Summary of Data From the 1981–83 Pilot Study and 1985–89 Operations of the Hueco Bolson Recharge Project, Northeast El Paso, Texas

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METRIC CONVERSIONS

Factors for converting inch-pound units to metric (International System) units are given in the following table:

Multiply inch-pound unit	By	To obtain metric unit
acre-foot (acre-ft)	0.001233	cubic hectometer
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
foot per year (ft/yr)	0.3048	meter per year
gallon (gal)	0.003785	cubic meter
gallon per minute (gal/min)	0.06308	liter per second
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter
inch (in.)	25.40	millimeter
mile (mi)	1.609	kilometer
million gallons (Mgal)	3,785	cubic meter
million gallons per day (Mgal/d)	0.04381	cubic meter per second
pound per square inch (lb/in^1)	6.895	kilopascal

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

SUMMARY OF DATA FROM THE 1981-83 PILOT STUDY AND 1985-89 OPERATIONS OF THE HUECO BOLSON RECHARGE PROJECT, NORTHEAST EL PASO, TEXAS

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ABSTRACT

Pumping and injection tests were conducted during a 1981-83 pilot study of the Hueco bolson recharge project in northeast El Paso. Water-level decline and buildup were measured in a recharge well and an observation well. The specific capacity of the recharge well during the October 1982 injection test was 18.3 gallons per minute per foot after 22.5 hours. The recharge well was redeveloped in June 1983. The specific capacity during the final pumping test of the pilot study was 27.5 gallons per minute per foot after 24.5 hours, compared to 35.8 gallons per minute per foot after 24 hours during the May 1981 pre-injection pumping test.

During the initial 5 years (1985-89) of operation of the Hueco bolson recharge project, water levels in the observation well were measured, and concentrations of selected water-quality constituents were determined. Water levels in six production wells located 0.25 to 0.6 mile from the injection wells of the recharge project declined at a rate of about 2 feet per year prior to 1985. Since 1980, water-level measurements indicate that the effects of pumping and recharge are approaching equilibrium.

INTRODUCTION

The Hueco bolson recharge project (HBRP) in northeast El Paso, Texas, includes an advanced waste-treatment plant with a pipeline system to 11 injection wells (figs. 1 and 2). The additional well (RW-11) was drilled in June 1988 after construction of the project. The project was previously described by White (1983, p. 64) as follows:

> "In 1982, construction started on a tertiary treatment plant at the northeast oxidation ponds. The plant is part of the Hueco bolson recharge project (HBRP), which will treat sewage to drinking-water standards and recycle the water via injection wells (Garza and others, 1980; U.S. Environmental Protection Agency, 1980). The project is planned to include a 10 Mgal/d (11,000 acre-ft per year) advanced waste-treatment plant with a pipeline system to 10 injection wells. The injection wells will be spaced at distances from pumping wells so that there will be a minimum of 2 years residence time in the bolson prior to production. The existing oxidation ponds will be abandoned upon completion of the treatment plant and injection facilities."

Several studies were conducted prior to and during construction of the project (1982-84). During the late 1970's, the U.S. Geological Survey (USGS) made a preliminary study of factors relating to recharging the Hueco bolson aquifer with treated sewage effluent through well injection (Garza and others, 1980). A digital model was developed to simulate several scenarios of pumping and recharge rates and to estimate changes in the potentiometric surface and average interstitial-flow velocities. The study also addressed the potential for clogging the injection wells.

During May 1981 to July 1983, the El Paso Water Utilities (EPWU) and the USGS conducted a series of pumping, injection, and redevelopment tests. All of the water used for the injection tests was piped from nearby EPWU production wells (fig. 2).

The purpose of this report is to present basic data collected during the 1981-83 HBRP pilot study and the early years (1985-89) of the HBRP operation. The data are presented in 10 figures and 15 tables (at the end of the report).

HUECO BOLSON RECHARGE PROJECT PILOT STUDY, 1981-83

Well Construction

During April 1981, the EPWU drilled a pilot recharge well "PI" (State no. JL-49-05-613) and observation well "PIOW" (State no. JL-49-05-614) on the east side of McCombs Road (Farm Road 2529, fig. 2). Electric logs were run to 1,173 ft in the recharge well and 820 ft in the observation well, which is 100 ft south of the recharge well. The wells were then plugged back to 810 ft and completed with steel casing and screen or torch slots as shown in figure 3.

Pumping and Injection Tests

A 3-day pumping test was conducted on May 11-14, 1981, and a 24-day injection test was conducted from September 14 to October 8, 1981. During the first test, well PI was pumped at a rate of 1,800 gal/min for 3 days, and water-level declines were measured in wells PI and PIOW. The test results (drawdown and recovery levels) are presented in tables 1-4. The 3-day

specific capacity for the pumped well is about 35 (gal/min)/ft as shown in table 1.

During the 24-day injection test, water from the EPWU distribution system was injected into well PI through two 4-in. pipes set at 378 ft, about 30 ft below the static water level. The injection rate varied from 359 to 1,186 gal/min and averaged 950 gal/min. The rates of injection and resulting water-level buildup in wells PI and PIOW are given in tables 5 and 6. The maximum water-level buildups measured in wells PI and PIOW are 74.48 and 3.85 ft, respectively.

Additional tests were conducted by the EPWU in 1982-83 to better define the changes in injection efficiency with time and to determine the rate and extent of efficiency recovery by redeveloping the injection well (tables 7-11). The results of these and previous tests showed injection efficiency is less than pumping efficiency as measured by well specific capacity (ratio of pumping or injection rate to drawdown or buildup in water levels). During the 24-day injection test (September 14 to October 8, 1981) and the 32-day injection test (January 19 to February 24, 1982), the specific capacity for well PI decreased from almost 40 (gal/min)/ft to about 7 (gal/min)/ft (tables 5 and 7). The head buildup was as much as 140 ft at an injection rate of about 1,000 gal/min on February 24, when the injection tests were shut down for well redevelopment. All of the water injected, about 81.9 Mgal or 251 acre-ft, was piped directly from city production wells. The nearest is EPWU well 36 located 1,250 ft north of the injection well (fig. 2).

A program of pumping and surging the injection well (PI) was initiated by the EPWU in March 1982. This program continued on an intermittent schedule through September 1982 and was successful to the extent that the specific capacity (1-hour readings) increased to 31.7 (gal/min)/ft. This value is about 80 percent of the 1-hour specific capacity of 39.5 (gal/min)/ft determined during the May 1981 pre-injection pumping test (table 1).

Another long-term injection test was conducted by the EPWU from October 20, 1982, to February 18, 1983 (table 12). Except for a 4-day shutdown from January 20 to 25, the injection was continuous during the test. The injection time totaled 116 days, and the injection rate averaged 812 gal/min. As in previous injection tests, the water was piped from nearby EPWU production wells.

The results of the 116-day injection test during 1982-83 are shown in figure 4. Included are graphs of injection rate and injection specific capacity and hydrographs for wells PI and PIOW. The hydrographs show water-level buildups of about 70 ft in well PI and 5.9 ft in well PIOW during the first 10 days of injection. The rate of buildup in well PI was nearly linear at about 3 ft/d. At the end of 10 days, the water level in PI was very close to the predevelopment (1903) water level estimated at 276 ft below land surface. After 10 days of injection, the rate of water-level buildup in well PI progressively decreased; and after about 60 days (mid to late December), the level had stabilized. This suggests that the effects of recharge and pumping had approached equilibrium during that time.

The injection test was temporarily shut down on January 20, 1983. When the test resumed on January 25, the initial water-level buildup in well PI was very rapid compared to the rate of buildup at the start of the test in October 1982. Some of the increased buildup rate was caused by increasing the injec-

tion rate from about 800 to 870 gal/min. Most of the buildup, however, could be attributed to increased water content (less void space) in the unsaturated zone.

When the test was terminated on February 18, 1983, the injection rate was 808 gal/min and the water-level buildup was 104.7 ft in well PI and 7.6 ft in PIOW. The 116-day injection specific capacity for well PI was 7.7 (gal/min)/ft. This value was essentially the same as that measured at the end of the January-February 1982 injection test (table 7).

From June 30 to July 1, 1983, the EPWU redeveloped well PI by pumping at a rate of 1,050 gal/min for 24.5 hours (table 13). The 1-hour and 24.5-hour specific capacities were 29.2 and 27.5 (gal/min)/ft, respectively. These values are substantially less than the 1-hour and 72-hour specific capacities of 39.5 and 35.1 (gal/min)/ft, respectively, measured during the May 1981 3-day aquifer interference test (table 1) and are slightly less than the 1-hour and 22.5-hour specific capacities of 31.7 and 30.9 (gal/min)/ft, respectively, measured during the September 1982 redevelopment test (table 8). The June-July 1983 redevelopment of well PI terminated the pilot recharge study.

A summary (table 13) is given of pumping and injection rates and the resulting water-level drawdowns or buildups and specific capacities for well PI during pumping and injection tests from May 1981 to July 1983.

The tests conducted during the 1981-83 pilot study provided valuable information for the HBRP. The results of the tests indicated that: (1) Hueco bolson water can be recycled via well injection for extended periods, with periodic well redevelopment; (2) injection efficiency is less than pumping efficiency as measured by well specific capacity; (3) excessive pressure and/or injection rates may cause sloughing of aquifer material surrounding the borehole and reduce injection efficiency; (4) air entrainment also must be avoided to maintain injection efficiency; and (5) water storativity in the unsaturated zone varies with antecedent pumping or recharge conditions or both (percent of water in retention is not constant).

HUECO BOLSON RECHARGE PROJECT IN OPERATION, 1985-89

The HBRP (fig. 2) was constructed in northeast El Paso during 1982-84, and injection of tertiary-treated sewage began on May 28, 1985. The initial injection rate was about 1 Mgal/d or about 10 percent of the project's future capacity. The volumes processed during the 5 years of operation were:

Year	Inflow to northeast plant[1] [2]		Treated and injected[2]	
	Thousands of gallons	Millions of gallons per day	Thousands of gallons	Millions of gallons per day
1985	2,275,968	6.235	626,568	2.887
1986	2,419,136	6.628	1,565,526	4.289
1987	2,550,741	6.988	1,173,105	3.214
1988	2,783,370	7.605	968,929	2.647
1989	2,805,234	7.686	1,599,067	4.381

[1] Volumes were measured with magnetic flow meter through 1986 and with a Parshall flume starting in 1987.
[2] Data from EPWU files.

The process train at the HBRP waste-treatment plant includes screening, degritting, primary settling, two stage PACT[1] system, lime treatment, sand filtration, ozone disinfection, granular activated carbon, storage, chlorination, and well injection (Knorr and Cliett, 1985). The quality of water is monitored throughout the process. Seven parameters including chlorine residual, dissolved oxygen, nitrates, ozone residual, hydrogen ion concentration, turbidity, and total organic carbon are measured continuously at specific stages. Samples are collected daily for chemical analysis.

Drinking-water standards of the U.S. Environmental Protection Agency and Texas Department of Health are given in table 14. The table also includes the anticipated (preconstruction) and the 1985-88 average concentrations of selected chemical constituents in the HBRP product water. About one-third of the constituents exceeded the proposed quality of the reclaimed water; however, none of the constituents exceeded the water-quality standards of the Environmental Protection Agency or Texas Department of Health.

Beginning in May 1981, concurrent with the pilot recharge study and continuing to the present, water levels have been measured monthly in well PIOW. During the period of record, the levels have ranged from a low of 349.48 ft on Oct. 19, 1989, to a high of 333.37 ft on December 21, 1982 (table 15). The levels mainly reflect rates of discharge from, or recharge to, well PI (RW-8) located 100 ft north of the observation well.

Water levels also are measured in six EPWU production wells located 0.25 to 0.6 mi from injection wells in the HBRP. The hydrographs for these wells (figs. 5-10) show water levels were declining at rates of about 2 ft/yr prior to 1985 and the injection of treated sewage. Since 1980, the hydrographs have flattened to about 0.6 ft of decline per year, which indicates that the effects of pumping and recharge are approaching equilibrium. The EPWU and USGS will continue to monitor changes in water quality and water levels in and near the HBRP.

The monitoring program will be expanded in conjection with the U.S. Bureau of Reclamation-El Paso Water Utilities Hueco bolson demonstration project which is scheduled to start in 1990. A program of drilling five additional monitoring wells has been proposed by the USGS.

