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ENGINEERING DESIGN FILE

Project/Task

Subtask

TITLE: Large-Scale Aquifer Stress Test and Infiltration Test: Water Management System Operation and Results

SUMMARY:

Two experiments were conducted at the Idaho National Engineering Laboratory to characterize the subsurface near the Radioactive Waste Management Complex: the Large Scale Aquifer Test (LSAT) and the Large Scale Infiltration Test (LSIT). The LSAT was an aquifer pumping test and the LSIT was a vadose zone infiltration and tracer test. Part of the water produced during the LSAT was discharged into the LSIT infiltration basin, spiked with tracers, and allowed to infiltrate. The remainder of the water produced was discharged to Spreading Area A. The water management system included a pipeline that conveyed water from the production well to both the infiltration basin and Spreading Area A, and flow meters for monitoring the quantity of water discharged through the pipeline. The aquifer production well was pumped at an average rate of 2,837 gallons per minute (gpm) for 35.5 days. Of the 148.3 million gallons produced, 109.7 million gallons were discharged to Spreading Area A, 38.5 million gallons were discharged to the infiltration basin, and 0.1 million gallons were required to fill the pipeline. A volume balance was calculated for the infiltration basin that included precipitation, evaporation, and infiltration. Of the 38.5 million gallons discharged into the basin and 0.1 million gallons added by precipitation, calculated estimates are that 4.9 million gallons evaporated, 33.3 million gallons infiltrated, and 1.8 million gallons remained in the basin at the end of the experiment. The error of 1.4 million gallons is 3.6% of the volume of water discharged into the basin. Infiltration rates varied from 297 gpm to 657 gpm, and averaged 528 gpm for the entire test. Infiltration fluxes varied from 1.42×10^{-3} gpm/ft^2 to 2.35×10^{-3} gpm/ft^2, and averaged 1.99×10^{-3} gpm/ft^2.

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Large-Scale Aquifer Stress Test and Infiltration Test: Water Management System Operation and Results

1. INTRODUCTION

This Engineering Design File (EDF) describes the operation of and data collection from the Water Management System of the Large-Scale Aquifer Stress Test/Large-Scale Infiltration Test. It includes water budgets for the production well and the infiltration basin, and estimates of infiltration rates.

The Large-Scale Aquifer Test (LSAT) and the Large-Scale Infiltration Test (LSIT) were complementary field experiments conducted during the summer of 1994 by the Applied Geosciences Unit and the Environmental Restoration Department of the Idaho National Engineering Laboratory (INEL). Overviews of the experiments are given in Norrell et al. (1994) and Wylie et al. (1994). The purpose of these two experiments was to develop data that could be used for evaluating conceptual models used for simulating subsurface flow and transport at the Radioactive Waste Management Complex (RWMC) at the INEL, and to measure parameter values needed for subsurface flow and transport modelling.

The LSAT was a high-capacity (3,000 gpm) long-term (36-day) aquifer pumping test. It was conducted to determine hydraulic properties of the eastern Snake River Plain Aquifer in the vicinity of the RWMC. Results are reported by Wylie et al. (1995). The LSAT field site is approximately 0.8 mi south-southwest from the RWMC. Part of the water produced in this experiment was used to conduct a vadose zone tracer test referred to as the Large-Scale Infiltration Test. The LSIT field site is approximately 1.3 mi south-southeast of the RWMC. Figure 1 shows the locations of the facilities discussed in this document.

The LSIT was conducted to measure vadose zone hydraulic and solute transport properties. Water from the LSAT production well was ponded at the ground surface in a 600-ft-diameter basin formed by a circular embankment. Part of the water added to the infiltration basin was spiked with conservative and reactive dissolved tracers. Changes in water content in the subsurface and the movement of tracers were monitored. The results are reported in Burgess (1995), Dunnivant et al. (1994), Newman et al. (1995), Pfeifer et al. (1995), and Porro et al. (1995). Water in excess of that needed for the LSIT was discharged in Spreading Area A, which is approximately 1 mi west of the RWMC.

The LSAT and the LSIT were linked by the Water Management System, which conveyed water from the production well pumped during the LSAT to both the infiltration basin and to Spreading Area A. The Water Management System is described in Starr and Mecham (1994). Records of volumes of water discharged through different portions of the water management system were used for interpreting the LSAT and LSIT test results. In particular, the flowrate of water from the production well was used for interpreting the pumping test results and the volume of water discharged into the infiltration basin was used in volume balance calculations for the infiltration experiment.

The purpose of this EDF is to document the discharge of water from the production well into the infiltration basin and into the spreading area. Additionally, this EDF contains estimates of the rate of infiltration that occurred within the infiltration basin. This information will be used in conjunction with other data to calculate parameter values needed for RWMC flow and transport simulations.

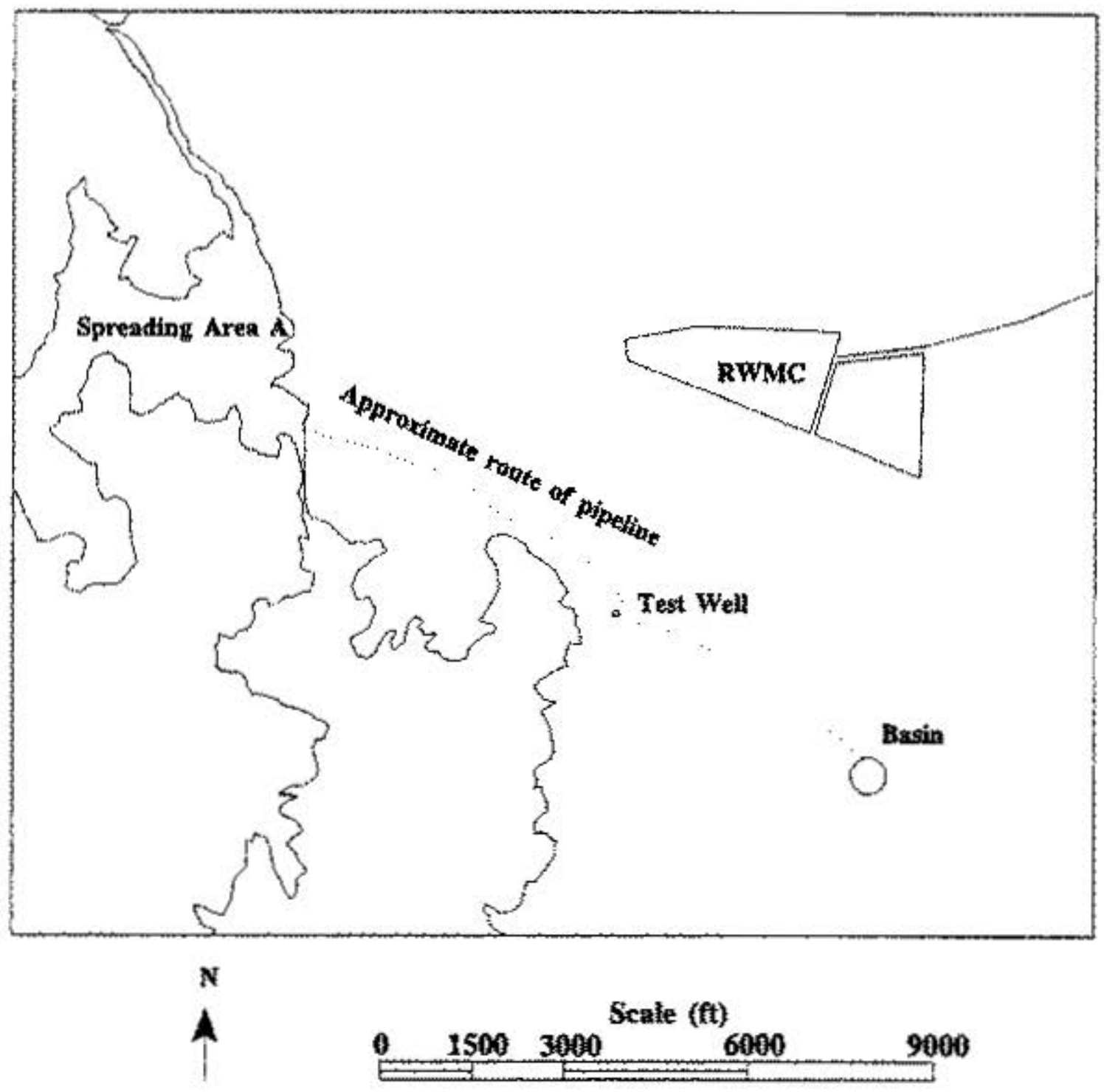

Figure 1. Location of facilities involved with the LSAT and LSIT.

2. WATER MANAGEMENT SYSTEM

2.1 Description

The water management system is illustrated in Figure 2. It includes a pipeline that extends from the production well to the infiltration basin, and a second leg that extends from the production well to Spreading Area A. The pipeline is constructed primarily of nominal 16-in. diameter polyethylene pipe, with nominal 16-in., 10-gauge steel pipe from the production well to immediately downstream of Tee 1, as well as downstream of Check Valve 2. Valves BF-1, BF-2, and BF-3 allow the discharge of water through different legs of the pipeline to be controlled. Pressure gauges P1 through P5 allow the pressure in different portions of the system to be monitored. Sample ports allow water samples to be collected from the system. Air vents and drains allow the system to be drained after use. Tracers were injected into the pipeline through tracer injector/mixers.

Flow Meters T-1, T-2, and T-3 allow the instantaneous flowrate and the cumulative discharge through the system to be monitored. T-1 monitors flow from the production well, while T-2 and T-3 monitor flow into the infiltration basin.

The flow meters are AQUAMASTER brand Model 400R units, and were installed in accordance with the manufacturer's specifications. A copy of the installation manual and programming guide is included in Appendix A. Each meter consists of a sensor in the pipeline and a display unit. The display units were programmed to display instantaneous flowrate in 1×10^2 gpm and cumulative discharge in 1×10^4 gal. Flowrate is indicated by a liquid crystal display, while cumulative discharge is indicated by an electromechanical display. Both are driven by an internal computer, and failure of either indicator does not compromise the operation of the other. This is important because the cumulative flow indicator in Flow Meter 1 appears to have stuck periodically; therefore, cumulative flow was estimated by integrating the instantaneous flowrate data. The minimum flowrate that the meters could reliably indicate was approximately 600 gpm. Flow data were manually recorded.

The Water Management System Test Plan specified that system parameters be recorded four times per day. Readings were usually read approximately every 6 hours and whenever the discharge of water into the infiltration basin was changed by adjusting valve settings. In some instances, operating parameters were recorded less frequently due to personnel limitations. These instances do not affect the infiltration calculations because the readings required for the calculations were collected when the valves were adjusted to change the flowrate into the basin.

The water level (stage) in the infiltration basin was recorded by manual observations of a staff gauge in the basin, and by an In-Situ brand Hermit 1000C model data logger that recorded data from a 5-psig pressure transducer. Approximately 7,000 measurements of basin stage were made by the pressure transducer-data logger system.

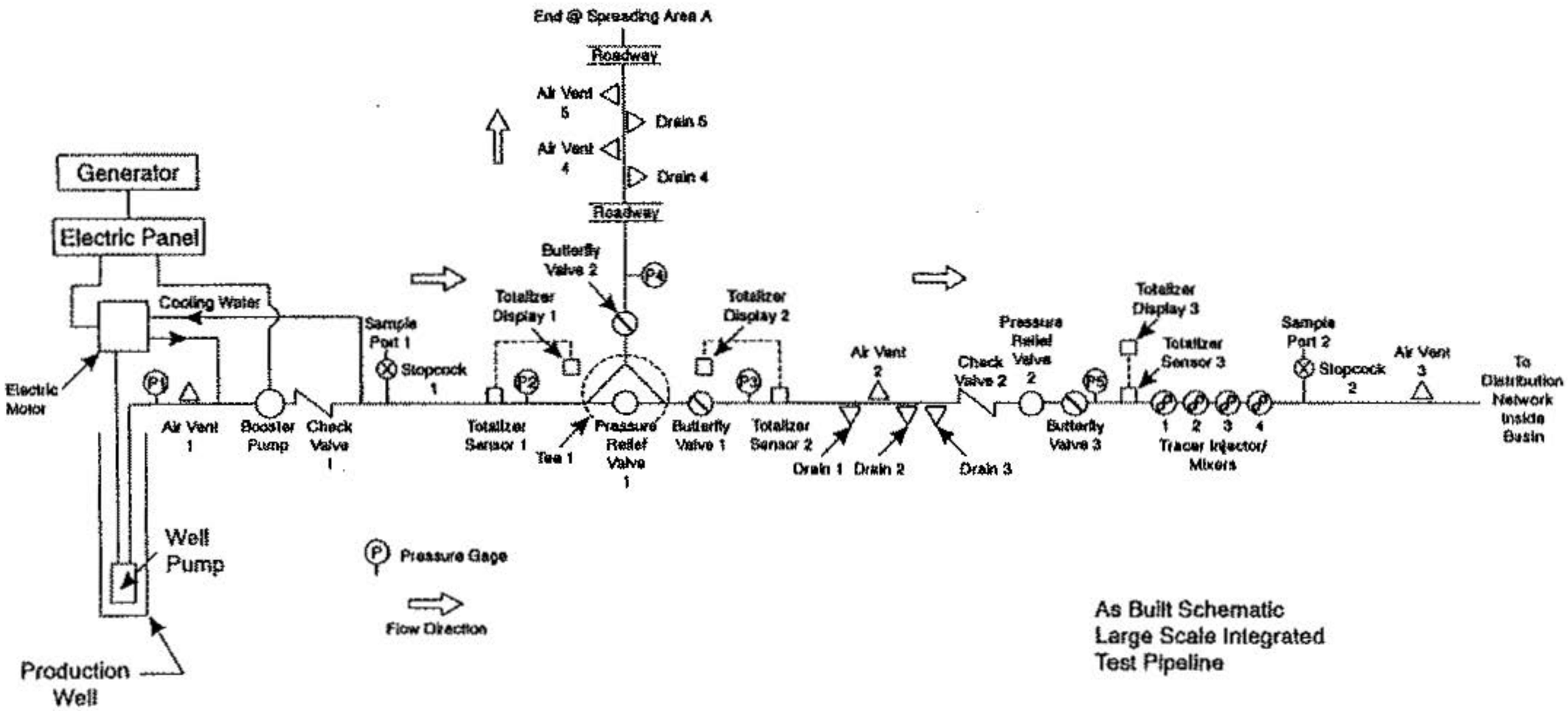

Figure 2. Water distribution system schematic.

