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OIL RECOVERY BY CARBON DIOXIDE INJECTION

Quarterly Report, January—March 1977

By  
George P. SanFilippo

April 1977  
Date Published

Work Performed Under Contract No. EF-76-C-05-5301

Pennzoil Company  
Vienna, West Virginia

U. S. DEPARTMENT OF ENERGY



FORN HANDBOOK

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Period January-March 1977

George P. SanFilippo

PENNZOIL COMPANY  
Vienna, West Virginia 26105

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PREPARED FOR THE UNITED STATES  
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Under Contract No. EF-76-C-05-5301

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## INTRODUCTION

This report is the eleventh report on the progress of the Rock Creek carbon dioxide project in Roane County, West Virginia.

Designed, developed and operated by Pennzoil Company, this project will demonstrate the feasibility of miscible carbon dioxide oil recovery in the Rock Creek Big Injun Field. A successful demonstration of this process will lead to a field wide commercial development. Also, the technical success of this project would be utilized in the development of other miscible carbon dioxide oil recovery projects in numerous fields within the Appalachian area.

## SUMMARY

No major delays in the project were incurred during the first quarter of 1977. Therefore, the revised project schedule, graphically detailed in Figure No. 1, remained unchanged.

During the past quarter, the new producing facilities were nearly completed. The two center producing wells continued to pump but the inability to run the stock tank oil during the severe weather necessitated a decrease in pumping time which, in turn, caused a decrease in production.

The D. T. Cummings water supply wells continued to be the only source of water for the project. The T. Henderson WSW No. 1, drilled in December, 1976, underwent a three month production test which proved it to be a stable source of water. Installation of the water supply line from the Henderson well to the injection facility was started in late February and neared completion as of April 1, 1977.

Progress on the carbon dioxide storage system continued on schedule with the four storage tanks being set at the injection facility. No progress was made on the carbon dioxide injection system which is scheduled for completion during the third quarter of 1977.

Water injection into the thirteen back-up water injection wells continued on schedule with the exception of a few problem wells. Since an adequate water supply is forthcoming with the completion of the Henderson water supply line, no action will be taken to increase injectivity until this water supply is on stream. The start of pattern injection will occur coincidentally with the increased water supply.

OIL RECOVERY BY CARBON DIOXIDE INJECTION  
 ROCK CREEK FIELD, ROMAIE COUNTY, WEST VIRGINIA

PROJECT SCHEDULE

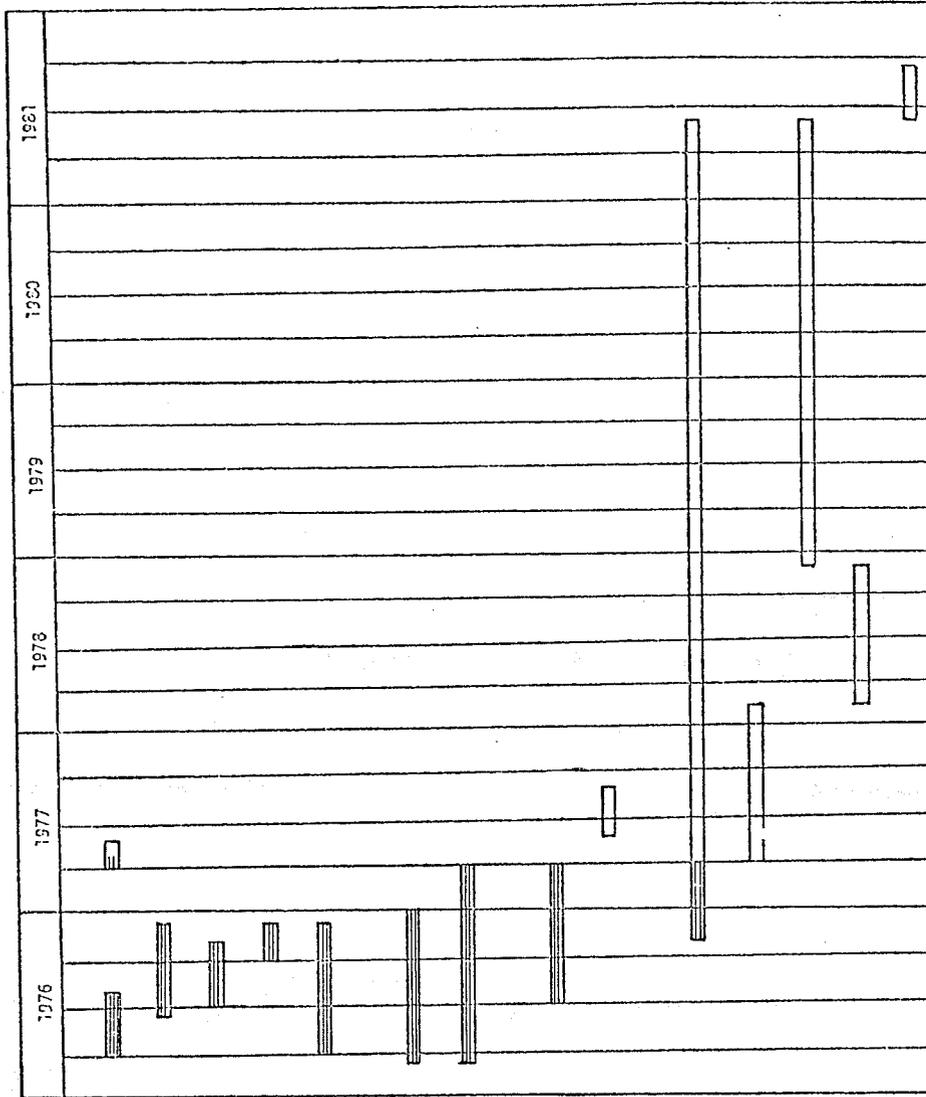
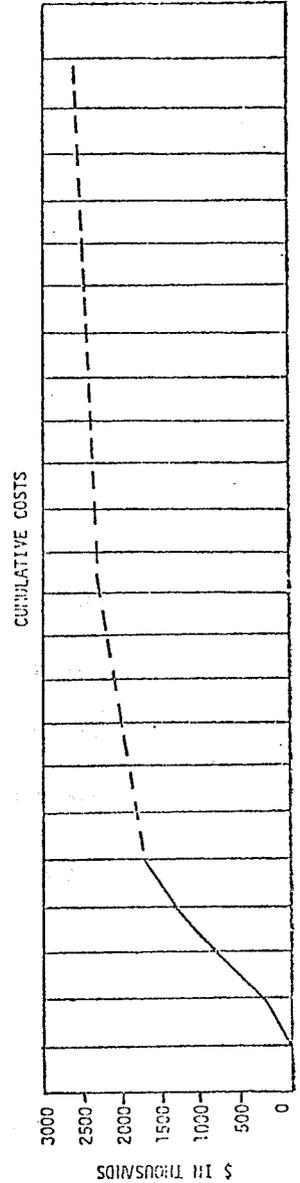


Figure 1



Legend  
 [ ] Schedule  
 [ ] Progress  
 [ ] Schedule Extension  
 - - - Budgeted Cost  
 — Actual Cost

## WELL WORK

### Producing Wells - Work Accomplished

The severe weather of January and February made running the stock tank oil impossible for the better part of both months which in turn limited the number of hours that each well could be pumped and therefore reduced production. L. W. Shaffer No. 4 began to show oil production with less water production near the end of the quarter. This oil production indicated that the water contamination of the formation during clean-out neared being overcome. The monthly production of these two wells is listed below and graphically shown in Appendix A.