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[1] Use of trade name in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

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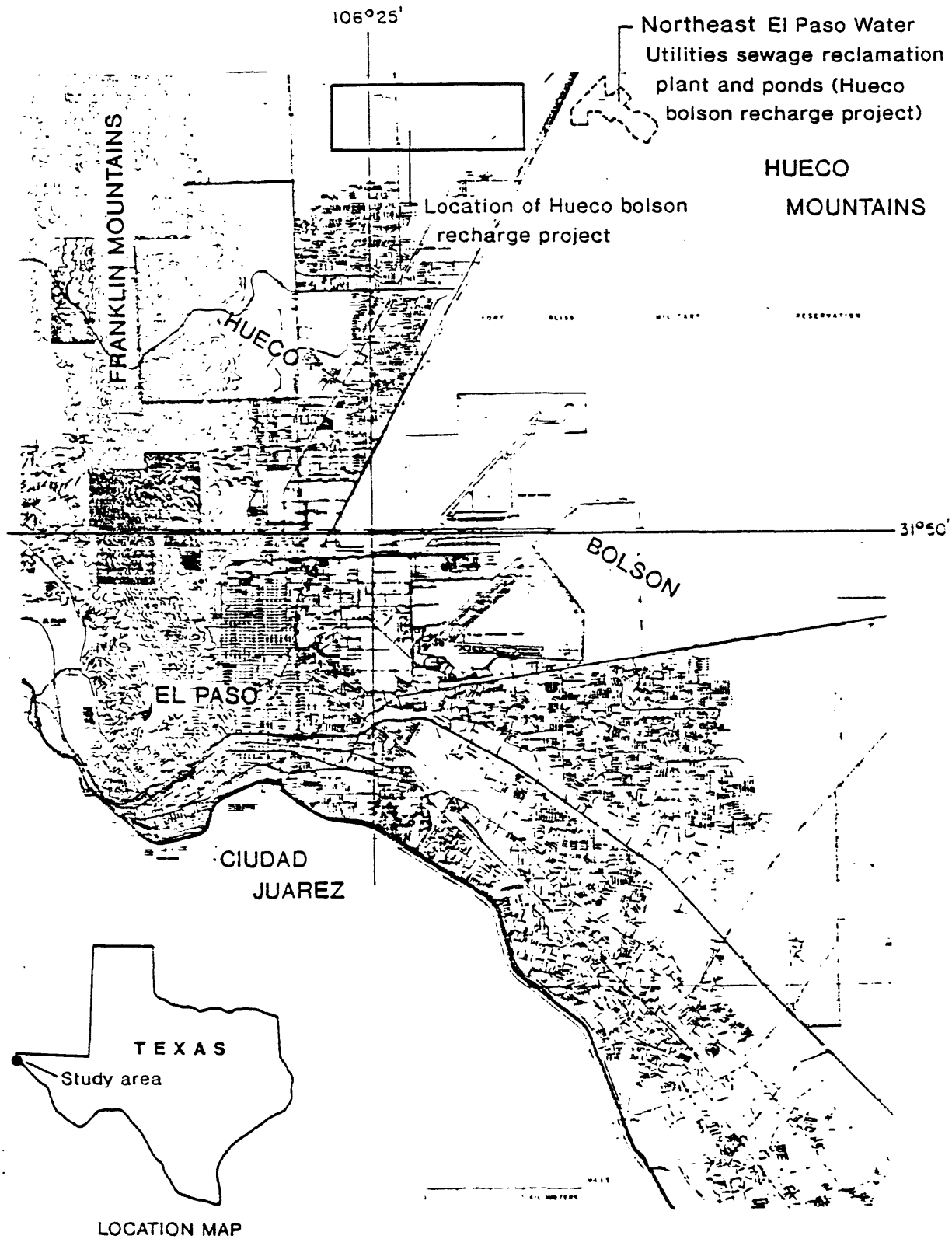


Figure 1.--Location of Hueco bolson recharge project.

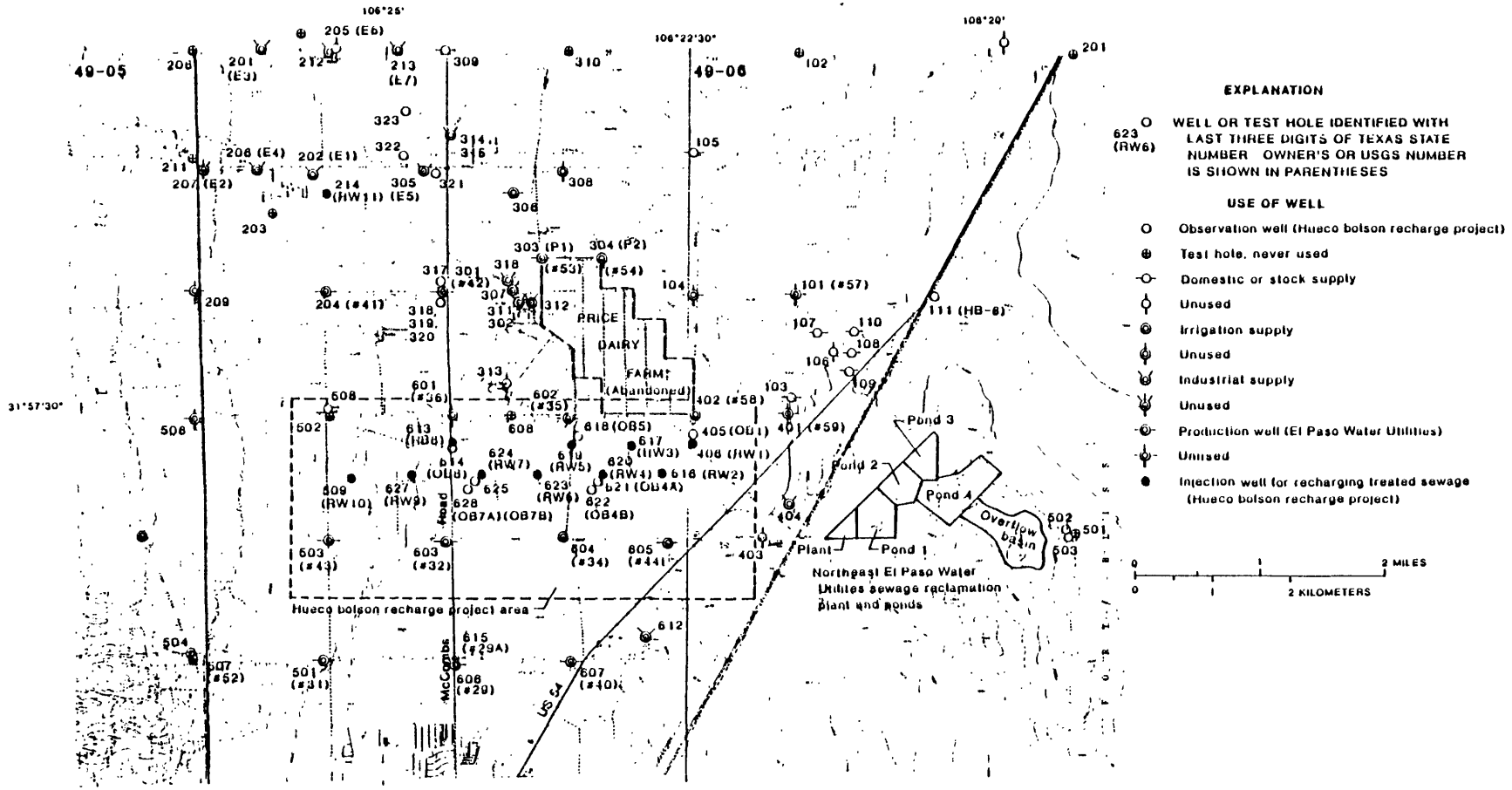
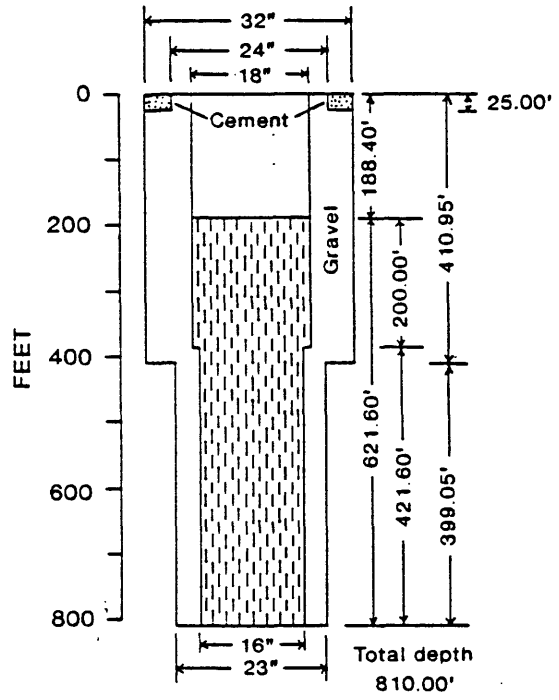


Figure 2.--Location of wells in northeast El Paso and the Hueco bolson recharge project.

PI

(JL-49-05-613)

Pilot injection



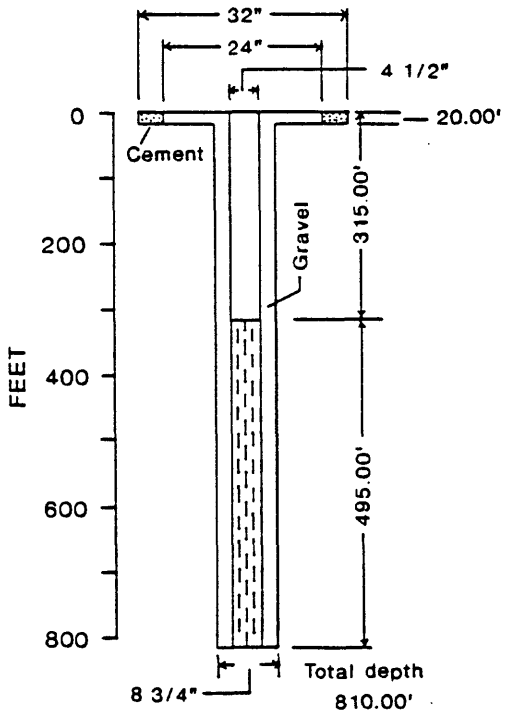
Materials

Size (inches)	Length (feet)	Thickness (inches)	Type
Wall			
24	~25.00	0.250	Steel
18	188.40	.375	Steel
Screen			
18	200.00	.375	Galvanized steel; mill slot 0.15 x 2.375 inches
16	421.60	.375	Steel; mill slot 0.10 x 2.375 inches

PIOW

(JL-49-05-614)

Pilot injection observation



Materials

Size (inches)	Length (feet)	Thickness (inches)	Type
Wall			
24	20.00	0.250	Steel
4 1/2	315.00	.250	Steel
Screen			
4 1/2	495.00	.250	Steel, torch slotted

Figure 3.--Completion diagrams of pilot study wells PI and PIOW, Hueco bolson recharge project.

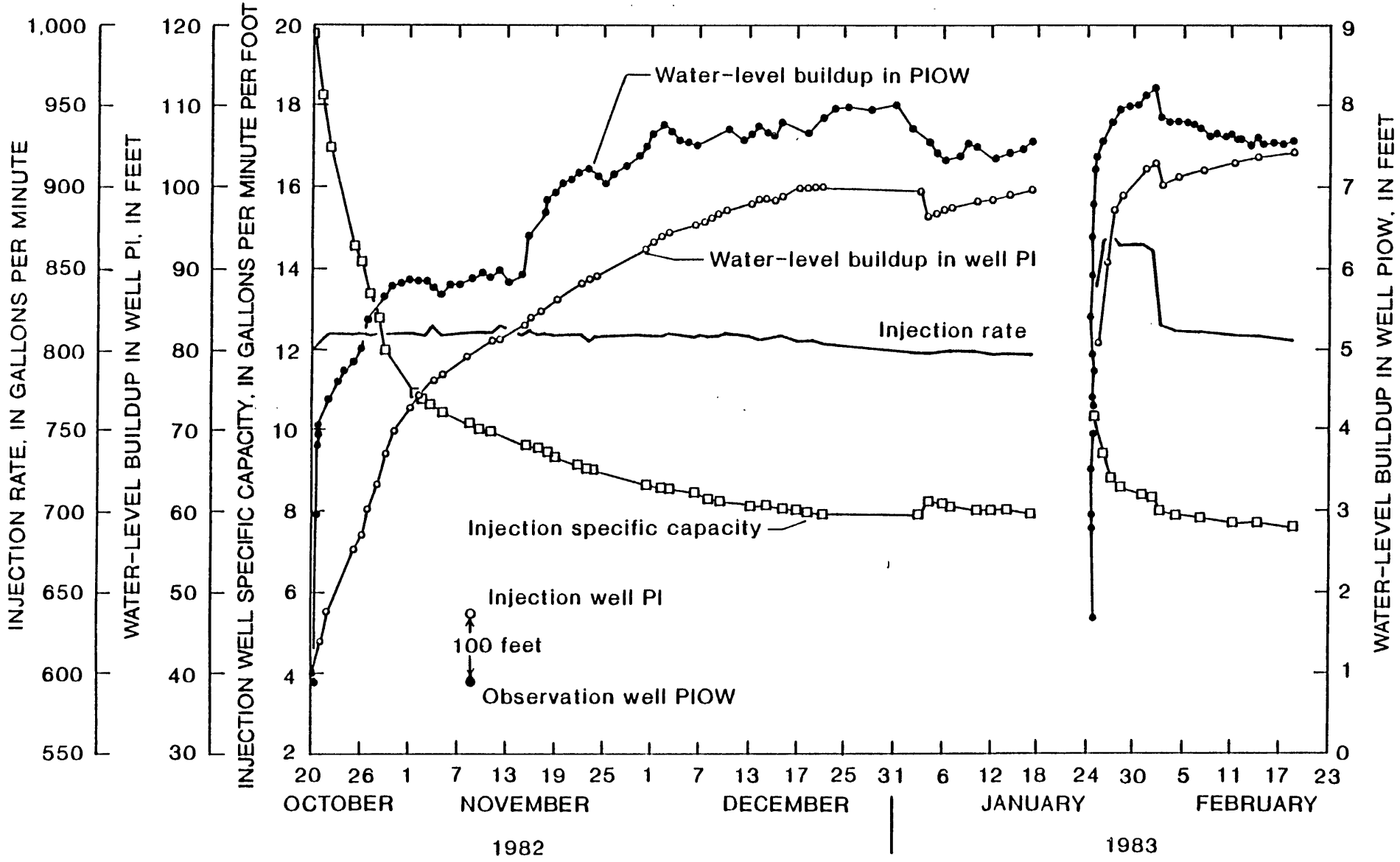


Figure 4.--Buildup of water levels in wells PI and PIOW during October 20, 1982, to February 18, 1983, injection test.

