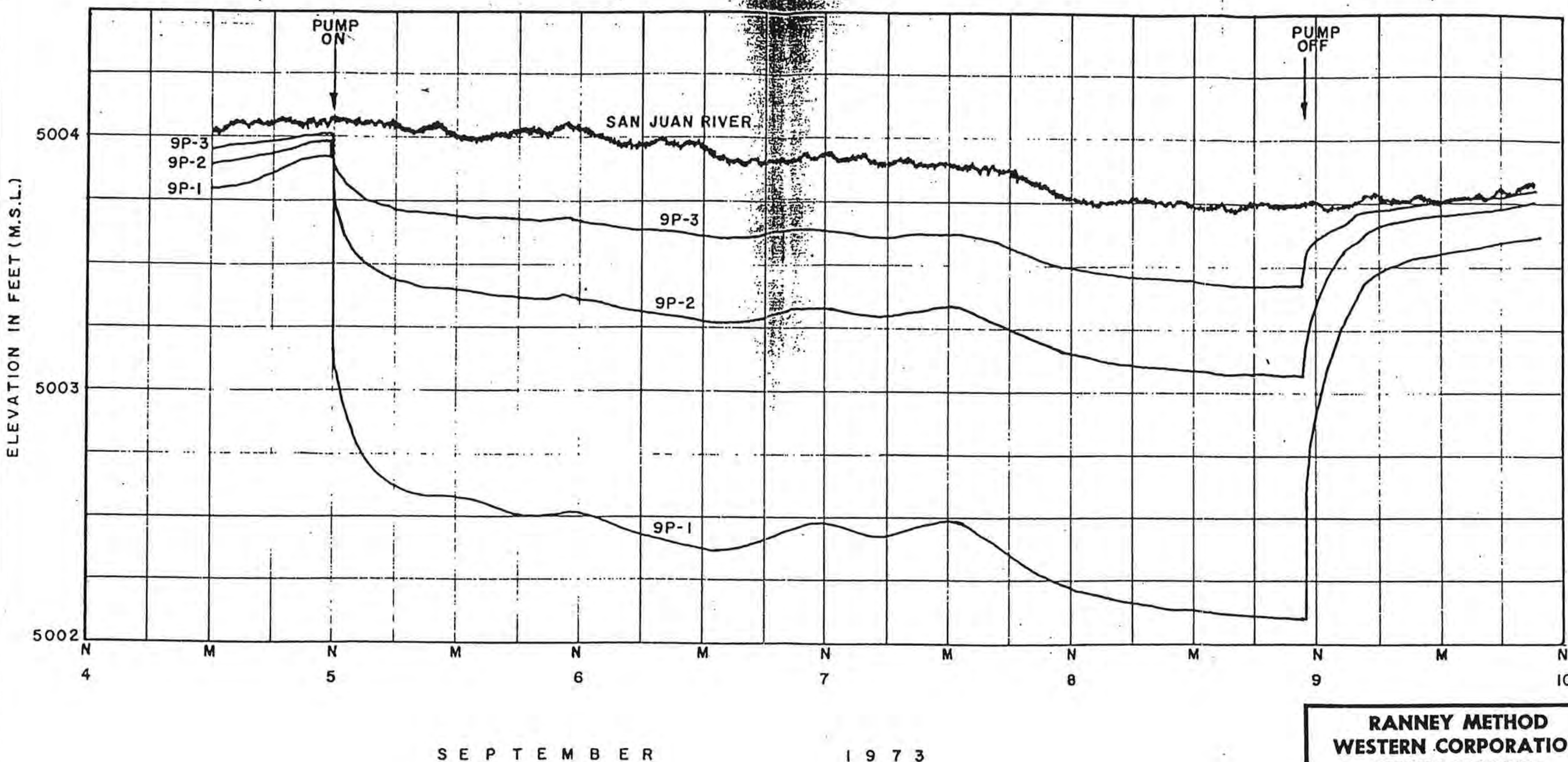
HYDROGRAPHS
PUMPING TEST T.H. 6

| | |
|---|---|
| DRAWN: BK | APPROVED: FCM |
| DATE: 9-15-73 | FIG.: SW-61-10 |

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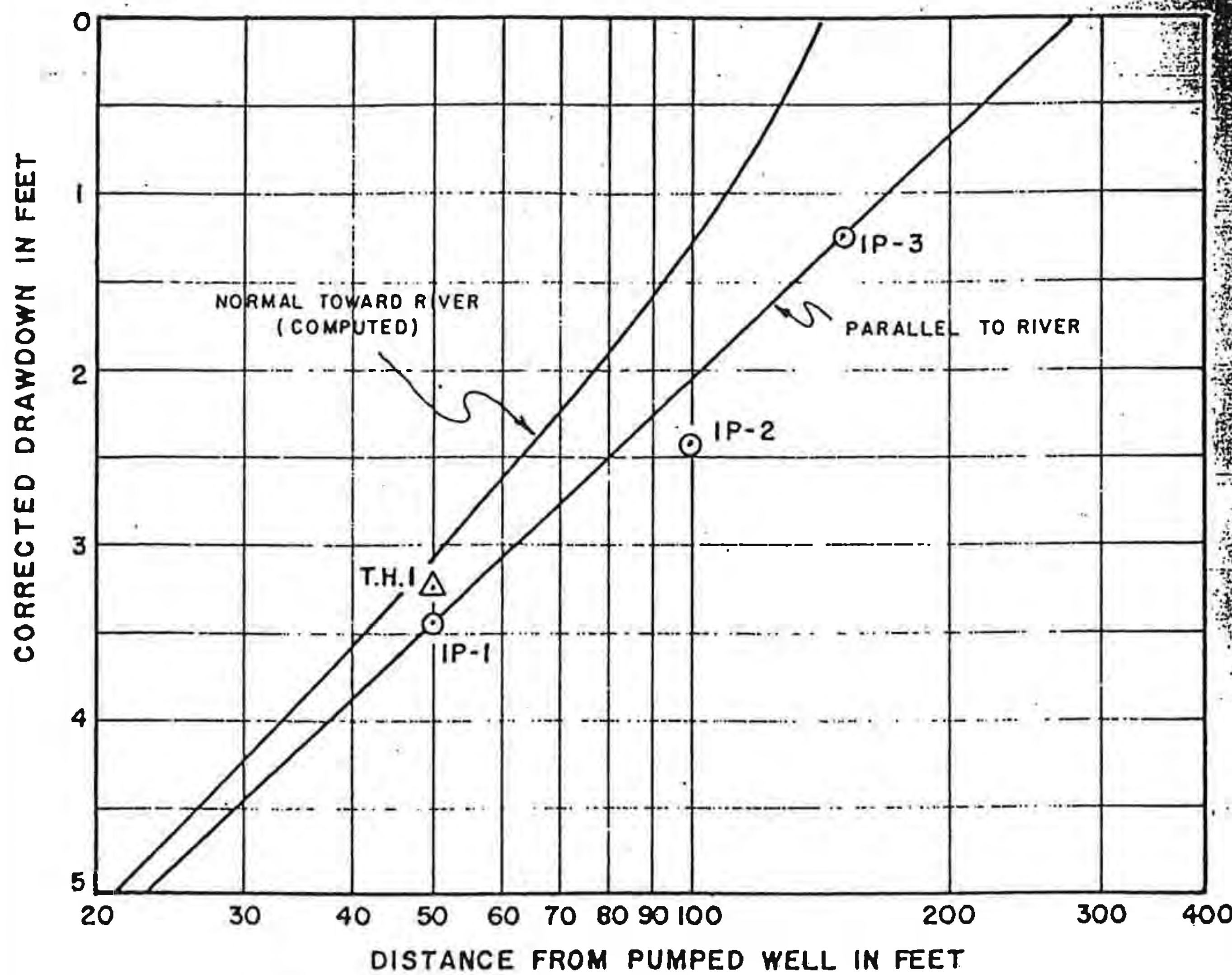
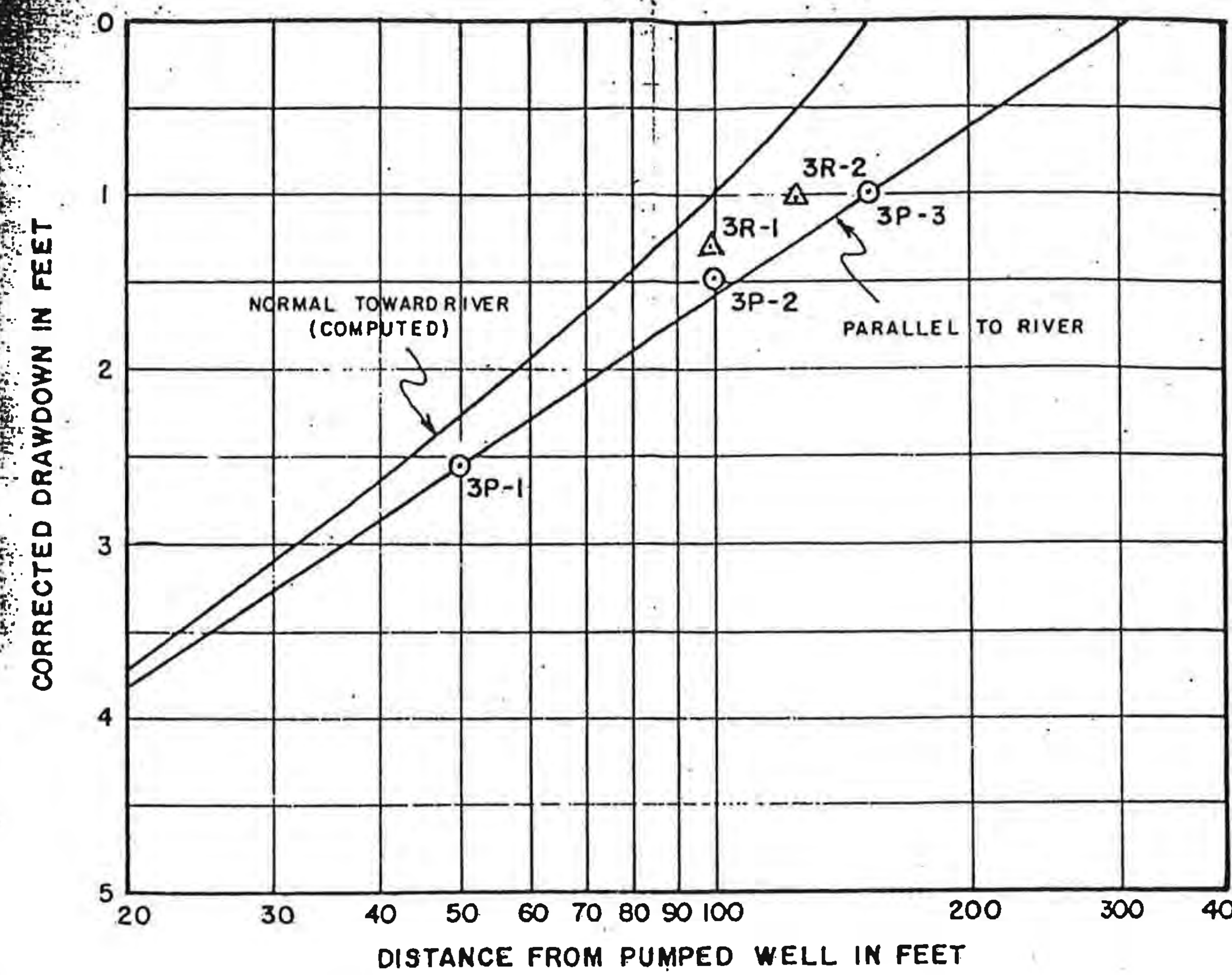
HYDROGRAPHS
PUMPING TEST T.H.9

| | |
|---|---|
| DRAWN: BK | APPROVED: JCM |
| DATE: 9-15-73 | FIG.: SW-61-11 |




(1) $T = Pm = \dfrac{2.30 \log \frac{r_1}{r_2}}{2\pi(s_1 - s_2)}$

(2) $\log \dfrac{\sqrt{4D^2 + r_1^2}}{r_1} = \dfrac{2\pi T s_1}{2.30}$

(3) $I = \dfrac{T}{(D - R)^2}$

in which,

- T = Transmissibility, in GPD/ft.
- P = Permeability, in GPD/sq.ft.
- m = Aquifer thickness, in ft.
- Q = Pumping rate, in GPD.
- $r_1$ & $r_2$ = Distances from pumped well, in ft.
- $s_1$ & $s_2$ = Drawdowns at distances $r_1$ & $r_2$, in ft.
- I = River bed infiltration rate, in GPD/sq.ft./ft.
- D = Effective distance to line of infiltration, in ft.
- R = Distance from pumped well to river's edge, in ft.

PUMPING TEST - T.H.1:

$T = \dfrac{2.3(151)(1,440)(1)}{2\pi(4.57)}$

T = 17,430 GPD/ft. (50°F.)

$P = \dfrac{17,430}{17.5} =$ 996 GPD/sq.ft. (50°F.)

$\log \dfrac{\sqrt{4D^2 + (50)^2}}{50} = \dfrac{2\pi(17,430)(3.45)}{2.3(151)(1,440)}$

D = 140 ft.

$I = \dfrac{17,430}{(140 - 93.5)^2}$

I = 8.06 GPD/sq.ft./ft. (50°F.)

PUMPING TEST-T.H.3:

$T = \dfrac{2.3(178)(1,440)(1)}{2\pi(3.23)}$

T = 29,100 GPD/ft. (52°F)

$P = \dfrac{29,100}{18.5} =$ 1,573 GPD/sq.ft. (52°F.)

$\log \dfrac{\sqrt{4D^2 + (50)^2}}{50} = \dfrac{2\pi(29,100)(2.54)}{2.3(178)(1,440)}$

D = 151 Ft.

$I = \dfrac{29,100}{(151 - 137)^2}$

I = 149 GPD/sq.ft./ft. (52°F)