	L. W. Shaffer No. 1					
	<u>BO</u>	<u>BW</u>	<u>MCF</u>	<u>Hrs.</u>	<u>WOR</u>	<u>GOR, CFPB</u>
January	40	0	57.6	37	0	1440
February	39	0	67.2	46	0	1723
March	53	0	163.5	62	0	3085
Cumulative*	275	0	509.1		0	1851

	L. W. Shaffer No. 4					
	<u>BO</u>	<u>BW</u>	<u>MCF</u>	<u>Hrs.</u>	<u>WOR</u>	<u>GOR, CFPB</u>
January	0	15	42.0	34	-	-
February	0	16	56.0	38	-	-
March	22	10	126.8	62	2.2	5764
Cumulative*	25	183	408.8		7.3	16352

\*As of October 1, 1976

Both wells continued to be pumped into the old producing facilities throughout the quarter. The new producing facilities have been completed with the exception of the pipeline hook-up. The produced water disposal building was completed, but the installation of the produced water filter and disposal pump has yet to be accomplished.

#### Producing Wells - Work Forecast

As soon as the pipeline hook-up is secured, both wells will be changed over to pump into the new producing facilities. Both wells will continue to be produced regularly throughout the next quarter.

#### Carbon Dioxide Injection Wells - Work Accomplished

The original intention of starting water injection into these six wells during the first quarter of 1977 was postponed until the water supply from the T. Henderson WSW No. 1 is on stream. This policy was dictated by the ability of the thirteen back-up injection wells to take all of the water available from the D. T. Cummings water supply wells.

#### Carbon Dioxide Injection Wells - Work Forecast

Water injection into these six wells will begin coincidentally

with the increased water supply.

#### Back-up Water Injection Wells - Work Accomplished

On January 7, 1977 the element of the packer in E. Lewis No. 17 failed. The reason for the failure could not be determined by the local packer representative so the element was sent into the factory for analysis. To date, no word has been received concerning the outcome of the factory test. On February 2, 1977, the well was returned to injection. The long lag time needed to return the well to injection was caused by the severe weather conditions.

On January 26, 1977, E. Lewis No. 28 was treated with 500 gallons of 15% hydrochloric acid in an attempt to improve injectivity. This treatment did improve injection for three days. On February 17 and 18, 1977, E. Lewis No. 28 was swabbed down with ferric hydroxide being very evident in the swabbed water. The well was returned to injection on February 18. Improved injectivity lasted nine days. On March 1, 1977, the well was treated with 500 gallons of 3% hydrofluoric and 12% hydrochloric acid. The well was returned to injection on March 2. Improved injectivity lasted one day. On March 4, 1977 the chemical treatment to remove dissolved iron from the raw water was suspended. Injectivity into E. Lewis No. 28 started to increase on March 5 and continued to do so throughout

the month. No other attempts were made to increase injectivity on the remaining twelve active injection wells pending the increase in water supply from the Henderson well.

Table I lists the injection history for the active water injection wells for the first quarter of 1977. The graphical injection and pressure history of these wells are presented in Appendix B.

TABLE I  
Injection History  
Back-up Water Injection Wells

	Date of First Injection	Injection, Bbl			Avg. WHP* PSIG	Cum. Inj. 4/1/77
		January	February	March		
R. C. Elmore No. 1	10/16/76	4,895	7,273	8,558	0	29,451
R. C. Elmore No. 4	10/16/76	2,250	2,213	2,547	810	12,843
E. Lewis No. 17	10/16/76	601	2,279	3,117	775	14,512
E. Lewis No. 18	10/16/76	2,990	2,561	2,595	810	16,047
E. Lewis No. 27	11/2/76	2,696	1,687	1,814	810	12,091
E. Lewis No. 28	10/16/76	1,326	1,194	3,027	740	10,805
E. Lewis No. 29	11/11/76	1,081	782	685	860	4,713
J. H. Looney No. 1	10/16/76	3,658	6,259	6,527	800	26,741
J. H. Looney No. 5	11/11/76	1,344	1,101	1,073	860	6,612
L. W. Shaffer No. 2	10/16/76	7,174	7,634	9,334	0	33,822
L. W. Shaffer No. 8	10/16/76	3,785	4,328	3,961	690	20,693
L. W. Shaffer No. 10	11/4/76	356	191	178	835	1,699
L. W. Shaffer No. 11	11/6/76	<u>484</u>	<u>267</u>	<u>277</u>	<u>865</u>	<u>1,807</u>
Total or Average		32,640	37,772	43,693	680	191,836

\*Average wellhead pressure for March.

### Back-up Water Injection Wells - Work Forecast

The next quarter will continue to see water injection maintained into all back-up injection wells. The wells that continue to display below average injectivity will be subjected to remedial treatment to improve injection rates. These treatments will begin soon after the water supply from the Henderson water supply well is put on stream.

## WATER SYSTEM

### Water Supply Wells - Work Accomplished

The project continued to be supplied by water from the D. T. Cummings WSW Nos. 1 and 5. The combined 1,500 BPD productivity of these two wells is not an adequate supply for the entire project. The T. Henderson WSW No. 1, drilled in December, 1976, underwent a three month test which proved it to be a stable water source.

### Water Supply Wells - Work Forecast

Until such time that the T. Henderson water supply well is put on stream, the D. T. Cummings wells will continue to provide the water supply for the project.

### Water Handling - Work Accomplished

In January, 1977, it was discovered that a bacteria problem existed between the water supply wells and the injection wells. This bacteria was oxidizing both the iron in solution and in the transfer and injection lines. After this bacteria problem was recognized, a large biocide treatment was used to bring the bacteria under control. A bi-weekly batch treatment is now used to prevent the reoccurrence of this problem.

Continued poor performance of the equipment used in the chemical flocculation of the dissolved iron in the raw water necessitated the cessation of this treatment on March 4, 1977. The inability to continually provide a good quality effluent was made evident by the needed repeated attempts to increase the injectivity into E. Lewis No. 28.

Rights-of-way for the installation of the near 20,000 ft. water supply line from the Henderson water supply well to the project site have been secured. Construction on this line started in late February and neared completion as of April 1, 1977.

### Water Handling - Work Forecast

The Henderson water supply line will be completed in early April, thus providing an adequate water supply for the project. As soon as this supply line is completed, the six pattern injectors

will become active. Although it appears that the supply from the Henderson well will be adequate to completely supply the project, the line system will be connected so that each supply system can be used separately or coincidentally.

### CARBON DIOXIDE SYSTEM

#### Carbon Dioxide Storage - Work Accomplished

On February 10 and 11, 1977, the four carbon dioxide storage tanks were installed at the plant site. This installation completes work to be accomplished under this category.

#### Carbon Dioxide Handling - Work Accomplished

No progress was made on this system during the first quarter of 1977.

#### Carbon Dioxide Handling - Work Forecast

The final construction necessary to complete the carbon dioxide handling system is scheduled to begin during the second quarter of 1977.

## RESERVOIR PROPERTIES

### Permeability and Porosity

The results of the initial tests performed to possibly explain the two permeability anomalies that appeared to exist between R. C. Elmore P.I. No. 5 and E. Lewis No. 29 have been received. Before definite conclusions can be made concerning the hypothesis that technique discrepancies could provide varying results, further testing must be completed. A report on the data obtained from these tests will be presented when all testing is completed.

### Water Saturations

The Energy Research and Development Administration at Morgantown, West Virginia, had tests performed to measure both the Formation Resistivity Factor and the Formation Resistivity Index on six preserved core samples from E. Lewis No. 29 and four preserved core samples from J. H. Looney P.I. No. 4. Due to the results of these tests, it was decided to have tests performed to measure the irreducible water saturation in selected preserved core samples. This measurement is currently in the process of being completed. When the irreducible water saturation results become available, both test results will be presented.