2.2 Water Management System Operation

The water management system was operated as described in the *Water Management System Test Plan*, Revision 0 (Starr and Mecham 1994). Deviations from the procedures described in the test plan include the following: (1) in some instances, the system operation data were collected less frequently than the four-times-per-day frequency specified, and (2) the basin water level was not maintained at a constant elevation as specified in the test plan, but was varied by alternately filling the basin and allowing it to partially drain. Deviation 1 did not adversely affect the interpretation of the experimental results. Deviation 2 was necessary to collect the required data at the infiltration rates that occurred in the experiment. The original operating plan was to fill the infiltration basin by diverting all water from the production well into it, and then to reduce the inflow rate to maintain a constant water level in the basin. The infiltration rate would be calculated from the discharge rate of water necessary to maintain a constant water level. This approach was attempted between July 28 and 29, but was found to be unsuccessful. The inflow rate necessary to maintain a constant water level was below the flowrate that could be accurately measured by the flow meters in the size of pipe used. A cyclic operating program was adopted instead, in which all water from the production well was discharged to the basin without diversion to the Spreading Area, to raise the water level to approximately 4.2 ft. When the basin level of 4.2 ft was reached, all pumped water was then diverted to Spreading Area A, and the water level in the infiltration basin was allowed to fall to approximately 3.9 ft. When the water level fell to 3.9 ft, the cycle was repeated. This cycle of filling and draining was continued on a daily basis for most of the duration of the experiment. Infiltration rates were determined from the rate of water level decline while no water was being discharged into the basin, i.e., from the falling limbs of the basin hydrograph.

The hydrograph of water level in the infiltration basin is shown in Figure 3. It includes approximately 7,000 measurements of basin stage made by the pressure transducer—data logger system, and 14 manual observations that cover the periods in which the water level in the basin was below the height of the pressure transducer. Two exceptions to the daily cyclic pattern can be seen on the hydrograph. First, the basin was drained after the tracers were added on July 31, 1994. This was done so that the tracer concentration would be approximately constant and a pulse tracer input would be accomplished, as opposed to a decaying tracer concentration that would result if the water level had been maintained with the resulting dilution of tracer. The second exception occurred after the pump in the production well was shut off on August 31, 1994, after which the basin water level declined.

The basin stage shown on Figure 3 is referenced to the staff gauge in the infiltration basin. The zero point on the staff gauge is 1.34 ft above the lowest point in the basin, which was used as the elevation datum for the calculations described in Appendix D.

Water management system operating parameters were recorded periodically in the field logbook and transcribed into a tabular form (Appendix B). To briefly summarize, water pumped from the production well was discharged to either the infiltration basin or to Spreading Area A, depending on the requirements of the infiltration experiment. Typically, either all water was discharged into the infiltration basin by opening BF-1 and closing BF-2, or all water was discharged into Spreading Area A by opening valve BF-2 and closing BF-1 and/or BF-3.

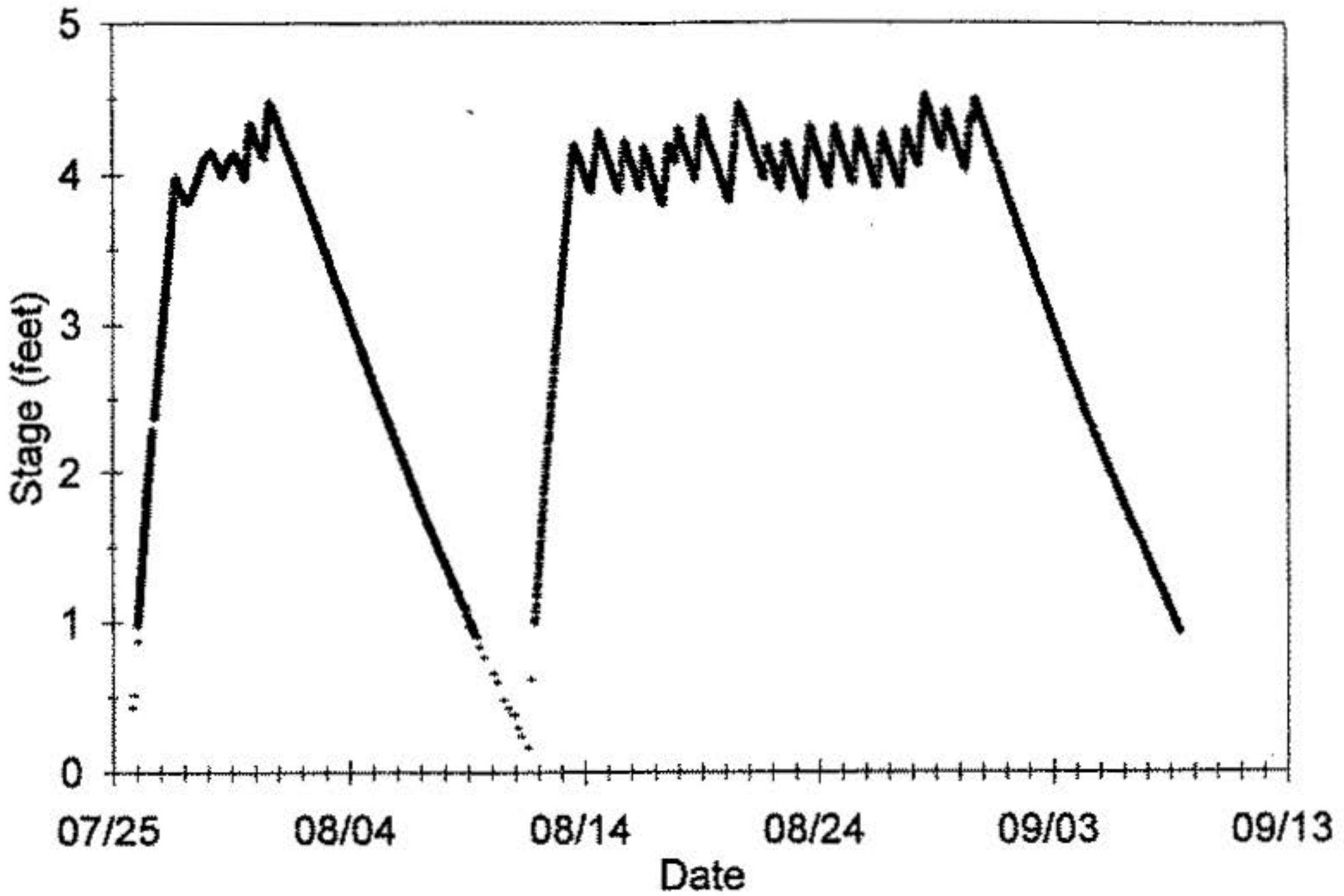

Figure 3. Infiltration basin hydrograph.

Three occurrences recorded in the field notes warrant elaboration. First, the totalizer in Flow Meter 2 failed and did not advance after July 28, 1994, although the instantaneous flowrate indicator appeared to function correctly. The display unit of Flow Meter 2 was removed on August 8, 1994 and replaced on August 16, 1994. The failure of Flow Meter 2 does not compromise the test because Flow Meter 3 worked properly and measured the discharge through the same leg of the pipeline, with Flow Meter 2 at the upstream of the pipeline and Flow Meter 3 at the downstream end. Second, the sensor of Flow Meter 3 was installed after discharging 100,000 gal (measured with Flow Meter 1) into the pipeline to flush out debris that entered the pipeline during construction. Of this 100,000 gal, 60,000 gal were required to fill the pipeline and the remaining 40,000 gal were discharged into the basin. Therefore, the cumulative volume of water discharged into the infiltration basin is 40,000 gal greater than the volume calculated from Flow Meter 3 data. Third, although it was intended that the production well be pumped continuously, electrical problems caused the pump to stop twice, from 0602 hours to 1502 hours on August 6, 1994, and from 0947 hours to 1847 hours on August 9, 1994. These shutdowns did not affect the LSIT because they occurred while the basin was being drained after tracer addition.

3. DISCHARGE CALCULATIONS

This section outlines the methods used for calculating the discharge from the production well, the discharge into the infiltration basin, and the discharge into Spreading Area A.

3.1 Discharge from the Production Well

The discharge from the production well was calculated using data from Flow Meters 1 and 3. Figure 4 shows the observed values of instantaneous flowrate and cumulative discharge measured by Flow Meter 1. The two data sets are inconsistent in that the measured cumulative volume pumped (124,920,000 gal) is substantially lower than the cumulative volume estimated by integrating the instantaneous flowrate values. To estimate the volume pumped from the instantaneous flowrate data, the average flowrate was assumed to be 3,000 gpm. The product of 3,000 gpm and a pumping time of 35.5375 days (duration of the pumping test minus the pump down-time) yields a pumped volume of 153,522,000 gal. The measured value is 81% of this estimated value, which suggests that either the cumulative volume or the instantaneous flowrate data is incorrect. The instantaneous flowrate data are thought to be correct and the cumulative discharge data incorrect based on three lines of evidence. First, the instantaneous flowrate readings from Flow Meters 1, 2, and 3 are consistent, and both the instantaneous flowrate data and the cumulative discharge volume from Flow Meter 3 are consistent. Second, the cumulative flow indicator of Flow Meter 2 failed to advance although the flowrate indicator appeared to function properly, which is the same failure mode hypothesized for Flow Meter 1, except that Meter 1 appeared to experience an intermittent failure. Third, cumulative flow data from Flow Meter 1 during August 17–19, 1994, clearly show alternating periods in which the cumulative volume display increased and failed to increase, even though the discharge through the pipeline during this interval is thought to have been constant (Figure 5).

Since the instantaneous flowrate data are though to be correct, the cumulative discharge through Flow Meter 1 was determined by integrating the instantaneous flowrate readings. Unfortunately, the instantaneous flowrate indicator failed on August 25, 1994. After this failure, flowrate data from Flow Meter 3 were used to calculate the cumulative discharge through Flow Meter 1. This approach is valid because the discharge through the pipeline at Flow Meter 1 was the same as that at Flow Meter 3 while all water was being discharged into the infiltration basin. Data from Flow Meter 3 were used as a surrogate for data from Flow Meter 1 only while all water was being discharged into the basin, but not while water was being discharged into Spreading Area A. The data from Flow Meter 3 were modified to compensate for differences in calibration between the two flow meters. Based on a comparison of flowrates indicated by Flow Meters 1 and 3 while all water was being discharged into the infiltration basin, the flowrate indicated by Flow Meter 3 averaged 1.06 times the flowrate indicated by Flow Meter 1. Therefore, flowrates at Flow Meter 1 after it failed were estimated as the flowrate indicated by Flow Meter 3 while all water was discharging into the infiltration basin, divided by 1.06.

The cumulative discharge through Flow Meter 1 was calculated as the product of the time-weighted average flowrate from the start of the pumping test and elapsed time from the start of the pumping test. The time-weighted average flowrate was calculated to assist in the pumping test interpretation. Figure 6 and Table 1 show the observed instantaneous flowrates, the time-

weighted average flowrate, and the calculated cumulative discharge. The total volume of water pumped from the production well based on this data set is 148.3 million gal.

3.2 Discharge to the Infiltration Basin

The instantaneous and cumulative discharge to the infiltration basin, measured with Flow Meter 3, are presented in Figure 7 and Table 2. The total volume of water discharged to the infiltration basin is 38.5 million gal, including the 40,000 gal discharged before Flow Meter 3 was installed. Flow Meter 3 did not fail during the experiment, and therefore the data are thought to be valid.

3.3 Discharge to Spreading Area A

The total volume of water discharged into Spreading Area A is the difference between the volume pumped from the production well (148.3 million gal) and the sum of the volumes needed to fill the pipeline to the infiltration basin (0.1 million gal) and the volume discharged into the infiltration basin (38.5 million gal), namely 109.7 million gal. The 0.1 million gal needed to fill the pipeline between the production well and Spreading Area A were assumed to have been discharged to Spreading Area A.

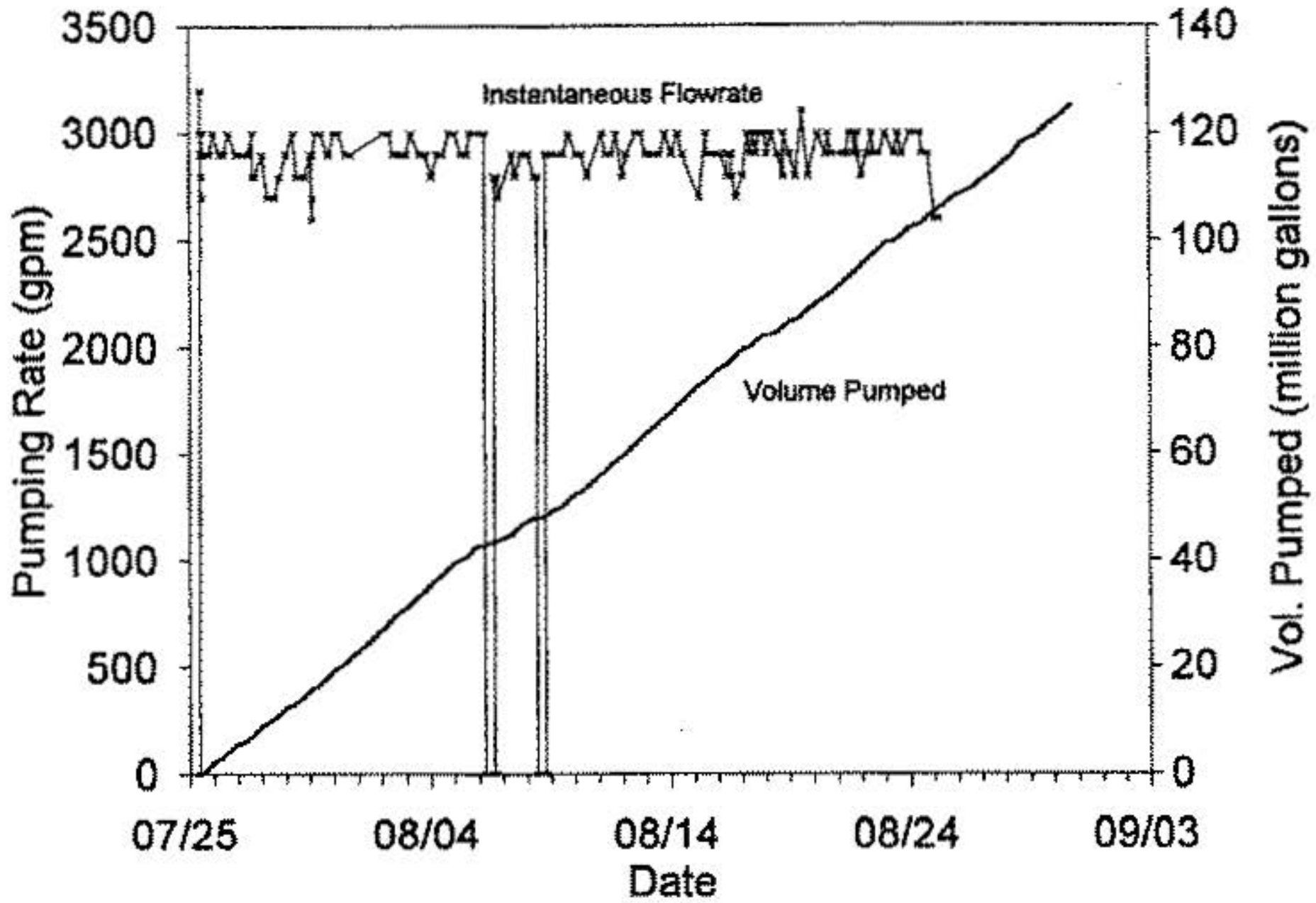

Figure 4. Flowrate and discharge volume measured with Flow Meter 1.