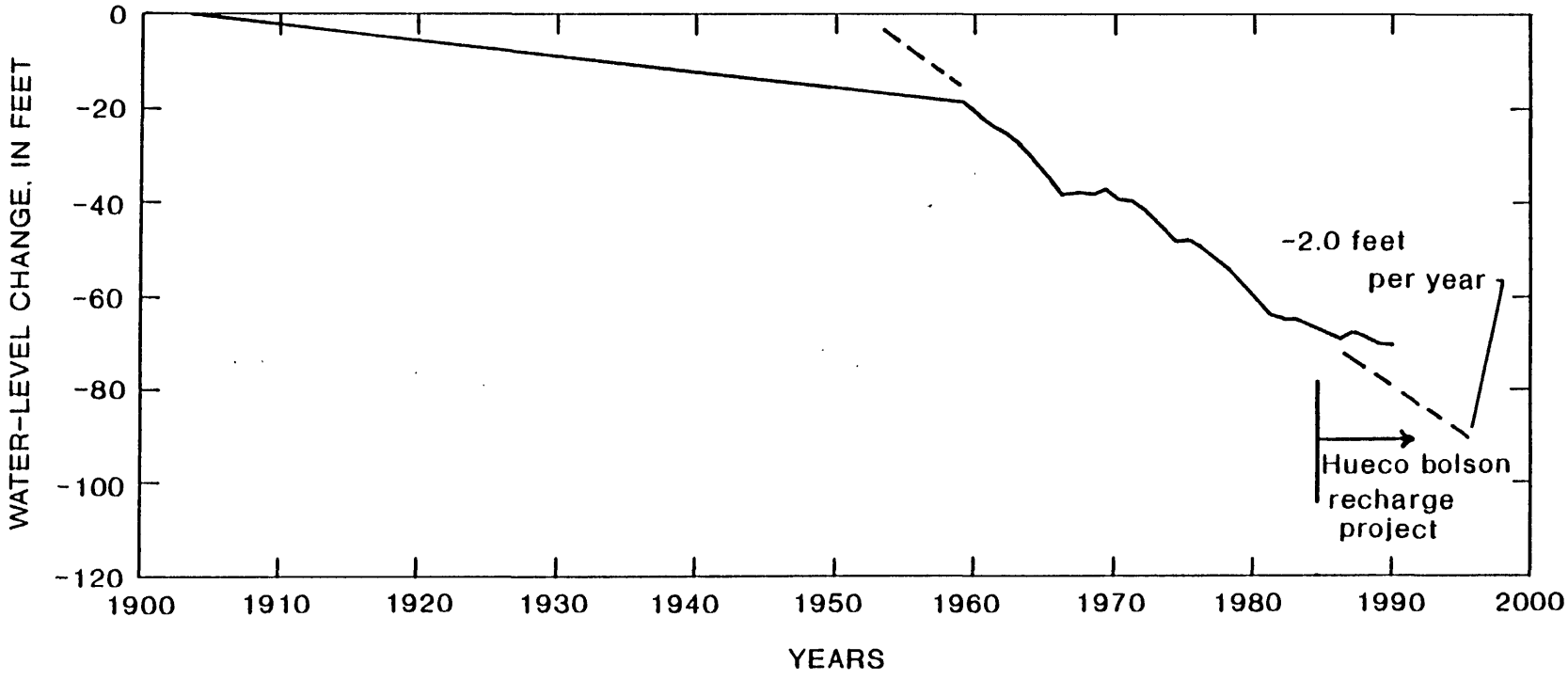


Figure 5.--Hydrograph of El Paso Water Utilities well 36 (JL-49-05-601), January 1, 1903, to December 11, 1989.

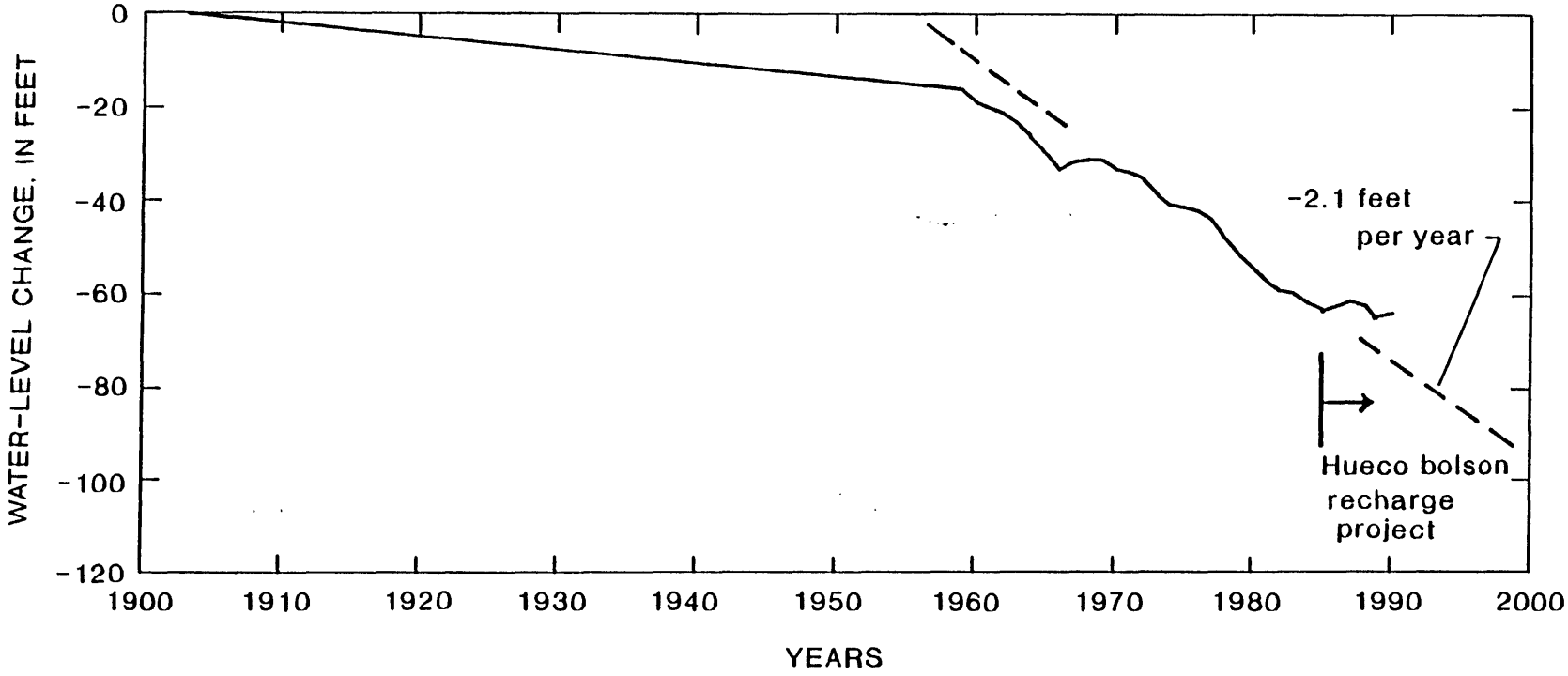


Figure 6.--Hydrograph of El Paso Water Utilities well 35 (JL-49-05-602), January 1, 1903, to December 12, 1989.

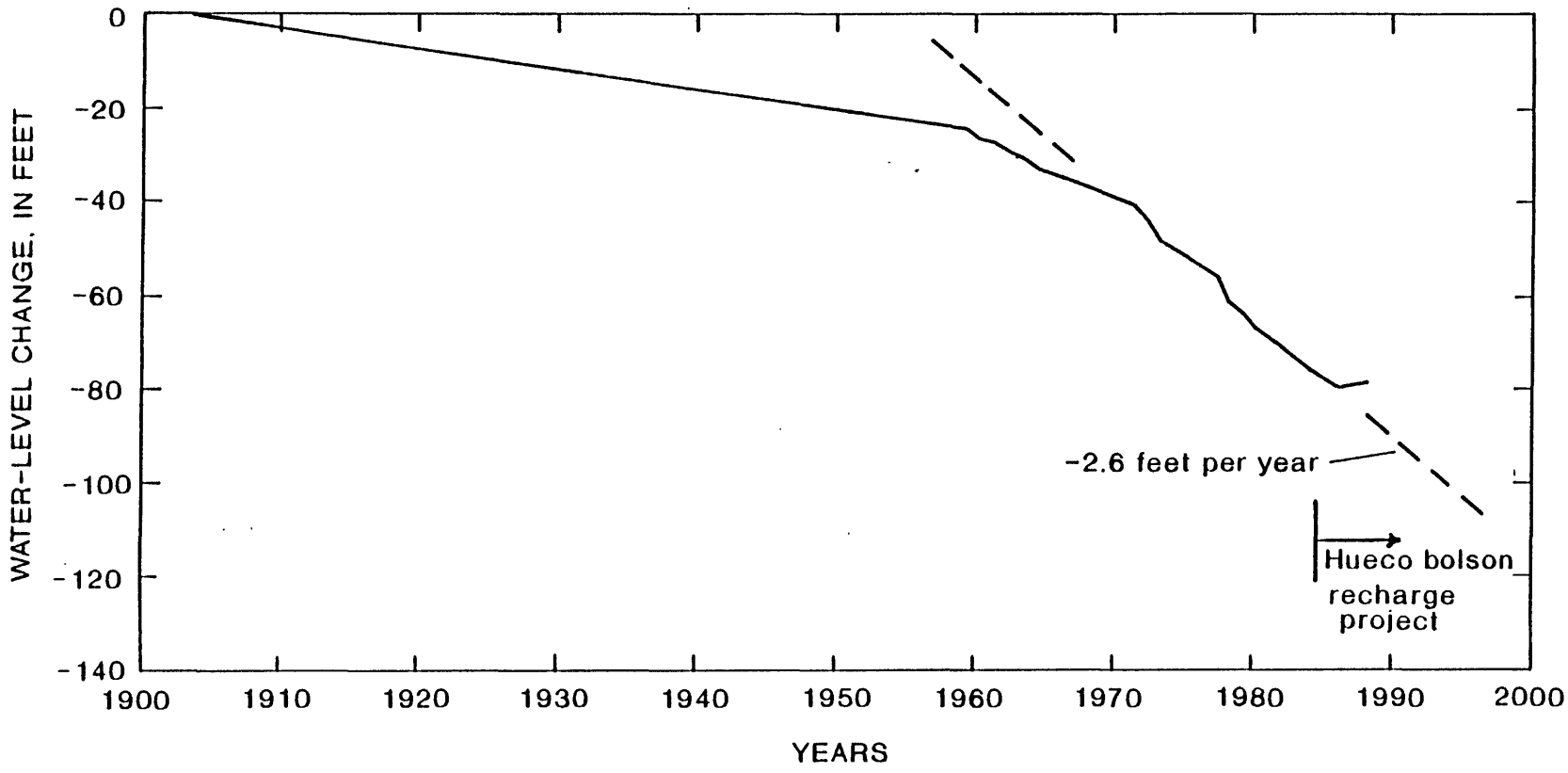


Figure 7.--Hydrograph of El Paso Water Utilities well 32 (JL-49-05-603), January 1, 1903, to December 10, 1987.