## CONCLUSION

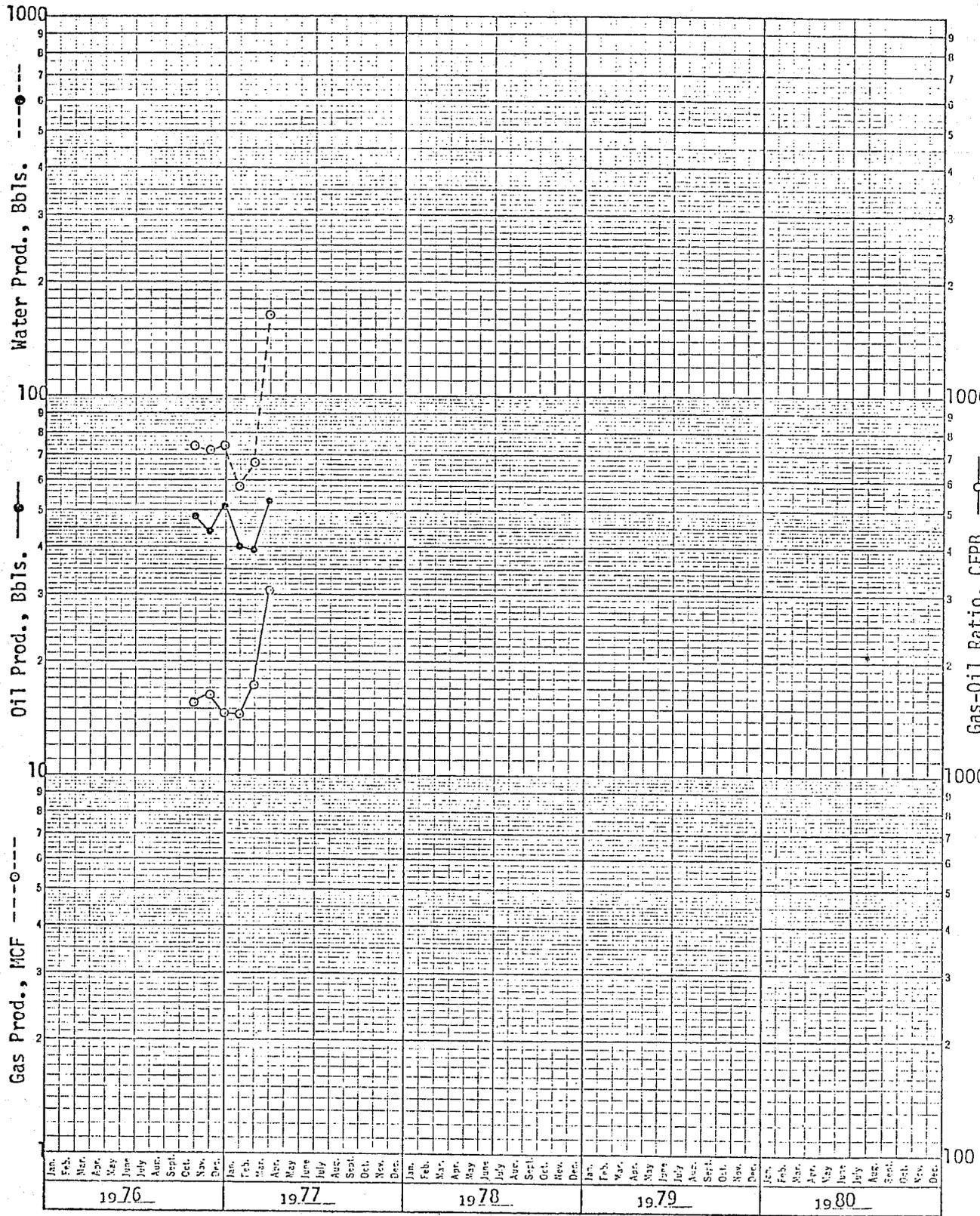
The project proceeded as outlined in the revised project schedule. Testing proved the stability of the T. Henderson WSW No. 1 as an alternate water source for the project. This water supply will be put on stream in early April, 1977. No attempt was made to increase the injection rate into the problem injection wells. These problem wells will undergo remedial treatment after the new water source becomes available.

To date no insurmountable adverse effects have occurred to inhibit the desired final outcome of a successful project.