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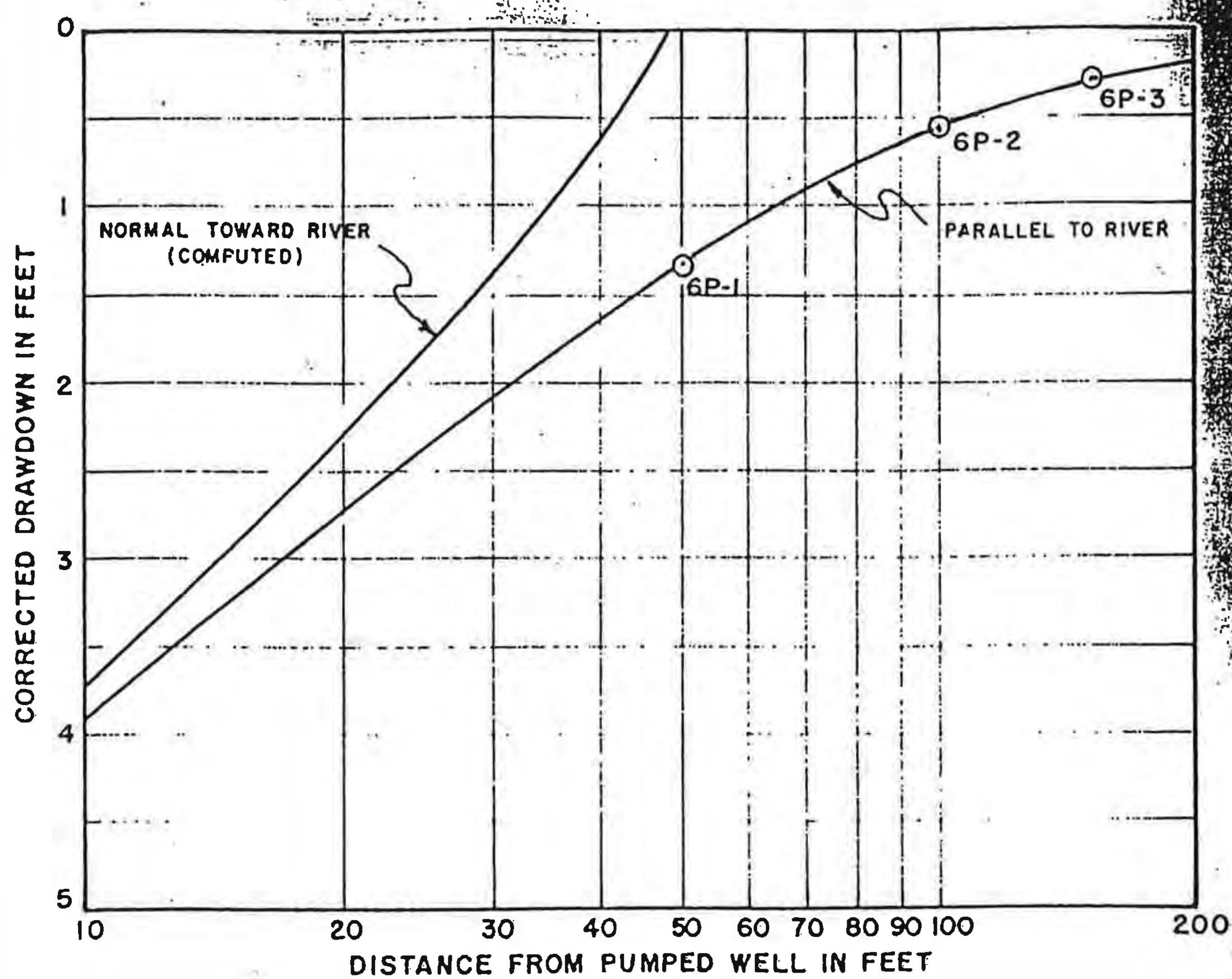
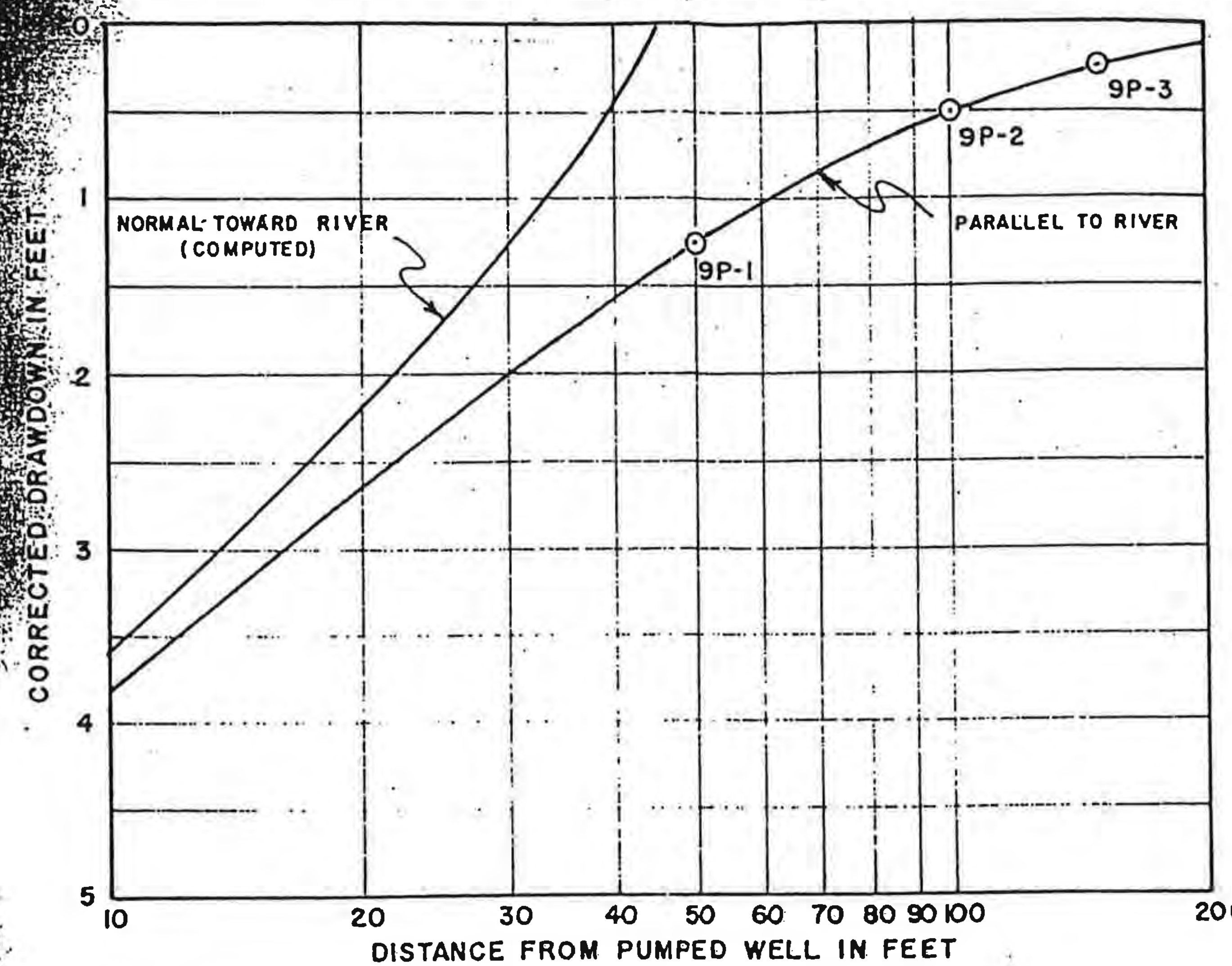
PERMEABILITY COMPUTATIONS
T.H. 1 & T.H. 3

| | |
|---|---|
| DRAWN: BK | APPROVED: FCm |
| DATE: 9-17-73 | FIG.: SW-61-12 |




(1) $$\frac{s_1}{s_2} = \frac{\log \frac{\sqrt{4D^2 + r_1^2}}{r_1}}{\log \frac{\sqrt{4D^2 + r_2^2}}{r_2}}$$

(2) $$T = Pm = \frac{2.3\, Q \log \frac{\sqrt{4D^2 + r_1^2}}{r_1}}{2\pi s_1}$$

(3) $$I = \frac{T}{(D - R)^2}$$

in which,

Symbols are as defined on Figure SW-61-12

PUMPING TEST - T.H.6:

$$\frac{1.34}{0.30} = \frac{\log \frac{\sqrt{4D^2 + (50)^2}}{50}}{\log \frac{\sqrt{4D^2 + (150)^2}}{150}}$$

D = 48.5 ft.

$$T = \frac{2.3(128)(1{,}440) \log \frac{\sqrt{4(48.5)^2 + (50)^2}}{50}}{2\pi(1.34)}$$

T = 17,080 GPD/ft.(60°F.)

$$P = \frac{17{,}080}{18.5} = 923 \text{ GPD/sq.ft.}(60°\text{F.})$$

$$I = \frac{17{,}080}{(48.5 - 38)^2} = 155 \text{ GPD/sq.ft./ft.}(60°\text{F.})$$

PUMPING TEST - T.H.9:

$$\frac{1.26}{0.27} = \frac{\log \frac{\sqrt{4D^2 + (50)^2}}{50}}{\log \frac{\sqrt{4D^2 + (150)^2}}{150}}$$

D = 45.5 ft.

$$T = \frac{2.3(164)(1{,}440) \log \frac{\sqrt{4(45.5)^2 + (50)^2}}{50}}{2\pi(1.26)}$$

T = 21,800 GPD/ft.(59°F.)

$$P = \frac{21{,}800}{16} = 1{,}363 \text{ GPD/sq.ft.}(59°\text{F.})$$

$$I = \frac{21{,}800}{(45.5 - 34)^2} = 165 \text{ GPD/sq.ft./ft}(59°\text{F.})$$

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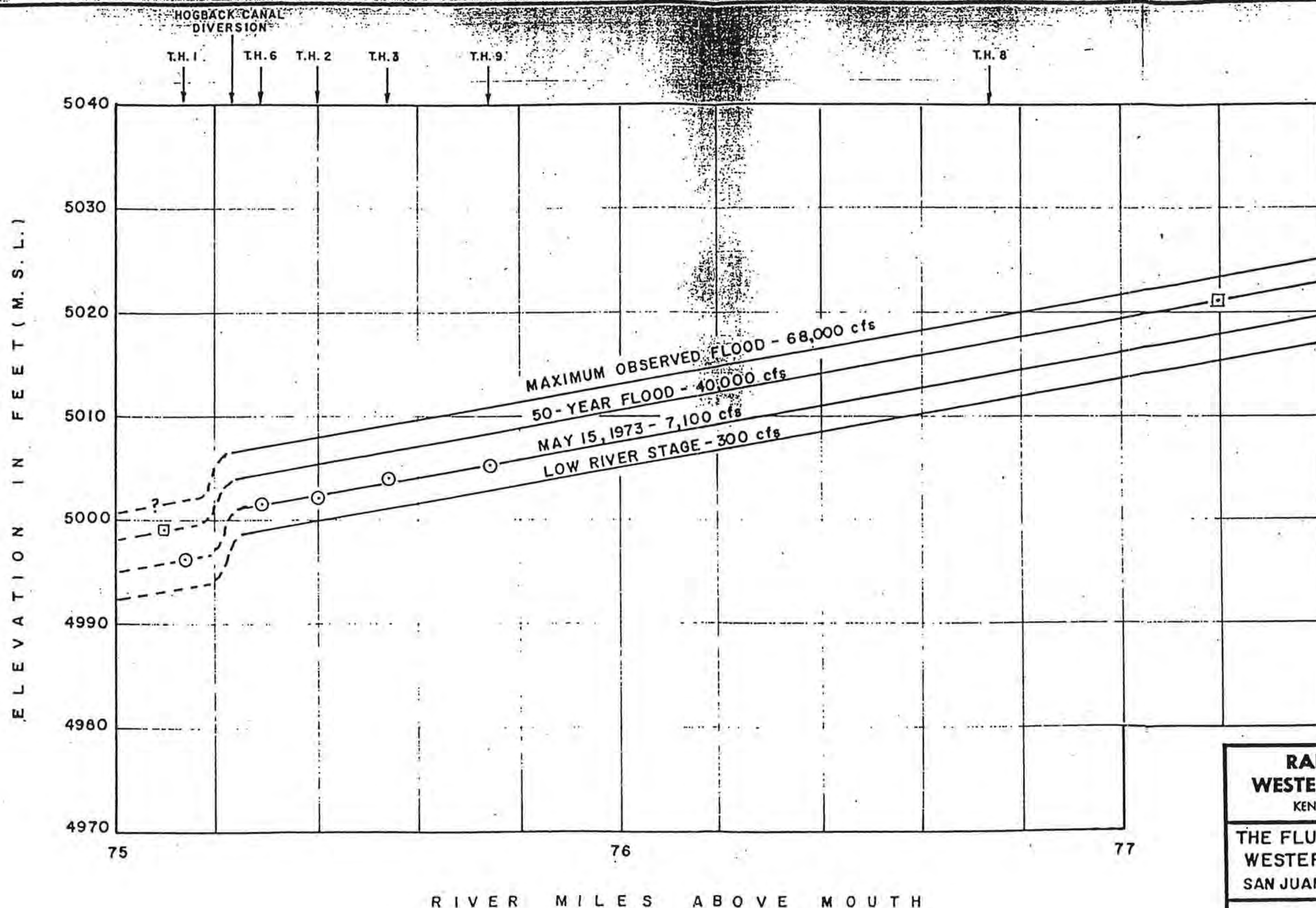
**PERMEABILITY COMPUTATIONS T.H. 6 & T.H. 9**

| | |
|---|---|
| DRAWN: BK | APPROVED: 7Cm |
| DATE: 9-17-73 | FIG.: SW-61-13 |




NOTE:
DATA FOR 50-YEAR FLOOD FROM SACRAMENTO DISTRICT CORPS OF ENGINEERS.

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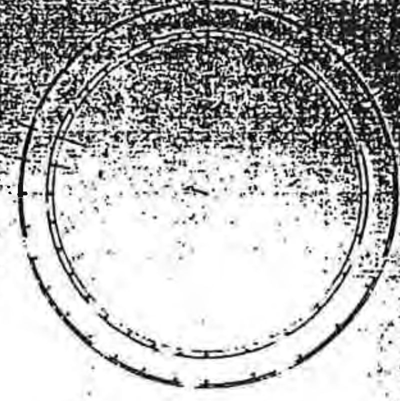
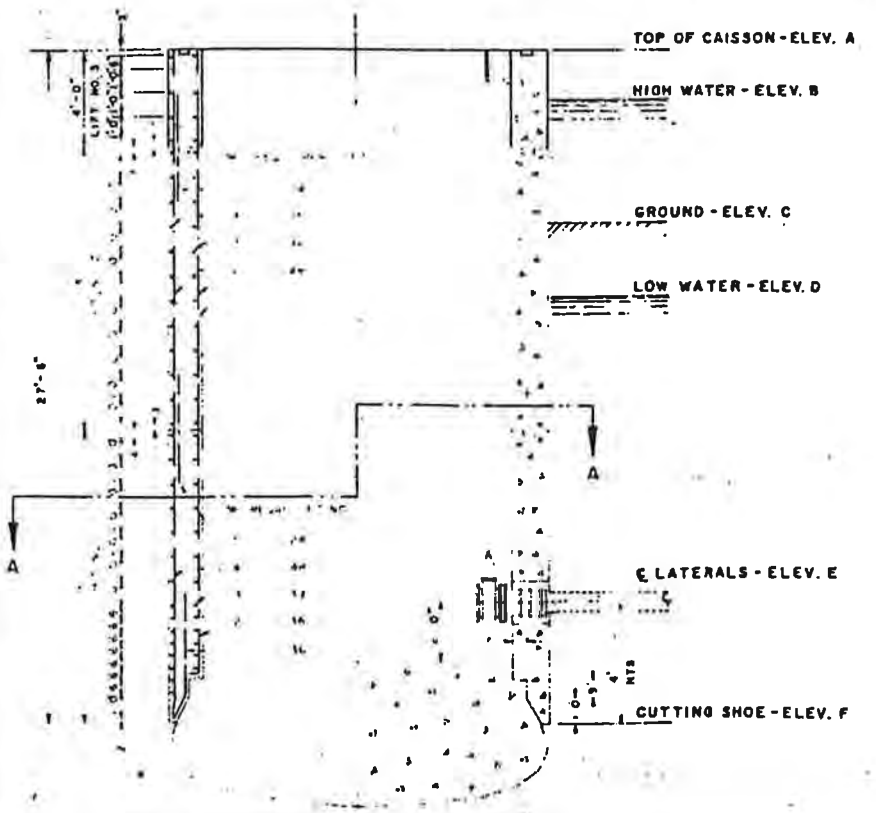
WATER PROFILES
SAN JUAN RIVER

| | |
|---|---|
| DRAWN: BK | APPROVED: 7Cm |
| DATE: 9-17-73 | FIG.: SW-61-14 |

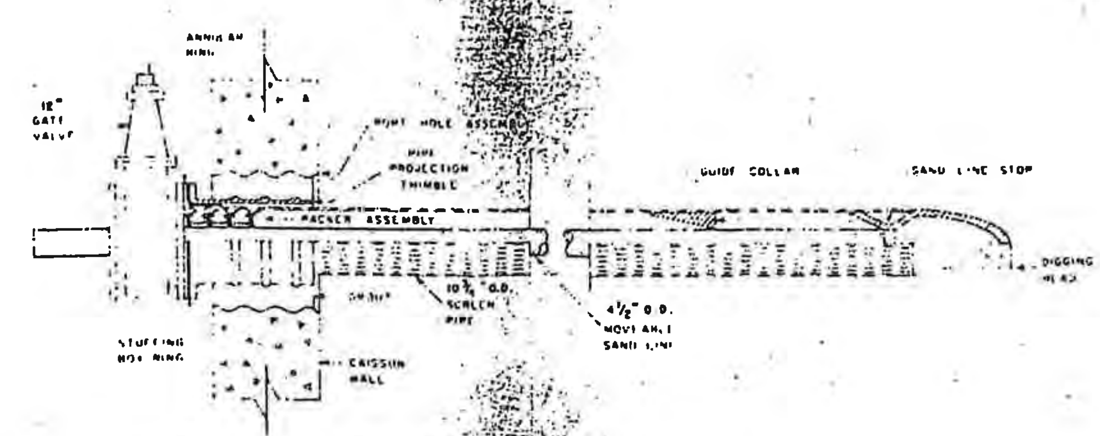


SECTION A-A

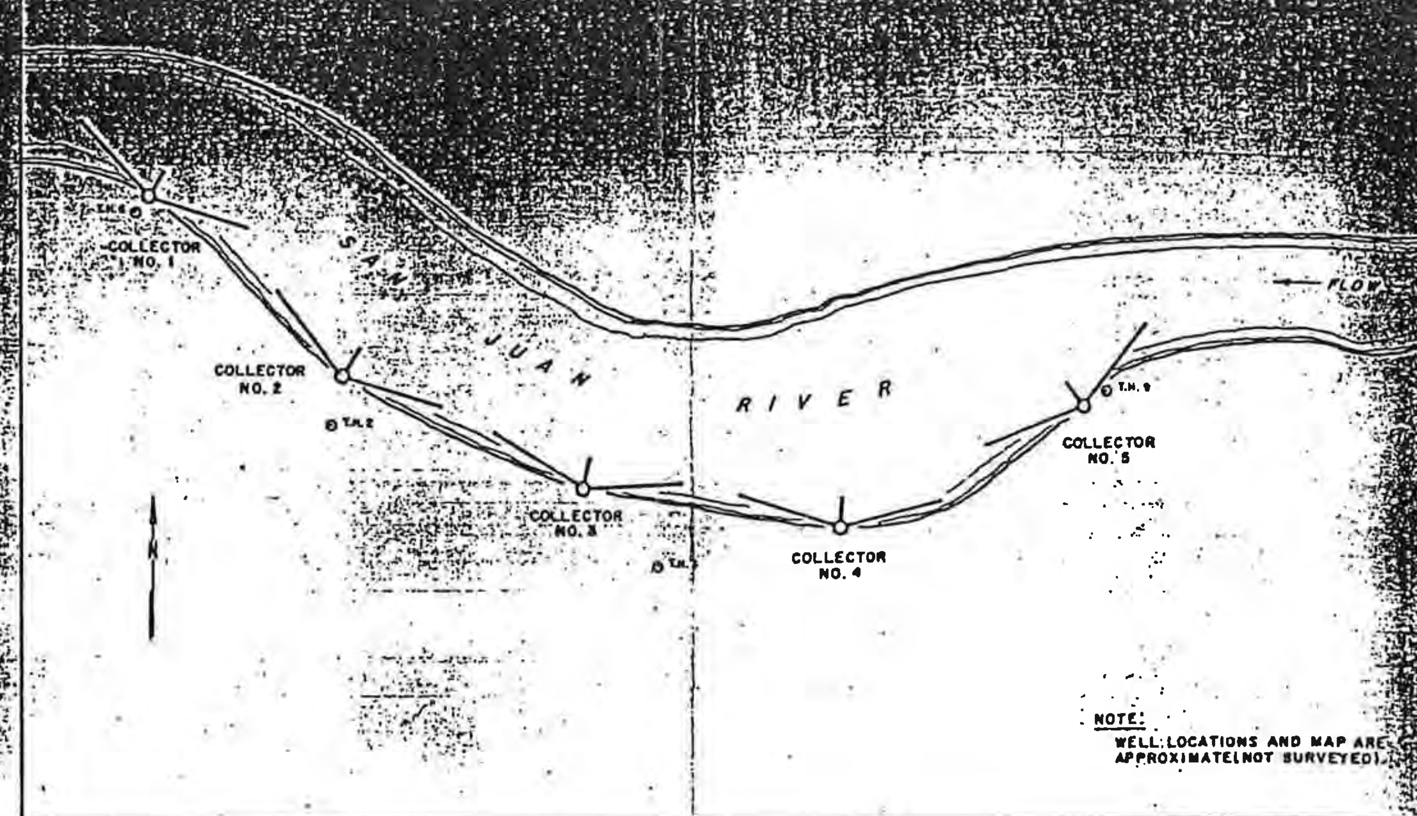

ENLARGED SECTION SHOWING REQUIRED METHOD OF DEVELOPMENT USING SAND REMOVAL DEVICE AND FLUSHING "Y"