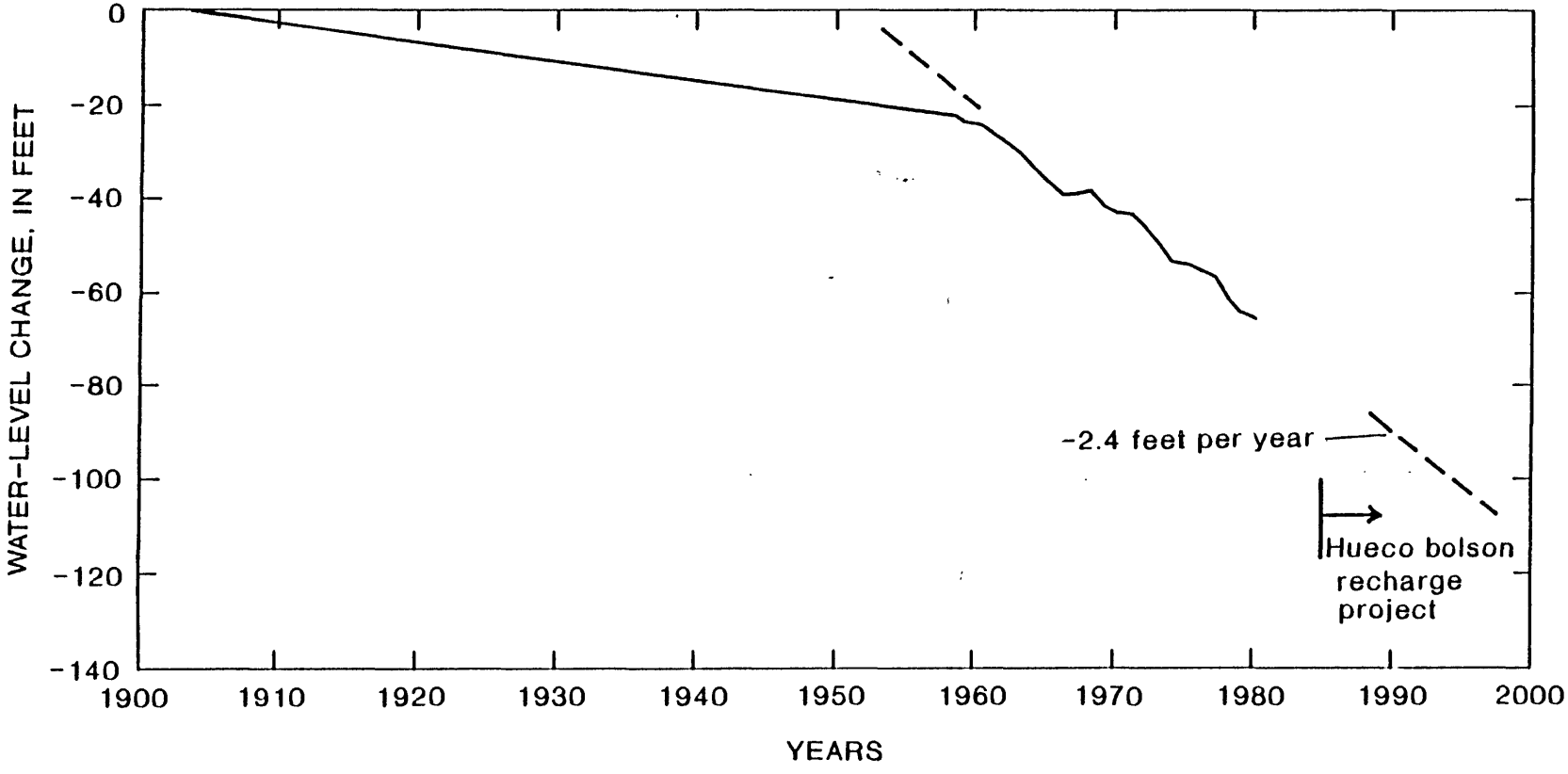


Figure 8.--Hydrograph of El Paso Water Utilities well 34 (JL-49-05-604), January 1, 1903, to January 7, 1980.

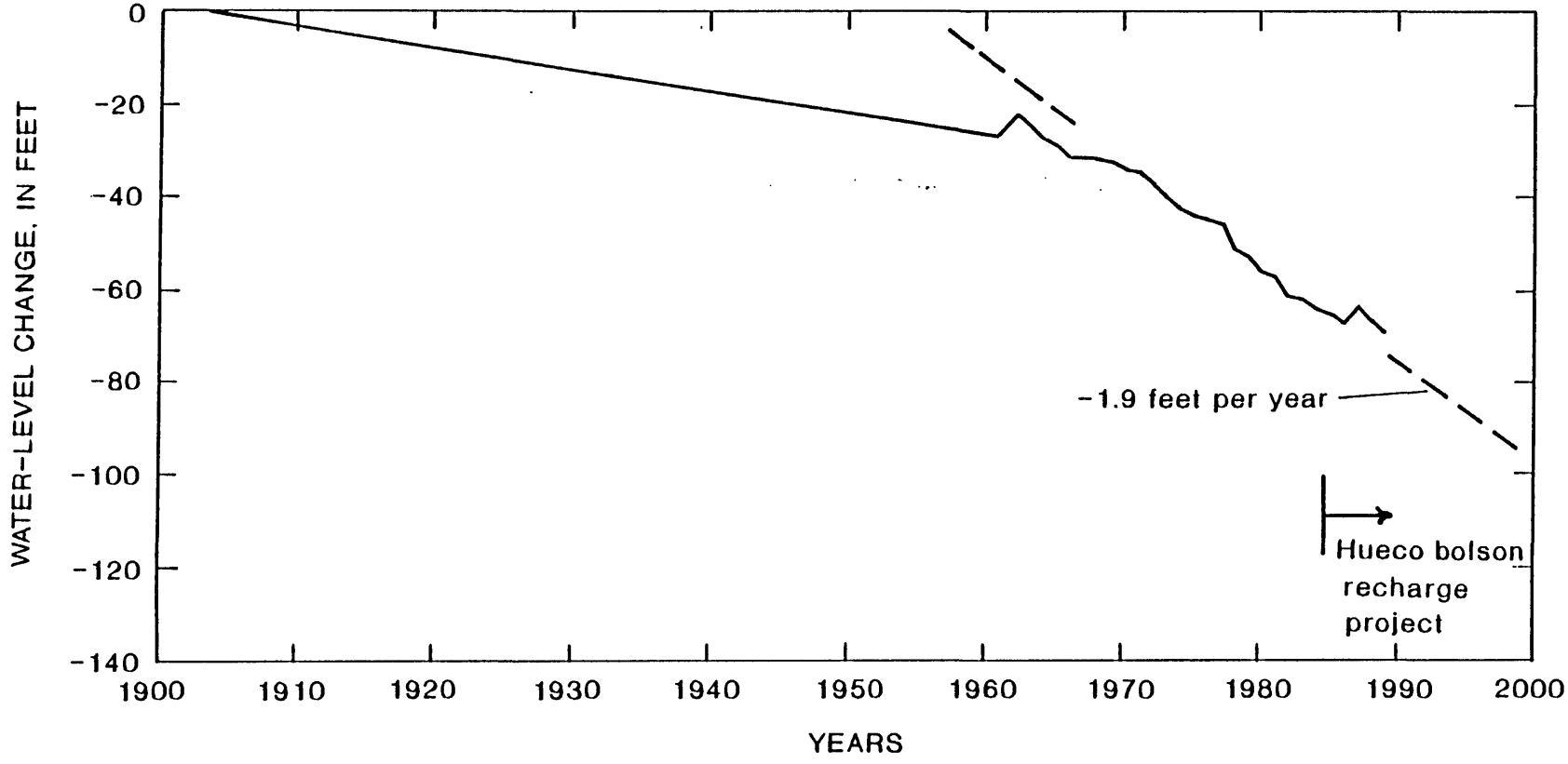


Figure 9.--Hydrograph of El Paso Water Utilities well 44 (JL-49-05-605), January 1, 1903, to December 13, 1988.

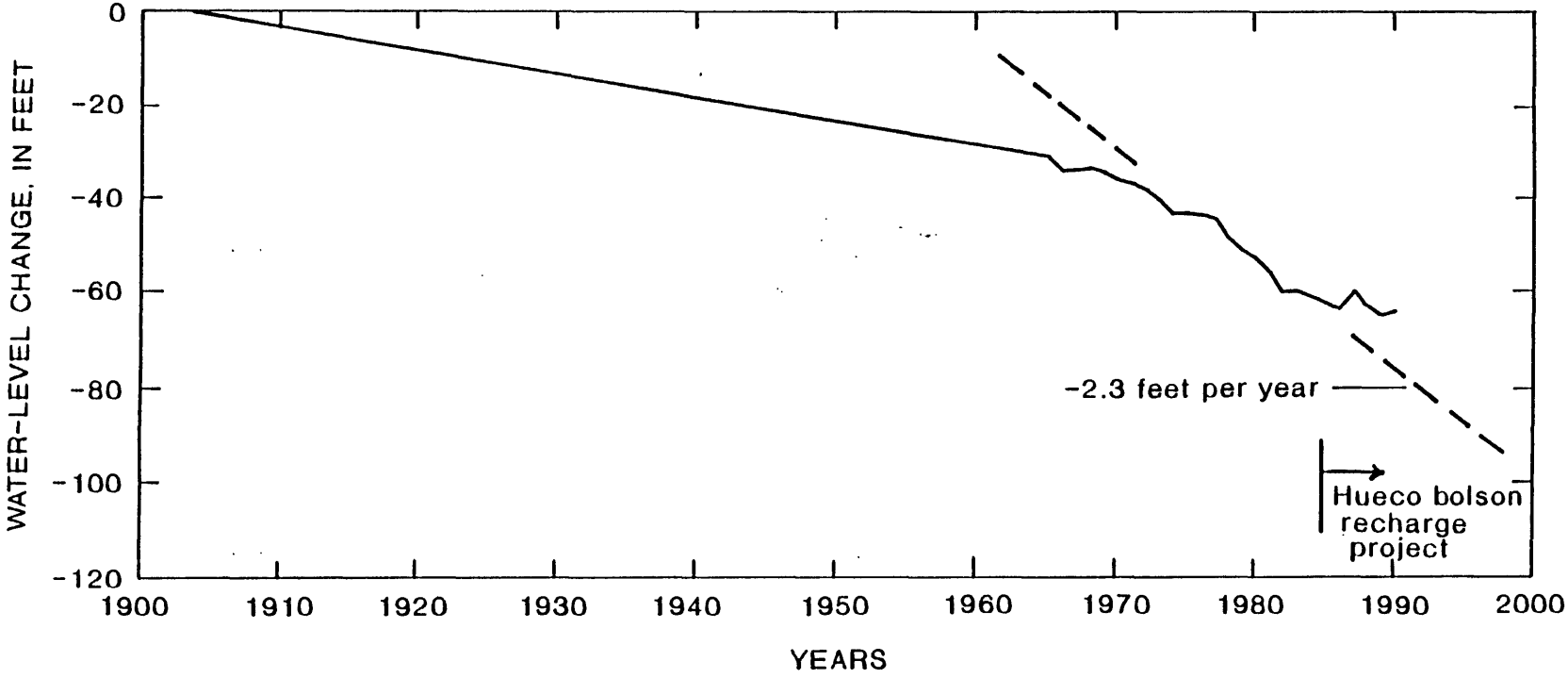


Figure 10.--Hydrograph of El Paso Water Utilities well 56 (JL-49-06-402), January 1, 1903, to December 12, 1989.