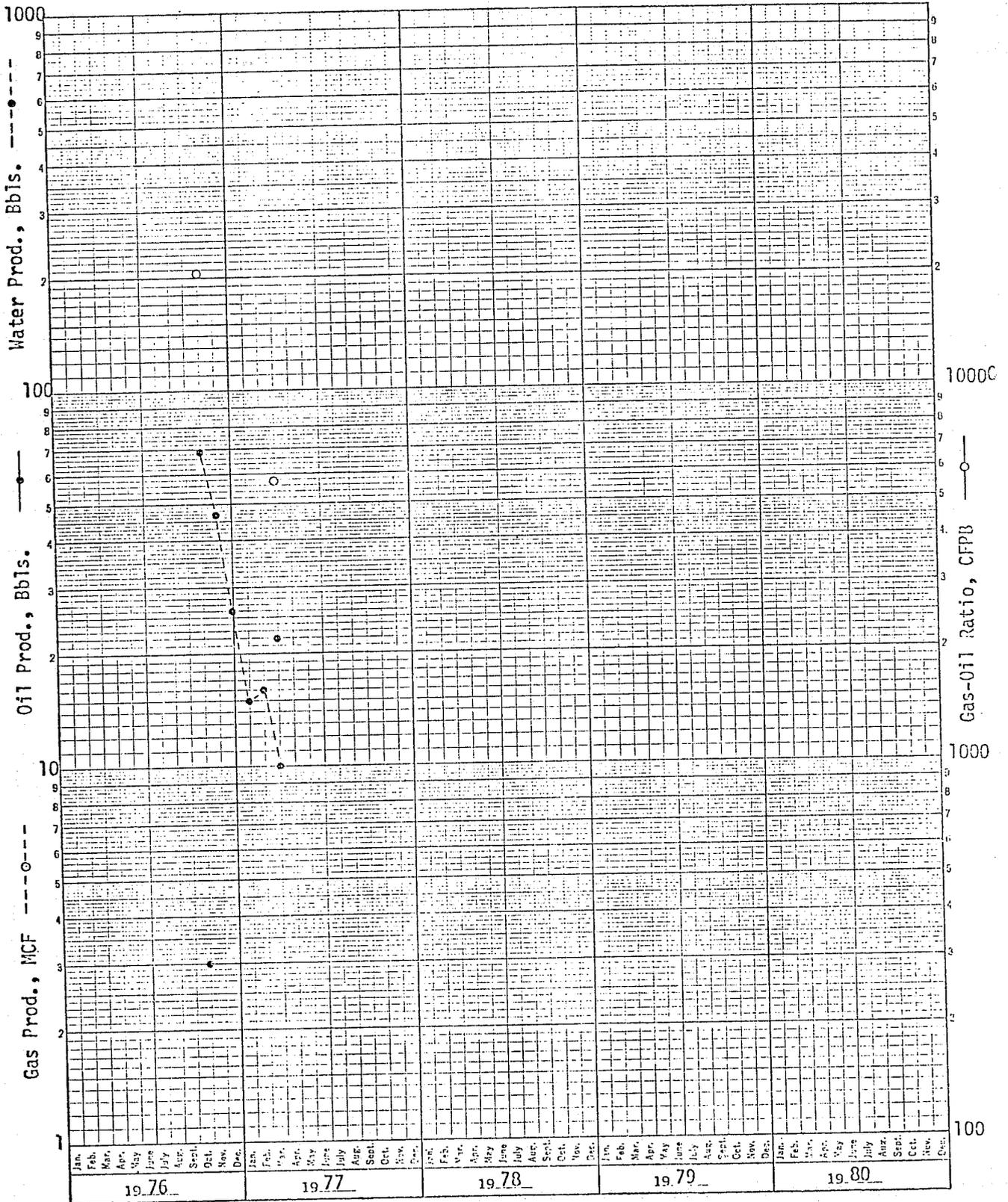
APPENDIX A

Producing Well History

L. W. Shaffer No. 1



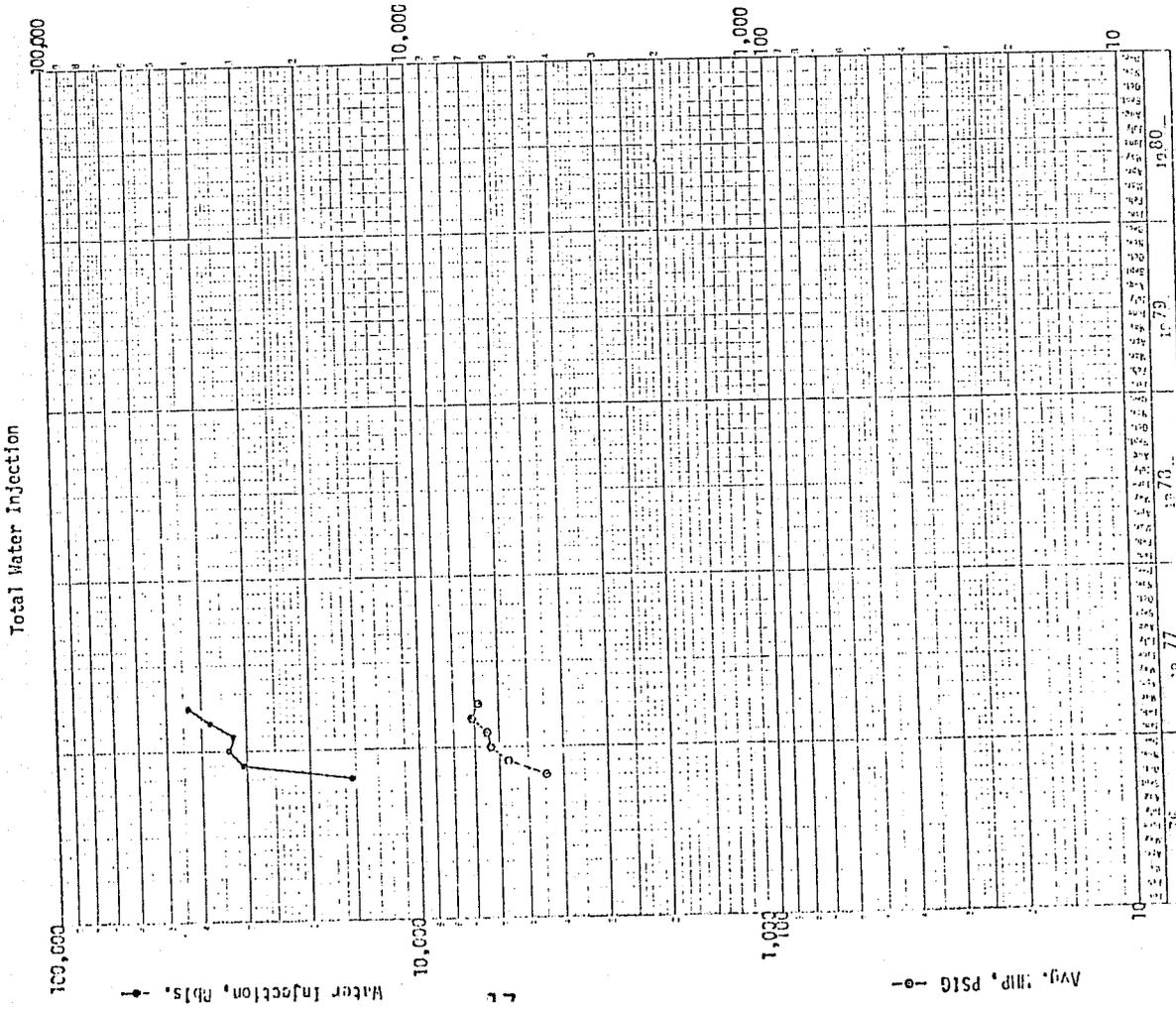
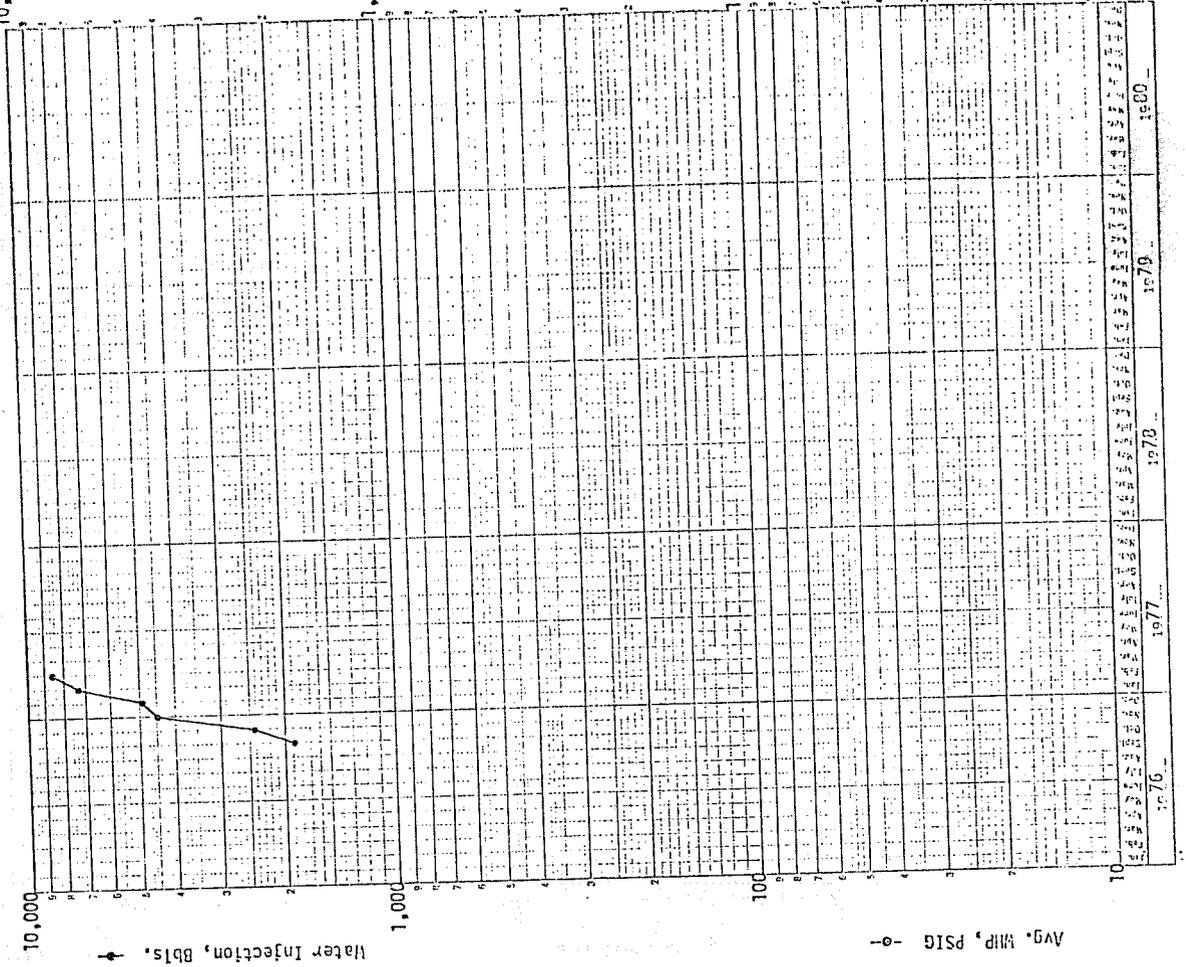
L. W. Shaffer No. 4