VERTICAL SECTION THRU CAISSON




ENLARGED SECTION SHOWING SCREEN PIPE AND ACCESSORIES




LOCATION MAP

SCALE 1" = 400'

| RANNEY COLLECTOR NO. | ELEVATIONS IN FEET (M.S.L.) | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| 1 | 5009 | 5007 | 5001.5 | 4999 | 4985.5 | 4981.5 |
| 2 | 5010 | 5008 | 5003 | 4999.5 | 4984.5 | 4980.5 |
| 3 | 5011 | 5009 | 5004 | 5001 | 4987.5 | 4983.5 |
| 4 | 5012 | 5010 | 5005 | 5002 | 498[illegible] | 4985 |
| 5 | 5013 | 5011 | 5006 | 5002.5 | 4992 | 4988 |

REQ'D EACH COLLECTOR:

| | | |
|---|---|---|
| 36 [illegible] | [illegible] | [illegible] |
| 38 [illegible] | [illegible] | [illegible] |
| 90 [illegible] 99 [illegible] | [illegible] | [illegible] |
| 48 [illegible] | [illegible] | [illegible] |
| 72 [illegible] | [illegible] | [illegible] |

| | |
|---|---|
| TOTAL VOLUME CONCRETE | 85 CU YDS |
| TOTAL WEIGHT RE-STEEL | 6,200 LBS |

| REVISION | BY | DATE |
|---|---|---|

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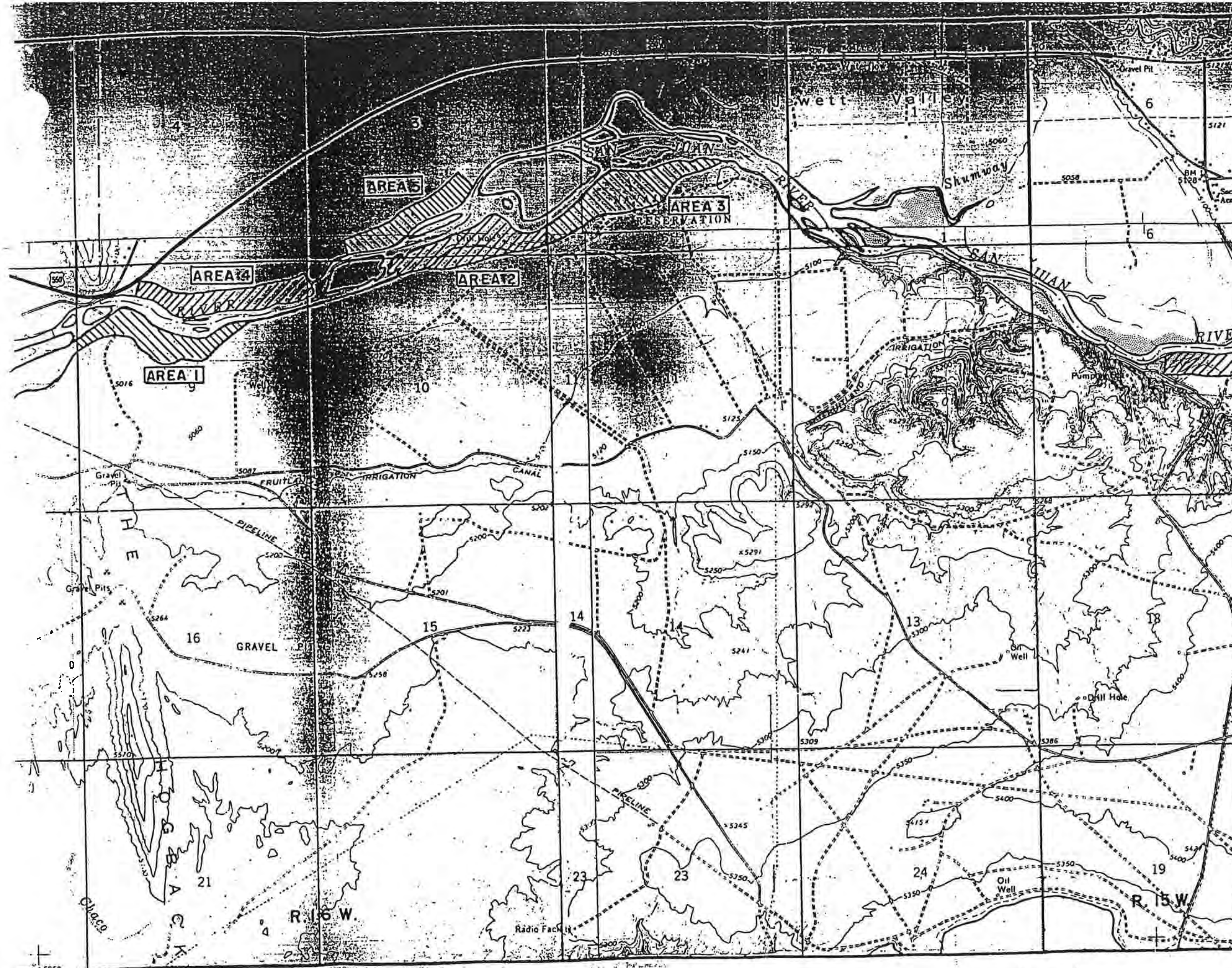
PROPOSED
RANNEY COLLECTOR SYSTEM

| | |
|---|---|
| DRAWN BY: BK | CHECKED BY: |
| SCALE: AS SHOWN | APPROVED BY: |
| DATE: 9-24-73 | FIG: SW-61-15 |

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POTENTIAL AREAS FOR FUTURE DEVELOPMENT

| | |
|---|---|
| DRAWN: BK | APPROVED: 7Cm |
| DATE: 9-25-73 | FIG: SW-161-16 |

# RANNEY DIVISION MEMORANDUM

TO: MR. THOMAS STRAIN

FROM: MATTHEW REED

SUBJECT: USBR NAVAJO GALLUP WATER SUPPLY PROJECT

DATE: 01/02/01

CC: ROBERT HUSKISSON

This memo documents our findings resulting from our site visit and preliminary water supply options for the US Bureau of Reclamation's Navajo Gallup Water Supply Project. Our examination has been limited to an initial assessment of the practicality of developing a infiltrated water supply using the native aquifer materials to provide pretreatment of the source of supply (surface water from the San Juan River). This supply would be obtained from a series of infiltration galleries constructed in the streambed of the San Juan River.

Based upon our site visit with you and a review of information in our files, we believe it is prudent to initiate investigations to assess local aquifer characteristics, including saturated thickness and grain size distribution. Specific grain-size information needed include any cementation of the material, percent silt, and the size distribution of the sand and gravel. As we have discussed, that information can be collected by digging and logging a series of test pits between the Hogback area and the confluence of the San Juan with the Chaco River. Based upon the information obtained from those test pits, detailed testing can then be conducted in a more focused manner.

Information from our files confirms that Ranney Method Western Corporation installed a similar unit approximately one mile west of Farmington, New Mexico in the early 1980's. That gallery was predicted to yield between 1.1 and 1.5 million gallons per day (mgd) as calculated from pumping test information at the proposed location. Actual construction proceeded approximately 400 feet upstream (east) of that location. The final yield was approximately 1.0 mgd and the water produced had a noticeable hydrogen sulfide odor. Both the reduced yield and the odor appear attributable to native organic material that was encountered during gallery construction. This same material was not identified during the detailed testing. Documents from our files describing the aquifer and performance testing are attached to this memo. Based upon this information, it appears that the subsurface material is sufficiently heterogeneous to impact unit yield over short distances. As a result, the successful development of a water supply will be dependent upon the local hydrogeologic conditions and the adequate definition of those conditions.

Based upon a number of preliminary assumptions regarding local hydrogeologic conditions and potential construction, we believe it possible to construct a number of infiltration gallery units along the reach of the San Juan River currently under consideration. For current planning purposes, it can be assumed that individual unit yields would be approximately 1.0 mgd. We have estimated the cost for each unit to be between $900,000 and $1,100,000. This cost includes the construction of an infiltration gallery unit with 500 feet of gallery line, installed beneath the streambed and connected to a 20 foot deep reinforced concrete caisson with an inside diameter of nine feet and concrete top slab.

Costs for the pumps, pumphouse, and piping will be dependent upon the owners preferences, pumping head requirements, and the distance from the infiltration gallery to the water treatment plant.

As noted above, we recommend that preliminary investigations be undertaken prior to construction. If suitable locations are identified from the test pit effort, a more detailed investigation, including aquifer testing should be performed at each potential gallery location. Costs for these investigations will range between $50,000 and $75,000 and are not included in the unit cost estimates noted above. Upon completion of these investigations, final design and more formal construction cost estimates can be developed.

If practical, we recommend that any construction program be initiated by undertaking a detailed hydrogeologic investigation and installing a pilot unit. This unit could be operated and a long-term assessment made of the unit yield and raw water quality. This information can then be used to develop water treatment facilities, identify spacing between the gallery units, and quantify gallery yield.

We hope this information meets your needs. Please call us if you have any questions or when you have established a schedule for the test pit investigations so we can coordinate a site visit.

RANNEY METHOD WESTERN CORPORATION

RANNEY METHOD

WATER SUPPLY ENGINEERS AND CONTRACTORS

RANNEY COLLECTORS
SURFACE WATER INTAKES
ARTIFICIAL RECHARGING
CONSTRUCTION DEWATERING

P. O. BOX 6387
KENNEWICK, WASHINGTON 99336
TELEPHONE: (509) 586-6947

February 4, 1977

Lawrence A. Brewer & Associates
P. O. Box 2079
Farmington, New Mexico 87401

Attention: Mr. Richard P. Cheney, P.E.
Project Engineer

Re: Hydrogeological Survey
Lower Valley Water Users
Association

Gentlemen:

This letter-report sets forth the results of a preliminary exploratory test drilling program conducted to determine the feasibility of developing a naturally-filtered water supply of 1.5 million gallons per day by means of a Ranney Collector constructed adjacent to the San Juan River near Kirtland, New Mexico.

A total of three 12-inch diameter exploratory test holes and seven test pits were constructed to determine the depth, character and areal extent of the underlying unconsolidated alluvial deposits along the north bank of the San Juan River in an area extending from the Zia Trading Post upstream for a distance of about 8 miles. The locations of the test holes and test pits are shown in Figure SW-78-1 and their logs in Figure SW-78-2.

All three of the test holes were drilled to bedrock and three of the seven test pits encountered bedrock. The results of the tests show that bedrock occurs at relatively shallow depths throughout the area of the tests, ranging, in depth below river level, from a minimum of 4.5 feet at Test Pit 3 to a maximum of 11.5 feet at Test Pit 6. These depths are referenced to the river level at the time of the tests, corresponding to a river flow of about 1700 cubic feet per second. When consideration is given to the fact that minimum river flows on the order of 300 cubic feet per second can be expected to occur and that such flows will result in a river stage of about 1.2 feet lower than those existing at the time of the tests, these observed depths to bedrock below river level reduce to a minimum 3.3 feet and a maximum of 10.3 feet. These depths are considered too small for any significant water supply development.

Furthermore, the water-bearing characteristics of the sands and gravels overlying the bedrock appear to be generally poor, containing large amounts of silt and, in some places, being tight and/or cemented. At Test Pit 6, where the maximum depth to bedrock was found to exist, the alluvial materials consist of cemented sand, gravel and boulders, containing only small seams of water-bearing materials. Water-bearing sands and gravels were encountered at Test Holes 1, 2, 3 and Test Pit 1. However, these permeable deposits were only a few feet in thickness and extended to depths of only 2.5 to 6.5 feet below river level, considered much too shallow for any significant water supply development.

It is therefore concluded that, within the area of the tests, hydrogeological conditions are not suitable for the development of the required water supply of 1.5 million gallons per day by means of a Ranney Collector or by any other method of ground water extraction.

Based upon the results of previous tests carried out by our company along the south bank of the San Juan River in the vicinity of The Hogback, it is our opinion that a minimum depth, below river level, of about 15 feet of permeable, saturated sand and gravel will be necessary to develop the required water supply of 1.5 million gallons per day. None of the present test sites show these characteristics.

However, records of three test wells drilled by the U. S. Geological Survey in 1969 on the north side of the San Juan River immediately upstream from The Hogback show that such conditions may exist in that area. The records of these wells are set forth as follows:

<u>SW¼ SE¼ SE¼ Section 4, T.29N., R.16E.</u>
<u>Static water level-4.4 feet (9-20-69)</u>

| | |
|---|---|
| 0 - 18' | Sand |
| 18'- 28' | Coarse gravel |
| 28'- | Bedrock |

<u>NE¼ NW¼ NW¼ Section 9, T.29N. R.16E.</u>
<u>Static water level-1.5 feet (9-20-69)</u>

| | |
|---|---|
| 0 - 8' | Sand |
| 8'- 16' | Coarse gravel |
| 16'- | Bedrock |

<u>SW¼ NW¼ NW¼ Section 9, T.29N. R.16E.</u>
<u>Static water level-3.3 feet (9-20-69)</u>

| | |
|---|---|
| 0 - 7' | Sand |
| 7'- 17.5' | Coarse gravel |
| 17.5'- | Bedrock |

Although the elevation of the ground surface at these well sites is not known, if it is assumed that the static water level represents river level, then the saturated depth of sands and gravels below river level is 23.6, 14.5 and 14.2 feet, respectively.

It is not known whether or not similar conditions may be found to exist in the area between The Hogback and the site of the present tests. This can only be determined by a further testing program, considered to be beyond the scope of the present investigation.

Should you wish to review the possibility of an additional testing program, we will be pleased to meet with you at your convenience.