Table 1.--Drawdown of water level in well PI, May 11-14, 1981, during 3-day pumping test

[ft, feet; bmp, below measuring point; gal/min, gallons per minute; (gal/min)/ft, gallons per minute per foot]

Date and time	Pumping level (ft, bmp)	Drawdown (ft)	Discharge (gal/min)	Specific capacity [(gal/min)/ft]
05/11/81				
0800	Pump started, pretest water level 345.60 ft			
0900	391.15	45.55	1,799	39.5
1000	392.35	46.75	1,799	38.5
1100	393.28	47.68	1,799	37.7
1200	393.60	48.00	1,799	37.5
1300	393.73	48.13	1,799	37.4
1400	394.06	48.46	1,799	37.1
1500	394.05	48.45	1,799	37.1
1600	393.87	48.27	1,799	37.3
1700	394.03	48.43	1,799	37.1
1800	394.22	48.62	1,799	37.0
1900	394.33	48.73	1,799	36.9
2000	394.48	48.88	1,799	36.8
2100	394.60	49.00	1,799	36.7
2200	394.55	48.95	1,799	36.8
2300	394.54	48.94	1,799	36.8
2400	395.00	49.40	1,799	36.4
05/12/81				
0100	395.10	49.50	1,799	36.3
0200	395.18	49.58	1,799	36.3
0300	395.55	49.95	1,799	36.0
0400	394.65	49.05	1,799	36.7
0500	396.00	50.40	1,799	35.7
0600	396.45	50.85	1,799	35.4
0700	395.20	49.60	1,799	36.3
0800	395.79	50.19	1,799	35.8
0900	395.45	49.85	1,799	36.1
1000	395.85	50.20	1,799	35.8
1100	395.52	49.92	1,799	36.0
1200	395.65	50.05	1,799	36.0
1300	395.43	49.83	1,799	36.1
1400	395.87	50.27	1,799	35.8
1500	396.20	50.60	1,799	35.6
1600	396.17	50.57	1,799	35.6
1700	395.90	50.30	1,799	35.8
1800	395.96	50.36	1,799	35.7
1900	395.88	50.28	1,799	35.8
2000	396.52	50.92	1,799	35.3
2100	396.17	50.57	1,799	35.6
2200	396.55	50.95	1,799	35.3
2300	395.63	50.03	1,799	36.0
2400	395.34	49.74	1,799	36.2
5/13/81				
0100	395.70	50.10	1,799	35.9
0200	395.68	50.08	1,799	35.9
0300	395.80	50.20	1,799	35.8
0400	395.85	50.25	1,799	35.8
0500	395.85	50.25	1,799	35.8
0600	396.53	50.93	1,799	35.3
0700	396.00	50.40	1,799	35.7
0800	396.40	50.80	1,799	35.4
0900	396.90	51.30	1,799	35.1
1000	396.40	50.80	1,799	35.4
1100	396.20	50.60	1,799	35.6
1200	396.15	50.55	1,799	35.6
1300	395.53	49.93	1,799	36.0
1400	395.68	50.08	1,799	35.9
1500	396.15	50.55	1,799	35.6
1600	396.20	50.60	1,799	35.6
1700	396.07	50.47	1,799	35.6
1800	395.82	50.22	1,799	35.8
1900	396.75	51.15	1,799	35.2
2000	396.32	50.72	1,799	35.5
2100	396.74	51.14	1,799	35.2
2200	396.57	50.97	1,799	35.3
2300	396.62	51.02	1,799	35.3
2400	396.80	51.20	1,799	35.1
05/14/81				
0100	397.20	51.60	1,799	34.9
0200	396.55	50.95	1,799	35.3
0300	396.63	51.03	1,799	35.3
0400	396.56	50.96	1,799	35.3
0500	396.85	51.25	1,799	35.1
0600	396.70	51.10	1,799	35.2
0700	396.50	50.90	1,799	35.3
0800	396.87	51.27	1,799	35.1

Table 2.--Drawdown of water level in well PIOW, May 8-14, 1981, during 3-day pumping test in well PI

[ft, feet; bls, below land surface]

Date and time	Time since pumping started (minutes)	Depth to water (ft, bls)	Drawdown (ft)
05/08/81			
1000	--	343.08	--
05/09/81			
1415	--	342.85	--
05/11/81			
0800	0	342.80	0.00
0822	22	347.85	5.05
0825	25	348.07	5.27
0830	30	348.30	5.50
0840	40	348.75	5.95
0850	50	348.94	6.14
0855	55	349.24	6.44
0900	60	349.33	6.53
0905	65	349.36	6.56
0910	70	349.47	6.67
0915	75	349.56	6.76
0920	80	349.64	6.84
0930	90	349.83	7.03
0935	95	349.88	7.08
0945	105	349.97	7.17
0950	110	350.07	7.27
1010	130	350.32	7.52
1028	148	350.50	7.70
1045	165	350.64	7.84
1100	180	350.78	7.98
1130	210	351.01	8.21
1200	240	351.28	8.48
1300	300	351.45	8.65
1400	360	351.65	8.85
1500	420	351.78	8.98
1600	480	351.93	9.13
1700	540	352.00	9.20
1800	600	352.08	9.28
1900	660	352.19	9.39
2000	720	352.26	9.46
2100	780	352.30	9.50
2200	840	352.37	9.57
2300	900	352.45	9.65
2400	960	352.50	9.70
05/12/81			
0100	1,020	352.55	9.75
0200	1,080	352.60	9.80
0300	1,140	352.65	9.85
0400	1,200	352.65	9.85
0500	1,260	352.70	9.90
0600	1,320	352.80	10.00
0700	1,380	352.74	9.94
0800	1,440	352.79	9.99
0900	1,500	352.80	10.00
1000	1,560	352.87	10.07
1100	1,620	352.84	10.04
1200	1,680	352.84	10.04
1300	1,740	352.84	10.04
1400	1,800	352.82	10.02
1500	1,860	352.84	10.04
1600	1,920	352.91	10.11
1700	1,980	352.94	10.14
1800	2,040	352.94	10.14
1900	2,100	352.94	10.14
2000	2,160	352.96	10.16
2100	2,220	352.98	10.18
2200	2,280	352.98	10.18
2300	2,340	352.96	10.16
2400	2,400	352.94	10.14
05/13/81			
0100	2,460	352.90	10.10
0200	2,520	352.85	10.05
0300	2,580	352.90	10.10
0400	2,640	352.85	10.05
0500	2,700	352.80	10.00
0600	2,760	352.93	10.13
0700	2,820	352.90	10.10
0800	2,880	352.90	10.10
0900	2,940	352.99	10.19
1000	3,000	352.98	10.18
1100	3,060	352.98	10.18
1200	3,120	352.95	10.15
1300	3,180	352.95	10.15
1400	3,240	352.95	10.15
1500	3,300	352.95	10.15
1600	3,360	352.94	10.14
1700	3,420	352.95	10.15
1800	3,480	352.95	10.15
1900	3,540	352.95	10.15
2000	3,600	352.95	10.15
2100	3,660	352.95	10.15
2200	3,720	352.95	10.15
2300	3,780	352.95	10.15
2400	3,840	352.95	10.15
05/14/81			
0100	3,900	352.95	10.15
0200	3,960	353.00	10.20
0300	4,020	353.05	10.25
0400	4,080	353.05	10.25
0500	4,140	353.05	10.25
0600	4,200	353.05	10.25
0700	4,260	353.05	10.25
0800	4,320	353.05	10.25

Table 3.--Water-level recovery in well PI, May 14-15, 1981, following 3-day pumping test

[t/t^1, time since pumping started/time since pumping ceased; ft, feet; bmp, below measuring point]

Date and time	t, time since pumping started (minutes)	t^1, time since pumping ceased (minutes)	t/t^1	Depth to water (ft, bmp)	Residual drawdown (ft)
05/14/81					
0800	4,320	0	Pump off, pumping level 396.87 ft		
0801	4,321	1	4,321.0	354.36	8.81
0802	4,322	2	2,161.0	318.81	1/-26.74
0803	4,323	3	1,441.0	353.96	8.41
0804	4,324	4	1,081.0	354.56	9.01
0805	4,325	5	865.0	354.46	8.91
0806	4,326	6	721.0	354.21	8.66
0807	4,327	7	618.1	354.01	8.46
0808	4,328	8	541.0	353.71	8.16
0809	4,329	9	481.0	353.56	8.01
0810	4,330	10	433.0	353.36	7.81
0812	4,332	12	361.0	353.06	7.51
0814	4,334	14	309.6	352.81	7.26
0816	4,336	16	271.0	352.63	7.08
0818	4,338	18	241.0	352.41	6.86
0820	4,340	20	217.0	352.23	6.68
0822	4,342	22	197.4	352.06	6.51
0824	4,344	24	181.0	351.91	6.36
0826	4,346	26	167.2	351.81	6.26
0828	4,348	28	155.3	351.69	6.14
0830	4,350	30	145.0	351.56	6.01
0835	4,355	35	124.4	351.32	5.77
0840	4,360	40	109.0	351.11	5.56
0845	4,365	45	97.0	350.96	5.41
0850	4,370	50	87.4	350.74	5.19
0855	4,375	55	79.5	350.57	5.02
0900	4,380	60	73.0	350.43	4.88
0915	4,395	75	58.6	350.03	4.48
0930	4,410	90	49.0	349.83	4.28
0945	4,425	105	42.1	349.56	4.01
1000	4,440	120	37.0	349.40	3.85
1015	4,455	135	33.0	349.25	3.70
1030	4,470	150	29.8	349.11	3.56
1100	4,500	180	25.0	348.85	3.30
1130	4,530	210	21.6	348.61	3.06
1200	4,560	240	19.0	348.41	2.86
1230	4,590	270	17.0	348.26	2.71
1300	4,620	300	15.4	348.10	2.55
1330	4,650	330	14.1	347.88	2.33
1400	4,680	360	13.0	347.86	2.31
1430	4,710	390	12.1	347.75	2.20
1500	4,740	420	11.3	347.67	2.12
1530	4,770	450	10.6	347.58	2.03
1600	4,800	480	10.0	347.47	1.92
1700	4,860	540	9.00	347.41	1.86
1800	4,920	600	8.20	347.30	1.75
1900	4,980	660	7.54	347.23	1.68
2000	5,040	720	7.00	347.17	1.62
2100	5,100	780	6.54	347.10	1.55
2200	5,160	840	6.14	347.04	1.49
2300	5,220	900	5.80	347.00	1.45
2400	5,280	960	5.50	347.00	1.45
05/15/81					
0100	5,340	1,020	5.24	346.95	1.40
0200	5,400	1,080	5.00	346.94	1.39
0300	5,460	1,140	4.79	346.92	1.37
0400	5,520	1,200	4.60	346.81	1.26
0500	5,580	1,260	4.43	346.80	1.25
0600	5,640	1,320	4.27	346.75	1.20
0700	5,700	1,380	4.13	346.73	1.18
0800	5,760	1,440	4.00	346.71	1.16

1/ Slug effect from draining column pipe.

Table 4.--Water-level recovery in well PIOW, May 14-15 and 18, 1981, following 3-day pumping test in well PI

[t/t^1, time since pumping started/time since pumping ceased; ft, feet; bmp, below measuring point]

Date and time	t, time since pumping started (minutes)	t^1, time since pumping ceased (minutes)	t/t^1	Depth to water (ft, bmp)	Residual drawdown (ft)
05/14/81					
0800	4,320	0	Pump off	353.05	10.25
0801	4,321	1	4,321.0	352.80	10.00
0802	4,322	2	2,161.0	351.95	9.15
0803	4,323	3	1,441.0	351.40	8.60
0804	4,324	4	1,081.0	351.10	8.30
0805	4,325	5	865.0	350.90	8.10
0806	4,326	6	721.0	350.60	7.80
0807	4,327	7	618.1	350.30	7.50
0808	4,328	8	541.0	350.00	7.20
0809	4,329	9	481.0	349.80	7.00
0810	4,330	10	433.0	349.70	6.90
0811	4,331	11	393.7	349.55	6.75
0812	4,332	12	361.0	349.45	6.65
0813	4,333	13	333.3	349.34	6.54
0815	4,335	15	289.0	349.15	6.35
0820	4,340	20	217.0	348.85	6.05
0823	4,343	23	188.8	348.60	5.80
0825	4,345	25	173.8	348.41	5.61
0830	4,350	30	145.0	348.34	5.54
0837	4,357	37	117.8	348.15	5.35
0840	4,360	40	109.0	348.03	5.23
0850	4,370	50	87.4	347.73	4.93
0900	4,380	60	73.0	347.55	4.75
0910	4,390	70	62.7	347.36	4.56
0920	4,400	80	55.0	347.19	4.39
0930	4,410	90	49.0	347.07	4.27
0945	4,425	105	42.1	346.88	4.08
1000	4,440	120	37.0	346.72	3.92
1015	4,455	135	33.0	346.56	3.76
1030	4,470	150	29.8	346.44	3.64
1100	4,500	180	25.0	346.20	3.40
1145	4,545	225	20.2	345.93	3.13
1230	4,590	270	17.0	345.70	2.90
1300	4,620	300	15.4	345.56	2.76
1330	4,650	330	14.1	345.43	2.63
1400	4,680	360	13.0	345.32	2.52
1430	4,710	390	12.1	345.23	2.43
1500	4,740	420	11.3	345.12	2.32
1530	4,770	450	10.6	345.00	2.20
1600	4,800	480	10.0	344.95	2.15
1630	4,830	510	9.47	344.87	2.07
1700	4,860	540	9.00	344.83	2.03
1800	4,920	600	8.20	344.67	1.87
1900	4,980	660	7.54	344.64	1.84
2000	5,040	720	7.00	344.56	1.76
2100	5,100	780	6.54	344.45	1.65
2200	5,160	840	6.14	344.40	1.60
2300	5,220	900	5.80	344.34	1.54
2400	5,280	960	5.50	344.30	1.50
05/15/81					
0100	5,340	1,020	5.24	344.26	1.46
0200	5,400	1,080	5.00	344.22	1.42
0300	5,460	1,140	4.79	344.15	1.35
0400	5,520	1,200	4.60	344.07	1.27
0500	5,580	1,260	4.43	344.00	1.20
0600	5,640	1,320	4.27	343.98	1.18
0700	5,700	1,380	4.13	343.96	1.16
0800	5,760	1,440	4.00	343.93	1.13
0900	5,820	1,500	3.88	343.83	1.09
05/18/81					
1450	10,490	6,170	1.70	342.42	+.38