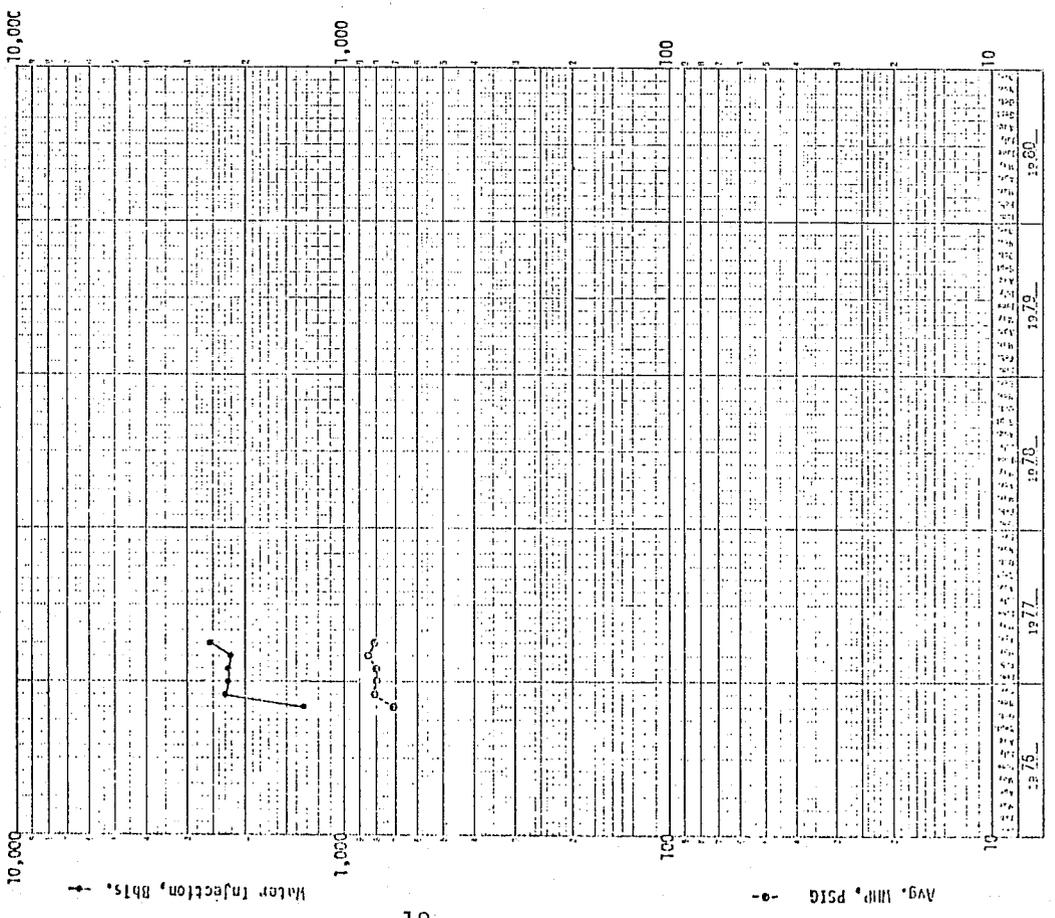
APPENDIX B

Injection Well History

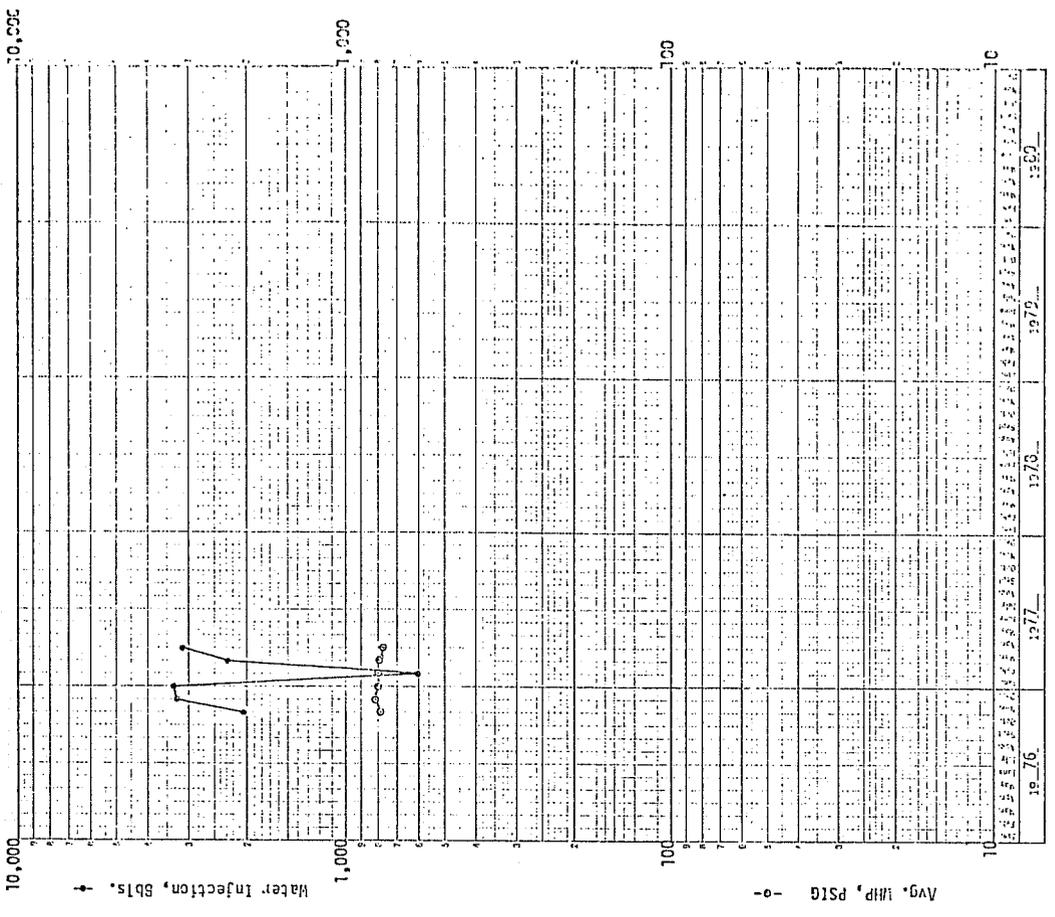
R. C. Elmore WIV No. 1



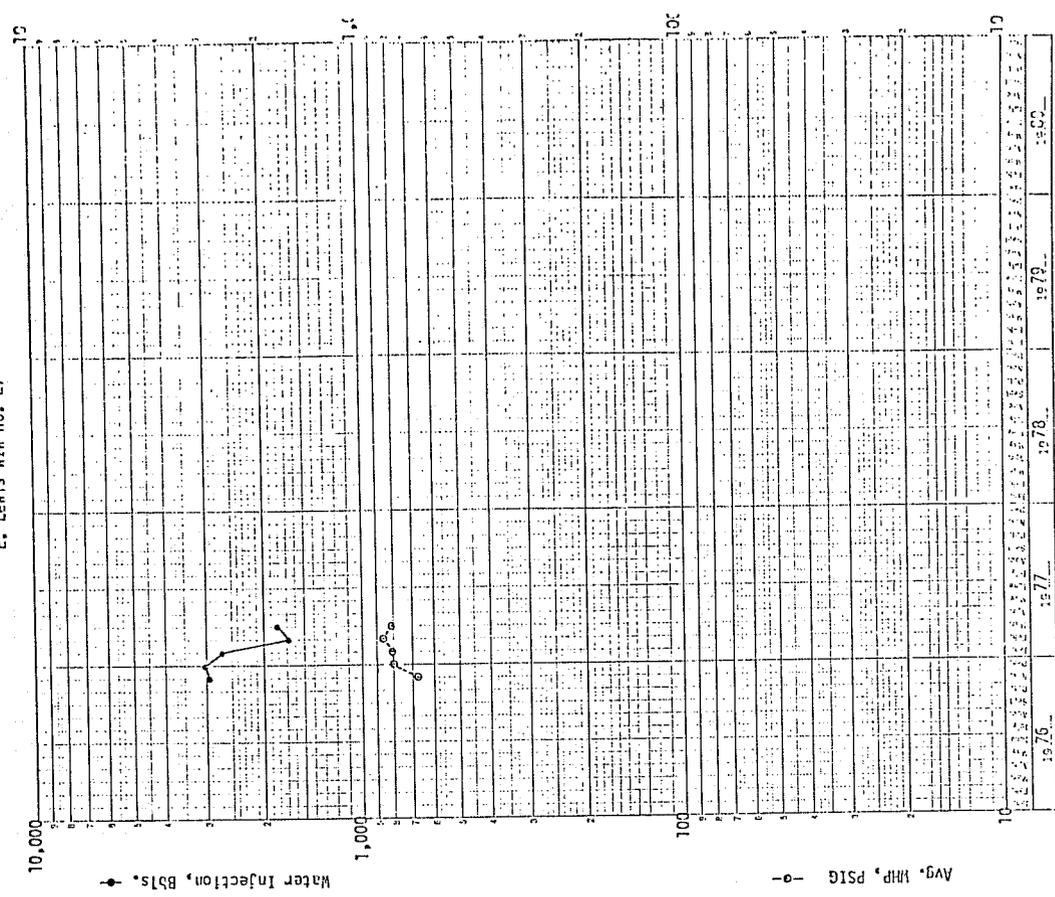