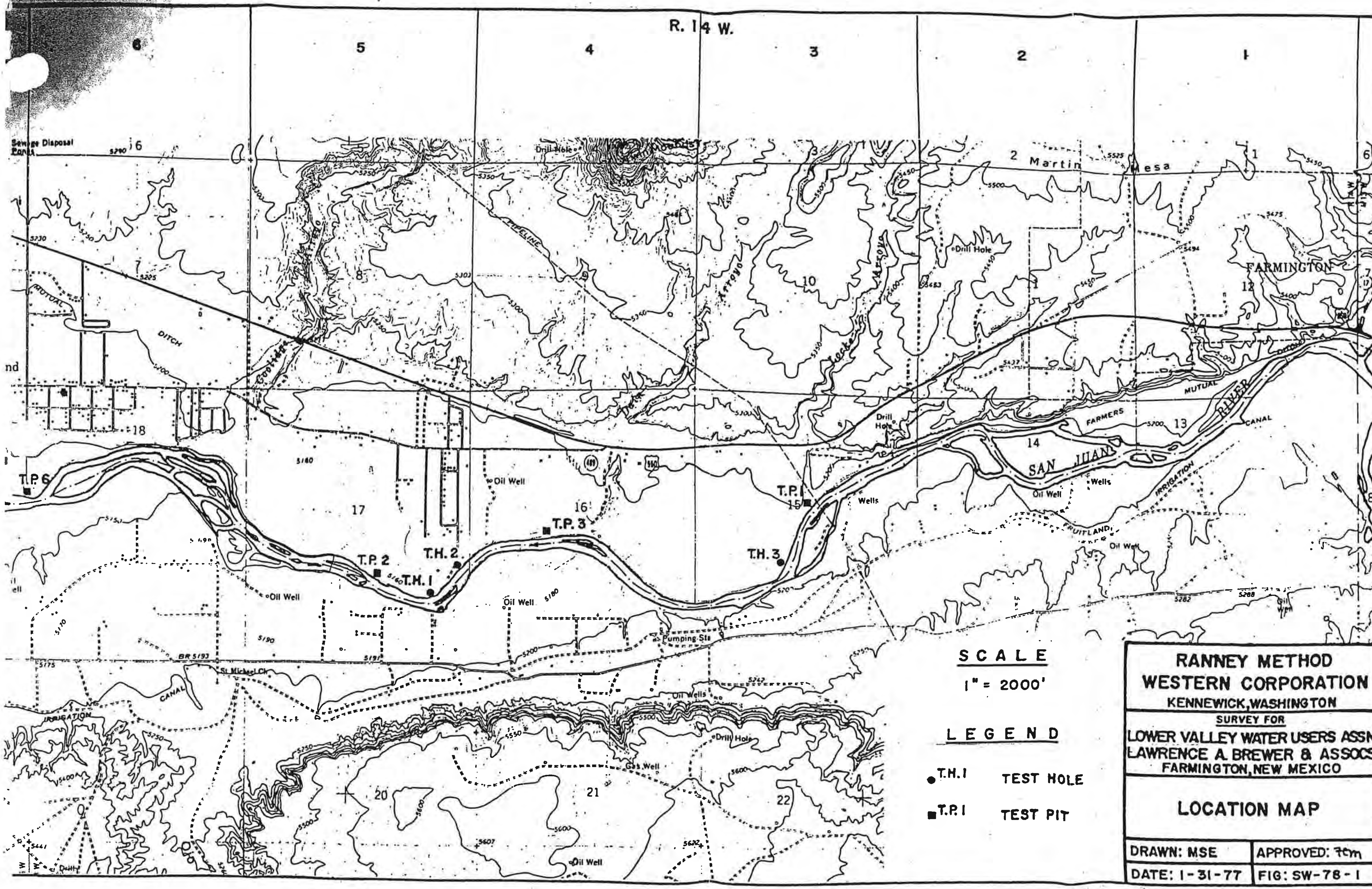
Very truly yours,

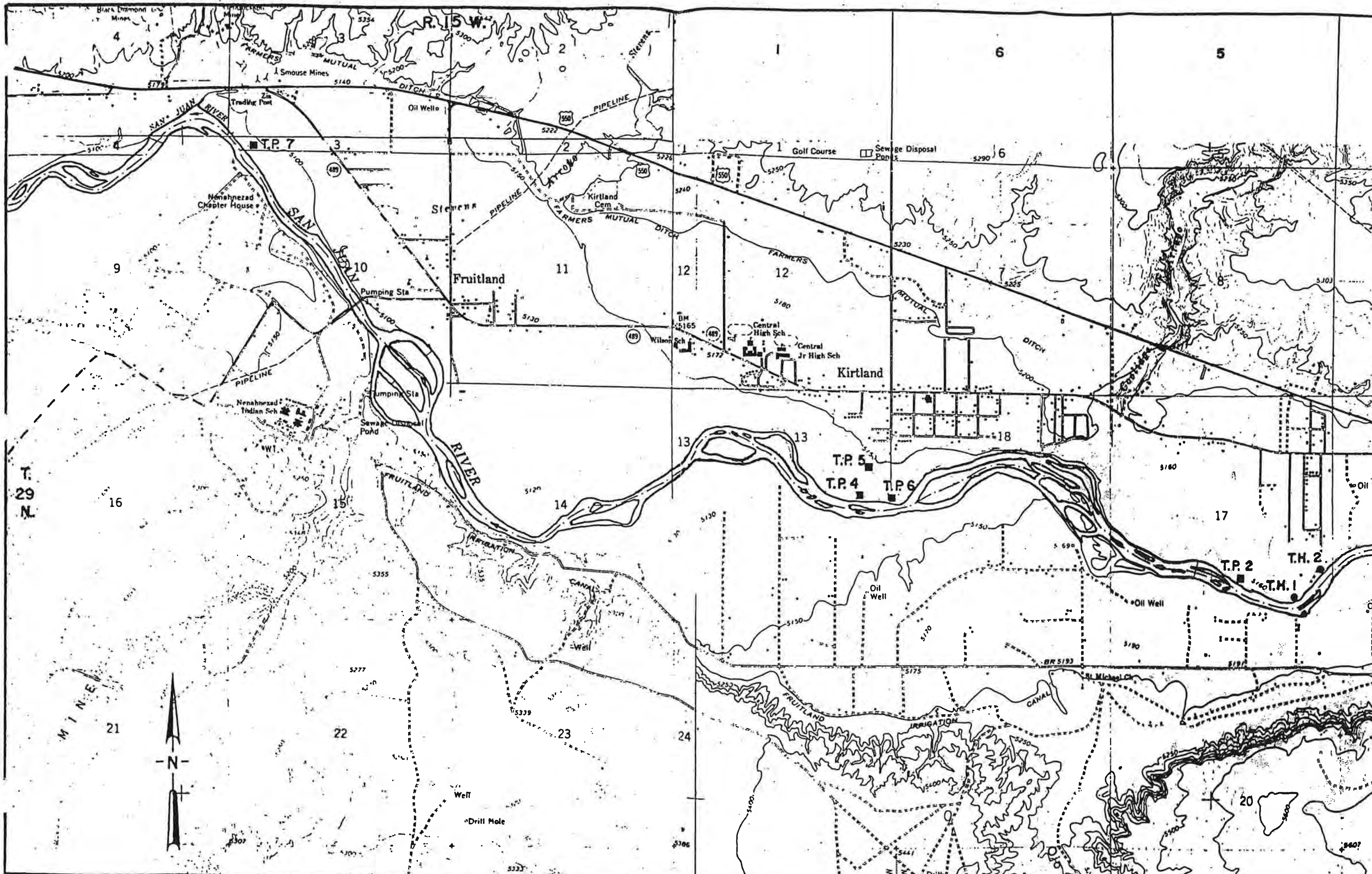
RANNEY METHOD WESTERN CORPORATION

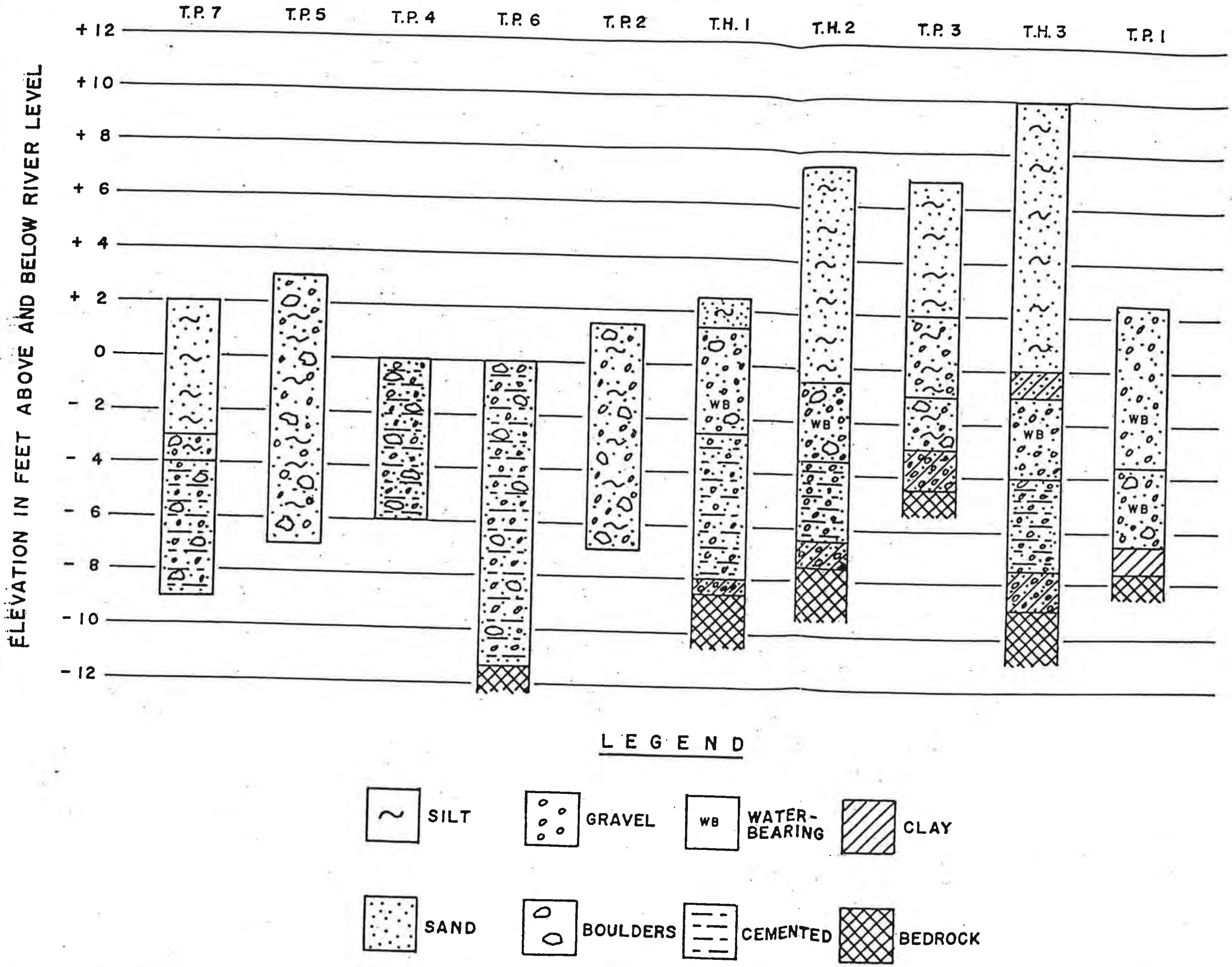
Frederick C. Mikels

Frederick C. Mikels, P.E.
President & Chief Engineer

FM/r


R. 14 W.
Martin Mesa
FARMINGTON
Coolidge
Locke Arroyo
PIPELINE
MUTUAL DITCH
SAN JUAN RIVER
FARMERS MUTUAL CANAL
FRUITLAND IRRIGATION
IRRIGATION CANAL
Sewage Disposal Ponds
Drill Hole
Oil Well
Wells
Pumping Sta.
St. Michael Ch.
Oil Wells
Gas Well
T.P. 1
T.P. 2
T.P. 3
T.P. 6
T.H. 1
T.H. 2
T.H. 3
SCALE
1" = 2000'
LEGEND
T.H. 1 TEST HOLE
T.P. 1 TEST PIT
RANNEY METHOD
WESTERN CORPORATION
KENNEWICK, WASHINGTON
SURVEY FOR
LOWER VALLEY WATER USERS ASSN.
LAWRENCE A. BREWER & ASSOCS.
FARMINGTON, NEW MEXICO
LOCATION MAP
DRAWN: MSE
APPROVED: TCM
DATE: 1-31-77
FIG: SW-78-1


R. 15 W.
T. 29 N.
SAN JUAN RIVER
FARMERS MUTUAL DITCH
Smouse Mines
Trading Post
Oil Wells
PIPELINE
T.P. 7
Golf Course
Sewage Disposal Ponds
Nenahnezad Chapter House
Kirtland Cem
Stevens
Fruitland
Pumping Sta
Central High Sch
Central Jr High Sch
Wilson Sch
Kirtland
Nenahnezad Indian Sch
Sewage Disposal Pond
T.P. 5
T.P. 4
T.P. 6
FRUITLAND IRRIGATION CANAL
Oil Well
T.P. 2
T.H. 2
T.H. 1
Well
St Michael Ch
Drill Hole
MINE
N




**NOTE:**

RIVER LEVEL SHOWN CORRESPONDS TO A RIVER FLOW OF 1700 CFS. RIVER LEVEL CAN BE EXPECTED TO DROP 1.2 FEET BELOW THAT SHOWN AT A MINIMUN RIVER FLOW OF 300 CFS.

**RANNEY METHOD WESTERN CORPORATION**
KENNEWICK, WASHINGTON

SURVEY FOR
LOWER VALLEY WATER USERS ASSN.
~~LAWRENCE A. BREWER & ASSOCS.~~
FARMINGTON, NEW MEXICO

**LOGS OF TEST HOLES AND TEST PITS**

| | |
|---|---|
| DRAWN: MSE | APPROVED: FCM |
| DATE: 1-31-77 | FIG.: SW-78-2 |

REPORT ON
HYDROGEOLOGICAL SURVEY
FOR
LOWER VALLEY WATER USERS ASSOCIATION
LAWRENCE A. BREWER & ASSOCS., CONS. ENGRS.
FARMINGTON, NEW MEXICO

May 26, 1977

SW-78

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## LIST OF ILLUSTRATIONS

REPORT ON
HYDROGEOLOGICAL SURVEY
FOR
LOWER VALLEY WATER USERS ASSOCIATION
LAWRENCE A. BREWER & ASSOCS., CONS. ENGRS.
FARMINGTON, NEW MEXICO

## I PURPOSE OF SURVEY:

This report presents the results of a hydrogeological survey conducted to determine the feasibility of developing a naturally-filtered water supply of 1.5 million gallons per day for the Lower Valley Water Users Association by means of a Ranney Collector constructed adjacent to the San Juan River.

## II ACKNOWLEDGEMENTS:

The assistance and cooperation of the following individuals and firms, which aided materially during this investigation, is gratefully acknowledged: Mr. Jim Dunlap, Lower Valley Water Users Association; Mr. Richard P. Cheney, Lawrence A. Brewer & Associates; Mr. J. P. Borland, U. S. Geological Survey; U. S. Army Corps of Engineers and Lloyd Matson, driller.

## III LOCATION AND HYDROGEOLOGY:

In January 1977, a preliminary exploratory test drilling program was carried out to determine the depth, character and areal extent of the underlying unconsolidated alluvial deposits along the north bank of the San Juan River in an area extending from the Zia Trading Post upstream for a distance of about 8 miles. The results of this study, given in detail in our letter-report dated February 4, 1977, showed that bedrock occurs at relatively shallow depths throughout the area of the tests, ranging, in depth below river level, from 4.5 to 11.5 feet. Because of these shallow depths and the generally poor character of the alluvial deposits, it was concluded that, within the area of the tests, hydrogeological conditions were not suitable for developing of the required water supply of 1.5 million gallons per day by means of a Ranney Collector or by any other method of ground water extraction.

Following this preliminary study, personnel of the Lower Valley Water Users Association continued exploration at other locations along the San Juan River by digging test pits with a backhoe. A favorable appearing site was found to exist along the north bank of the San Juan River about 500 feet upstream from the irrigation diversion structure located in Section 18, T.29N., R.13W. The location of this test site is shown in Figure SW-78-1. Three test pits constructed in this area showed the existence of sands, gravels and boulders extending from ground surface to a depth of approximately 19 feet, where shale bedrock was encountered.

In order to confirm the depth and character of these alluvial materials, Wells E-1, E-2 and E-3 were drilled. The locations of these wells are shown in Figure SW-78-2 and their logs in Figure SW-78-3. Well E-1 encountered sand, gravel and boulders from ground surface to a depth of 20.6 feet where shale bedrock was encountered. Well E-3 encountered sand, gravel and boulders from ground surface to a depth of 19.2 feet where shale bedrock was encountered. Difficulties were experienced in the drilling of Well E-2, with the well casing reportedly being stopped at a depth of 14.5 feet due to a boulder or bedrock.

These wells show that the shale bedrock occurs at Elevation 5219 to 5220 (MSL). With the minimum river stage at Elevation 5217 (MSL), a total of 17 to 18 feet of saturated sand, gravel and boulders is available for development. Because of favorable indications from a small-rate, short-term pumping test conducted on April 20, 1977, it was decided to conduct a detailed pumping test at this site.

## IV PUMPING TEST:

For the pumping test, an additional observation well (E-4) and a 10-inch diameter pumping well (EPW) were drilled. The locations of these wells are shown in Figure SW-78-2 and their logs in Figure SW-78-3. The pumping well, EPW, was pumped continuously from 8:00 a.m. on May 2 until 9:00 a.m. on May 4, 1977, a total of 49 hours. The initial pumping rate was 150 gallons per minute. After three hours of pumping, the rate was reduced to 130 gallons per minute and was held constant at that rate throughout the remaining 46 hours of the test. The stabilized, corrected drawdown in the pumping well was 11.0 feet below river level. The temperature of the discharge water, during the test, gradually increased from 50 to 53°F. while that of the San Juan River fluctuated from 55 to 69°F. The flow of the San Juan River varied from 295 to 890 cubic feet per second during the test.

Water levels in observation wells and changes in river stage were recorded continuously and are shown on the hydrographs in Figure SW-78-4. As can be noted from the hydrographs, water levels in the observation wells stabilized within the first few hours of the test and followed the fluctuations of the river level throughout the remainder of the test. The rapid response of the ground-water levels to changes in river stage is an indication of a good hydraulic connection with the river and, therefore, conditions which are favorable for recharge from the river.

From the distance-drawdown graph in Figure SW-78-5, the transmissibility of the aquifer is determined as 9,990 gallons per day per foot and the permeability as 555 gallons per day per square foot for the test temperature of 53°F. The effective distance to the line of infiltration, as measured from the pumping well, is determined as 40 feet. These results show a rather low permeability but, because of the short effective distance, good conditions for river infiltration.

## V FLOW AND TEMPERATURE CHARACTERISTICS - SAN JUAN RIVER:

Water profiles of the San Juan River at the test site are shown in Figure SW-78-6. These profiles were obtained from data supplied by the U. S. Army Corps of Engineers(1). The Standard Project Flood is one that can be expected from the most severe combination of meteorological conditions reasonably characteristic of the geographical region and corresponds to a river flow at the State Highway 371 bridge of 40,000 cfs. The profiles indicate that such a flood would create a maximum river stage of Elevation 5229 at the test site. The minimum river flow is conservatively taken as 200 cfs and, based upon observations during the pumping test, corresponds to a minimum river stage of Elevation 5217 at the test site. This low flow is based upon a study of the U. S. Geological Survey stream flow records at Farmington for the period 1962-1972, i.e., the period of record since partial control of the river has been in effect by the operation of Navajo Reservoir. These records show that the minimum mean monthly flow has ranged from 329 to 1,159 cfs and the extreme minimum daily flow has ranged from 200 to 729 cfs.