Table 5.--Water-level buildup in well PI, September 14 to October 8, 1981, during 24-day injection test

[gal, gallons; gal/min, gallons per minute; ft, feet; (gal/min)/ft, gallons per minute per foot]

Date and time	Time since injection started (minutes)	Cumulative injection (gal)	Average rate of injection (gal/min)	Water-level buildup (ft)	Specific capacity [(gal/min)/ft)]
9/14/81					
1245	0	Pretest water level 340.34 ft			
1255	10	4,937	494	13.00	38.0
1300	15	6,733	359	13.20	27.2
1315	30	14,738	534	13.50	39.6
1330	45	20,872	409	13.60	30.1
1400	75	34,712	461	13.85	33.3
1430	105	48,552	461	13.75	33.5
1500	135	62,242	456	13.85	32.9
1530	165	75,184	431	13.80	31.2
9/15/81					
0840	1,195	527,560	439	12.44	35.3
0915	1,230	549,704	633	31.49	20.1
1000	1,275	589,802	891	30.29	29.4
1100	1,335	644,264	908	30.47	29.8
1200	1,395	697,902	894	30.41	29.4
1300	1,455	744,808	782	30.59	25.6
1400	1,515	798,821	900	31.49	28.6
1500	1,575	852,909	901	31.57	28.5
1515	1,590	869,217	1,087	31.56	34.4
9/16/81					
0825	2,620	1,706,715	813	30.88	26.3
0900	2,655	1,734,844	804	30.08	26.7
0930	2,685	1,760,803	865	33.09	26.1
1000	2,715	1,788,258	915	32.77	27.9
1030	2,745	1,810,327	736	33.70	21.8
1100	2,775	1,836,137	860	34.19	25.2
1430	2,985	2,024,583	897	35.90	25.0
9/17/81					
0830	4,065	3,013,646	916	37.77	24.3
0900	4,095	3,038,034	813	37.74	21.5
1400	4,395	3,291,565	845	37.88	22.3
1500	4,455	3,362,710	1,186	38.06	31.2
9/18/81					
0830	5,505	4,244,270	840	37.40	22.5
0900	5,535	4,269,930	855	39.14	21.8
1000	5,595	4,324,093	903	40.09	22.5
1430	5,865	4,588,322	979	41.79	23.4
9/21/81					
0830	9,825	8,199,700	912	64.67	14.1
0900	9,855	8,222,143	748	64.36	11.6
0930	9,885	8,250,196	935	69.64	13.4
9/22/81					
0830	11,265	9,570,069	956	68.34	14.0
9/23/81					
0830	12,705	10,923,083	940	68.74	13.7
09/24/81					
0830	14,145	12,284,924	946	69.26	13.7
09/25/81					
0815	15,570	13,633,524	946	69.70	13.6
1250	15,845	13,891,693	939	69.47	13.5
09/28/81					
0830	19,905	17,732,514	946	72.02	13.1
09/29/81					
0825	21,340	19,160,412	995	73.25	13.6
2225	22,180	20,001,202	1,001	74.48	13.4
09/30/81					
0810	22,765	20,065,143	1,032	73.67	14.0
10/01/81					
0830	24,225	22,123,337	1,040	72.86	14.3
10/02/81					
0820	25,655	23,607,717	1,038	71.05	14.6
10/05/81					
0830	29,985	28,089,584	1,035	71.88	14.4
10/06/81					
0830	31,425	29,567,830	1,027	71.79	14.3
10/07/81					
0830	32,865	31,053,781	1,032	71.87	14.4
10/08/81					
0915	34,350	32,598,981	1,041	71.55	14.5
1235	34,550	32,808,898	1,050	--	--

Table 6.--Water-level buildup in well PIOW, September 14 to October 8, 1981, during 24-day injection test in well PI

[gal, gallons; gal/min, gallons per minute; ft, feet]

Date and time	Time since injection started (minutes)	Cumulative injection (gal)	Average rate of injection (gal/min)	Depth to water (ft)	Water-level buildup (ft)
9/14/81					
1245	0	Pretest water level 337.20 ft			
1700	255	114,712	450	1/--	1/--
2400	675	299,176	439	--	--
9/15/81					
0600	1,035	457,288	439	--	--
1200	1,395	697,902	894	--	--
1800	1,755	1,003,379	813	--	--
2400	2,115	1,296,097	813	--	--
9/16/81					
0600	2,475	1,588,815	813	--	--
1200	2,835	1,889,979	897	--	--
1800	3,195	2,216,901	916	--	--
2400	3,555	2,546,588	916	--	--
9/17/81					
0600	3,915	2,876,276	916	--	--
1200	4,275	3,190,153	845	--	--
1800	4,635	3,513,835	840	--	--
2400	4,995	3,816,084	840	--	--
9/18/81					
0600	5,355	4,118,333	840	--	--
1200	5,715	4,441,528	979	--	--
1800	6,075	4,779,834	912	334.47	2.73
2400	6,435	5,108,142	912	334.46	2.74
9/19/81					
0600	6,795	5,436,449	912	334.30	2.90
1200	7,155	5,764,756	912	334.25	2.95
1800	7,515	6,093,063	912	334.35	2.85
2400	7,875	6,421,370	912	334.24	2.96
9/20/81					
0600	8,235	6,749,677	912	333.60	3.60
1200	8,595	7,077,984	912	334.40	2.80
1800	8,955	7,406,291	912	334.60	2.60
2400	9,315	7,734,598	912	334.45	2.75
9/21/81					
0600	9,675	8,062,905	912	334.22	2.98
1200	10,035	8,393,660	956	334.68	3.52
1800	10,395	8,737,975	956	333.47	3.73
2400	10,755	9,082,290	956	333.78	3.42
9/22/81					
0600	11,115	9,426,604	956	333.55	3.65
1200	11,475	9,767,384	940	333.78	3.42
1800	11,835	10,105,637	940	333.88	3.32
2400	12,195	10,443,891	940	333.63	3.57
9/23/81					
0600	12,555	10,782,144	940	333.70	3.50
1200	12,915	11,121,685	946	333.81	3.39
1800	13,275	11,462,145	946	333.66	3.54
2400	13,635	11,802,605	946	333.72	3.48
09/24/81					
0600	13,995	12,143,066	946	333.67	3.53
1200	14,355	12,483,665	946	333.76	3.44
1800	14,715	12,824,364	946	333.73	3.47
2400	15,075	13,165,063	946	333.75	3.45
09/25/81					
0600	15,435	13,505,762	946	333.74	3.46
1200	15,795	13,844,753	939	333.86	3.34
1800	16,155	14,184,958	946	333.85	3.35
2400	16,515	14,525,523	946	333.82	3.38
09/26/81					
0600	16,875	14,866,088	946	333.48	3.72
1200	17,235	15,206,654	946	333.80	3.40
1800	17,595	15,547,219	946	333.86	3.34
2400	17,955	15,887,785	946	333.86	3.34
09/27/81					
0600	18,315	16,228,350	946	333.96	3.24
1200	18,675	16,568,916	946	333.83	3.37
1800	19,035	16,909,481	946	333.70	3.50
2400	19,395	17,250,046	946	333.88	3.32
09/28/81					
0600	19,755	17,590,612	946	333.74	3.46
1200	20,115	17,941,475	995	333.60	3.60
1800	20,475	18,299,693	995	333.46	3.74
2400	20,835	18,657,911	995	333.51	3.69
09/29/81					
0600	21,195	19,016,130	995	333.61	3.59
1200	21,555	19,375,614	1,001	333.98	3.22
1800	21,915	19,735,953	1,001	333.56	3.64
2400	22,275	20,099,278	1,032	333.35	3.85
09/30/81					
0600	22,635	20,470,934	1,032	333.38	3.82
1200	22,995	20,844,311	1,040	333.52	3.68
1800	23,355	21,218,660	1,040	333.49	3.71
2400	23,715	21,593,009	1,040	333.48	3.72
10/01/81					
0600	24,075	21,967,358	1,040	333.36	3.84
1200	24,435	22,341,323	1,038	333.78	3.42
1800	24,795	22,715,013	1,038	334.16	3.04
2400	25,155	23,088,703	1,038	334.40	3.80

Table 6.--Water-level buildup in well PIOW, September 14 to October 8, 1981, during 24-day injection test in well PI--Continued

Date and time	Time since injection started (minutes)	Cumulative injection (gal)	Average rate of injection (gal/min)	Depth to water (ft)	Water-level buildup (ft)
10/02/81					
0600	25,515	23,462,393	1,038	334.53	3.67
1200	25,875	23,835,433	1,035	334.40	3.80
1800	26,235	24,208,059	1,035	333.76	3.44
2400	26,595	24,580,686	1,035	333.77	3.43
10/03/81					
0600	26,955	24,953,312	1,035	333.85	3.35
1200	27,315	25,325,939	1,035	333.85	3.35
1800	27,675	25,698,565	1,035	333.85	3.35
2400	28,035	26,071,191	1,035	333.87	3.33
10/04/81					
0600	28,395	26,443,818	1,035	333.86	3.34
1200	28,755	26,816,444	1,035	333.85	3.35
1800	29,115	27,189,070	1,035	333.90	3.30
2400	29,475	27,561,697	1,035	333.98	3.22
10/05/81					
0600	29,835	27,934,323	1,035	333.97	3.23
1200	30,195	28,305,162	1,027	333.95	3.25
1800	30,555	28,674,723	1,027	334.03	3.17
2400	30,915	29,044,285	1,027	334.12	3.08
10/06/81					
0600	31,275	29,413,846	1,027	334.11	3.09
1200	31,635	29,784,531	1,032	334.20	3.00
1800	31,995	30,156,019	1,032	334.14	3.06
2400	32,355	30,527,507	1,032	334.14	3.06
10/07/81					
0600	32,715	30,898,994	1,032	334.07	3.13
1200	33,075	31,272,294	1,041	334.05	3.15
1800	33,435	31,646,888	1,041	334.06	3.14
2400	33,795	32,021,482	1,041	334.07	3.13
10/08/81					
0600	34,155	32,396,076	1,041	333.96	3.24
1200	34,515	32,772,163	1,050	333.96	3.24
1235	34,550	32,808,898	1,050	333.96	3.24

1/ Recorder float hanging--water levels were questionable through 1200 Sept. 18, and not used.

Table 7.--Water-level buildup in well PI, January 19 to February 24, 1982, during 32-day injection test

[gal, gallons; gal/min, gallons per minute; ft, feet; (gal/min)/ft, gallons per minute per foot]

Date and time	Time since injection started (minutes)	Cumulative injection (gal)	Average rate of injection (gal/min)	Water-level buildup (ft)	Specific capacity [(gal/min)/ft]
1/19/82					
1400	0	Pretest water level 339.39 ft			
1410	10	--	--	63.02	--
1420	20	--	--	64.96	--
1430	30	28,428	948	65.77	14.4
1500	60	60,596	1,072	67.59	15.9
1530	90	87,528	898	68.58	13.1
1/20/82					
0840	1,120	1,113,173	996	72.38	13.8
1430	1,470	1,455,803	979	74.76	13.1
1530	1,530	1,514,154	973	74.81	13.0
1/21/82					
0830	2,550	2,523,341	989	76.45	12.9
0900	2,580	2,551,021	923	77.03	12.0
0915	2,595	2,568,229	1,147	77.22	14.9
0930	2,610	2,583,189	997	--	--
1055	2,695	2,669,969	1,021	80.31	12.7
1300	2,820	2,810,612	1,125	94.45	11.9
1400	2,880	2,878,689	1,135	97.27	11.7
1500	2,940	2,949,010	1,172	100.19	11.7
1/22/82					
0835	3,995	4,142,978	1,132	107.54	10.5
1340	4,300	4,488,600	1,133	107.49	10.5
1/25/82					
0825	8,305	9,018,346	1,131	109.66	10.3
1/26/82					
0835	9,755	10,638,730	1,118	109.97	10.2
1/27/82					
0835	11,195	12,237,420	1,110	110.01	10.1
1/28/82					
0835	12,635	13,828,629	1,105	110.10	10.0
1/29/82					
0835	14,075	15,416,845	1,103	110.44	9.99
2/01/82					
0835	18,395	20,133,615	1,092	110.55	9.88
2/02/82					
0820	19,820	21,674,701	1,081	110.76	9.76
2/03/82					
0820	21,260	23,225,513	1,077	110.53	9.74
2/04/82					
0845	22,725	24,796,523	1,072	110.63	9.69
02/05/82					
1305	24,425	26,621,887	1,074	110.73	9.70
02/08/82					
0835	28,475	30,918,225	1,061	110.77	9.58
02/09/82					
0835	29,915	32,439,112	1,056	110.58	9.55
02/10/82					
0835	31,355	33,954,015	1,052	110.84	9.49
02/11/82					
0825	32,785	35,456,200	1,050	110.85	9.47
1015	32,895	35,572,903	1,061	--	--
1015		Shut down injection			
1415		Started injection			
1415	32,895	35,572,903	--	--	--
02/12/82					
0830	33,990	36,716,748	1,045	126.22	8.28
02/15/82					
0837	38,317	41,227,043	1,042	130.59	7.98
02/16/82					
0840	39,760	42,720,250	1,035	131.49	7.87
02/17/82					
0915	41,235	44,240,390	1,031	132.09	7.81
02/18/82					
0830	42,630	45,673,001	1,027	132.49	7.75
1545	43,065	46,403,147	1,678	--	--
1545		Shut down injection, well 44 failed			
02/22/82					
1230		Started injection with well 42 pumping			
1230	43,065	46,403,147	--	--	--
1300	43,095	46,430,827	923	69.93	13.2
1330	43,125	46,460,003	973	74.21	13.1
1400	43,155	46,488,430	948	77.87	12.2
1445	43,200	46,533,316	997	83.76	11.9
02/23/82					
0830	44,265	47,593,374	995	138.29	7.20
02/24/82					
0830	45,705	49,014,016	987	140.07	7.05
0910	45,745	49,055,162	1,029	--	--
0910		Shut down injection			