R. C. Elmore WTH No. 4



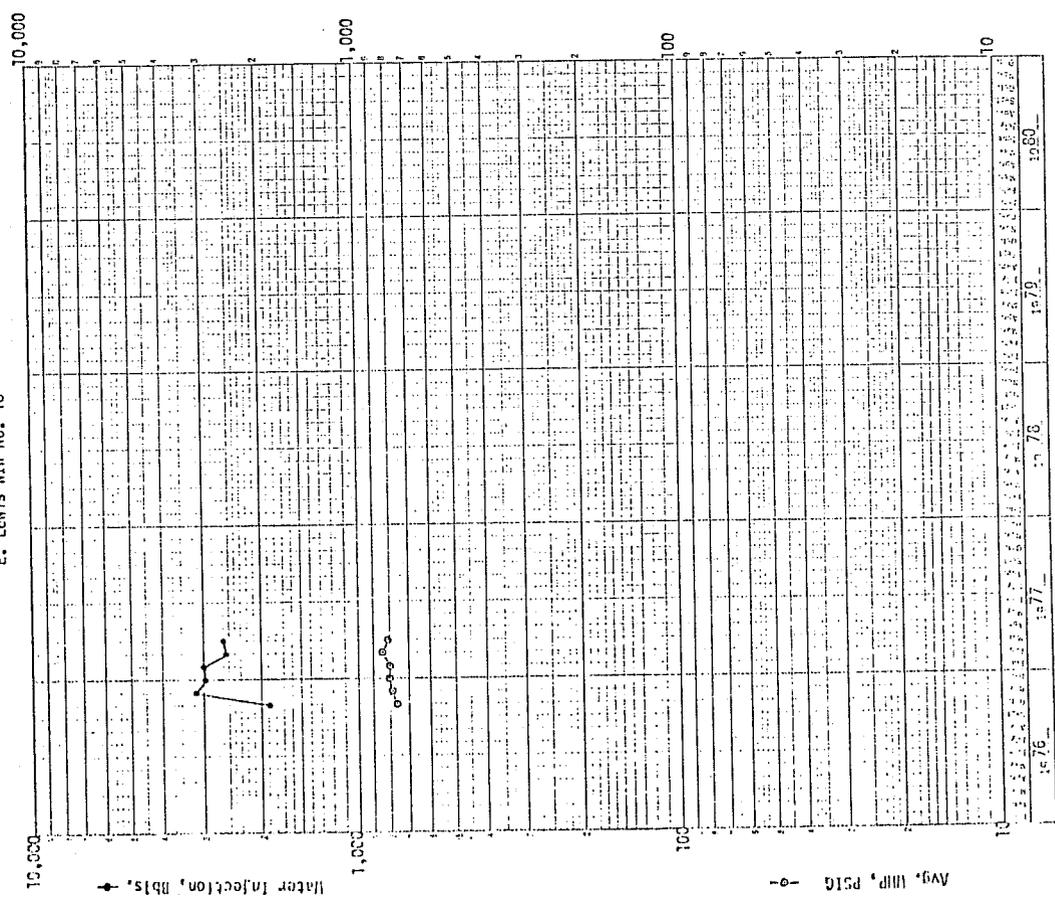
E. Lewis WTH No. 17



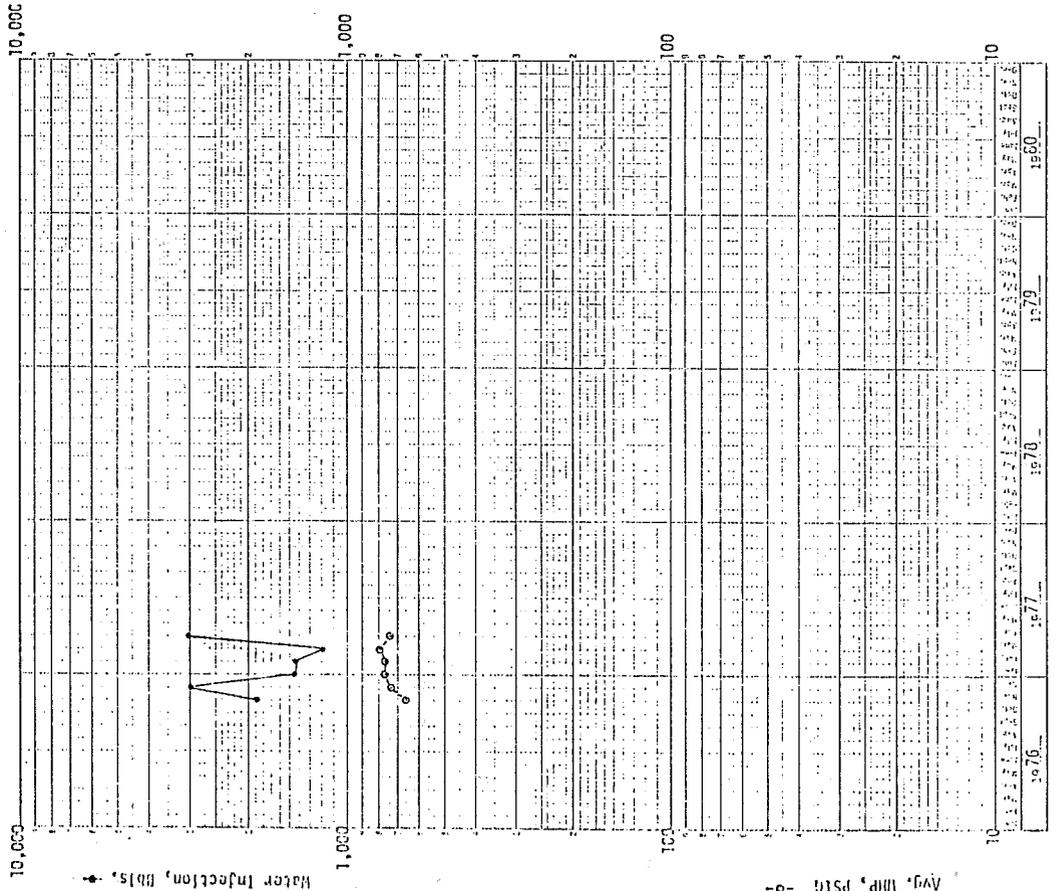
E. Lewis WTW No. 27



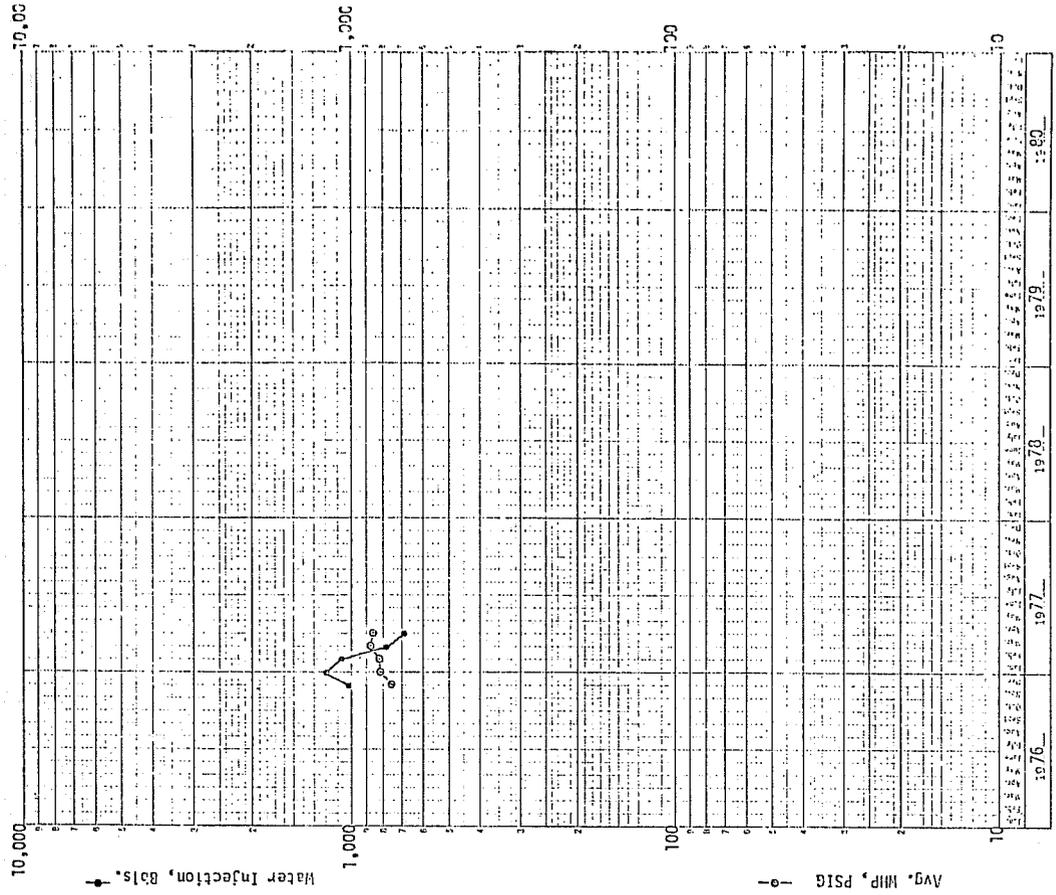