The temperature of the San Juan River has a seasonal variation generally ranging from 38 to 75°. Minimum temperatures normally occur in January while maximum temperatures normally occur in July. Throughout the summer months of May to September, inclusive, the water temperature is usually in excess of 60°F.

## VI RANNEY COLLECTOR YIELD:

Because of the rather low permeability and limited amount of head available for development, a Ranney Infiltration Gallery, rather than the conventional radial-type Ranney Collector, has been selected for maximum aquifer development. Bennett(2), and others have given the following equation for an infiltration gallery constructed parallel to a recharging river:

$$Q = \left( \frac{PmsL}{D} + \frac{2\pi Pms}{2.3 \log \frac{2D}{r}} \right) \frac{V_1}{V_2}$$

in which,

Q = Gallery Yield, in gallons per day.
P = Permeability of the aquifer for the test temperature, in gallons per day per square foot.

---

(1) "Flood Plain Information, San Juan River and Tributaries, Farmington, New Mexico." Department of the Army, Sacramento District, Corps of Engineers, Sacramento, California (June 1975).
(2) BENNETT, TRUMAN W. "On the Design and Construction of Infiltration Galleryies", Ground Water, Volume 8, Number 3, May-June 1970.

m = Average saturated aquifer thickness, in feet.
s = Drawdown below river level, in feet.
D = Effective distance to the line of infiltration, in feet.
L = Gallery length, in feet.
r = Effective radius of the gallery ends, in feet.
$V_1$ = Viscosity correction factor for the test temperature.
$V_2$ = Viscosity correction factor for the temperature for which the yield is being determined.

In the foregoing expression, the first term represents direct lineal flow to the gallery, as determined by Darcy's Law, and the second term represents radial flow to the gallery ends.

The yield of the Ranney Infiltration Gallery during the summer months is of primary interest since this yield will coincide with the Association's high water use period. Design conditions for the summer months are based upon a water temperature in excess of 60°F. ($V_2$ = 1.00) and a minimum river stage of Elevation 5217 (MSL). The test temperature is taken at the measured value of 53°F. ($V_1$ = 1.06).

The proposed Ranney Infiltration Gallery consists of a central reinforced concrete caisson with two 10-inch diameter horizontal screen laterals, each 400 feet in length, extending parallel to the river's edge, all as shown in Figure SW-78-7.

Using a design pumping level of Elevation 5207 (MSL), the drawdown will be 10 feet below the minimum river stage of Elevation 5217 and the summer yield will be:

$$Q_{summer} = \left( \frac{(555)(12)(10)(800)}{40} + \frac{2\pi(555)(12)(10)}{2.3 \log\frac{2(40)}{2}} \right) \frac{1.06}{1.00}$$

$$Q_{summer} = 1.5 \text{ million gallons per day}$$

The extreme minimum yield will occur when low river stage conditions and low water temperatures coincide. This yield can be expected to occur during low water temperature conditions in January, a time when the Association's water use is at a minimum. Using a lowest expected gallery water temperature of 40°F. ($V_2$ = 1.37) and a minimum river stage of Elevation 5217 (MSL), the minimum yield will be:

$$Q_{minimum} = \left( \frac{(555)(12)(10)(800)}{40} + \frac{2\pi(555)(12)(10)}{2.3 \log\frac{2(40)}{2}} \right) \frac{1.06}{1.37}$$

$$Q_{minimum} = 1.1 \text{ million gallons per day}$$

It is concluded from the foregoing computations that the proposed Ranney Infiltration Gallery, located and constructed as shown in Figure SW-78-7, will be capable of developing the required water supply of 1.5 million gallons per day during the summer months of May to September, inclusive. It is pointed out that, because of the necessity of constructing long (400 feet) horizontal screen laterals, it will not be possible to project these laterals from the central caisson by the conventional Ranney Method. Because of the length, it will be necessary to install the horizontal screen laterals by open excavation and backfilling. However, after installation of the laterals, final flushing and development can be carried out by using the sand removal device and the conventional Ranney Method of development.

It should be noted that the existing irrigation diversion structure plays an important role in maintaining the river stage and head at the proposed gallery site. Referring to the water and streambed profiles in Figure SW-78-6, it can be seen that the existing diversion structure maintains the river stage at a level of about 5 feet higher than the natural river gradient. Failure of this structure would result in a loss of this head and a serious reduction in the yield of the proposed Ranney Infiltration Gallery.

## VII WATER QUALITY:

The chemical analyses of water samples collected during the pumping test are set forth in the following table.

| | PARTS PER MILLION(2) | | |
|---|---|---|---|
| | PUMPING WELL EPW | | SAN JUAN RIVER |
| CONSTITUENT(1) | 5-2-77 | 5-4-77 | 5-4-77 |
| Total Hardness ($CaCO_3$) | 384 | 318 | 224 |
| Calcium ($CaCO_3$) | -- | 264 | 196 |
| Magnesium ($CaCO_3$) | -- | 54 | 28 |
| Total Alkalinity ($CaCO_3$) | -- | 174 | 122 |
| Hydroxide ($CaCO_3$) | -- | 0 | 0 |
| Carbonates ($CaCO_3$) | -- | 0 | 0 |
| Bicarbonate ($CaCO_3$) | -- | 174 | 122 |
| Chlorides (Cl) | -- | 43 | 17 |
| Sulfates ($SO_4$) | -- | 300 | 225 |
| Nitrates ($NO_3$) | -- | 0.1 | <0.1 |
| Iron (Fe) | -- | 0.1 | <0.1 |
| Sodium (By Difference) | -- | 65 | 44 |
| Total Dissolved Solids | 800 | 633 | 445 |
| Conductivity (mho/cm @ 68°F.) | 1160 | 980 | 610 |
| pH | 8.3 | 8.0 | 8.0 |
| Turbidity (FTU) | -- | 5 | 7 |
| Turbidity (JTU)(3) | | 1.6 | 7.2 |

(1) Analyses by San Juan Testing Laboratory, Farmington, New Mexico.
(2) Parts per million except pH and Conductivity.
(3) Analyses by Ranney Method Western Corporation using a Hach Model 2100 Turbidimeter.

The foregoing analyses show that the water produced during the pumping test is substantially more mineralized than that of the San Juan River. This is to be expected, since the water produced during the test represents the relatively stagnant ground water in the area rather than infiltrated water from the river, the pumping test rate being too small and the duration of the test too short to induce a significant amount of water into the aquifer from the river. For example, using the permeability value of 555 gallons per day per square foot and the natural river gradient as indicative of the natural ground-water gradient, the natural rate of ground-water movement is computed as about 1/2 foot per day. Even during the pumping test, the average rate of ground-water movement is only on the order of 6 feet per day. Even with this slow rate of movement, a significant improvement in mineral quality did occur when the water sample at the start of the test (5-2-77) is compared with that at the end of the test (5-4-77).

In addition to these analyses, a strong odor of hydrogen sulfide was noted during the pumping test. Pumping has continued, since completion of the pumping test, and is still continuing, as of the writing of this report, to determine if pumping can eliminate this odor. The results, to date, show a significant decline in the amount of hydrogen sulfide from an initial reading of 6.8 ppm to a present reading of 3.4 ppm. It has been our experience that, in situations where odors have been encountered during testing programs, these odors have been completely eliminated after construction and start of pumping from the Ranney Collector.

Since most of the water produced from the Ranney Infiltration Gallery will be infiltrated from the river, the dissolved inorganic chemical quality of the water produced can be expected to approach that of the river, once continuous pumping has started and the relatively stagnant ground-water flushed out. Being naturally filtered, the water produced will be clear and free of silt, sand, turbidity and pathogenic bacteria and, as such, will be suitable for municipal use without treatment except for preventive chlorination as required by health regulations.

## VIII SUMMARY AND CONCLUSIONS:

The results of the hydrogeological survey have shown the existence of a permeable sand and gravel aquifer, approximately 20 feet in depth, located along the north bank of the San Juan River in Section 18, T.29N., R.13W. A detailed pumping test has shown that, while the permeability of the aquifer is rather low, conditions for river infiltration are good.

Because of the rather low permeability and limited amount of head available for development, a Ranney Infiltration Gallery, rather than the conventional radial-type Ranney Collector, is recommended for maximum aquifer development. Computations show that a Ranney Infiltration

Gallery, located and constructed as shown in Figure SW-78-7, will have a summer yield of 1.5 million gallons per day during the months of May to September, inclusive. The extreme minimum yield will occur in January when low river stage conditions and low water temperature conditions coincide and is computed to be 1.1 million gallons per day.

Since most of the water produced from the Ranney Infiltration Gallery will be infiltrated from the river, the dissolved inorganic chemical quality of the water produced can be expected to approach that of the river, once continuous pumping has started and the relatively stagnant ground-water flushed out. Being naturally filtered, the water produced will be clear and free of silt, sand, turbidity and pathogenic bacteria and, as such, will be suitable for municipal use without treatment except for preventive chlorination as required by health regulations.

It is therefore concluded that a Ranney Infiltration Gallery, located and constructed as shown in Figure SW-78-7, will be capable of providing the required water supply of 1.5 million gallons per day during the summer months of May to September, inclusive.

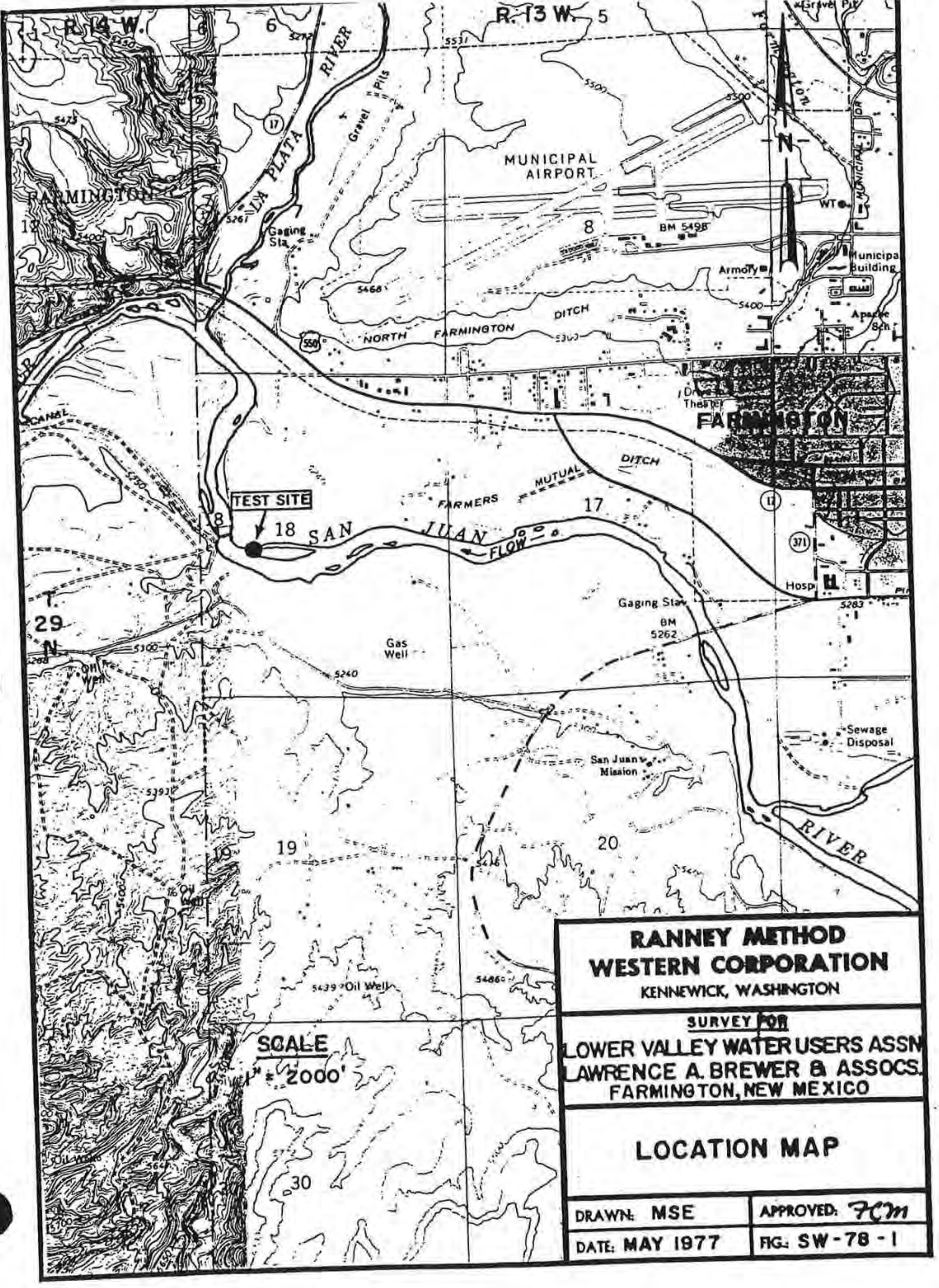
Respectfully submitted

RANNEY METHOD WESTERN CORPORATION

Frederick C. Mikels

Frederick C. Mikels, P.E.
President & Chief Engineer

May 26, 1977

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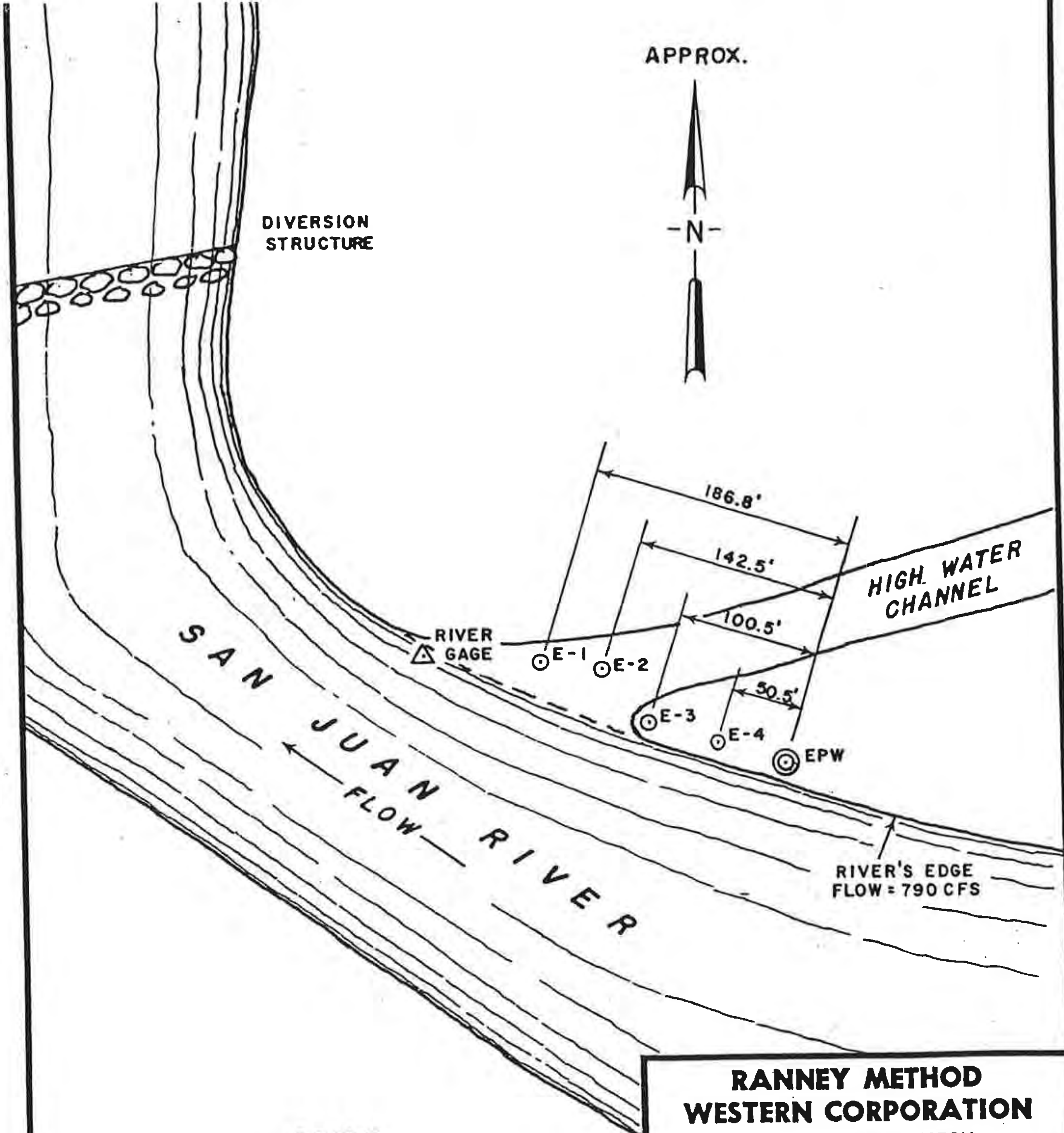
KENNEWICK, WASHINGTON

SURVEY FOR
LOWER VALLEY WATER USERS ASSN
LAWRENCE A. BREWER & ASSOCS.
FARMINGTON, NEW MEXICO

**LOCATION MAP**

| | |
|---|---|
| DRAWN: MSE | APPROVED: FCM |
| DATE: MAY 1977 | FIG.: SW-78-1 |




**SCALE**

1" = 100'