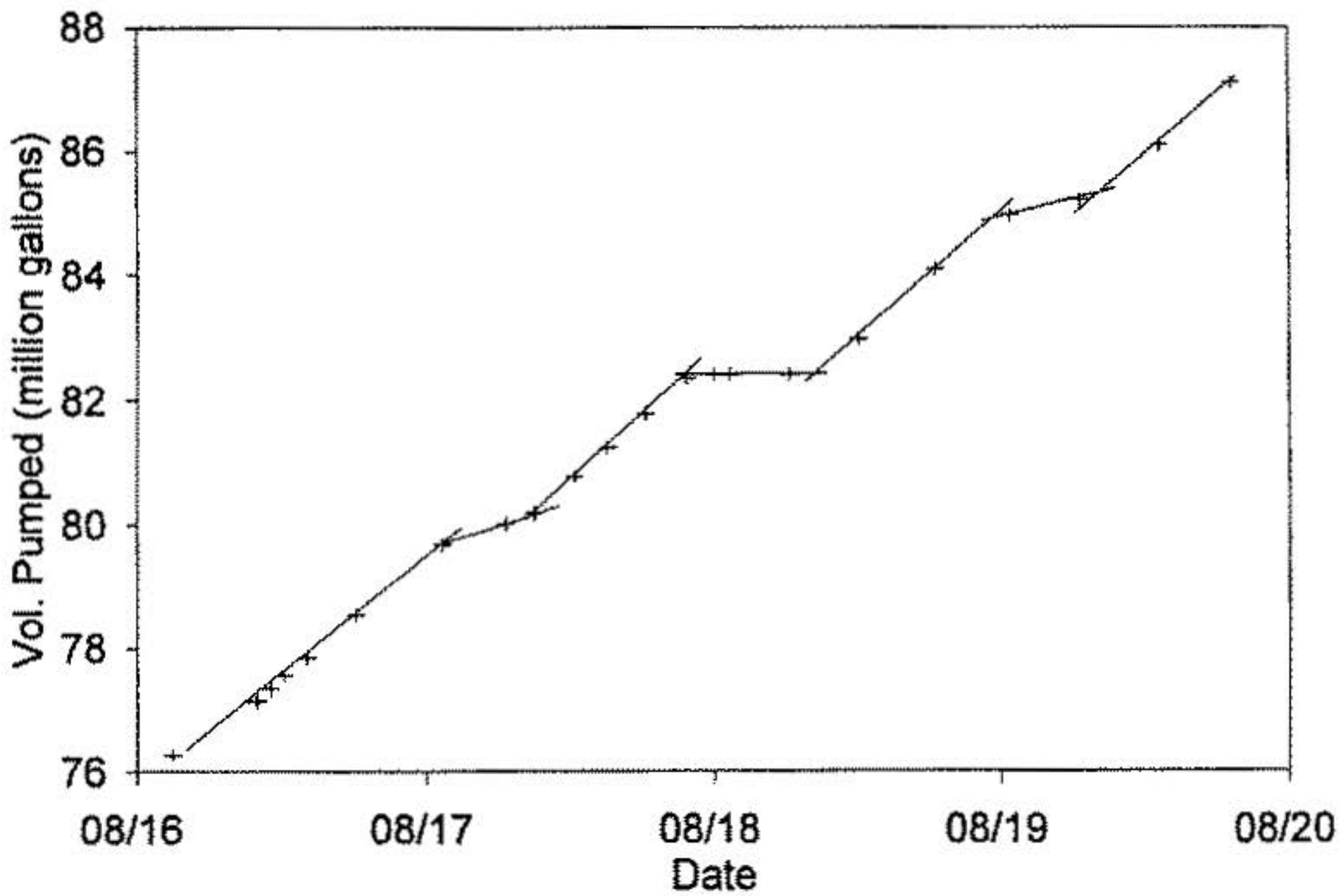

Figure 5. Cumulative discharge measured with Flow Meter 1, August 17–19, 1994.

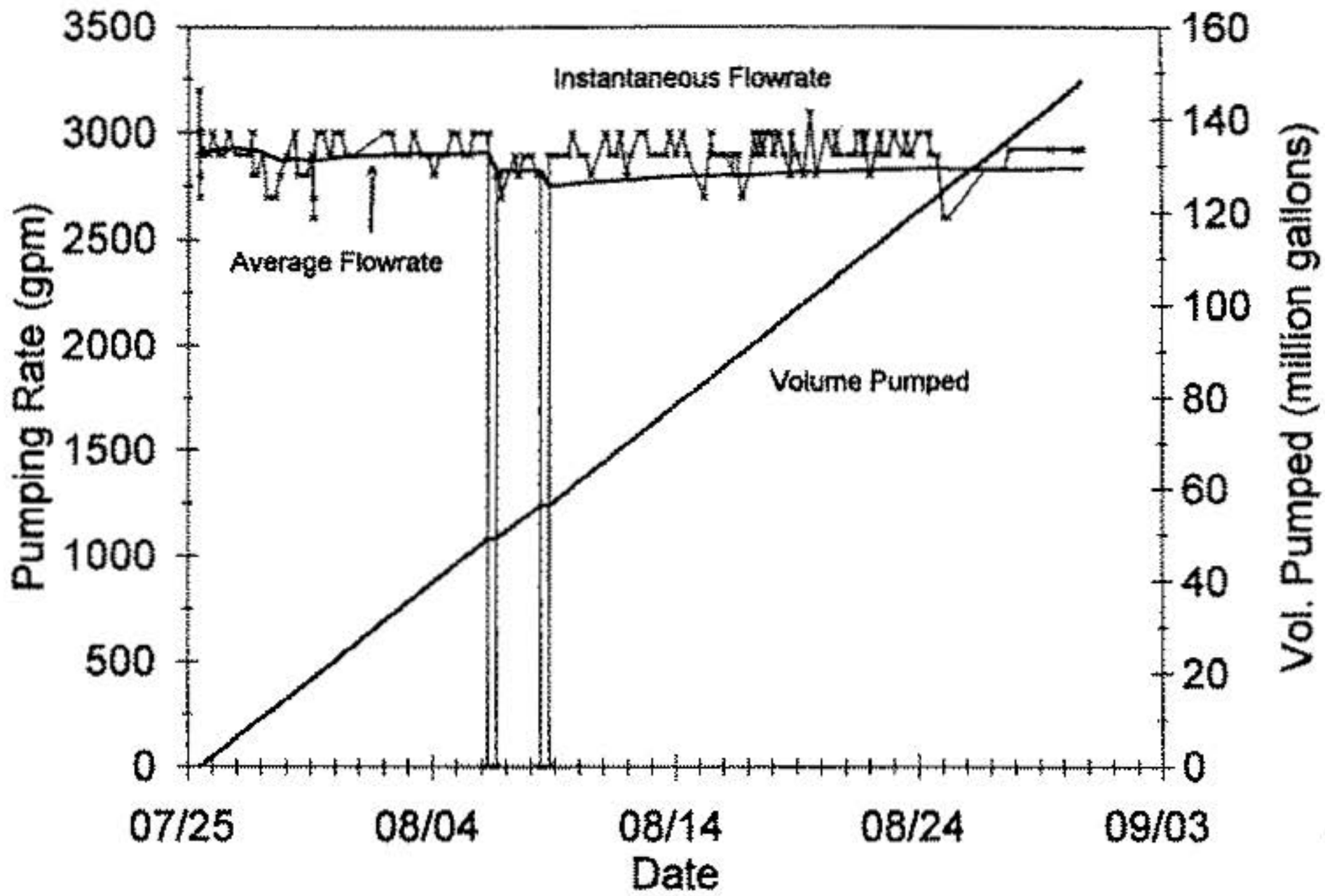

Figure 6. Flowrate and discharge volume from the test well.

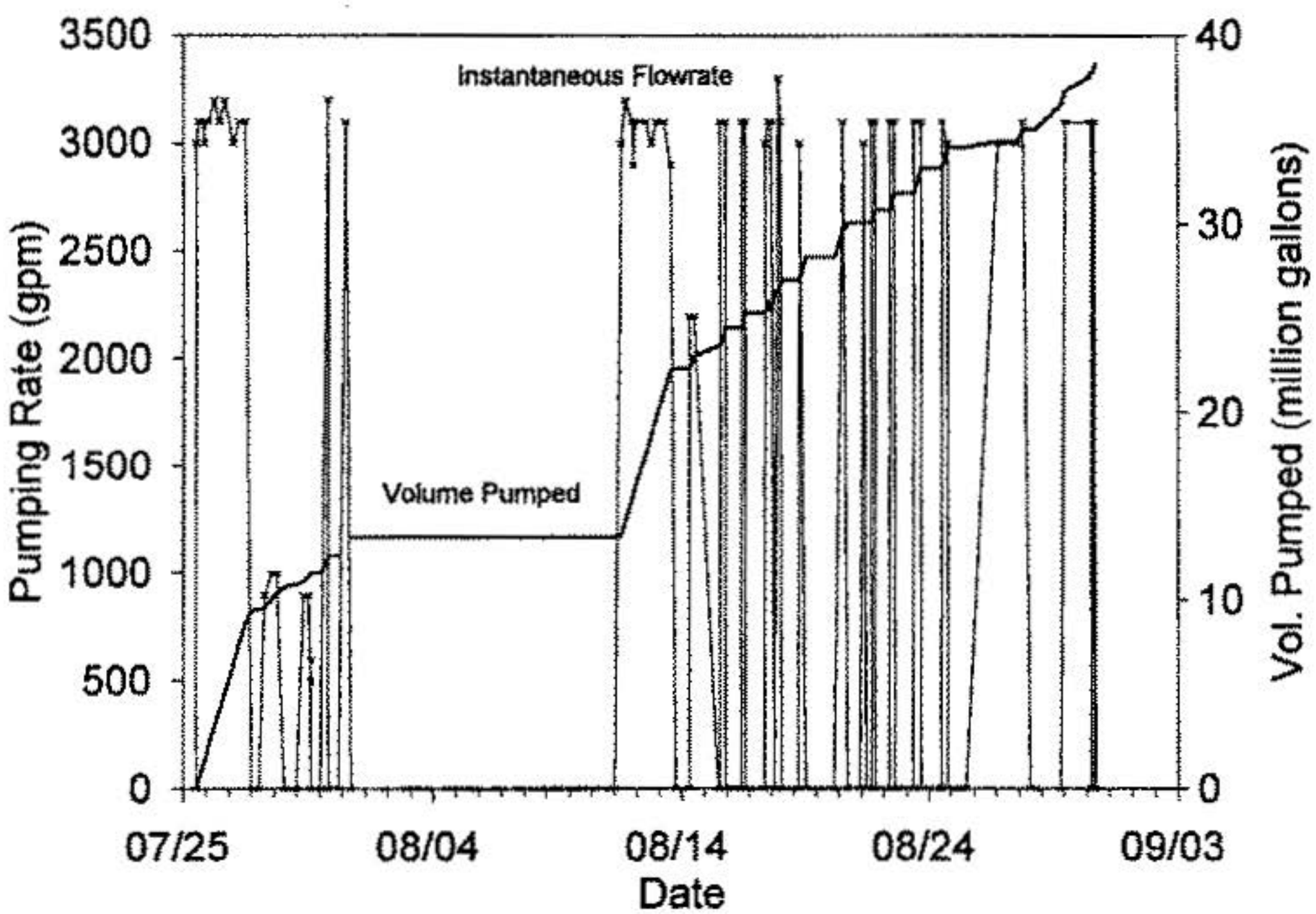

Figure 7. Flowrate and discharge volume into the infiltration basin.

Table 1. Flowrate and discharge volume from the production well (Flow Meter 1).

Date (m/d/y)	Time (h:m)	Serial time (days)	Elapsed time (days)	Observed flowrate (gpm)	Time-weighted average flowrate (gpm)	Calculated cumulative volume pumped (gal)	Calculated cumulative volume pumped (M gal)
07/25/94	11:21	34540.4729	0.0000	3200	3200	0	0.000
07/25/94	11:25	34540.4757	0.0028	3000	3100	12400	0.012
07/25/94	11:26	34540.4764	0.0035	2900	3070	15350	0.015
07/25/94	11:27	34540.4771	0.0042	3000	3050	18300	0.018
07/25/94	11:32	34540.4806	0.0076	2900	3004.55	33050	0.033
07/25/94	11:35	34540.4826	0.0097	2900	2982.99	41762	0.042
07/25/94	11:39	34540.4854	0.0125	2900	2964.4	53359	0.053
07/25/94	11:50	34540.4931	0.0201	3000	2958.91	85808	0.086
07/25/94	12:03	34540.5021	0.0292	2800	2940.75	123512	0.124
07/25/94	12:10	34540.5069	0.0340	2700	2913.82	142777	0.143
07/25/94	12:14	34540.5097	0.0368	3000	2908.97	154175	0.154
07/25/94	12:39	34540.5271	0.0542	2900	2922.14	227927	0.228
07/25/94	12:50	34540.5347	0.0618	3000	2925.57	260376	0.260
07/25/94	12:54	34540.5375	0.0646	3000	2928.79	272377	0.272
07/25/94	13:57	34540.5813	0.1083	2900	2937.36	458228	0.458
07/25/94	14:22	34540.5986	0.1257	2900	2932.22	530732	0.531
07/25/94	14:47	34540.6160	0.1431	2900	2928.3	603230	0.603
07/25/94	20:22	34540.8486	0.3757	2900	2910.78	1574732	1.575
07/26/94	00:13	34541.0090	0.5361	3000	2922.51	2256178	2.256
07/26/94	06:09	34541.2563	0.7833	2900	2931.19	3306382	3.306
07/26/94	10:51	34541.4521	0.9792	2900	2924.95	4124179	4.124
07/26/94	15:39	34541.6521	1.1792	3000	2929.2	4973782	4.974
07/26/94	23:41	34541.9868	1.5139	2900	2933.8	6395684	6.396
07/27/94	06:28	34542.2694	1.7965	2900	2928.48	7575978	7.576
07/27/94	11:24	34542.4750	2.0021	2900	2925.56	8434389	8.434
07/27/94	15:45	34542.6563	2.1833	3000	2927.59	9204343	9.204
07/27/94	15:46	34542.6569	2.1840	2800	2927.58	9207239	9.207
07/27/94	18:04	34542.7528	2.2799	2800	2922.21	9593615	9.594
07/28/94	01:08	34543.0472	2.5743	2900	2913.96	10802050	10.802
07/28/94	06:00	34543.2500	2.7771	2700	2905.63	11619614	11.620
07/28/94	13:30	34543.5625	3.0896	2700	2884.83	12834609	12.835
07/28/94	18:10	34543.7569	3.2840	2800	2876.85	13604624	13.605
07/29/94	00:25	34544.0174	3.5444	2900	2874.88	14673388	14.673
07/29/94	08:00	34544.3333	3.8604	3000	2881.03	16015646	16.016
07/29/94	12:00	34544.5000	4.0271	2800	2881.81	16711616	16.712
07/29/94	19:52	34544.8278	4.3549	2800	2875.65	18033201	18.033
07/30/94	01:01	34545.0424	4.5694	2900	2874.45	18913881	18.914
07/30/94	02:52	34545.1194	4.6465	2600	2872.39	19219161	19.219
07/30/94	02:54	34545.1208	4.6479	2700	2872.32	19224438	19.224
07/30/94	03:12	34545.1333	4.6604	2900	2872.13	19274864	19.275
07/30/94	06:30	34545.2708	4.7979	3000	2874.36	19858953	19.859
07/30/94	12:11	34545.5076	5.0347	3000	2880.27	20881958	20.882
07/30/94	18:40	34545.7778	5.3049	2900	2883.82	22029501	22.030
07/30/94	19:28	34545.8111	5.3382	2900	2883.92	22168693	22.169
07/30/94	19:40	34545.8194	5.3465	2900	2883.95	22203531	22.204
07/31/94	00:05	34546.0035	5.5306	3000	2886.14	22985219	22.985
07/31/94	05:41	34546.2368	5.7639	3000	2890.75	23993225	23.993
07/31/94	12:17	34546.5118	6.0389	2900	2893.45	25161441	25.161
07/31/94	17:19	34546.7215	6.2486	2900	2893.67	26037243	26.037
08/02/94	01:25	34548.0590	7.5861	3000	2903.6	31718926	31.719
08/02/94	07:54	34548.3292	7.8563	3000	2906.92	32885986	32.886
08/02/94	12:20	34548.5139	8.0410	2900	2907.91	33670690	33.671
08/02/94	21:00	34548.8750	8.4021	2900	2907.57	35178689	35.179
08/03/94	00:11	34549.0076	8.5347	2900	2907.45	35732561	35.733
08/03/94	05:00	34549.2083	8.7354	3000	2908.43	36585141	36.585
08/03/94	13:58	34549.5819	9.1090	2900	2910.13	38172175	38.172
08/03/94	19:17	34549.8035	9.3306	2900	2909.89	39097282	39.097
08/04/94	01:30	34550.0625	9.5896	2800	2908.27	40160300	40.160
08/04/94	07:00	34550.2917	9.8187	2900	2906.91	41100800	41.101
08/04/94	12:35	34550.5243	10.0514	2900	2906.75	42072300	42.072
08/04/94	19:24	34550.8083	10.3354	3000	2907.94	43278871	43.279
08/05/94	00:20	34551.0139	10.5410	3000	2909.74	44166943	44.167
08/05/94	06:40	34551.2778	10.8049	2900	2910.72	45287892	45.288
08/05/94	11:44	34551.4889	11.0160	2900	2910.52	46169579	46.170