E. Lewis WTW No. 18



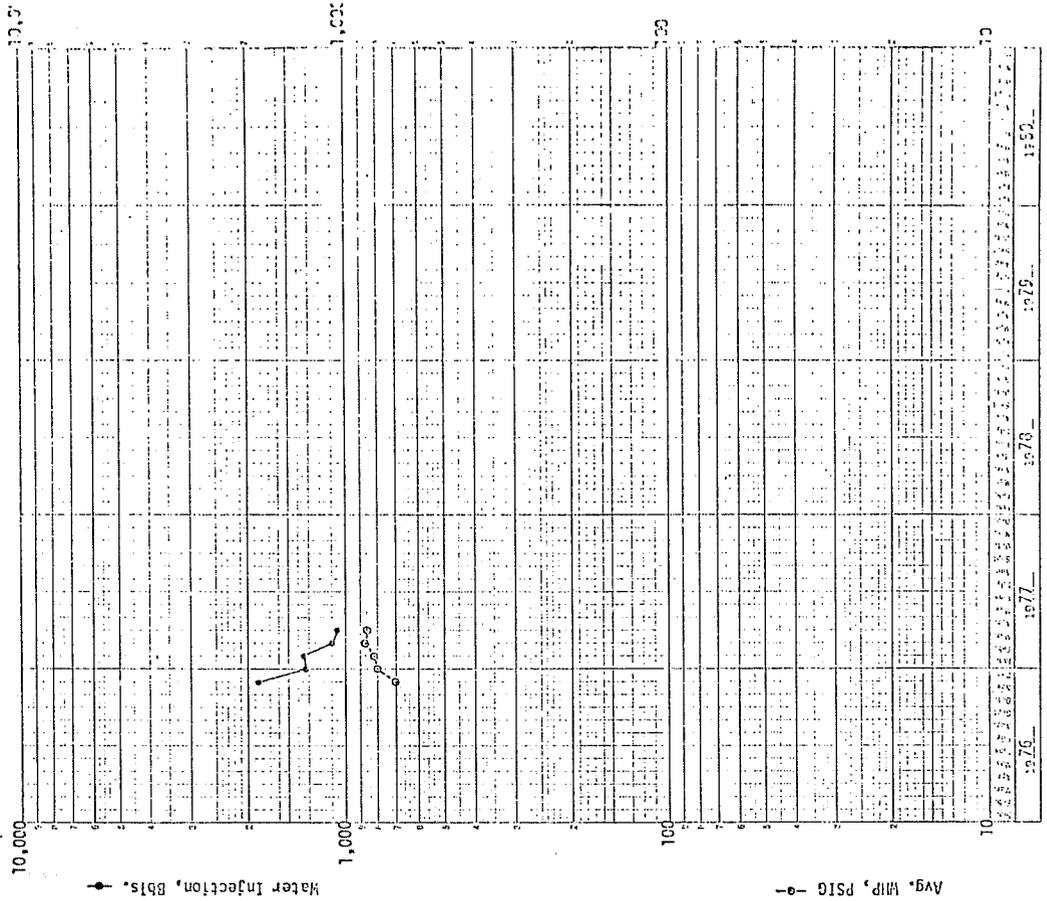
E. Lewis WTW No. 23



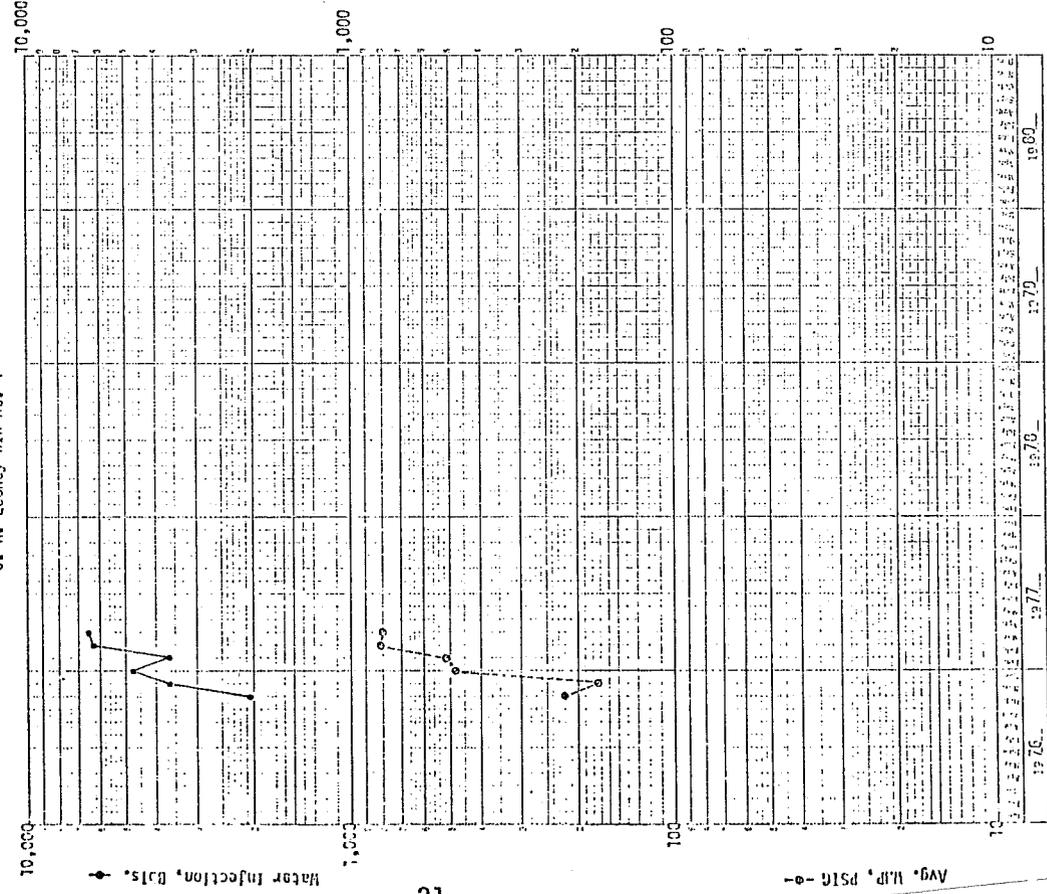
E. Lewis WTW No. 29



J. H. Looney WII No. 5



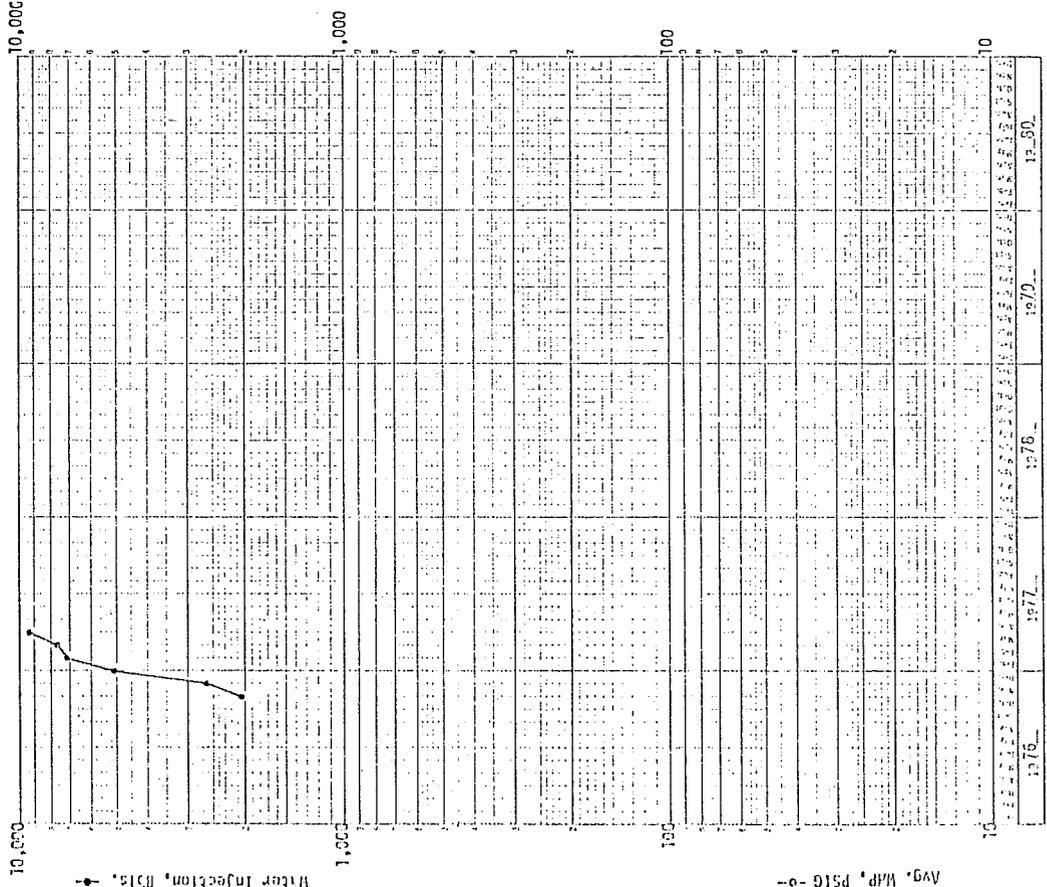