100 0 100 200 feet

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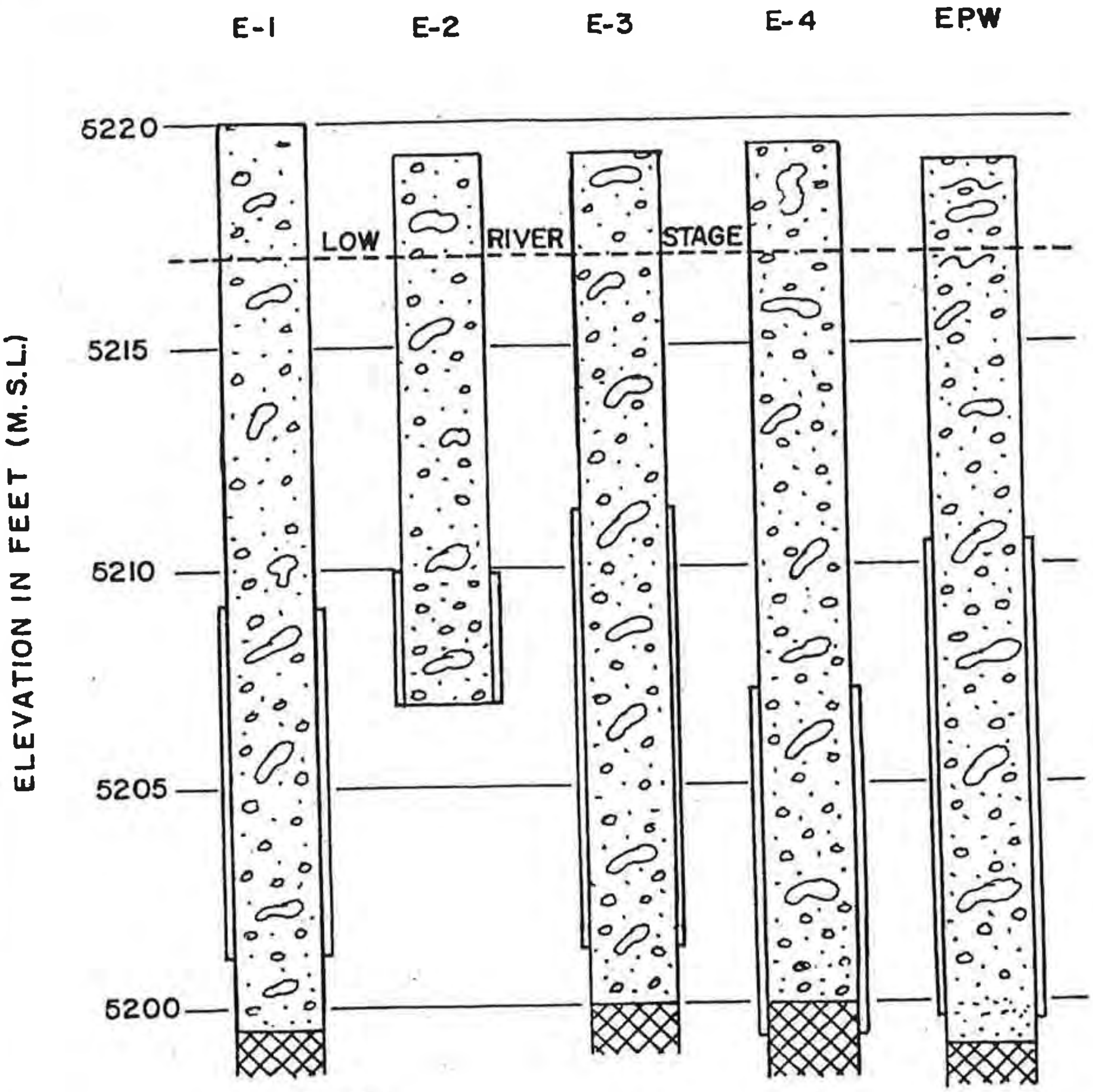
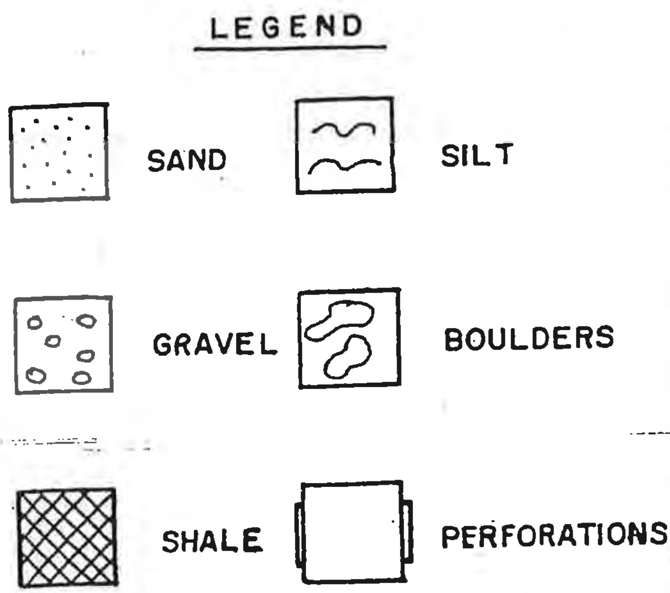
FARMINGTON, NEW MEXICO

**LOCATIONS OF TEST WELLS**

| | |
|---|---|
| DRAWN: MSE | APPROVED: 7CM |
| DATE: MAY 1977 | FIG.: SW-78-2 |

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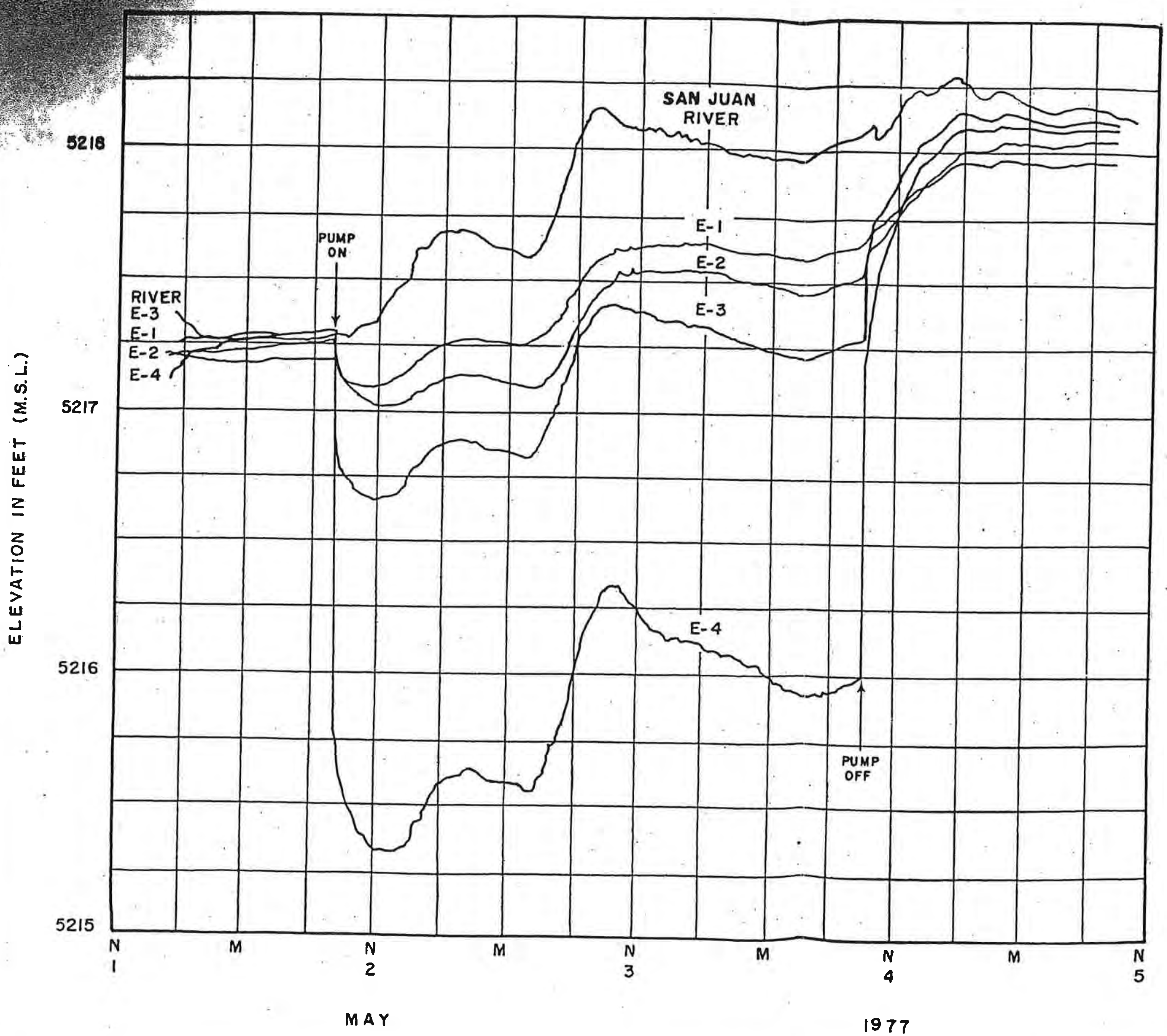
LOWER VALLEY WATER USERS ASSN.
LAWRENCE A. BREWER & ASSOCS.
FARMINGTON, NEW MEXICO

LOGS OF TEST WELLS

| | |
|---|---|
| DRAWN: G.E.H. | APPROVED: Jcm |
| DATE: MAY 1977 | FIG.: SW-78-3 |

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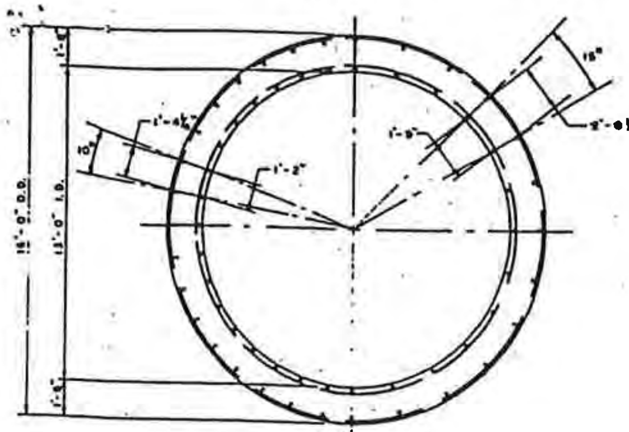
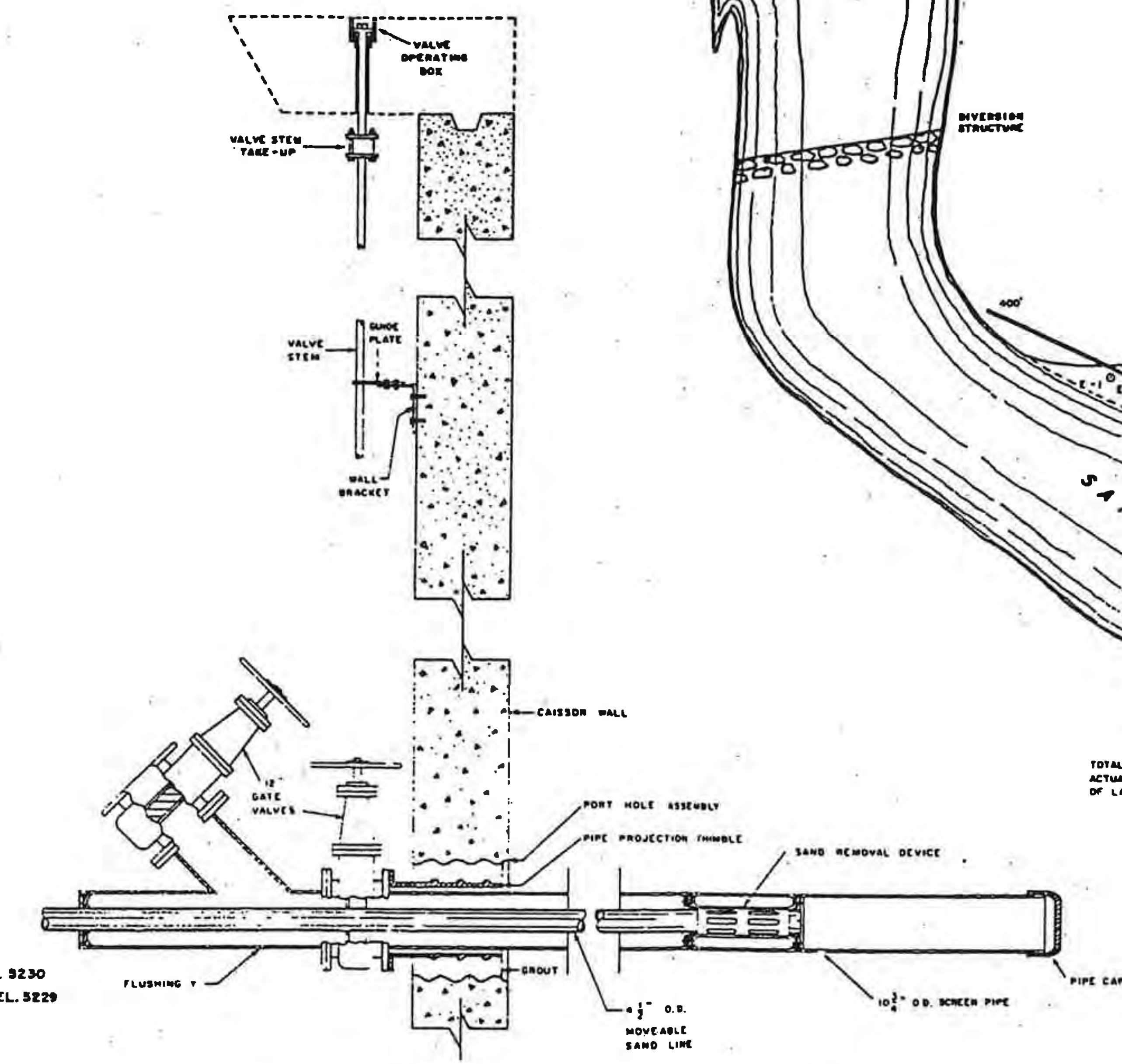
LAWRENCE A. BREWER & ASSOCS
FARMINGTON, NEW MEXICO

HYDROGRAPHS

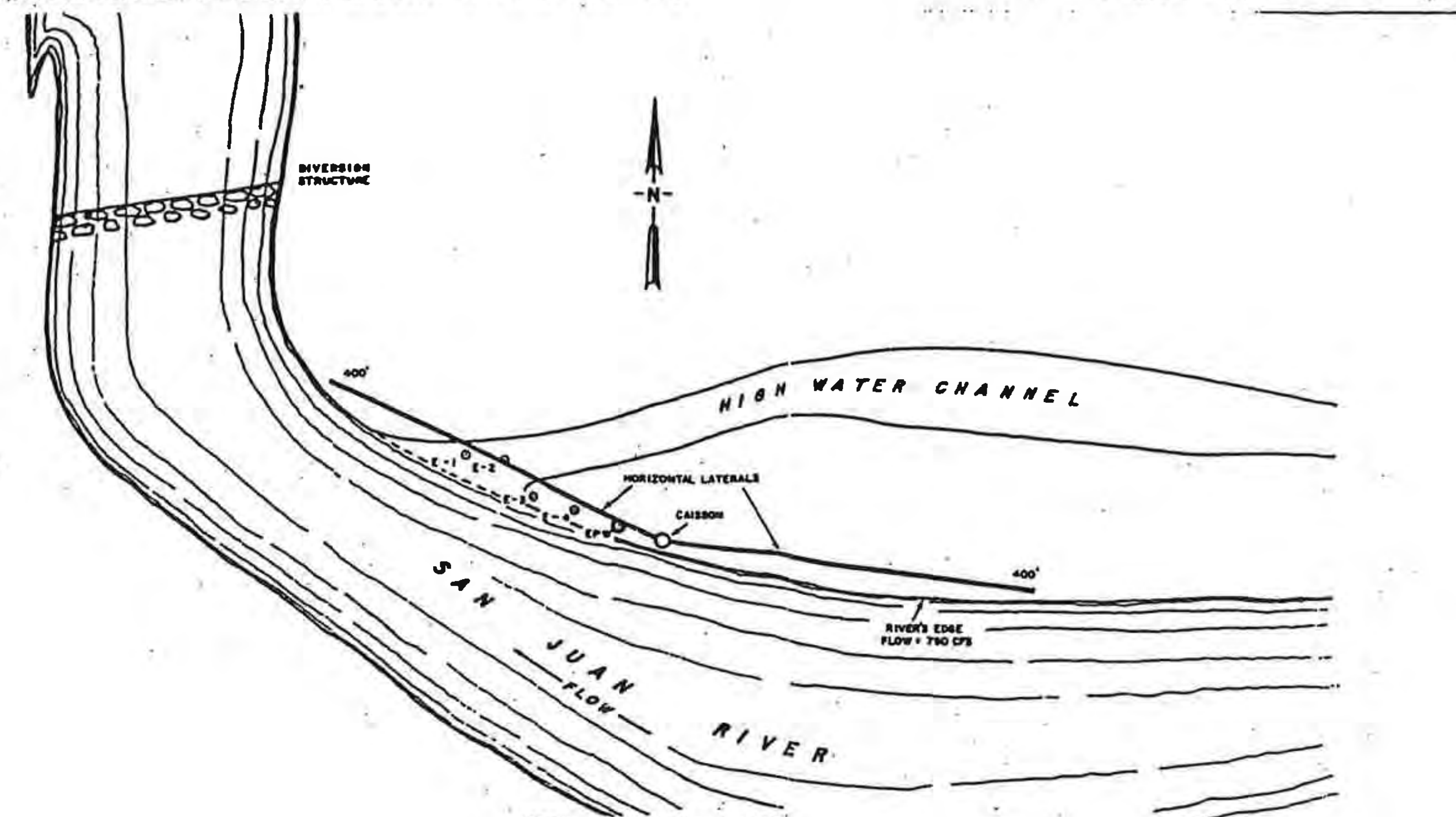
| | |
|---|---|
| DRAWN: G.E.H | APPROVED: 7cm |
| DATE: MAY 1977 | FIG.: SW-78-4 |