Table 1. (continued)

Date (m/d/y)	Time (h:m)	Serial time (days)	Elapsed time (days)	Observed flowrate (gpm)	Time-weighted average flowrate (gpm)	Calculated cumulative volume pumped (gal)	Calculated cumulative volume pumped (M gal)
08/05/94	15:40	34551.6528	11.1799	3000	2911.09	46865638	46.866
08/05/94	20:17	34551.8451	11.3722	3000	2912.6	47696738	47.697
08/06/94	06:01	34552.2507	11.7778	3000	2915.61	49448746	49.449
08/06/94	06:02	34552.2514	11.7785	0	2915.52	49450135	49.450
08/06/94	11:20	34552.4722	11.9993	0	2861.87	49450252	49.450
08/06/94	13:15	34552.5521	12.0792	0	2842.94	49450098	49.450
08/06/94	15:02	34552.6264	12.1535	0	2825.56	49450126	49.450
08/06/94	15:03	34552.6271	12.1542	2800	2825.48	49451551	49.452
08/06/94	18:01	34552.7507	12.2778	2800	2825.23	49950066	49.950
08/06/94	18:47	34552.7826	12.3097	2700	2825.03	50076482	50.076
08/07/94	08:46	34553.3653	12.8924	2900	2823.9	52425703	52.426
08/07/94	12:01	34553.5007	13.0278	2800	2824.17	52981429	52.981
08/07/94	18:10	34553.7569	13.2840	2900	2824.67	54033112	54.033
08/08/94	00:45	34554.0313	13.5583	2900	2826.19	55178534	55.179
08/08/94	06:55	34554.2882	13.8153	2800	2826.64	56233176	56.233
08/08/94	09:46	34554.4069	13.9340	2800	2826.41	56711917	56.712
08/08/94	09:47	34554.4076	13.9347	0	2826.34	56713338	56.713
08/08/94	13:37	34554.5674	14.0944	0	2794.29	56712910	56.713
08/08/94	18:47	34554.7826	14.3097	0	2752.27	56713276	56.713
08/08/94	18:48	34554.7833	14.3104	2900	2752.21	56714791	56.715
08/08/94	21:04	34554.8778	14.4049	2900	2753.18	57109213	57.109
08/09/94	00:30	34555.0208	14.5479	2900	2754.62	57706534	57.707
08/09/94	06:30	34555.2708	14.7979	2900	2757.08	58750618	58.751
08/09/94	12:08	34555.5056	15.0326	2900	2759.31	59730784	59.731
08/09/94	17:16	34555.7194	15.2465	3000	2761.98	60639271	60.639
08/10/94	01:30	34556.0625	15.5896	2900	2766.12	62096628	62.097
08/10/94	06:21	34556.2646	15.7917	2900	2767.83	62940454	62.940
08/10/94	12:27	34556.5188	16.0458	2800	2769.14	63983749	63.984
08/11/94	03:10	34557.1319	16.6590	3000	2773.95	66544287	66.544
08/11/94	07:14	34557.3014	16.8285	2900	2775.72	67264023	67.264
08/11/94	13:06	34557.5458	17.0729	2900	2777.5	68284837	68.285
08/11/94	17:19	34557.7215	17.2486	3000	2779.26	69031260	69.031
08/12/94	00:00	34558.0000	17.5271	2800	2781.18	70194202	70.194
08/12/94	03:20	34558.1389	17.6660	2900	2781.72	70764175	70.764
08/12/94	13:00	34558.5417	18.0687	3000	2785.47	72475144	72.475
08/12/94	18:00	34558.7500	18.2771	3000	2787.92	73375266	73.375
08/12/94	23:40	34558.9861	18.5132	2900	2789.98	74378077	74.378
08/13/94	07:16	34559.3028	18.8299	2900	2791.83	75700470	75.700
08/13/94	13:42	34559.5708	19.0979	2900	2793.35	76819918	76.820
08/13/94	18:08	34559.7556	19.2826	3000	2794.85	77604600	77.605
08/14/94	01:00	34560.0417	19.5687	2900	2797.12	78820044	78.820
08/14/94	07:11	34560.2993	19.8264	3000	2799.11	79914591	79.915
08/14/94	07:25	34560.3090	19.8361	3000	2799.21	79956634	79.957
08/14/94	12:08	34560.5056	20.0326	2900	2800.69	80791504	80.792
08/15/94	05:00	34561.2083	20.7354	2700	2800.66	83624907	83.625
08/15/94	11:59	34561.4993	21.0264	3000	2801.35	84819275	84.819
08/15/94	13:10	34561.5486	21.0757	2900	2801.69	85028490	85.028
08/15/94	13:12	34561.5500	21.0771	2900	2801.7	85034397	85.034
08/15/94	18:23	34561.7660	21.2931	2900	2802.7	85936387	85.936
08/15/94	18:24	34561.7667	21.2938	2900	2802.7	85939190	85.939
08/15/94	22:45	34561.9479	21.4750	2900	2803.52	86696052	86.696
08/16/94	03:00	34562.1250	21.6521	2900	2804.31	87435581	87.436
08/16/94	10:00	34562.4167	21.9437	2800	2804.92	88632667	88.633
08/16/94	10:07	34562.4215	21.9486	2900	2804.93	88652618	88.653
08/16/94	11:09	34562.4646	21.9917	2900	2805.11	88832223	88.832
08/16/94	12:14	34562.5097	22.0368	2900	2805.31	89020902	89.021
08/16/94	14:08	34562.5889	22.1160	2900	2805.65	89351536	89.352
08/16/94	14:10	34562.5903	22.1174	2800	2805.65	89357147	89.357
08/16/94	18:11	34562.7576	22.2847	2700	2805.23	90019831	90.020
08/17/94	01:20	34563.0556	22.5826	2800	2804.5	91199536	91.200
08/17/94	06:30	34563.2708	22.7979	3000	2805.4	92098477	92.098
08/17/94	08:53	34563.3701	22.8972	2900	2806.03	92520421	92.520

Table 1. (continued)

Date (m/d/y)	Time (h:m)	Serial time (days)	Elapsed time (days)	Observed flowrate (gpm)	Time-weighted average flowrate (gpm)	Calculated cumulative volume pumped (gal)	Calculated cumulative volume pumped (M gal)
08/17/94	09:00	34563.3750	22.9021	2900	2806.05	92540723	92.541
08/17/94	12:20	34563.5139	23.0410	3000	2806.92	93130799	93.131
08/17/94	15:02	34563.6264	23.1535	2900	2807.61	93608525	93.609
08/17/94	15:05	34563.6285	23.1556	2900	2807.62	93617281	93.617
08/17/94	18:16	34563.7611	23.2882	3000	2808.43	94180700	94.181
08/17/94	21:40	34563.9028	23.4299	3000	2809.59	94792757	94.793
08/18/94	00:00	34564.0000	23.5271	3000	2810.38	95212864	95.213
08/18/94	01:20	34564.0556	23.5826	2900	2810.71	95448901	95.449
08/18/94	06:20	34564.2639	23.7910	3000	2811.93	96333910	96.334
08/18/94	12:07	34564.5049	24.0319	2900	2813.31	97357406	97.357
08/18/94	18:32	34564.7722	24.2993	2800	2813.72	98454877	98.455
08/18/94	18:33	34564.7729	24.3000	3000	2813.72	98457690	98.458
08/19/94	00:45	34565.0313	24.5583	2900	2815.15	99554965	99.555
08/19/94	06:35	34565.2743	24.8014	2800	2815.49	100552410	100.552
08/19/94	13:15	34565.5521	25.0792	3100	2816.98	101732416	101.732
08/19/94	19:13	34565.8007	25.3278	2800	2818.29	102788673	102.789
08/20/94	05:00	34566.2083	25.7354	3000	2819.58	104490815	104.491
08/20/94	13:10	34566.5486	26.0757	2900	2821.29	105936618	105.937
08/20/94	15:00	34566.6250	26.1521	3000	2821.66	106260894	106.261
08/20/94	18:05	34566.7535	26.2806	2900	2822.29	106806743	106.807
08/21/94	05:30	34567.2292	26.7562	2900	2823.67	108793181	108.793
08/21/94	09:00	34567.3750	26.9021	2900	2824.09	109402423	109.402
08/21/94	12:12	34567.5083	27.0354	3000	2824.71	109968785	109.969
08/21/94	16:58	34567.7069	27.2340	3000	2825.98	110826458	110.826
08/21/94	17:00	34567.7083	27.2354	2900	2825.99	110832502	110.833
08/21/94	20:27	34567.8521	27.3792	3000	2826.64	111443109	111.443
08/21/94	20:30	34567.8542	27.3812	2900	2826.65	111451983	111.452
08/22/94	00:30	34568.0208	27.5479	2800	2826.79	112135933	112.136
08/22/94	06:00	34568.2500	27.7771	2900	2826.98	113076373	113.076
08/22/94	10:20	34568.4306	27.9576	3000	2827.78	113843595	113.844
08/22/94	10:35	34568.4410	27.9681	3000	2827.84	113888428	113.888
08/22/94	12:32	34568.5222	28.0493	2900	2828.2	114233826	114.234
08/22/94	15:30	34568.6458	28.1729	2900	2828.51	114749822	114.750
08/22/94	15:33	34568.6479	28.1750	2900	2828.52	114758713	114.759
08/22/94	18:11	34568.7576	28.2847	2900	2828.79	115216617	115.217
08/23/94	00:00	34569.0000	28.5271	3000	2829.82	116246176	116.246
08/23/94	09:21	34569.3896	28.9167	2900	2831.44	117901162	117.901
08/23/94	09:33	34569.3979	28.9250	2900	2831.46	117935972	117.936
08/23/94	11:54	34569.4958	29.0229	3000	2831.86	118351925	118.352
08/23/94	16:39	34569.6938	29.2208	2900	2832.66	119192667	119.193
08/23/94	16:41	34569.6951	29.2222	2900	2832.67	119198754	119.199
08/24/94	00:24	34570.0167	29.5438	3000	2833.94	120564309	120.564
08/24/94	10:23	34570.4326	29.9597	3000	2836.25	122361497	122.361
08/24/94	12:12	34570.5083	30.0354	2900	2836.54	122683192	122.683
08/24/94	12:15	34570.5104	30.0375	2900	2836.54	122691701	122.692
08/24/94	17:58	34570.7486	30.2757	2900	2837.04	123686433	123.686
08/24/94	18:21	34570.7646	30.2917	2900	2837.07	123752993	123.753
08/25/94	01:08	34571.0472	30.5743	2600	2836.27	124872459	124.872
08/25/94	04:40	34571.1944	30.7215	2600	2835.14	125423758	125.424
08/26/94	19:07	34572.7965	32.3236	2830	2829.18	131687012	131.687
08/27/94	13:32	34573.5639	33.0910	2830	2829.2	134814209	134.814
08/27/94	19:15	34573.8021	33.3292	2925	2829.55	135801423	135.801
08/29/94	11:55	34575.4965	35.0236	2925	2834.16	142938025	142.938
08/30/94	11:39	34576.4854	36.0125	2925	2836.66	147103514	147.104
08/30/94	13:06	34576.5458	36.0729	2925	2836.81	147358095	147.358
08/30/94	16:04	34576.6694	36.1965	2925	2837.11	147878685	147.879
08/30/94	18:14	34576.7604	36.2875	2925	2837.33	148261774	148.262

Table 2. Flowrate and discharge into the infiltration basin (Totalizer 3).