J. H. Looney WII No. 1



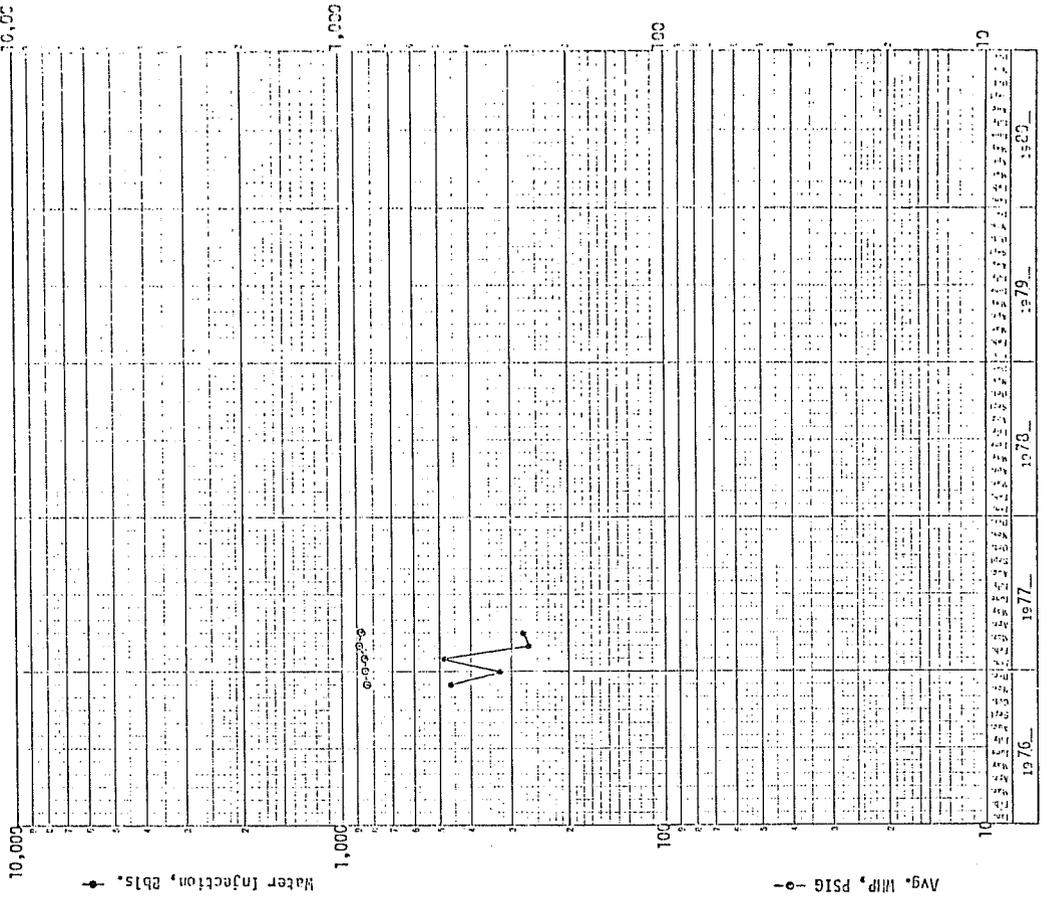
L. W. Shaffer MW No. 8



L. W. Shaffer MW No. 2



L. W. Shaffer WIM No. 11



L. W. Shaffer WIM No. 10