Table 8.--Drawdown of water level in well PI, September 27-28, 1982, during redevelopment test

[ft, feet; bmp, below measuring point; gal/min, gallons per minute; (gal/min)/ft, gallons per minute per foot]

Date and time	Depth to water (ft, bmp)	Drawdown (ft)	Discharge (gal/min)	Specific capacity [(gal/min)/ft]
09/27/82				
1000	Pump started, pretest water level 348.6 ft			
1005	379.2	30.6	1,045	34.2
1010	380.0	31.4	1,045	33.3
1020	380.6	32.0	1,045	32.7
1030	380.9	32.3	1,045	32.4
1045	381.3	32.7	1,045	32.0
1100	381.6	33.0	1,045	31.7
1130	381.9	33.3	1,045	31.4
1200	382.1	33.5	1,045	31.2
1230	382.4	33.8	1,045	30.9
1300	382.5	33.9	1,045	30.8
1330	382.7	34.1	1,045	30.6
1400	382.8	34.2	1,045	30.6
1430	382.9	34.3	1,045	30.5
1530	383.0	34.3	1,045	30.4
09/28/82				
0820	382.5	33.9	1,045	30.8
0830	382.4	33.8	1,045	30.9

Table 9.--Drawdown of water level in well PIOW, September 27-28, 1982, during redevelopment test in well PI

[ft, feet; bls, below land surface]

Date and time	Time since pumping started (minutes)	Depth to water (ft, bls)	Drawdown (ft)
09/27/82			
1000	0	343.02	0.00
1030	30	345.85	2.83
1100	60	346.30	3.28
1200	120	346.78	3.76
1300	180	347.20	4.18
1400	240	347.40	4.38
1500	300	347.50	4.48
1600	360	347.75	4.73
1700	420	347.85	4.83
1800	480	347.94	4.92
1900	540	347.05	5.03
2000	600	348.20	5.18
2100	660	348.26	5.24
2200	720	348.26	5.24
2300	780	348.25	5.23
2400	840	348.18	5.16
09/28/82			
0100	900	348.04	5.02
0200	960	347.94	4.92
0400	1,080	347.91	4.89
0600	1,200	347.90	4.88
0830	1,350	347.89	4.87

Table 10.--Water-level recovery in well PI, September 28, 1982, following redevelopment test

[t/t^1, time since pumping started/time since pumping ceased; ft, feet; bls, below land surface]

Time	t, time since pumping started (minutes)	t^1, time since pumping ceased (minutes)	t/t^1	Depth to water (ft, bls)	Residual drawdown (ft)
0830	1,350	0	Pump off	382.4	33.8
0830.5	1,350.5	.5	2,701.0	351.5	2.9
0831	1,351	1	1,351.0	346.7	1/-1.9
0832	1,352	2	676.0	350.6	2.0
0833	1,353	3	451.0	351.9	3.3
0834	1,354	4	338.5	351.9	3.3
0835	1,355	5	271.0	351.8	3.2
0836	1,356	6	226.0	351.6	3.0
0837	1,357	7	193.9	351.5	2.9
0838	1,358	8	169.8	351.4	2.8
0839	1,359	9	151.0	351.3	2.7
0840	1,360	10	136.0	351.2	2.6
0842	1,362	12	113.5	351.0	2.4
0845	1,365	15	91.0	350.8	2.2
0850	1,370	20	68.5	350.5	1.9
0855	1,375	25	55.0	350.3	1.7
0900	1,380	30	46.0	350.1	1.5
0905	1,385	35	39.6	350.0	1.4
0910	1,390	40	34.8	349.9	1.3

1/ Slug effect from draining column pipe.

Table 11.--Water-level recovery in well PIOW, September 28-29, 1982, following redevelopment test in well PI

[t/t^1, time since pumping started/time since pumping ceased; ft, feet; bmp, below measuring point]

Time	t, time since pumping started (minutes)	t^1, time since pumping ceased (minutes)	t/t^1	Depth to water (ft, bmp)	Residual drawdown (ft)
09/28/82					
0830	1,350	0	Pump off	347.89	4.87
0900	1,380	30	46.0	345.50	2.48
1000	1,440	90	16.0	344.75	1.73
1100	1,500	150	10.0	344.38	1.36
1200	1,560	210	7.43	344.15	1.13
1300	1,620	270	6.00	343.98	.96
1400	1,680	330	5.09	343.80	.78
1600	1,800	450	4.00	343.60	.58
1800	1,920	570	3.37	343.45	.43
2000	2,040	690	2.96	343.35	.33
2400	2,280	930	2.45	343.25	.23
09/29/82					
0300	2,460	1,110	2.22	343.15	.13
0716	2,716	1,366	1.99	342.93	-.09

Table 12.--Water-level buildup in well PI, October 20, 1982, to February 18, 1983, during injection test

[gal, gallons; gal/min, gallons per minute; ft, feet; (gal/min)/ft, gallons per minute per foot]

Date and time	Time since injection started (minutes)	Cumulative injection (gal)	Average rate of injection (gal/min)	Water-level buildup (ft)	Specific capacity [(gal/min)/ft]
10/20/82					
0950	0	0	--	0.0	--
0953	3	--	--	19.0	--
0955	5	--	--	22.7	--
0956	6	--	--	23.8	--
1000	10	7,481	748	26.7	28.0
1010	20	16,458	898	31.1	28.9
1020	30	23,939	748	33.1	22.6
1030	40	32,168	823	34.6	23.8
1040	50	39,649	748	35.7	21.0
1050	60	47,878	823	36.5	22.5
1105	75	59,848	798	37.1	21.5
1120	90	71,818	798	37.7	21.2
1135	105	83,787	798	38.0	21.0
1150	120	95,009	748	38.7	19.3
1220	150	119,696	823	39.0	21.1
1250	180	144,383	823	39.3	20.9
1320	210	168,322	798	39.6	20.2
1350	240	191,514	773	39.9	19.4
1420	270	215,453	798	40.0	20.0
1450	300	238,644	773	40.2	19.2
1520	330	264,079	848	40.5	20.9
10/21/82					
0820	1,350	1,086,241	806	44.1	18.3
10/22/82					
0815	2,785	2,248,789	810	47.7	17.0
10/25/82					
0815	7,105	5,744,660	809	55.4	14.6
10/26/82					
0815	8,545	6,911,696	810	57.2	14.2
10/27/82					
0835	10,005	8,092,946	809	60.3	13.4
10/28/82					
0830	11,440	9,255,493	810	63.4	12.8
10/29/82					
0830	12,880	10,422,529	810	67.4	12.0
10/31/82					
Gained 1 hour in Daylight Saving Time change					
11/01/82					
0830	17,260	13,971,516	810	73.0	11.1
11/02/82					
0830	18,700	15,137,055	809	74.2	10.9
11/03/82					
0830	20,140	16,302,595	809	75.4	10.7
11/04/82					
0830	21,580	17,474,120	814	76.2	10.7
11/05/82					
0930	23,080	18,689,782	810	77.1	10.5
11/08/82					
0845	27,355	22,154,982	811	79.2	10.2
11/09/82					
0815	28,765	23,297,330	810	79.8	10.2
11/10/82					
0815	30,205	24,464,366	810	80.7	10.0
11/11/82					
0815	31,645	25,630,654	810	81.2	10.0
11/12/82					
0815	33,085	26,802,179	814	81.4	10.0
11/15/82					
0815	37,405	30,301,042	810	83.1	9.7
11/16/82					
0830	38,860	31,483,789	813	83.8	9.7
11/17/82					
0815	40,285	32,636,611	809	84.6	9.6
11/18/82					
0815	41,725	33,802,899	810	85.2	9.5
11/19/82					
0815	43,165	34,969,935	810	86.1	9.4
11/22/82					
0815	47,485	38,470,294	810	88.3	9.2
11/23/82					
0815	48,925	39,632,842	807	88.9	9.1

Table 12.--Water-level buildup in well PI, October 20, 1982, to February 18, 1983, during injection test--Continued

Date and time	Time since injection started (minutes)	Cumulative injection (gal)	Average rate of injection (gal/min)	Water-level buildup (ft)	Specific capacity [(gal/min)/ft)]
1/24/82					
0815	50,365	40,797,634	809	89.3	9.1
1/30/82					
0815	59,005	47,790,872	809	92.6	8.7
2/01/82					
0845	60,475	48,979,603	809	93.5	8.7
2/02/82					
0820	61,890	50,124,944	809	94.1	8.6
2/03/82					
0815	63,325	51,288,240	811	94.6	8.6
2/06/82					
0825	67,655	54,791,592	809	95.6	8.5
2/07/82					
0815	69,085	55,949,651	810	95.8	8.5
2/08/82					
0910	70,580	57,157,084	808	96.2	8.4
2/09/82					
0845	71,995	58,300,181	808	97.0	8.3
2/10/82					
0830	73,420	59,455,248	811	97.4	8.3
2/13/82					
0830	77,740	62,947,378	808	98.3	8.2
2/14/82					
0830	79,180	64,109,926	807	98.6	8.2
2/15/82					
0830	80,620	65,272,473	807	98.8	8.2
2/16/82					
0830	82,060	66,435,769	808	98.8	8.2
2/17/82					
0830	83,500	67,599,812	808	99.1	8.2
2/20/82					
0830	87,820	71,083,714	806	100.0	8.1
2/21/82					
0830	89,260	72,244,017	806	100.1	8.1
12/22/82					
0830	90,700	73,405,816	807	100.2	8.1
12/23/82					
0830	92,140	74,564,623	805	100.2	8.0
01/03/83					
0830	107,980	87,216,490	799	99.5	8.0
01/04/83					
0830	109,420	88,371,557	802	96.7	8.3
01/05/83					
0830	110,865	89,530,364	802	97.0	8.3
01/06/83					
0830	112,300	90,685,430	805	97.3	8.3
01/07/83					
0830	113,740	91,839,748	802	97.9	8.2
01/10/83					
0830	118,060	95,298,963	801	98.5	8.1
01/12/83					
0830	120,940	97,600,118	799	98.9	8.1
01/14/83					
0830	123,820	99,900,526	799	99.2	8.1
01/17/83					
0830	128,140	103,343,282	797	99.8	8.0
01/20/83					
0500	132,250	106,842,634	852	--	--
		Injection well shut down			
01/24/83					
0830		Static level, 343.05 ft			
01/25/83					
0830		Static level, 342.90 ft			
1020		Injection well started up			
1120	132,310	106,890,512	798	73.1	10.9
1220	132,370	106,940,635	835	77.0	10.8
1320	132,430	106,991,506	848	78.8	10.8
1420	132,490	107,043,873	873	80.0	10.9
1520	132,550	107,094,744	848	80.9	10.5
01/26/83					
0810	133,560	107,973,761	870	91.7	9.5

Table 12.--Water-level buildup in well PI, October 20, 1982, to February 18, 1983, during injection test--Continued

Date and time	Time since injection started (minutes)	Cumulative injection (gal)	Average rate of injection (gal/min)	Water-level buildup (ft)	Specific capacity [(gal/min)/ft)]
01/27/83					
1310	135,300	109,486,419	869	97.5	8.9
01/28/83					
0830	136,460	110,492,614	867	99.3	8.7
01/31/83					
0830	140,780	114,236,106	867	102.6	8.5
02/01/83					
0830	142,220	115,479,448	863	103.1	8.4
02/02/83					
0830	143,660	116,653,966	816	100.5	8.1
02/04/83					
0830	146,540	118,996,267	813	101.5	8.0
02/07/83					
0830	150,860	122,504,856	812	102.3	7.9
02/11/83					
0830	156,620	127,174,496	811	103.4	7.8
02/14/83					
0830	160,940	130,671,863	810	104.1	7.8
02/18/83					
1300	166,970	135,542,742	808	104.7	7.7
1437	167,067	135,620,545	802	--	--
		Well shut down			