Date (m/d/y)	Time (h:m)	Serial time (days)	Elapsed time (days)	Observed flow rate (100 gpm)	Observed flow total (gpm)	Observed flow total (10^4 gal)	Observed flow total (10^6 gal)
07/25/94	12:53	34540.5368	0.06	0	0	5	0.05
07/25/94	12:54	34540.5375	0.06	30	3000	5	0.05
07/25/94	15:12	34540.6333	0.16	31	3100	48	0.48
07/25/94	19:15	34540.8021	0.33	31	3100	124	1.24
07/25/94	20:10	34540.8403	0.37	30	3000	141	1.41
07/25/94	21:10	34540.8819	0.41	31	3100	159	1.59
07/26/94	00:45	34541.0313	0.56	31	3100	225	2.25
07/26/94	06:24	34541.2667	0.79	32	3200	331	3.31
07/26/94	10:51	34541.4521	0.98	31	3100	418	4.18
07/26/94	15:39	34541.6521	1.18	32	3200	514	5.14
07/27/94	00:05	34542.0035	1.53	30	3000	660	6.6
07/27/94	06:46	34542.2819	1.81	31	3100	785	7.85
07/27/94	11:42	34542.4875	2.01	31	3100	878	8.78
07/27/94	18:04	34542.7528	2.28	0	0	953	9.53
07/28/94	01:08	34543.0472	2.57	0	0	953	9.53
07/28/94	06:23	34543.2660	2.79	9	900	968	9.68
07/28/94	13:37	34543.5674	3.09	10	1000	1012	10.12
07/28/94	18:25	34543.7674	3.29	10	1000	1041	10.41
07/29/94	00:40	34544.0278	3.55	0	0	1072	10.72
07/29/94	08:30	34544.3542	3.88	0	0	1084	10.84
07/29/94	12:20	34544.5139	4.04	0	0	1084	10.84
07/29/94	20:03	34544.8354	4.36	9	900	1108	11.08
07/30/94	01:01	34545.0424	4.57	9	900	1135	11.35
07/30/94	02:52	34545.1194	4.65	5	500	1144	11.44
07/30/94	02:54	34545.1208	4.65	6	600	1144	11.44
07/30/94	03:12	34545.1333	4.66	0	0	1144	11.44
07/30/94	06:30	34545.2708	4.80	0	0	1144	11.44
07/30/94	12:22	34545.5153	5.04	0	0	1144	11.44
07/30/94	18:57	34545.7896	5.32	32	3200	1225	12.25
07/30/94	19:28	34545.8111	5.34	32	3200	1235	12.35
07/30/94	19:40	34545.8194	5.35	0	0	1239	12.39
07/31/94	00:05	34546.0035	5.53	0	0	1239	12.39
07/31/94	05:41	34546.2368	5.76	0	0	1239	12.39
07/31/94	12:28	34546.5194	6.05	31	3100	(no data entry)	
07/31/94	17:35	34546.7326	6.26	0	0	1337	13.37
08/02/94	01:12	34548.0500	7.58	0	0	1337	13.37
08/02/94	21:00	34548.8750	8.40	0	0	1337	13.37
08/03/94	00:11	34549.0076	8.53	0	0	1337	13.37
08/03/94	05:00	34549.2083	8.74	0	0	1337	13.37
08/03/94	13:58	34549.5819	9.11	0	0	1337	13.37
08/03/94	19:17	34549.8035	9.33	0	0	1337	13.37
08/04/94	12:35	34550.5243	10.05	0	0	1337	13.37
08/04/94	19:24	34550.8083	10.34	0	0	1337	13.37
08/05/94	00:20	34551.0139	10.54	0	0	1337	13.37
08/05/94	06:40	34551.2778	10.80	0	0	1337	13.37
08/05/94	11:44	34551.4889	11.02	0	0	1337	13.37
08/05/94	15:40	34551.6528	11.18	0	0	1337	13.37
08/05/94	20:17	34551.8451	11.37	0	0	1337	13.37
08/06/94	11:20	34552.4722	12.00	0	0	1337	13.37
08/06/94	13:15	34552.5521	12.08	0	0	1337	13.37
08/06/94	18:01	34552.7507	12.28	0	0	1337	13.37
08/06/94	18:47	34552.7826	12.31	0	0	1337	13.37
08/07/94	08:46	34553.3653	12.89	0	0	1337	13.37
08/07/94	12:01	34553.5007	13.03	0	0	1337	13.37
08/07/94	18:10	34553.7569	13.28	0	0	1337	13.37
08/08/94	00:45	34554.0313	13.56	0	0	1337	13.37
08/08/94	06:55	34554.2882	13.82	0	0	1337	13.37
08/08/94	13:37	34554.5674	14.09	0	0	1337	13.37
08/08/94	21:04	34554.8778	14.40	0	0	1337	13.37
08/09/94	00:30	34555.0208	14.55	0	0	1337	13.37
08/09/94	06:30	34555.2708	14.80	0	0	1337	13.37
08/09/94	12:08	34555.5056	15.03	0	0	1337	13.37
08/09/94	17:16	34555.7194	15.25	0	0	1337	13.37
08/10/94	01:30	34556.0625	15.59	0	0	1337	13.37
08/10/94	06:21	34556.2646	15.79	0	0	1337	13.37

Table 2. (continued)

Date (m/d/y)	Time (h:m)	Serial time (days)	Elapsed time (days)	Observed flow rate (100 gpm)	Observed flow total (gpm)	Observed flow total (10^4 gal)	Observed flow total (10^6 gal)
08/10/94	12:27	34556.5188	16.05	0	0	1337	13.37
08/10/94	23:30	34556.9792	16.51	0	0	1337	13.37
08/11/94	03:10	34557.1319	16.66	0	0	1337	13.37
08/11/94	07:14	34557.3014	16.83	0	0	1337	13.37
08/11/94	13:19	34557.5549	17.08	30	3000	1342	13.42
08/11/94	17:19	34557.7215	17.25	32	3200	1420	14.2
08/12/94	00:00	34558.0000	17.53	31	3100	1544	15.44
08/12/94	01:00	34558.0417	17.57	29	2900	1567	15.67
08/12/94	03:20	34558.1389	17.67	31	3100	1603	16.03
08/12/94	13:10	34558.5486	18.08	31	3100	1783	17.83
08/12/94	18:26	34558.7681	18.30	30	3000	1881	18.81
08/12/94	23:40	34558.9861	18.51	31	3100	1984	19.84
08/13/94	07:10	34559.2986	18.83	31	3100	2118	21.18
08/13/94	13:29	34559.5618	19.09	29	2900	2233	22.33
08/13/94	18:08	34559.7556	19.28	0	0	2242	22.42
08/14/94	01:09	34560.0479	19.58	0	0	2242	22.42
08/14/94	07:05	34560.2951	19.82	0	0	2242	22.42
08/14/94	07:30	34560.3125	19.84	22	2200	2245	22.45
08/14/94	11:57	34560.4979	20.03	22	2200	2303	23.03
08/15/94	11:59	34561.4993	21.03	0	0	2358	23.58
08/15/94	13:10	34561.5486	21.08	0	0	2358	23.58
08/15/94	13:20	34561.5556	21.08	31	3100	2360	23.6
08/15/94	18:23	34561.7660	21.29	31	3100	2455	24.55
08/15/94	18:24	34561.7667	21.29	0	0	2455	24.55
08/15/94	22:45	34561.9479	21.47	0	0	2454	24.54
08/16/94	03:00	34562.1250	21.65	0	0	2454	24.54
08/16/94	10:00	34562.4167	21.94	0	0	2454	24.54
08/16/94	10:24	34562.4333	21.96	31	3100	2459	24.59
08/16/94	12:19	34562.5132	22.04	30	3000	2495	24.95
08/16/94	14:03	34562.5854	22.11	31	3100	2527	25.27
08/16/94	14:10	34562.5903	22.12	0	0	2529	25.29
08/16/94	18:11	34562.7576	22.28	0	0	2529	25.29
08/17/94	01:20	34563.0556	22.58	0	0	2529	25.29
08/17/94	06:30	34563.2708	22.80	0	0	2529	25.29
08/17/94	08:53	34563.3701	22.90	0	0	2529	25.29
08/17/94	09:13	34563.3840	22.91	30	3000	2533	25.33
08/17/94	12:30	34563.5208	23.05	31	3100	2593	25.93
08/17/94	15:02	34563.6264	23.15	31	3100	2538	25.38
08/17/94	18:16	34563.7611	23.29	0	0	2641	26.41
08/17/94	21:40	34563.9028	23.43	33	3300	2641	26.41
08/18/94	00:00	34564.0000	23.53	31	3100	2684	26.84
08/18/94	01:20	34564.0556	23.58	0	0	2709	27.09
08/18/94	06:20	34564.2639	23.79	0	0	2709	27.09
08/18/94	12:07	34564.5049	24.03	0	0	2709	27.09
08/18/94	18:25	34564.7674	24.29	0	0	2709	27.09
08/18/94	18:39	34564.7771	24.30	30	3000	2711	27.11
08/19/94	00:45	34565.0313	24.56	0	0	2827	28.27
08/19/94	06:35	34565.2743	24.80	0	0	2827	28.27
08/19/94	13:15	34565.5521	25.08	0	0	2827	28.27
08/19/94	19:13	34565.8007	25.33	0	0	2827	28.27
08/20/94	05:00	34566.2083	25.74	0	0	2827	28.27
08/20/94	13:10	34566.5486	26.08	31	3100	2976	29.76
08/20/94	18:05	34566.7535	26.28	0	0	3011	30.11
08/21/94	05:30	34567.2292	26.76	0	0	3011	30.11
08/21/94	09:00	34567.3750	26.90	30	3000	3011	30.11
08/21/94	12:12	34567.5083	27.04	0	0	3011	30.11
08/21/94	16:58	34567.7069	27.23	0	0	3011	30.11
08/21/94	17:11	34567.7160	27.24	31	3100	3015	30.15
08/21/94	20:22	34567.8486	27.38	31	3100	3074	30.74
08/21/94	20:30	34567.8542	27.38	0	0	3076	30.76
08/22/94	00:30	34568.0208	27.55	0	0	3076	30.76
08/22/94	06:00	34568.2500	27.78	0	0	3076	30.76
08/22/94	10:20	34568.4306	27.96	0	0	3076	30.76
08/22/94	10:35	34568.4410	27.97	31	3100	3078	30.78

Table 2. (continued)

Date (m/d/y)	Time (h:m)	Serial time (days)	Elapsed time (days)	Observed flow rate (100 gpm)	Observed flow total (gpm)	Observed flow total (10^4 gal)	Observed flow total (10^6 gal)
08/22/94	12:12	34568.5083	28.04	31	3100	3110	31.1
08/22/94	15:19	34568.6382	28.17	31	3100	3165	31.65
08/22/94	15:33	34568.6479	28.18	0	0	3167	31.67
08/22/94	18:11	34568.7576	28.28	0	0	3167	31.67
08/23/94	00:00	34569.0000	28.53	0	0	3167	31.67
08/23/94	09:21	34569.3896	28.92	0	0	3167	31.67
08/23/94	09:33	34569.3979	28.93	31	3100	3169	31.69
08/23/94	11:42	34569.4875	29.01	31	3100	3208	32.08
08/23/94	16:29	34569.6868	29.21	31	3100	3297	32.97
08/23/94	16:41	34569.6951	29.22	0	0	3299	32.99
08/24/94	00:24	34570.0167	29.54	0	0	3299	32.99
08/24/94	10:15	34570.4271	29.95	0	0	3299	32.99
08/24/94	12:12	34570.5083	30.04	0	0	3299	32.99
08/24/94	12:38	34570.5264	30.05	31	3100	3306	33.06
08/24/94	18:11	34570.7576	30.28	30	3000	3409	34.09
08/24/94	18:20	34570.7639	30.29	0	0	3411	34.11
08/25/94	01:08	34571.0472	30.57	0	0	3411	34.11
08/25/94	04:40	34571.1944	30.72	0	0	3411	34.11
08/25/94	09:04	34571.3778	30.90	0	0	3411	34.11
08/25/94	12:36	34571.5250	31.05	0	0	3411	34.11
08/26/94	19:07	34572.7965	32.32	30	3000	3441	34.41
08/27/94	13:32	34573.5639	33.09	30	3000	3443	34.43
08/27/94	19:15	34573.8021	33.33	31	3100	3506	35.06
08/28/94	01:58	34574.0819	33.61	0	0	3504	35.04
08/28/94	07:30	34574.3125	33.84	0	0	3510	35.1
08/29/94	08:00	34575.3333	34.86	0	0	3635	36.35
08/29/94	11:55	34575.4965	35.02	31	3100	3707	37.07
08/30/94	11:39	34576.4854	36.01	31	3100	3780	37.8
08/30/94	13:06	34576.5458	36.07	31	3100	3805	38.05
08/30/94	13:16	34576.5528	36.08	0	0	3807	38.07
08/30/94	15:38	34576.6514	36.18	0	0	3807	38.07
08/30/94	16:04	34576.6694	36.20	31	3100	3812	38.12
08/30/94	18:15	34576.7604	36.29	0	0	3854	38.54

4. INFILTRATION RATE ESTIMATES

This section outlines the methods used for calculating infiltration rates from the infiltration basin. Infiltration rates were calculated from the basin hydrograph, evaporation rates, and precipitation amounts. Figure 8 shows the infiltration basin hydrograph with each falling limb labeled. The rising limbs of the hydrograph represent periods when water was being discharged into the basin, and the falling limbs represent periods when water was not being discharged into the basin. The exception to this is Falling Limb 2, when water was being discharged into the basin at a low rate.

Infiltration rates were determined using different methods for the falling limbs and rising limbs. For the falling limbs, the volume balance approach was used, and calculated infiltration rates are referred to as 'measured' rates. Falling Limb 2 was excluded from this analysis because the discharge into the basin was not zero and was not properly recorded. For the rising limbs and Falling Limb 2, the infiltration rates were estimated from the relationship between stage and infiltration rate observed for the falling limbs, and are referred to as 'estimated' rates. This approach was used instead of the volume balance approach to avoid errors due to inaccuracies in the measured volume of water discharged into the basin and because, in some instances, the observations of Flow Meter 3 needed for volume balance calculations were not made at the appropriate times.