SECTION A-A
SCALE ½" = 1'-0"

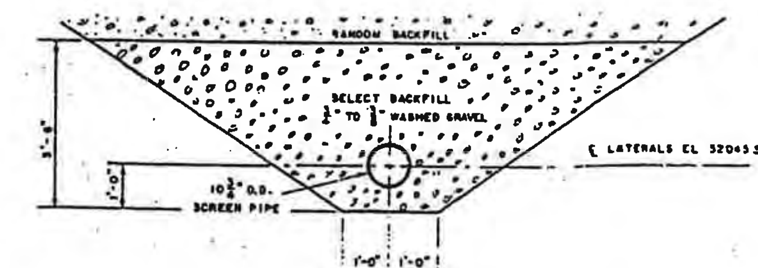



ENLARGED SECTION SHOWING REQUIRED METHOD OF DEVELOPMENT USING SAND REMOVAL DEVICE AND FLUSHING Y
SCALE ⅜" = 1'-0"

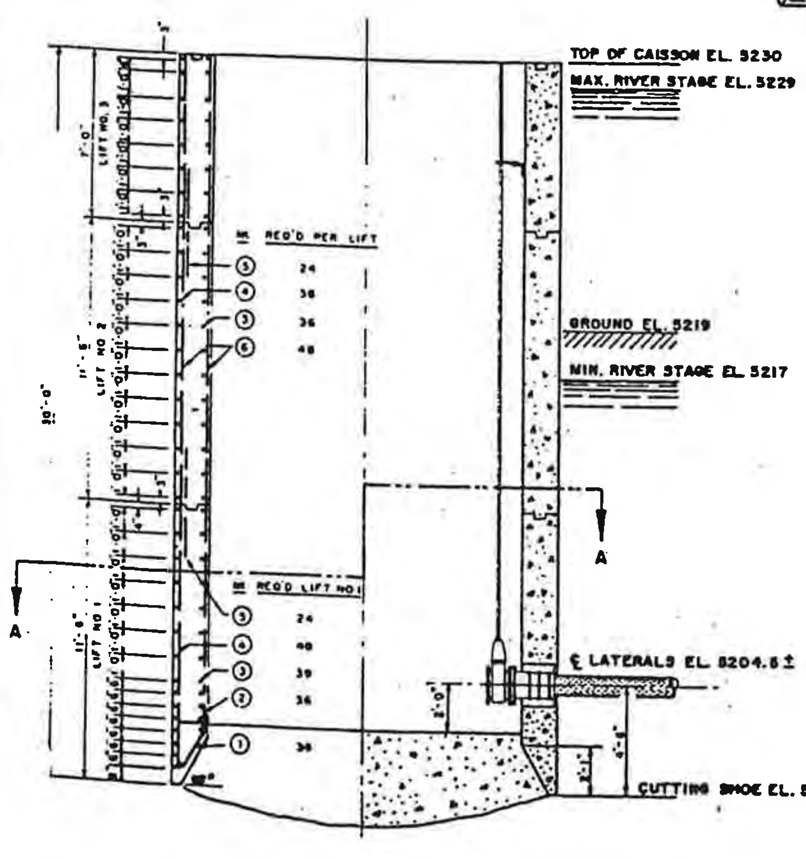



LATERAL PROJECTION DIAGRAM
SCALE 1" = 200'

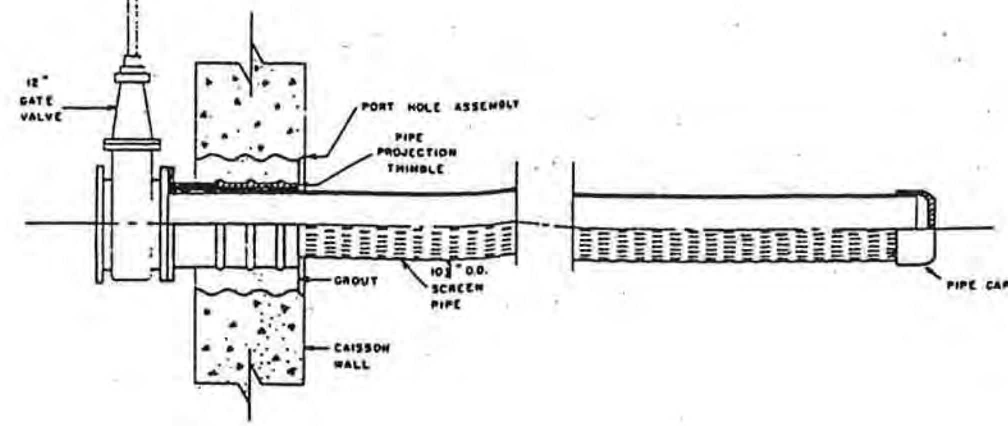
TOTAL LENGTH OF LATERALS TO BE NOT LESS THAN 800 FEET. ACTUAL LENGTH, LOCATION, DIRECTION, NUMBER AND ELEVATION OF LATERALS TO BE DETERMINED BY FIELD CONDITIONS.




SECTION THRU HORIZONTAL LATERALS
SCALE: ½" = 1'-0"




VERTICAL SECTION THRU CAISSON
SCALE ⅛" = 1'-0"




ENLARGED SECTION SHOWING SCREEN PIPE AND ACCESSORIES
SCALE ⅜" = 1'-0"

| REQ'D | SIZE | LENGTH | MK | A | B | C | D | E | H | R | DETAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | NO.5 | 19'-0" | (1) | 4'-0" | 1'-10" | 13'-2" | | | 1'-2" | 0'-1" | |
| 36 | NO.5 | 13'-2" | (2) | 12'-0" | 1'-2" | | | | | | |
| 96 | NO.5 | 16'-0" | (3) | 12'-5½" | | | | | 4'-2½" | 6'-8½" | |
| 105 | NO.5 | 18'-6" | (4) | 14'-5½" | | | | | 4'-10" | 17'-10" | |
| 48 | NO.5 | 11'-4" | (5) | 1'-2" | 4'-6" | 4'-6" | 1'-2" | | | | USE 4 INCH WHEEL |
| 96 | NO.5 | 13'-6" | (6) | 13'-6" | | | | | | | |

TOTAL VOLUME CONCRETE: 80 CU. YDS.
TOTAL WEIGHT RE-STEEL: 6800 LBS.

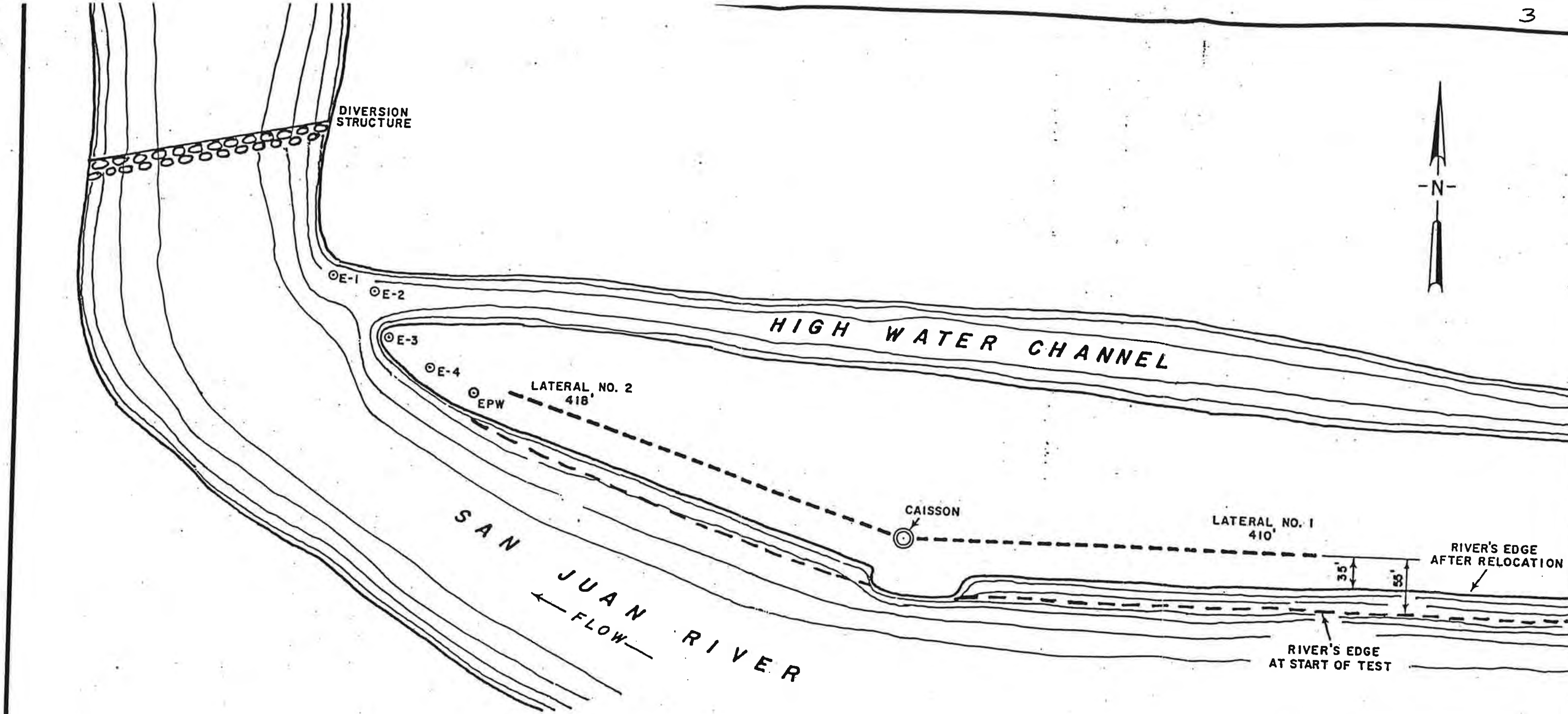
| REVISION | BY | DATE |
|---|---|---|
| | | |

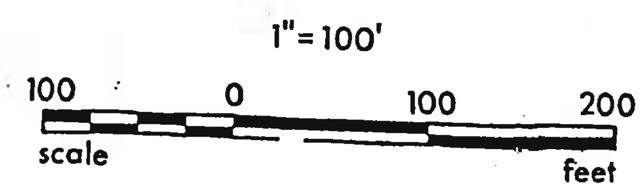
RANNEY METHOD WESTERN CORPORATION
KENNEWICK, WASHINGTON

PROJECT FOR
LOWER VALLEY WATER USERS ASSN.
LAWRENCE A. BREWER & ASSOCS.
FARMINGTON, NEW MEXICO

PROPOSED
RANNEY INFILTRATION GALLERY

| | |
|---|---|
| DRAWN BY: MSE | CHECKED BY: |
| SCALE: AS SHOWN | APPROVED BY: 7Cm |



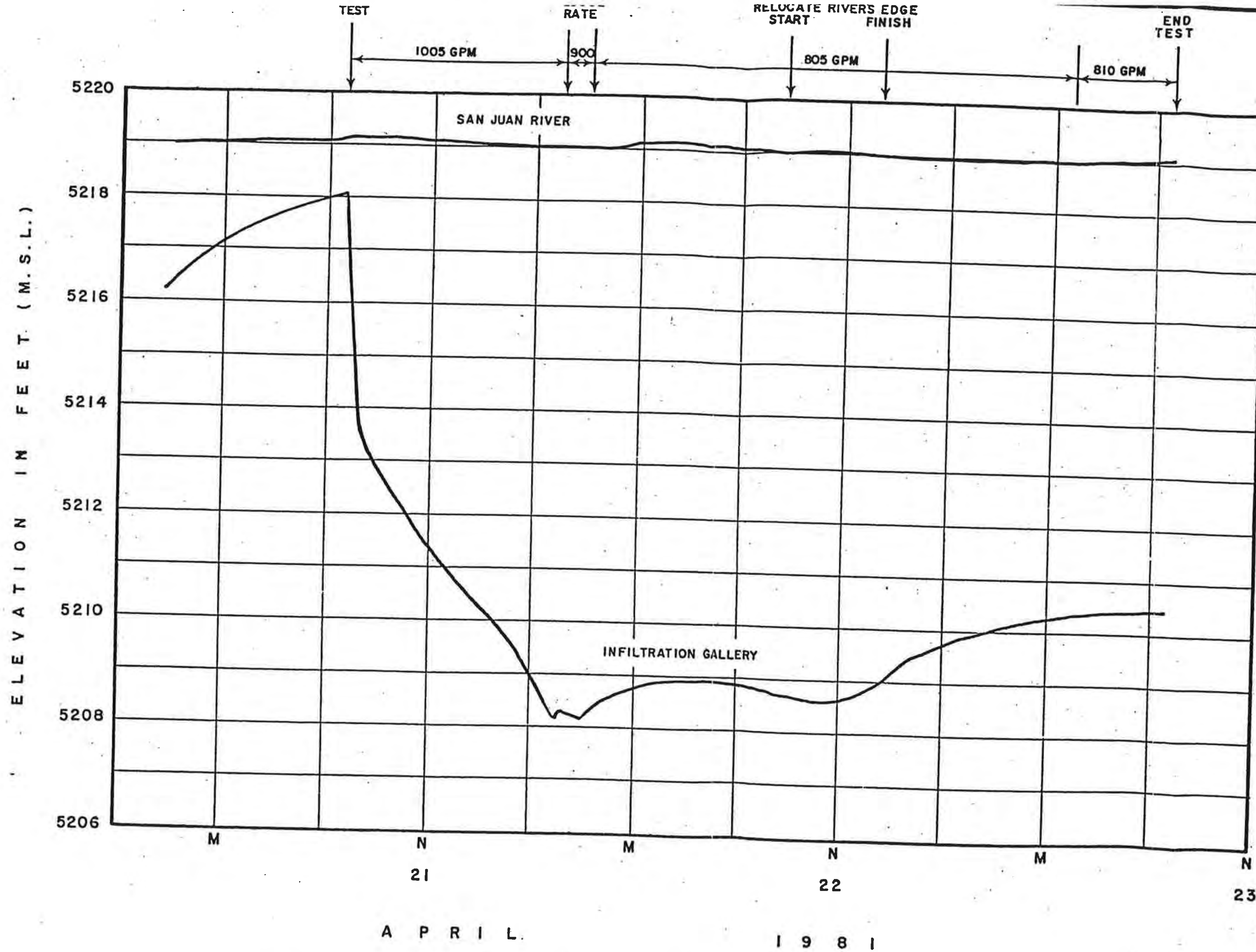

| | ELEVATION IN FEET (M.S.L.) |
|---|---|
| TOP OF CAISSON | 5234.2 |
| GROUND | ± 5222.0 |
| TEST RIVER STAGE | 5219.0 |
| LOW RIVER STAGE | 5218.5 |
| ℄ HORIZONTAL LATERALS | 5206.7 |
| BOTTOM OF CAISSON | 5204.7 |
| CUTTING SHOE | 5202.2 |

**RANNEY METHOD WESTERN CORPORATION**
KENNEWICK, WASHINGTON

**LOWER VALLEY WATER USERS COOPERATIVE ASSOCIATION**
SAN JUAN COUNTY, NEW MEXICO

**INFILTRATION GALLERY**

| | |
|---|---|
| DRAWN: MSE | APPROVED: FCM |
| DATE: 6-4-81 | FIG.: FT-47-01 |

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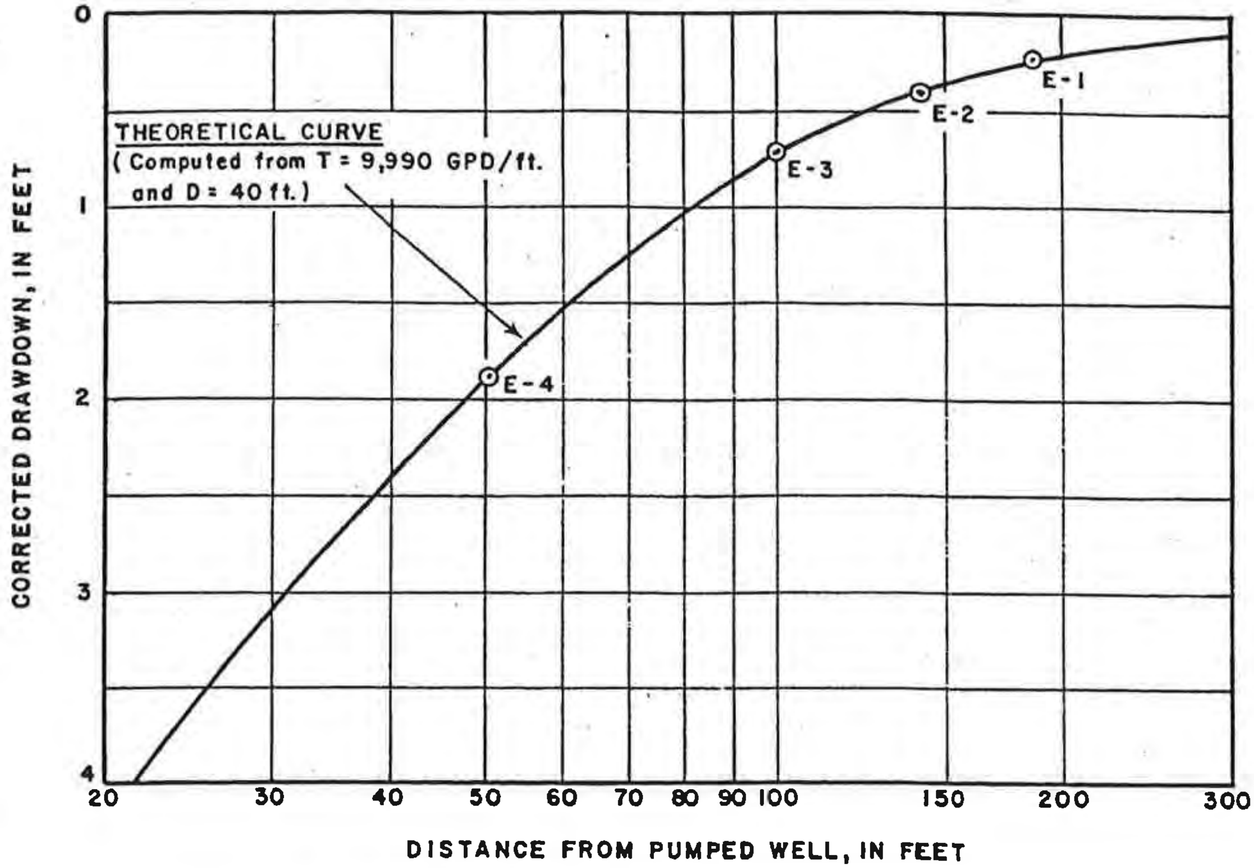
KENNEWICK, WASHINGTON

LOWER VALLEY WATER USERS COOPERATIVE ASSOCIATION
SAN JUAN COUNTY, NEW MEXICO

HYDROGRAPHS

| | |
|---|---|
| DRAWN: MSE | APPROVED: FCM |
| DATE: 6-4-81 | FIG.: PT-47-02 |




$$(1)\quad \frac{s_1}{s_2} = \frac{\log \dfrac{\sqrt{(2D)^2 + (r_1)^2}}{r_1}}{\log \dfrac{\sqrt{(2D)^2 + (r_2)^2}}{r_2}}$$

D = 40 ft.