Table 13.-Summary of pumping and injection tests and redevelopment in well PI from May 1981 to July 1983

[gal/min, gallons per minute; ft, feet; (gal/min)/ft, gallons per minute per foot]

Table no.	Date	Time since start of test		Pumping rate (gal/min)	Injection rate (gal/min)	Drawdown (ft)	Buildup (ft)	Specific capacity [(gal/min)/ft]
1	05/11/81	1	hr	1,800	--	45.55	--	39.5
	05/12/81	24	hrs	1,800	--	50.19	--	35.8
	05/14/81	72	hrs	1,800	--	51.27	--	35.1
5	09/14/81	1.25	hrs	--	461	--	13.85	33.3
	09/15/81	24.25	hrs	--	782	--	30.59	25.6
	10/08/81	24	days	--	1,050	--	72.0±	14.6±
7	01/19/82	1	hr	--	1,072	--	67.59	15.9
	01/20/82	24.5	hrs	--	979	--	74.76	13.1
	02/18/82	29.6	days	--	1,027	--	132.49	7.75
	02/24/82	31.7	days	--	987	--	140.07	7.05
8	09/27/82	1	hr	1,045	--	33.0	--	31.7
	09/28/82	22.5	hrs	1,045	--	33.8	--	30.9
12	10/20/82	1	hr	--	823	--	36.5	22.5
	10/21/82	22.5	hrs	--	806	--	44.1	18.3
	02/18/83	116	days	--	808	--	104.7	7.7
--	06/30/83	1	hr	1,040	--	35.55	--	29.2
	07/01/83	24.5	hrs	1,050	--	38.18	--	27.5

Table 14.--Average quality of water reclaimed by the Hueco bolson recharge project

[EPA, U.S. Environmental Protection Agency; TDH, Texas Department of Health; EPWU, El Paso Water Utilities; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, not available; <, less than; NTU, nephelometric turbidity units; mg/L, milligrams per liter; pCi/L, picocuries per liter; mrem/yr, millirems per year; MPN/100 mL, most probable number per 100 milliliters; µg/L, micrograms per liter]

Constituent	Water-quality standards		Quality of Hueco bolson water supply	Anticipated quality of plant influent and effluent 1/		Actual quality of plant effluent				
						EPWU analyses 2/				TDH analyses
	EPA drinking-water standards	TDH drinking-water standards		Influent	Proposed effluent quality	1985	1986	1987	1988	1/8/88
Electrical conductivity (µS/cm)	--	--	510	1,200	1,000	1,026	936	843	870	1,057
pH	--	3/7.0	8.1	7.1	7.5 - 8.0	7.7	7.7	7.7	7.7	8.0
Color (color units)	--	3/15	--	52	<10	--	--	--	--	--
Odor (threshold odor no.)	--	3/3	--	--	1	--	--	--	--	--
Turbidity (NTU)	1	1	.14	97	<.5	.17	.20	.20	.22	--
Dissolved oxygen (mg/L)	--	--	--	--	1.0	--	--	--	--	--
Entrained air	--	--	--	--	none	--	--	--	--	--
Chlorine residual	--	--	--	--	.25 free	<.10	<.10	<.20	<.30	--
Chemical oxygen demand (mg/L)	--	--	--	400	<10	--	25	23	23	--
Total hardness (mg/L)	--	--	102	120	140	134	136	132	142	137
Alkalinity (mg/L)	--	--	129	250	150	160	168	176	187	201
Total dissolved solids (mg/L)	--	3/1,000	391	770	680	592	606	607	575	547
Calcium (mg/L)	--	--	45	35	50	--	--	--	--	4
Magnesium (mg/L)	--	--	10.6	7.9	3.0	--	--	--	--	5.0
Sodium + potassium as Na (mg/L)	--	--	96	192	145	--	--	--	--	149
Sulfate (mg/L)	--	3/300	53.7	125	125	89	89	94	86	85
Chloride (mg/L)	--	300	64.7	122	140	172	192	160	135	122

Table 14.--Quality of water reclaimed by the Hueco bolson recharge project--Continued

Constituent	Water-quality standards		Quality of Hueco bolson water supply	Anticipated quality of plant influent and effluent 1/		Actual quality of plant effluent				
						EPWU analyses 2/				TDH analyses
	EPA drinking-water standards	TDH drinking-water standards		Influent	Proposed effluent quality	1985	1986	1987	1988	1/8/88
Fluoride (mg/L)	1.4 - 2.4	1.4 - 1.8	1.0	<0.9	0.9	0.29	0.78	0.66	0.80	0.80
Silica (mg/L)	--	--	38	38	38	--	22	35	--	--
Nitrate nitrogen, as N (mg/L)	10	10	<2.1	0	1.5	2.2	1.7	2.6	2.4	1.0
Ammonia nitrogen (mg/L)	--	--	--	25	<.1	.41	.18	.13	.18	--
Total nitrogen (mg/L)	--	--	--	36	2	2.6	1.9	2.8	2.5	1.0
Phosphorus as phosphate (mg/L)	--	--	<.5	20	.1	.45	.67	.74	.78	--
Aluminum (mg/L)	--	--	--	.28	<.15	--	--	--	--	--
Arsenic (mg/L)	.05	.05	--	.008	.05	<.05	<.01	<.02	<.02	<.01
Barium (mg/L)	1.0	1.0	--	.46	.1	<1.00	<1.00	<.20	<.02	<.50
Boron (mg/L)	--	--	--	<1.0	<.8	--	--	--	--	--
Cadmium (mg/L)	.01	.01	<.01	<.01	<.01	<.01	<.01	<.01	<.005	<.005
Chromium (mg/L)	.05	.05	<.05	.01	.01	<.05	<.01	<.01	<.01	<.02
Copper (mg/L)	--	3/1.0	<.1	<.05	<.05	<1.00	<.50	<1.00	<.01	<.02
Iron (mg/L)	--	3/.3	<.1	<.31	.05	<.30	<.30	<.30	<.30	<.02
Lead (mg/L)	.05	.05	.05	<.05	<.05	<.05	<.05	<.01	<.01	<.02
Manganese (mg/L)	--	3/.05	.01	<.05	<.05	<.05	<.05	<.05	<.05	<.02
Mercury (mg/L)	.002	.002	--	.002	.0014	<.002	<.002	<.002	<.002	<.0002
Selenium (mg/L)	.01	.01	--	<.0035	.01	<.010	<.005	<.010	<.010	<.003
Silver (mg/L)	.05	.05	--	<.01	<.01	<.05	<.05	<.05	<.001	<.01
Zinc (mg/L)	--	3/5.0	.1	<.1	<.1	<3.0	<.50	<.20	<.20	<.02
Gross alpha particle activity (excluding radon and uranium) (pCi/L)	15	15	--	--	<15	--	--	--	--	<2.0

Table 14.--Quality of water reclaimed by the Hueco bolson recharge project--Continued

Constituent	Water-quality standards		Quality of Hueco bolson water supply	Anticipated quality of plant influent and effluent 1/		Actual quality of plant effluent				
						EPWU analyses 2/				TDH analyses
	EPA drinking-water standards	TDH drinking-water standards		Influent	Proposed effluent quality	1985	1986	1987	1988	1/8/88
Average annual dose equivalent for beta particle and photon radio-activity from man-made radio-nuclides (mrem/yr)	4	4	--	--	<4	--	--	--	--	--
Combined radium 226 and 228 (pCi/L)	5	5	--	--	<5	--	--	--	--	--
Total organic carbon (mg/L)	--	--	--	--	<2	0.78	0.84	0.91	0.92	--
Endrin (mg/L)	.0002	.0002	--	--	<.0002	<.0002	<.0002	<.0002	<.00001	--
Lindane (mg/L)	.004	.004	--	--	<.004	<.004	<.004	<.0004	<.00001	<0.00003
Methoxychlor (mg/L)	.1	.1	--	--	<.1	<.10	<.10	<.001	<.0005	<.0005
Toxaphene (mg/L)	.005	.005	--	--	<.005	<.005	<.005	<.005	<.0005	<.005
Chlorophenoxys:										
2,4-D (mg/L)	.1	.1	--	--	<.1	<.10	<.10	<.01	<.0005	.020
2,4,5-TP Silvex (mg/L)	.01	.01	--	--	<.01	<.01	<.01	<.005	<.0001	.005
Escherichia coli (bacteria) (MPN/100 mL)	1	1	--	--	0	.00	.00	.00	.00	--
Virus	--	--	--	--	0	--	.0	.0	--	--
Total suspended solids (mg/L)	--	--	--	150	<1.0	--	--	--	--	--
Cyanide (mg/L)	--	--	--	--	.02	--	--	--	.006	--
Corrosivity	--	noncorrosive 3/	--	--	noncorrosive	--	--	--	--	--
Foaming Agents (ABS) (mg/L)	--	3/.5	--	3.5	.2	--	--	--	--	--
Hydrogen Sulfide (mg/L)	--	3/.05	--	1.0	.01	--	--	--	--	--

Table 14.--Quality of water reclaimed by the Hueco bolson recharge project--Continued

Constituent	Water-quality standards		Quality of Hueco bolson water supply	Anticipated quality of plant influent and effluent 1/		Actual quality of plant effluent				
						EPWU analyses 2/				TDH analyses
	EPA drinking-water standards	TDH drinking-water standards		Influent	Proposed effluent quality	1985	1986	1987	1988	1/8/88
Phenol	--	--	0.001	0.004	0.001	--	--	--	--	--
Total Trihalomethanes (mg/L)	4/0.10	--	--	--	<.10	--	--	--	--	0.01
Volatile halogenated compounds 5/ (µg/L)	4/.5	--	--	--	<.5	--	--	--	--	--

1/ From Knorr and Cliatt (1985, table 14.1).

2/ Unpublished data from John E. Ballew, EPWU, July 12, 1988. The values for individual constituents are the average of 75 or more analyses each year by the EPWU lab. The 1988 EPWU analyses are for samples collected through June.

3/ Secondary standard.

4/ Proposed standard.

5/ Each compound.

Table 15.--Monthly water-level measurements in well PIOW, May 1981 to December 1989

[ft, feet; bls, below land surface]

Elevation of land surface, 3,990 ft

Date measured	Depth to water (ft, bls)	Date measured	Depth to water (ft, bls)	Date measured	Depth to water (ft, bls)
1981		1983--Continued		1986--Continued	
05-08	341.00	11-21	342.04	06-18	340.80
05-18	340.34	12-13	342.05	07-21	341.05
08-10	340.51			08-24	343.74
08-20	339.31	1984		09-22	342.28
09-14	339.20	01-20	339.95	10-20	341.56
		02-20	340.14		
09-21	333.66	03-20	343.12	11-28	342.98
10-21	339.09	04-20	344.11	12-24	341.97
11-19	338.65	05-21	345.48		
12-03	338.04			1987	
12-19	336.33	06-20	346.30	01-20	339.82
		07-17	348.05	02-23	340.90
1982		08-20	343.36	03-27	339.46
01-18	335.75	09-17	345.23	04-20	338.35
02-20	336.31	10-19	343.93	05-21	342.04
03-22	339.72				
04-21	342.30	11-21	345.04	06-19	341.34
05-21	342.25	12-19	343.73	07-21	343.30
				08-22	346.72
06-21	342.95	1985		09-16	343.31
07-21	343.13	01-29	345.05	10-10	341.62
08-	--	02-25	345.38		
09-26	342.91	03-18	344.11	11-22	343.66
10-19	341.03	04-19	345.00	12-21	343.50
		05-20	346.35		
11-21	334.04			1988	
12-21	333.37	06-17	347.38	01-21	342.30
		07-	--	03-08	343.26
1983		08-20	346.24	03-21	343.75
01-21	338.83	09-20	344.11	04-21	341.86
02-19	339.02	10-24	343.34	05-20	345.07
03-21	340.37				
04-20	341.22	11-21	342.10	06-20	345.44
05-21	343.81	12-17	340.03	07-21	347.20
				08-19	339.94
06-27	344.65	1986		09-10	345.83
07-24	347.66	01-21	336.58	10-09	343.95
08-19	345.13	02-21	338.87		
09-20	345.90	03-18	339.24	11-18	342.80
10-21	343.00	04-28	341.80	12-07	345.21
		05-20	341.21		

Table 15.--Monthly water-level measurements in well PIOW, May 1981 to December 1989--Continued

Date measured	Depth to water (ft, bls)	Date measured	Depth to water (ft, bls)	Date measured	Depth to water (ft, bls)
1989		1989--Continued		1989--Continued	
01-20	346.38	06-22	346.59	11-20	344.48
02-21	345.95	07-20	344.45	12-14	340.94
03-17	340.47	08-21	342.34		
04-19	341.76	09-19	341.64		
05-21	341.16	10-19	1/349.48		

1/ Well was recently jetted for water sampling.