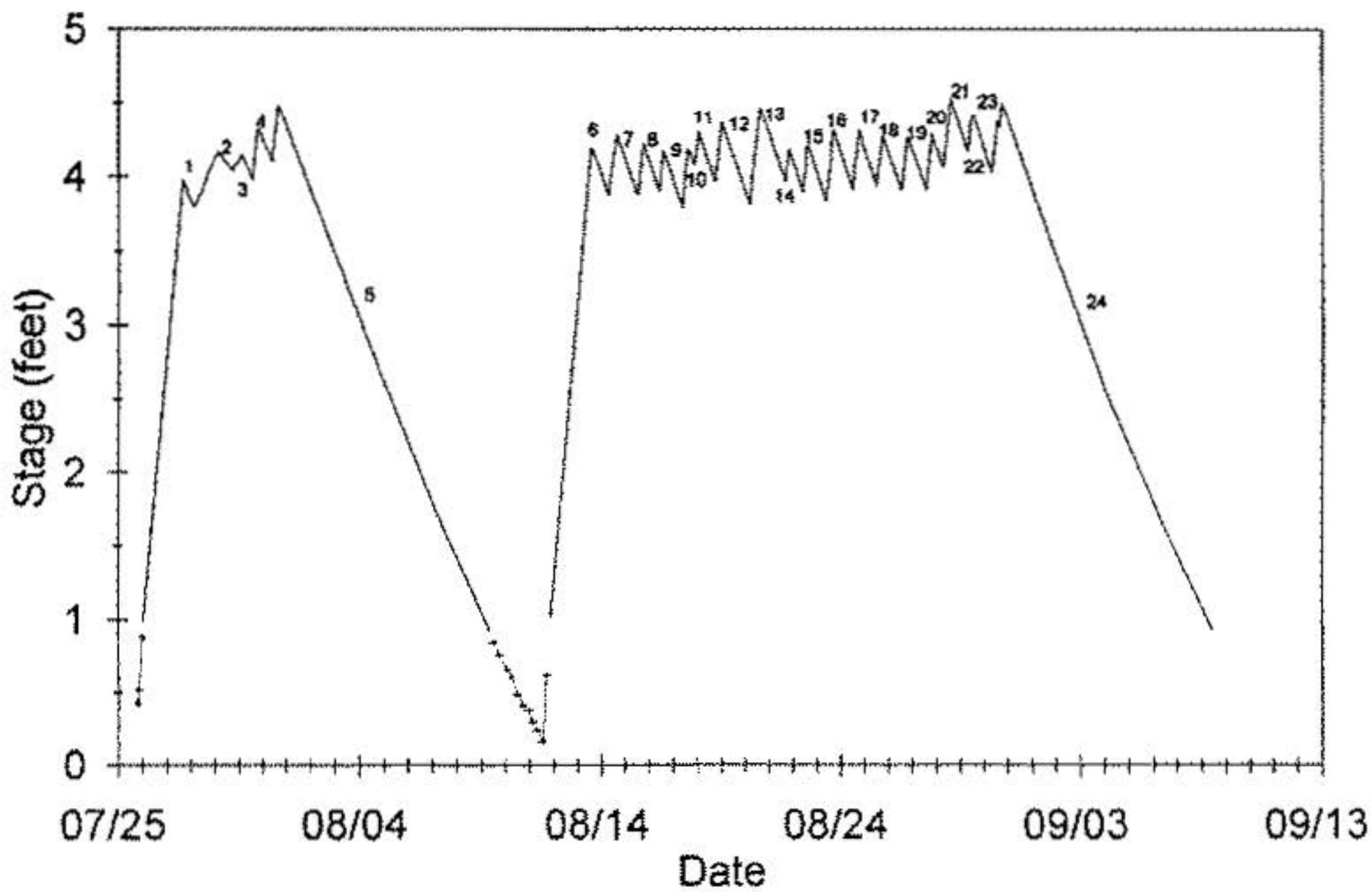

Figure 8. Hydrograph falling limbs.

4.1 Approach and Governing Equations

The volume balance equation states that the change in the volume of water in the basin during a period of time $t_1 \rightarrow t_2$ is equal to the sum of the volumes added to the basin (discharge from the pipeline and precipitation) minus the sum of the volumes removed from the basin (infiltration and evaporation) during $t_1 \rightarrow t_2$. If all components of this expression except the infiltration volume are known, then it can be solved for the infiltration volume. The equations used for calculating infiltration rates for the falling limbs are developed below.

$$\Delta V_{Basin\ t_1-t_2} = V_{Basin\ t_2} - V_{Basin\ t_1} \tag{1}$$

where

$\Delta V_{Basin\ t_1-t_2}$ = change in the volume of water in the basin during time interval $t_1 \rightarrow t_2$

$V_{Basin\ t_i}$ = volume of water in the basin at time i.

$$\Delta V_{Basin\ t_1-t_2} = \Sigma \text{ Inputs} - \Sigma \text{ Outputs} \tag{2}$$

$$\Delta V_{Basin\ t_1-t_2} = \left(\Delta V_{Disch\ t_1-t_2} + \Delta V_{Precip\ t_1-t_2}\right) - \left(\Delta V_{Infil\ t_1-t_2} + \Delta V_{Evap\ t_1-t_2}\right) \tag{3}$$

where

$\Delta V_{Disch\ t_1-t_2}$ = volume of water discharged from the pipeline into the basin during time interval $t_1 \rightarrow t_2$

$\Delta V_{Precip\ t_1-t_2}$ = volume of water that entered the basin via precipitation during time interval $t_1 \rightarrow t_2$

$\Delta V_{Infil\ t_1-t_2}$ = volume of water that infiltrated from the basin during time interval $t_1 \rightarrow t_2$

$\Delta V_{Evap\ t_1-t_2}$ = volume of water that evaporated from the basin during time interval $t_1 \rightarrow t_2$

Solving for $\Delta V_{Infil\ t_1-t_2}$,

$$\Delta V_{Infil\ t_1-t_2} = -\Delta V_{Basin\ t_1-t_2} + \Delta V_{Disch\ t_1-t_2} + \Delta V_{Precip\ t_1-t_2} - \Delta V_{Evap\ t_1-t_2} \tag{4}$$

Substituting Equation (1),

$$\Delta V_{Infil\ t_1-t_2} = V_{Basin\ t_1} - V_{Basin\ t_2} + \Delta V_{Disch\ t_1-t_2} + \Delta V_{Precip\ t_1-t_2} - \Delta V_{Evap\ t_1-t_2} \tag{5}$$

The infiltration rate is calculated as the infiltration volume divided by the length of the time interval.

$$R_{Infil\ t_1-t_2} = \frac{\Delta V_{infil\ t_1-t_2}}{t_2 - t_1} \tag{6}$$

where

$R_{Infil\ t_1-t_2}$ = infiltration rate during time interval $t_1 \rightarrow t_2$.

The infiltration flux, i.e., the volume of water that infiltrated per unit area per unit time, is the infiltration rate divided by the wetted area of the basin, which is taken to be the same as the surface area of the basin.

$$q = \frac{\dfrac{\Delta V_{Basin\ t_1-t_2}}{t_2 - t_1}}{A} \tag{8}$$

$$q = \frac{R_{Infil\ t_1-t_2}}{A} \tag{9}$$

where A is the surface area of the basin.

The following section describes how the parameters used in the infiltration rate calculations were determined.

4.2 Data Sources

The water level, or stage, in the infiltration basin is the primary data source for this calculation. Stage was measured using an In-Situ Hermit pressure transducer/data logger system, complemented by manual observations of a staff gauge when the water level was below the pressure transducer. Figure 9 shows the excellent agreement between the pressure transducer measurements and the manual observations, indicating that it is appropriate to combine these two data sets. A regression line was fit through each falling limb, with the exception of Limbs 2, 5, and 24, and the maximum and minimum stage for each limb was estimated using these regression lines. Falling Limb 2 was not analyzed because some water was discharged to the basin during this time. Falling Limb 5 encompasses the period while the basin was draining after tracer addition, and includes both data collected by the data logger system while the water level was above the pressure transducer and manual staff gauge observations after the water level fell below the transducer. The portion of Limb 5 that includes the pressure transducer readings was divided into four equal parts, and each part was analyzed as a separate limb. The portion of Limb 5 that includes the manual staff gauge observations was analyzed as a fifth separate limb. Falling Limb 24 encompasses the period in which the basin was draining after the pump was shut off at the end of the aquifer test. It was divided into four equal parts and each part was treated as a separate limb.

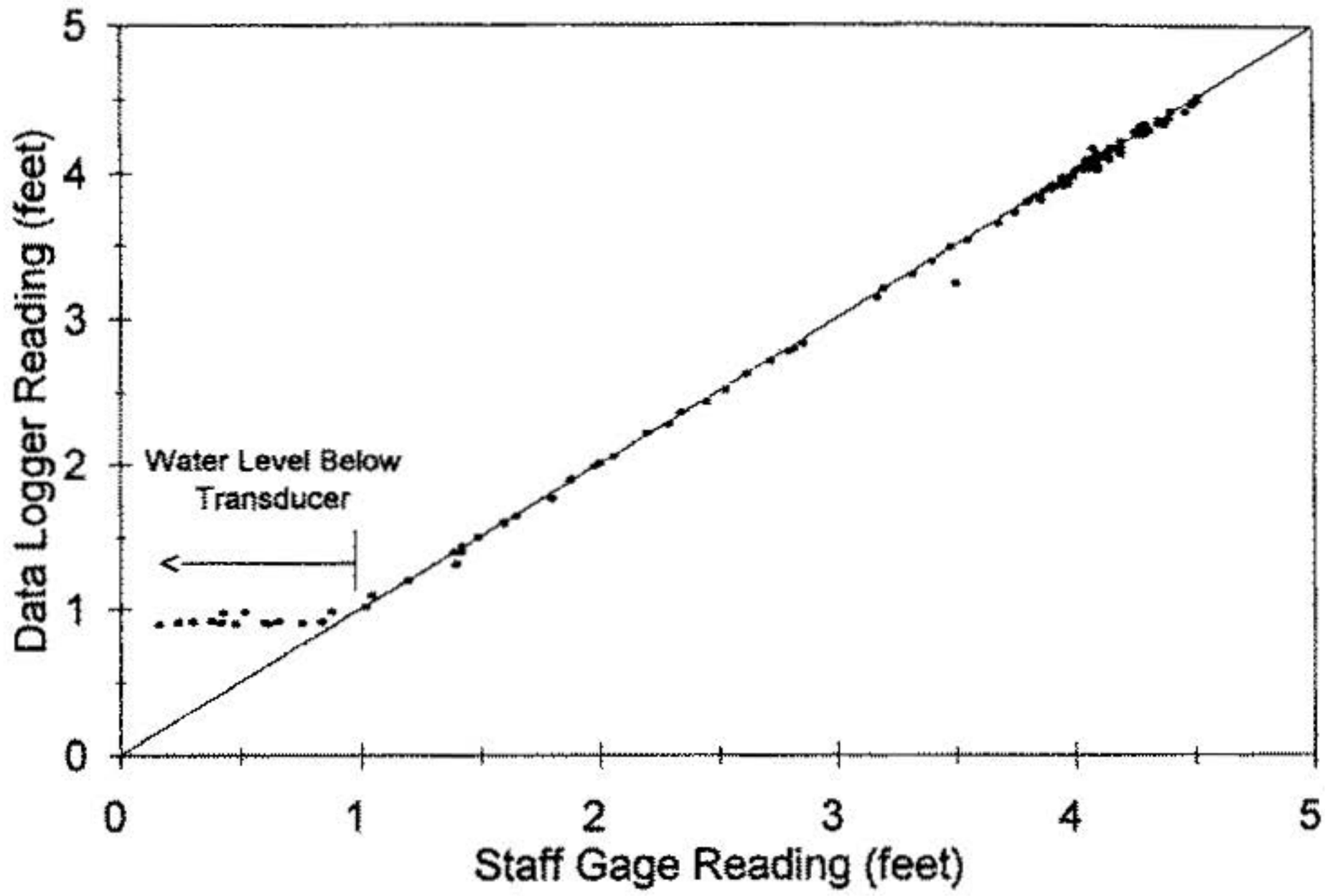

Figure 9. Data logger and manual observations of stage.

Appendix C includes a summary of the regression calculations and the estimated stage for each limb. The R^2 values for the regressions ranged from 0.992 to 0.999. (An R^2 value of 1 indicates that the regression line accounts for all of the variation in the data, and a value of 0 indicates that the regression line does not account for any of the variation in the data.) Hence, the observed R^2 values show that the regression lines are almost perfect fits to the data.

The volume of water in the basin as a function of stage was used in the volume balance calculations, and the surface area of water in the basin as a function of stage was used to calculate precipitation and evaporation volumes from measured precipitation amounts and evaporation rates, and to calculate infiltration fluxes from infiltration rates. Both the volume-stage and surface-area-stage relationships were determined from an elevation survey conducted after the infiltration basin was constructed. The calculations of the basin volume-stage and area-stage relationships are documented in Appendix D. Linear interpolation was used to determine values between the values tabulated in Appendix D.

A meteorological station was established at the infiltration basin by the National Oceanic and Atmospheric Administration (NOAA) to collect data that would allow precipitation amounts and evaporation rates to be determined. Appendix E contains a report from NOAA that documents the daily precipitation amounts and 5-day average evaporation rates at the infiltration basin. For cases in which a falling limb fell across the boundary between two 5-day evaporation rate values, a time-weighted average was used as the evaporation rate for that limb. The volume [L^3] of water that evaporated during a falling limb period was calculated as the product of the evaporation rate [$L\ T^{-1}$], average surface area [L^2], and duration of the falling limb [T] (the dimensions of the

parameter are shown in [brackets]). The average surface area was calculated as the arithmetic mean of the surface areas at the maximum and minimum stages for the falling limb. The volume [L^3] of precipitation was calculated as the product of the precipitation amount [L] and average surface area [L^2]. The volumes of water that evaporated and precipitated are used in the volume balance calculations.

4.3 Calculations and Results

The infiltration rate was calculated using the equations developed in Section 4.1. The calculations are documented in the spreadsheet in Appendix F. In addition, Appendix F includes the volume of water that evaporated from the basin during the falling limbs, which is needed for the water balance calculations.

The measured infiltration rates are illustrated in Figure 10. The horizontal lines indicate the duration of the falling limb for which the infiltration rate was measured. The first notable feature is that the measured infiltration rate was smaller the first time the basin was filled (Falling Limbs 1 and 3-5e) than the second time (Falling Limbs 6-24d). A statistical t-test shows that the mean of the early data is less than the mean of the later data ($P>0.99$). The least conductive layer in this system is the surficial soil, and the increase in infiltration rate over time indicates that the hydraulic conductivity of the soil increased over time. Although the reason for this has not been determined, several explanations can be postulated. First, characteristic curves (water