T = 9,990 GPD/ft. (53°F.)

P = 555 GPD/sq.ft. (53°F.)

$$(2)\quad T = Pm = \frac{2.3\, Q \log \dfrac{\sqrt{(2D)^2 + (r_1)^2}}{r_1}}{2\pi s_1}$$

in which,

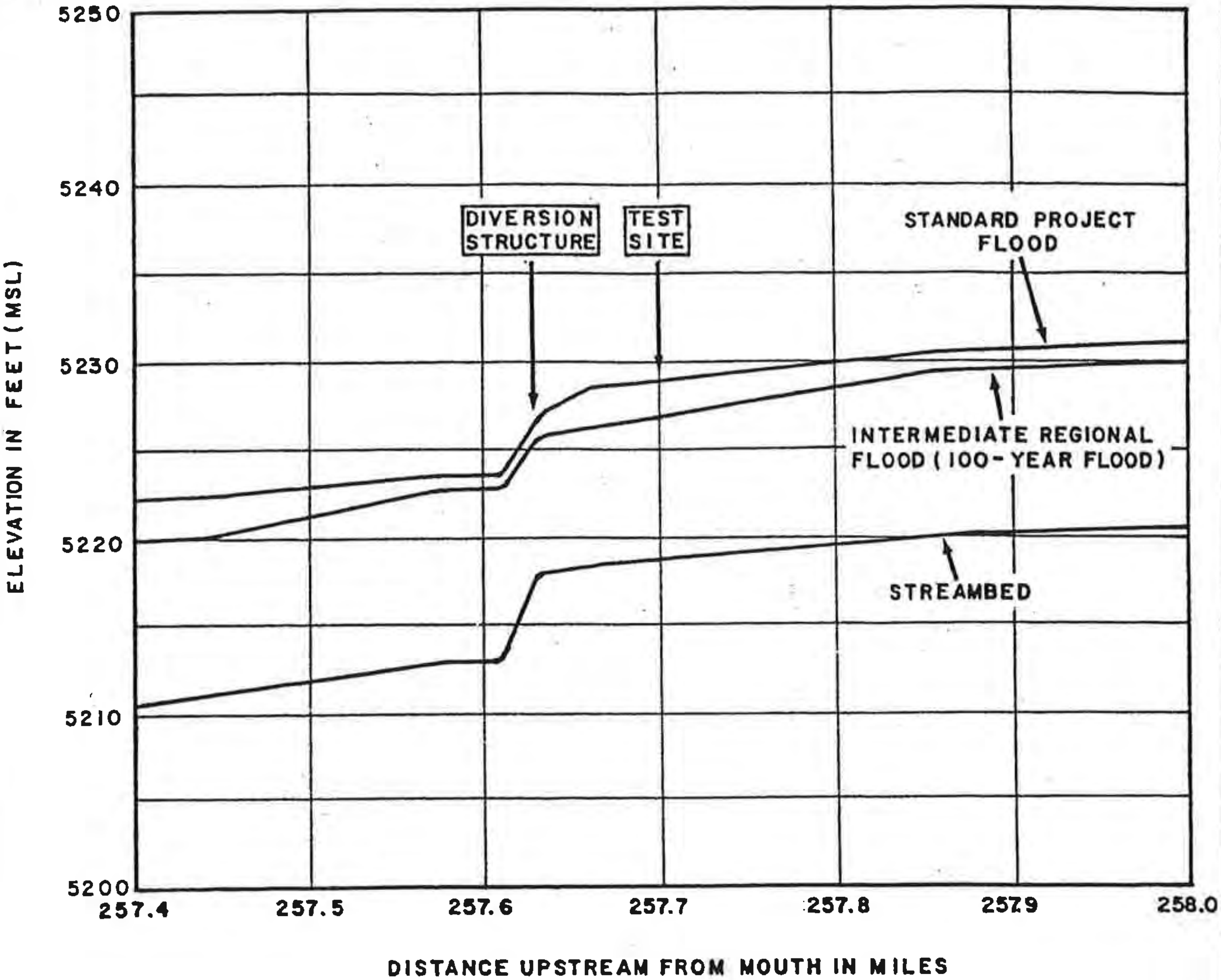
T = Transmissibility, in GPD/ft.
P = Permeability, in GPD/sq.ft.
m = Aquifer thickness, in ft.
Q = Pumping rate, in GPD.
$r_1$ & $r_2$ = Distances from pumped well, in ft.
$s_1$ & $s_2$ = Drawdowns at distances $r_1$ & $r_2$, in ft.
D = Effective distance to the line of infiltration, in ft.

**RANNEY METHOD WESTERN CORPORATION**
KENNEWICK, WASHINGTON

SURVEY FOR
LOWER VALLEY WATER USERS ASSN
LAWRENCE A. BREWER & ASSOCS.
FARMINGTON, NEW MEXICO

**PERMEABILITY COMPUTATION**

| | |
|---|---|
| DRAWN: MSE | APPROVED: 7Cm |
| DATE: MAY 1977 | FIG.: SW - 78 - 5 |




DATA TAKEN FROM:

"FLOOD PLAIN INFORMATION, SAN JUAN RIVER AND TRIBUTARIES, FARMINGTON, NEW MEXICO." DEPARTMENT OF THE ARMY, SACRAMENTO DISTRICT, CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA. (JUNE 1975).

**RANNEY METHOD WESTERN CORPORATION**
KENNEWICK, WASHINGTON

SURVEY FOR
LOWER VALLEY WATER USERS ASSN.
LAWRENCE A. BREWER & ASSOCS.
FARMINGTON, NEW MEXICO

## WATER PROFILES SAN JUAN RIVER

| | |
|---|---|
| DRAWN: MSE | APPROVED: FCM |
| DATE: MAY 1977 | FIG.: SW-78-6 |

# REPORT ON PERFORMANCE TEST
# INFILTRATION GALLERY
# LOWER VALLEY WATER USERS
# COOPERATIVE ASSOCIATION
# SAN JUAN COUNTY, NEW MEXICO

June 4, 1981 JW-47

REPORT ON PERFORMANCE TEST
INFILTRATION GALLERY
LOWER VALLEY WATER USERS
COOPERATIVE ASSOCIATION
SAN JUAN COUNTY, NEW MEXICO

## I PURPOSE OF TEST:

This report presents the results of a performance test conducted to determine the quantity and quality of water available from the Infiltration Gallery constructed adjacent to the San Juan River for the Lower Valley Water Users Cooperative Association. The test was performed in accordance with paragraph 3-L PERFORMANCE TEST of the SPECIFICATIONS.

## II INFILTRATION GALLERY - GENERAL DESCRIPTION:

The Infiltration Gallery was constructed under a contract dated February 12, 1981 and in accordance with SPECIFICATIONS FOR INFILTRATION GALLERY, OCTOBER 1980. The work was performed under the general engineering supervision of Lawrence A. Brewer & Associates, Inc., Consulting Engineers, Farmington, New Mexico.

Construction of the Infiltration Gallery was started on February 16, 1981 and completed on May 5, 1981. The construction details of the Infiltration Gallery, as built, are shown in Figure PT-47-01. Two 10-3/4-inch O.D. horizontal screen laterals were installed at Elevation 5206.7 (MSL). Lateral No. 1 (upstream) was completed at a total length of 410 feet while Lateral No. 2 (downstream) was completed at a total length of 418 feet. During the installation of Lateral No. 2, a black, organic material, having a strong hydrogen sulfide odor, was encountered in the sand and gravel trench at a distance of about 150 feet from the caisson. This organic material continued throughout the entire remainder of the trench, i.e., from 150 feet to 418 feet. This hydrogen sulfide odor had been previously noted during the Hydrogeological Survey conducted in 1977. Small rate pumping at that time showed a significant decline in the amount of hydrogen sulfide with continued pumping.

The Infiltration Gallery was located in such a manner that the horizontal laterals would be 35 feet from the river's edge. However, after diversion of the river during installation of the laterals, the river's edge was 55 feet from the laterals after completion of construction. As will be noted later in the discussion of the pumping test, this increased distance proved to be detrimental to the yield of the Infiltration Gallery and therefore the river's edge was relocated to the 35-foot distance during the pumping test (See Figure PT-47-01).

## III DESCRIPTION OF PUMPING TEST:

The Infiltration Gallery was pumped continuously from 7:00 a.m. on April 21, 1981 until 7:00 a.m. on April 23, 1981, a total of 48 hours. The initial pumping rate was 1005 gallons per minute. Due to an excessive amount of drawdown, the pumping rate was reduced to 900 gallons per minute at 7:30 p.m. on April 21 and subsequently to 810 gallons per minute at 9:00 p.m. on April 21, being held constant at this rate throughout the remainder of the test. The temperature of the discharge water fluctuated from 49 to 50°F. while that of the San Juan River varied from 52 to 61°F. Water levels in the Infiltration Gallery and the San Juan River were recorded continuously, by means of automatic water level recorders, throughout the test period. The hydrographs of water level fluctuations during the test are shown in Figure PT-47-02.

Because of the slowly declining water level in the Infiltration Gallery observed during the morning of April 22, it was decided to reestablish the river's edge at the original distance of 35 feet from the horizontal laterals. This work was performed with a bulldozer during the period 8:30 a.m. to 2:00 p.m. on April 22. The effects of this work are clearly noted on the hydrographs in Figure PT-47-02, with the water level in the Infiltration Gallery commencing to recover at 11:00 a.m. on April 22 and continuing to recover throughout the remainder of the test period.

The pertinent data from the pumping test are summarized as follows:

| | 7:00 A.M. 4/21/81 Static Water Elevation (MSL) | 7:00 A.M. 4/23/81 48-Hour Water Elevation (MSL) | 48-Hour Drawdown (feet) |
|---|---|---|---|
| San Juan River | 5219.1 | 5219.0 | -- |
| Infiltration Gallery | 5218.02 | 5210.5 | 8.5 |
| River Flow | 830 cfs | 730 cfs | |
| Pumping Rate | 1005 gpm | 810 gpm | |
| Gallery temperature | 49°F. | 49°F. | |
| River temperature | 52°F. | 54°F. | |

## IV INFILTRATION GALLERY YIELD:

The pumping test data can be used to determine the Infiltration Gallery yield for any given condition of river stage and water temperature using the following expressions:

$$\frac{Q_1}{Q_2} = \frac{m_1 s_1 V_2}{m_2 s_2 V_1}$$

and

$$Q_2 = \frac{m_2 s_2 V_1 Q_1}{m_1 s_1 V_2}$$

in which,

$Q_1$ = Infiltration Gallery test pumping rate, in gallons per minute.

$m_1$ = Average saturated aquifer thickness at the test pumping rate, in feet.

$s_1$ = Infiltration Gallery drawdown at the test pumping rate, in feet.

$V_1$ = Viscosity correction factor for the test temperature.

$Q_2$ = Infiltration Gallery yield being determined, in gallons per minute.

$m_2$ = Average saturated aquifer thickness for the Infiltration Gallery design drawdown, in feet.

$s_2$ = Infiltration Gallery design drawdown, in feet.

$V_2$ = Viscosity correction factor for the temperature for which the yield is being determined.

From the pumping test data:

$$Q_1 = 810 \text{ gpm}$$

$$m_1 = \frac{8.5+17}{2} = 12.75 \text{ feet}$$

$$s_1 = 8.5 \text{ feet}$$

$$V_1 = 1.18 \ (49^{\circ}\text{F.})$$

The extreme minimum Infiltration Gallery yield will occur when low river stage conditions and low water temperatures coincide, normally expected to occur in January or February. For an extreme low flow of 200 cfs, the low river stage is estimated as Elevation 5218.5 (MSL). Using a lowest expected gallery water temperature of 40°F. ($V_2$ = 1.37) and a design pumping level of Elevation 5208.5 (MSL), the gallery drawdown ($s_2$) will be 10 feet and the minimum yield will be:

$$Q_{minimum} = \frac{(11.5)(10)(1.18)(810)}{(12.75)(8.5)(1.37)} = 740 \text{ gallons per minute}$$

For the summer yield, the low flow is again taken as 200 cfs (river stage as Elevation 5218.5 (MSL)). Using a summer water temperature of 60°F. ($V_2$ = 1.00) and a design pumping level of Elevation 5208.5 (MSL), the gallery drawdown ($s_2$) will be 10 feet and the summer yield will be:

$$Q_{summer} = \frac{(11.5)(10)(1.18)(810)}{(12.75)(8.5)(1.00)} = 1014 \text{ gallons per minute}$$

The foregoing yields are very close to those predicted in the 1977 Hydrogeological Survey, which predicted a minimum yield of 760 gallons per minute and summer yield of 1040 gallons per minute. It should be pointed out that the above yields are based upon a minimum river flow of 200 cfs and therefore considered conservative. At higher river flow, higher yields can be expected.

## V WATER QUALITY:

The chemical analyses of water samples collected during the pumping test are given below:

| | Hydrogeological Survey (1) 5/4/77 | Infiltration Gallery(2) 4/22/81 6:00 p.m. | Infiltration Gallery(2) 4/23/81 7:00 a.m. | San Juan River( Weighted Avera |
|---|---|---|---|---|
| | Milligrams Per Liter, Except as Noted | | | |
| Total Dissolved Solids | 633 | 570 | 550 | 364 |
| Total Hardness | 318 | 248 | 240 | 263 |
| Carbonate Alkalinity | 0 | 0 | 0 | 0 |
| Bicarbonate Alkalinity | 174 | 181 | 181 | 138 |
| Sodium | 65 | 78 | 91 | 46 |
| Calcium | 105.8 | 83.8 | 90.7 | 61 |
| Magnesium | 54 | 11.3 | 13.1 | 8.0 |
| Iron | 0.1 | 0.0 | 0.0 | -- |
| Manganese | -- | 0.031 | 0.049 | -- |
| Sulfate | 300. | 125. | 215. | 157 |
| Chloride | 43. | 131. | 128. | 9.4 |
| Nitrate (as N) | 0.1 | 1.5 | 1.35 | 1.2 |
| pH Value | 8.0 | 7.7 | 7.61 | 7.7 |
| Color (Color Units) | -- | 10. | 5. | -- |
| Turbidity (JTU) | 1.6 | 10.3 | 10.2 | -- |

(1) Analysis by San Juan Testing Laboratory, Farmington, New Mexico.

(2) Analyses by AnaChem, Inc., Farmington, New Mexico.

(3) Published records of the U.S. Geological Survey.

In general, the water produced from the Infiltration Gallery is similar in dissolved mineral content to that of the San Juan River and typical of waters in this area. However, a persistent hydrogen sulfide odor and excessive color and turbidity were noted during the test. It is believed that these constituents are associated with the organic material encountered during the installation of Lateral No. 2 (downstream). A decrease in the hydrogen sulfide odor was noted during the 48-hour test although the odor persisted at the end of the test. Based upon our experience in similar situations, it is believed that further continuous pumping, which will result in inducing oxygen-saturated river water into the aquifer, will eliminate the excessive odor, color and turbidity.