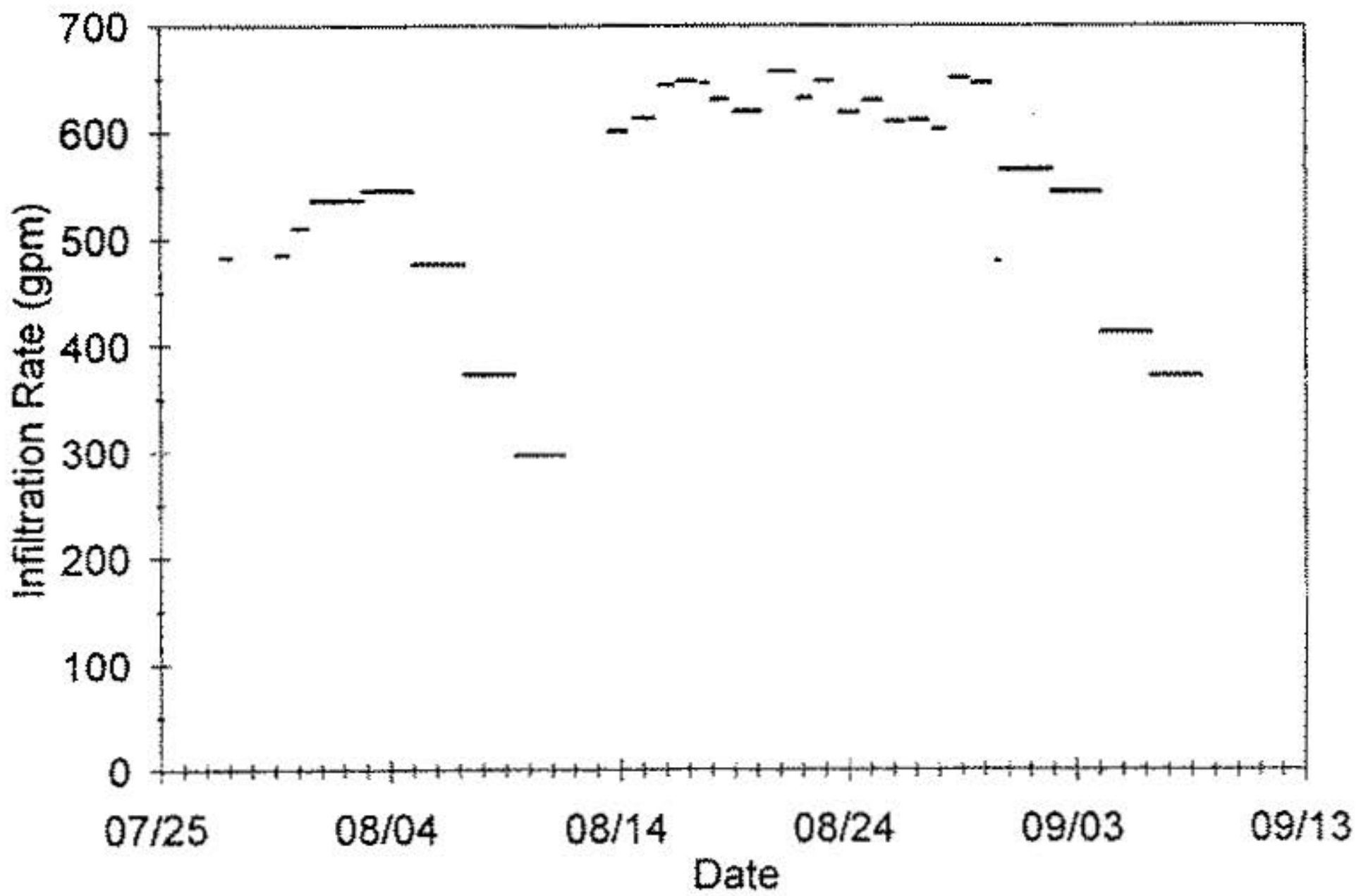

Figure 10. Measured infiltration rates.

content—matric potential) for soils are hysteretic, and it is likely that the soil attained a higher water content the second time the basin was filled (August 11) than it did the first time it was filled (July 26). Hydraulic conductivity is a function of water content, with larger values at higher water contents; therefore, the soil would have been more conductive if the water content was larger because more air was displaced from soil pores the second time the basin was filled. Second, air entrained in the pores could have dissolved over time with a corresponding increase in water content and hydraulic conductivity. Third, the structure of the soil may have changed due to carbonate dissolution or decreases in the volume of clay minerals after exposure to water with a chemical composition different from what it had been exposed to previously. Although the data necessary to rigorously evaluate these alternatives are not available, the concentrations of total dissolved solids (TDSs) measured in water samples from lysimeters below the basin were substantially greater than concentrations in samples from the basin, indicating that mineral dissolution occurred in the subsurface between the basin and the lysimeters. Although this does not prove that dissolution of minerals in soil occurred, it is consistent with it. This does not indicate that the other mechanisms did not occur too.

Figure 11 shows that the measured infiltration rates mimic the basin hydrograph, implying that infiltration rate is a function of basin stage. Figures 12 and 13 show regressions of infiltration rate against basin stage for the early (before Falling Limb 5) and late (after Falling Limb 5) measurements. The regressions have R^2 values of 0.75 and 0.70, demonstrating the strong dependence of infiltration rate on stage. The infiltration rate calculated for Falling Limb 23 appears to be an outlier, resulting from the very short duration of the limb.

Infiltration occurred during the rising limbs of the hydrograph as well as during the falling limbs. Infiltration rates were estimated for the rising limbs and Falling Limb 2 using the regression lines presented in Figures 12 and 13 and the average of the minimum and maximum stage for each limb. The rising limbs while the basin was initially filled and the rising limb that followed the drainage after tracer addition were both divided into four equal parts for this calculation. The early data regression (Figure 12) was used to estimate infiltration rates before Falling Limb 5, and the late data regression (Figure 13) was used to estimate rates after Limb 5. The infiltration rate estimates are documented in Appendix G. In addition, Appendix G includes the volume of water that evaporated from the basin during the rising limbs, which is needed for water volume balance calculations. The measured (falling limb) and estimated (rising limb) infiltration rates are shown in Figure 14 and Table 3. Figure 15 shows the time-weighted average infiltration rate determined from the measured and estimated values through the end of the pressure transducer data set on September 8, 1994. The time-weighted average infiltration rate for the entire experiment was calculated from Table 3 to be 528 gpm.

Infiltration flux values calculated by dividing the infiltration rates by the basin surface area are tabulated in Appendix H. Figure 16 shows the variations in infiltration flux throughout the duration of the LSIT, and the time-weighted average flux. Infiltration flux values ranged from 1.42×10^{-3} to 2.35×10^{-3} gpm/ft^2, and the time-weighted average flux for the entire experiment was 1.99×10^{-3} gpm/ft^2.

These infiltration rate and flux values can be used as input parameters for simulating flow and transport in this experiment as well as for predictive flow and transport modeling in similar environments.

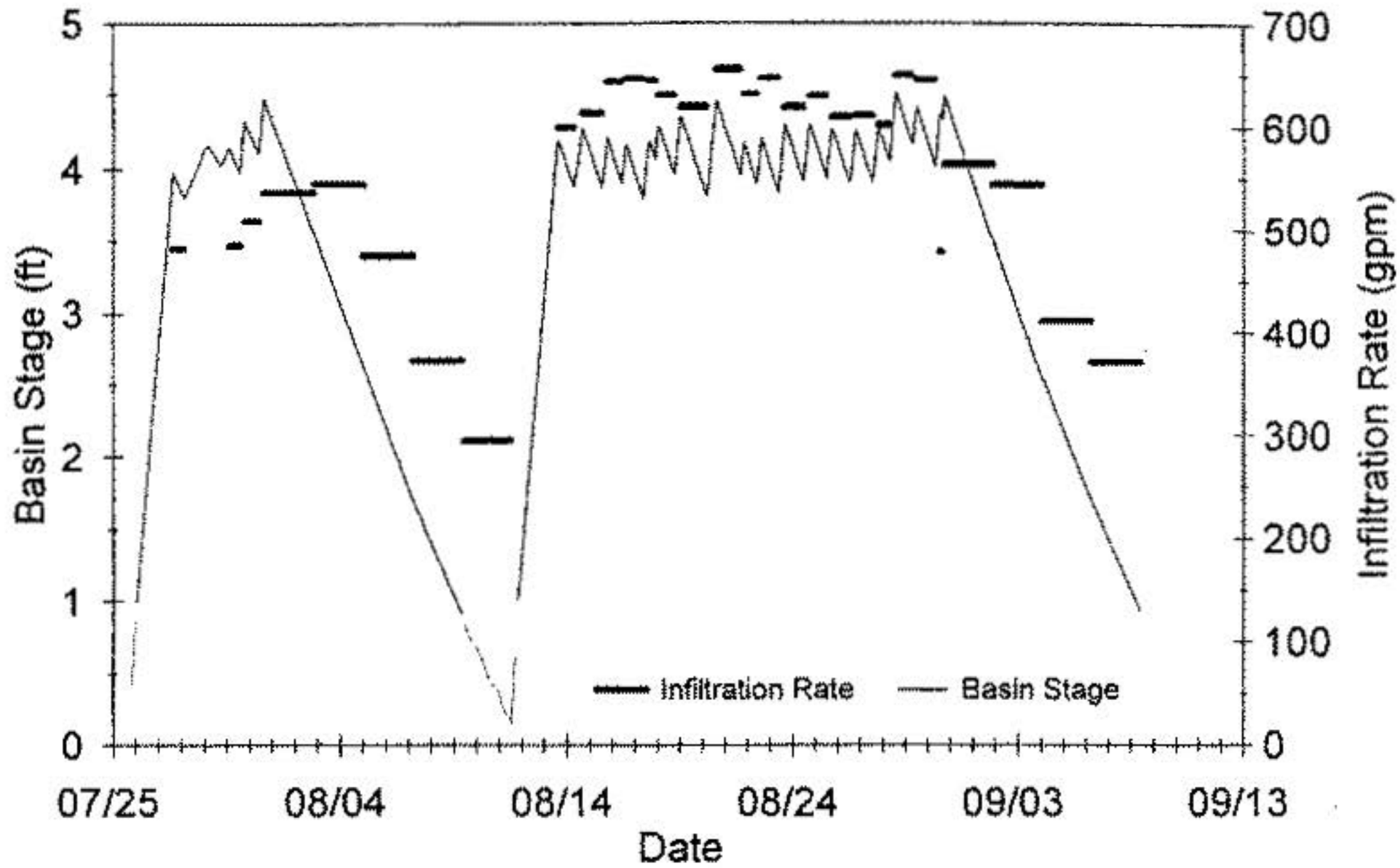

Figure 11. Measured infiltration rates and basin hydrograph.

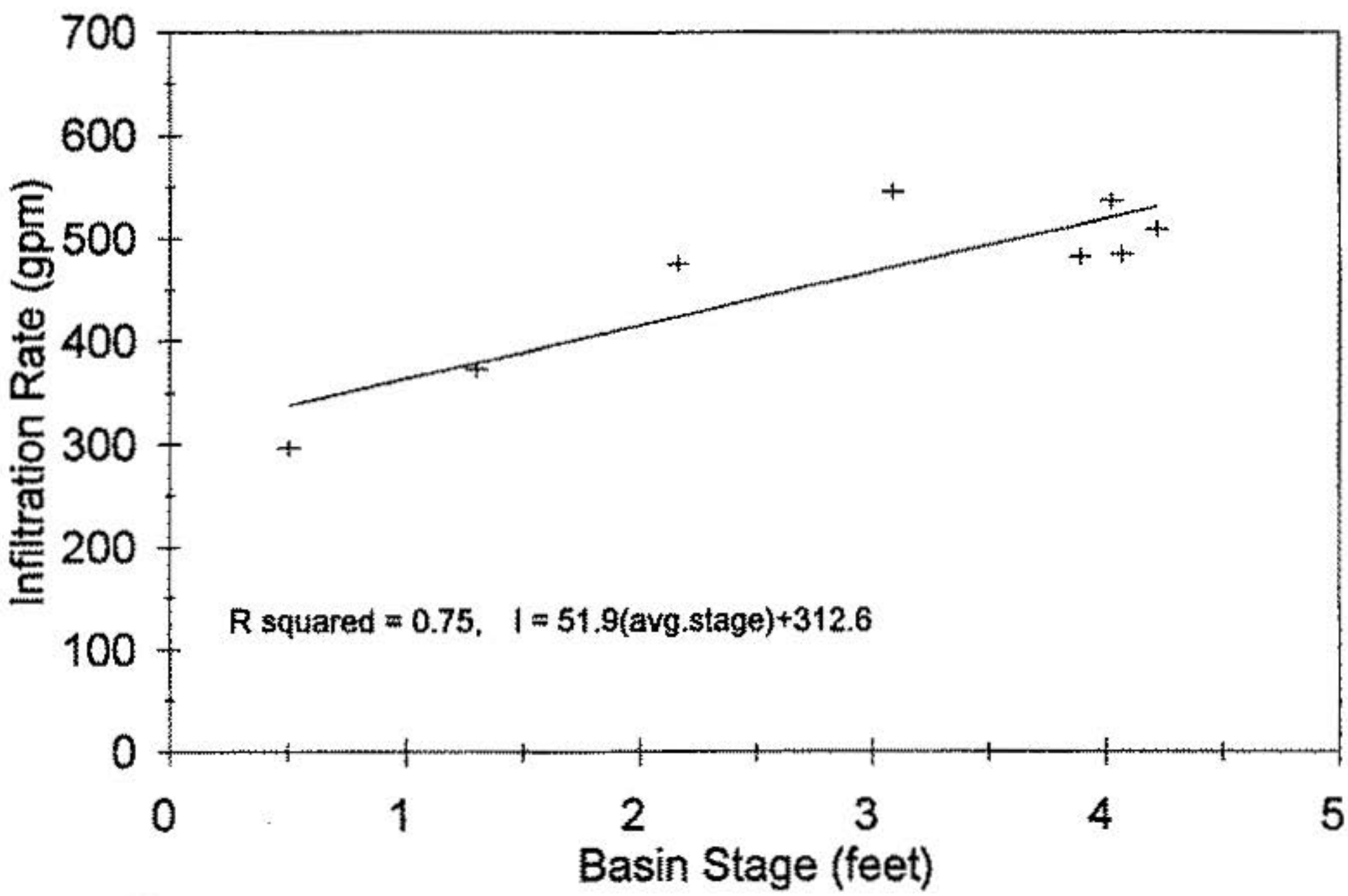

Figure 12. Infiltration rate—stage regression: early data.

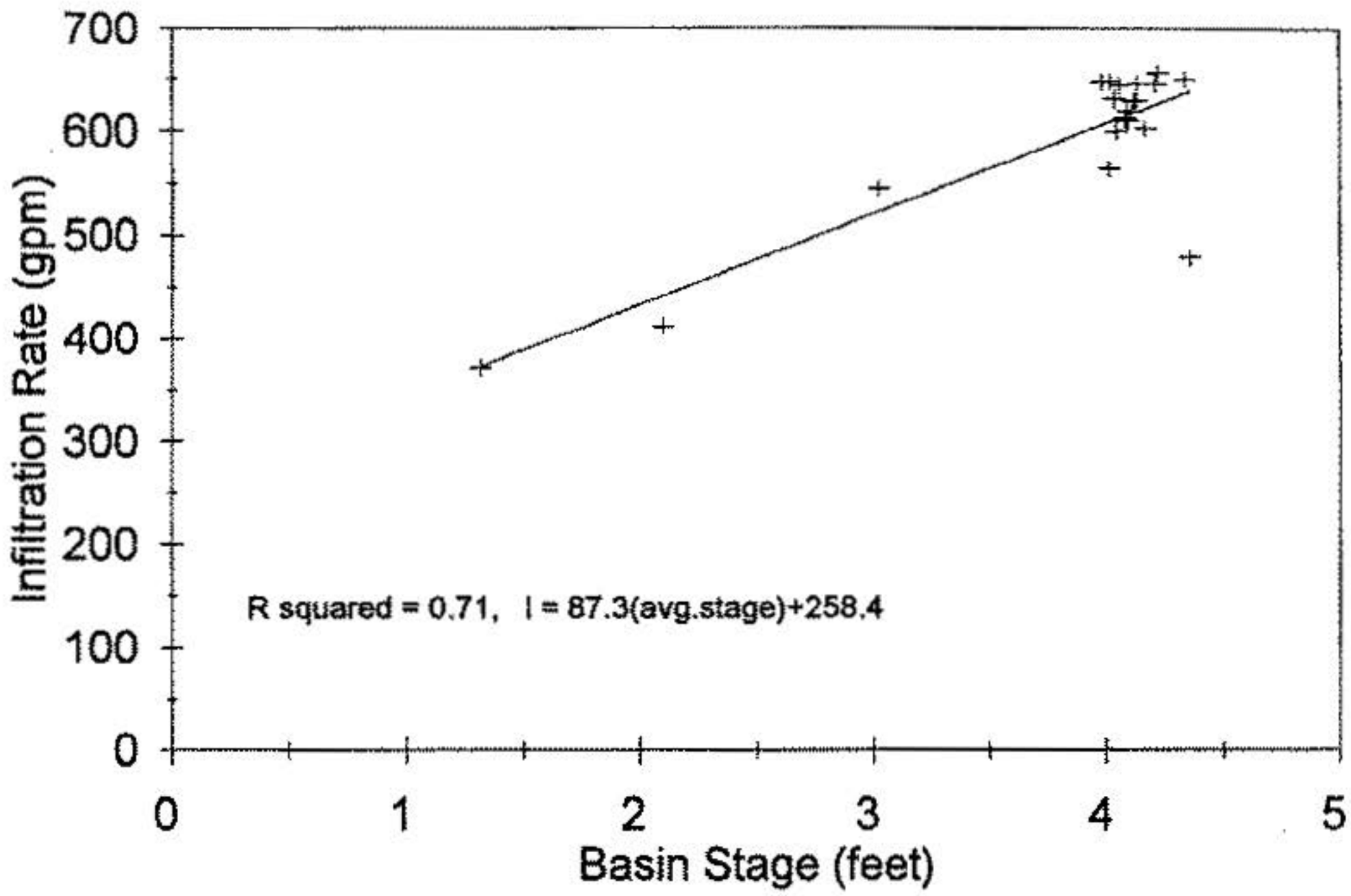

Figure 13. Infiltration rate—stage regression: late data.

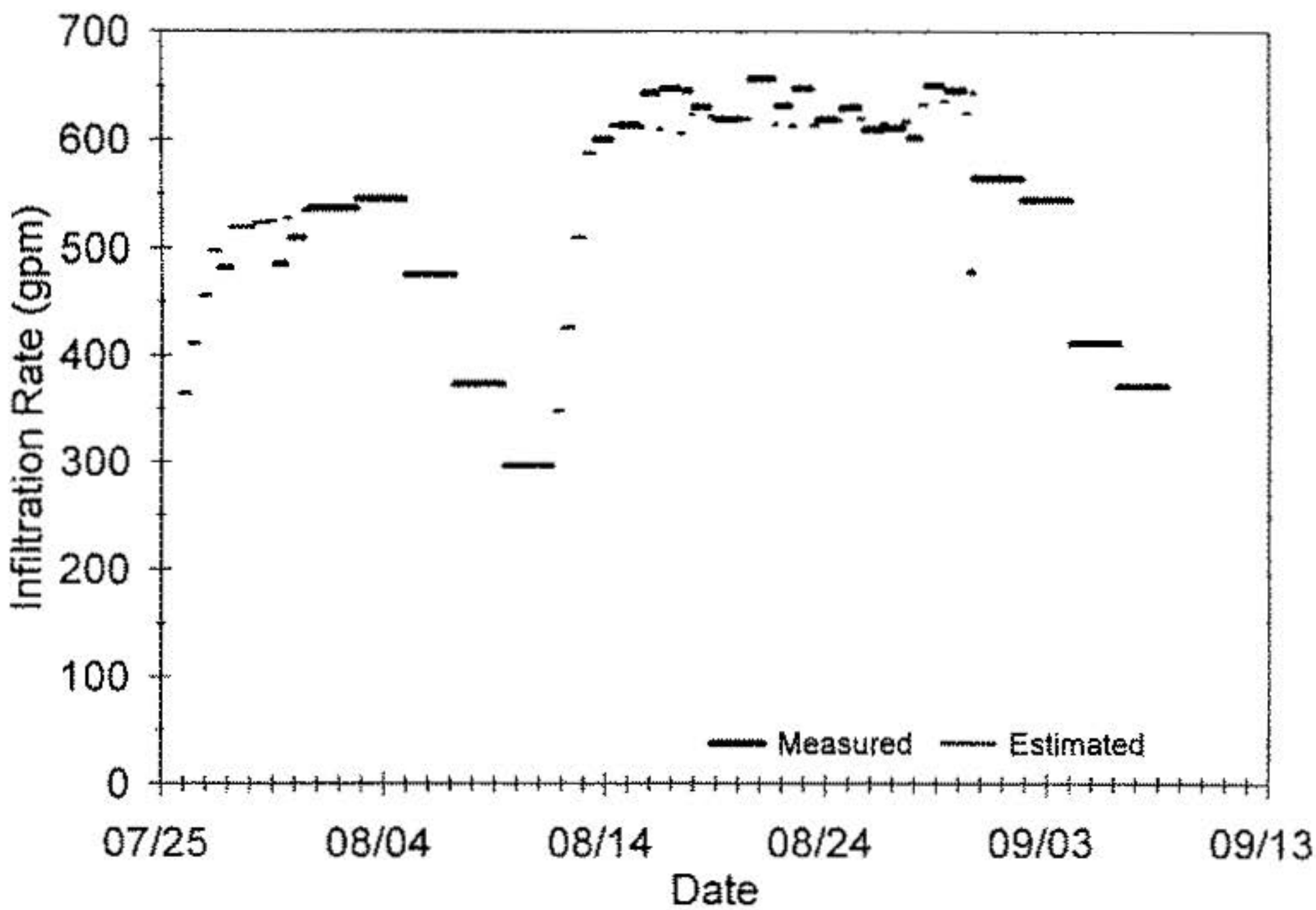

Figure 14. Measured and estimated infiltration rates.

Table 3. Measured and estimated infiltration rates.

Line Segment	Date (m/d/y)	Time (h:m)	Serial time (days)	Delta time (days)	Measured Infiltration rate (gpm)	Estimated Infiltration rate (gpm)	Product of rate delta T (gpm*days)	Sum of rate delta T (gpm*days)	Sum of delta T (days)	Average = sum (gpm*days)/ sum (days) (gpm)
0-1a	07/25/94	20:13	34540.84	0.452		365	165	165	0.452	365
rising	07/26/94	07:03	34541.29							
0-1b	07/26/94	07:04	34541.29	0.394		411	162	326	0.845	386
rising	07/26/94	16:31	34541.69							
0-1c	07/26/94	18:20	34541.76	0.434		456	198	524	1.279	410
rising	07/27/94	04:45	34542.20							
0-1d	07/27/94	04:50	34542.20	0.451		498	225	749	1.731	433
rising	07/27/94	15:40	34542.65							
1	07/27/94	15:45	34542.66	0.469	482		226	975	2.199	443
	07/28/94	03:00	34543.13							
1-2	07/28/94	03:05	34543.13	1.031		520	536	1511	3.231	468
rising	07/29/94	03:50	34544.16							
2	07/29/94	03:55	34544.16	0.611		523	320	1831	3.842	477
falling	07/29/94	18:35	34544.77							
2-3	07/29/94	18:40	34544.78	0.347		525	182	2013	4.189	481
rising	07/30/94	03:00	34545.13							
3	07/30/94	03:05	34545.13	0.469	486		228	2241	4.658	481
	07/30/94	14:20	34545.60							
3-4	07/30/94	14:25	34545.60	0.215		528	114	2354	4.873	483
rising	07/30/94	19:35	34545.82							
4	07/30/94	19:40	34545.82	0.601	510		306	2661	5.474	486
	07/31/94	10:05	34546.42							
4-5	07/31/94	10:15	34546.43	0.222		535	119	2780	5.696	488
rising	07/31/94	15:35	34546.65							
5a	07/31/94	15:40	34546.65	2.188	537		1174	3954	7.883	502
	08/02/94	20:10	34548.84							
5b	08/02/94	20:10	34548.84	2.188	546		1194	5149	10.071	511
	08/05/94	00:40	34551.03							
5c	08/05/94	00:40	34551.03	2.188	476		1042	6190	12.259	505
	08/07/94	05:10	34553.22							
5d	08/07/94	05:10	34553.22	2.188	374		818	7008	14.446	485
	08/09/94	09:41	34555.40							
5e	08/09/94	12:02	34555.50	2.047	297		607	7615	16.493	462
	08/11/94	13:09	34557.55							
5-6a	08/11/94	17:21	34557.72	0.326		349	114	7729	16.819	460
rising	08/12/94	01:11	34558.05							

Table 3. (continued).

Line Segment	Date (m/d/y)	Time (h:m)	Serial time (days)	Delta time (days)	Measured Infiltration rate (gpm)	Estimated Infiltration rate (gpm)	Product of rate delta T (gpm*days)	Sum of rate delta T (gpm*days)	Sum of delta T (days)	Average = sum (gpm*days)/ sum (days) (gpm)
5-6b	08/12/94	01:26	34558.06	0.500		426	213	7942	17.319	459
rising	08/12/94	13:26	34558.56							
5-6c	08/12/94	13:41	34558.57	0.490		510	250	8192	17.809	460
rising	08/13/94	01:26	34559.06							
5-6d	08/13/94	01:41	34559.07	0.510		588	300	8492	18.319	464
rising	08/13/94	13:56	34559.58							
6	08/13/94	14:11	34559.59	0.708	601		426	8917	19.028	469
	08/14/94	07:11	34560.30							
6-7	08/14/94	07:26	34560.31	0.346		614	212	9130	19.373	471
rising	08/14/94	15:44	34560.66							
7	08/14/94	15:59	34560.67	0.865	614		530	9660	20.238	477
	08/15/94	12:44	34561.53							
7-8	08/15/94	13:29	34561.56	0.198		612	121	9781	20.436	479
rising	08/15/94	18:14	34561.76							
8	08/15/94	18:29	34561.77	0.646	644		416	10197	21.082	484
	08/16/94	09:59	34562.42							
8-9	08/16/94	10:14	34562.43	0.156		610	95	10293	21.238	485
rising	08/16/94	13:59	34562.58							
9	08/16/94	14:14	34562.59	0.781	648		506	10799	22.019	490
	08/17/94	08:59	34563.37							
9-10	08/17/94	09:14	34563.38	0.229		607	139	10938	22.248	492
rising	08/17/94	14:44	34563.61							
10	08/17/94	14:59	34563.62	0.281	646		182	11120	22.530	494
	08/17/94	21:44	34563.91							
10-11	08/17/94	21:59	34563.92	0.135		624	84	11204	22.665	494
rising	08/18/94	01:14	34564.05							
11	08/18/94	01:29	34564.06	0.698	631		440	11644	23.363	498
	08/18/94	18:14	34564.76							
11-12	08/18/94	18:29	34564.77	0.260		621	162	11806	23.623	500
rising	08/19/94	00:44	34565.03							
12	08/19/94	00:59	34565.04	1.167	620		723	12529	24.790	505
	08/20/94	04:59	34566.21							
12-13	08/20/94	05:14	34566.22	0.406		620	252	12781	25.196	507
rising	08/20/94	14:59	34566.62							

Table 3. (continued).

Line Segment	Date (m/d/y)	Time (h:m)	Serial time (days)	Delta time (days)	Measured Infiltration rate (gpm)	Estimated Infiltration rate (gpm)	Product of rate delta T (gpm*days)	Sum of rate delta T (gpm*days)	Sum of delta T (days)	Average = sum (gpm*days)/ sum (days) (gpm)
13	08/20/94	15:14	34566.63	1.073	657		705	13485	26.269	513
	08/21/94	16:59	34567.71							
13-14	08/21/94	17:14	34567.72	0.135		615	83	13568	26.405	514
rising	08/21/94	20:29	34567.85							
14	08/21/94	20:44	34567.86	0.573	632		362	13930	26.978	516
	08/22/94	10:29	34568.44							
14-15	08/22/94	10:44	34568.45	0.198		613	121	14052	27.176	517
rising	08/22/94	15:29	34568.65							
15	08/22/94	15:44	34568.66	0.740	648		479	14531	27.915	521
	08/23/94	09:29	34569.40							
15-16	08/23/94	09:44	34569.41	0.281		614	173	14704	28.196	521
rising	08/23/94	16:29	34569.69							
16	08/23/94	16:44	34569.70	0.813	619		503	15206	29.009	524
	08/24/94	12:14	34570.51							
16-17	08/24/94	12:29	34570.52	0.240		618	148	15354	29.248	525
rising	08/24/94	18:14	34570.76							
17	08/24/94	18:29	34570.77	0.760	630		479	15833	30.009	528
	08/25/94	12:44	34571.53							
17-18	08/25/94	12:59	34571.54	0.229		619	142	15975	30.238	528
rising	08/25/94	18:29	34571.77							
18	08/25/94	18:44	34571.78	0.760	610		464	16439	30.998	530
	08/26/94	12:59	34572.54							
18-19	08/26/94	13:14	34572.55	0.240		615	147	16586	31.238	531
rising	08/26/94	18:59	34572.79							
19	08/26/94	19:14	34572.80	0.760	611		465	17051	31.998	533
	08/27/94	13:29	34573.56							
19-20	08/27/94	13:44	34573.57	0.240		617	148	17199	32.238	533
rising	08/27/94	19:29	34573.81							
20	08/27/94	19:44	34573.82	0.490	603		295	17494	32.728	535
	08/28/94	07:29	34574.31							
20-21	08/28/94	07:44	34574.32	0.281		633	178	17672	33.009	535
rising	08/28/94	14:29	34574.60							
21	08/28/94	14:44	34574.61	0.719	651		468	18140	33.728	538
	08/29/94	07:59	34575.33							

Table 3. (continued).

Line Segment	Date (m/d/y)	Time (h:m)	Serial time (days)	Delta time (days)	Measured Infiltration rate (gpm)	Estimated Infiltration rate (gpm)	Product of rate delta T (gpm*days)	Sum of rate delta T (gpm*days)	Sum of delta T (days)	Average = sum (gpm*days)/ sum (days) (gpm)
21-22 rising	08/29/94 08/29/94	08:14 12:59	34575.34 34575.54	0.198		636	126	18265	33.926	538
22	08/29/94 08/30/94	13:14 07:59	34575.55 34576.33	0.781	646		505	18770	34.707	541
22-23 rising	08/30/94 08/30/94	08:14 12:59	34576.34 34576.54	0.198		625	124	18894	34.905	541
23	08/30/94 08/30/94	13:14 15:44	34576.55 34576.66	0.104	479		50	18944	35.009	541
23-24 rising	08/30/94 08/30/94	15:59 18:14	34576.67 34576.76	0.094		645	60	19004	35.103	541
24a	08/30/94 09/01/94	18:29 22:25	34576.77 34578.93	2.164	565		1223	20227	37.267	543
24b	09/01/94 09/04/94	22:25 02:21	34578.93 34581.10	2.164	545		1179	21406	39.431	543
24c	09/04/94 09/06/94	02:21 06:17	34581.10 34583.26	2.164	412		892	22298	41.595	536
24d	09/06/94 09/08/94	06:17 10:14	34583.26 34585.43	2.164	372		805	23103	43.759	528
	Totals:			43.759			23103			avg rate: 528

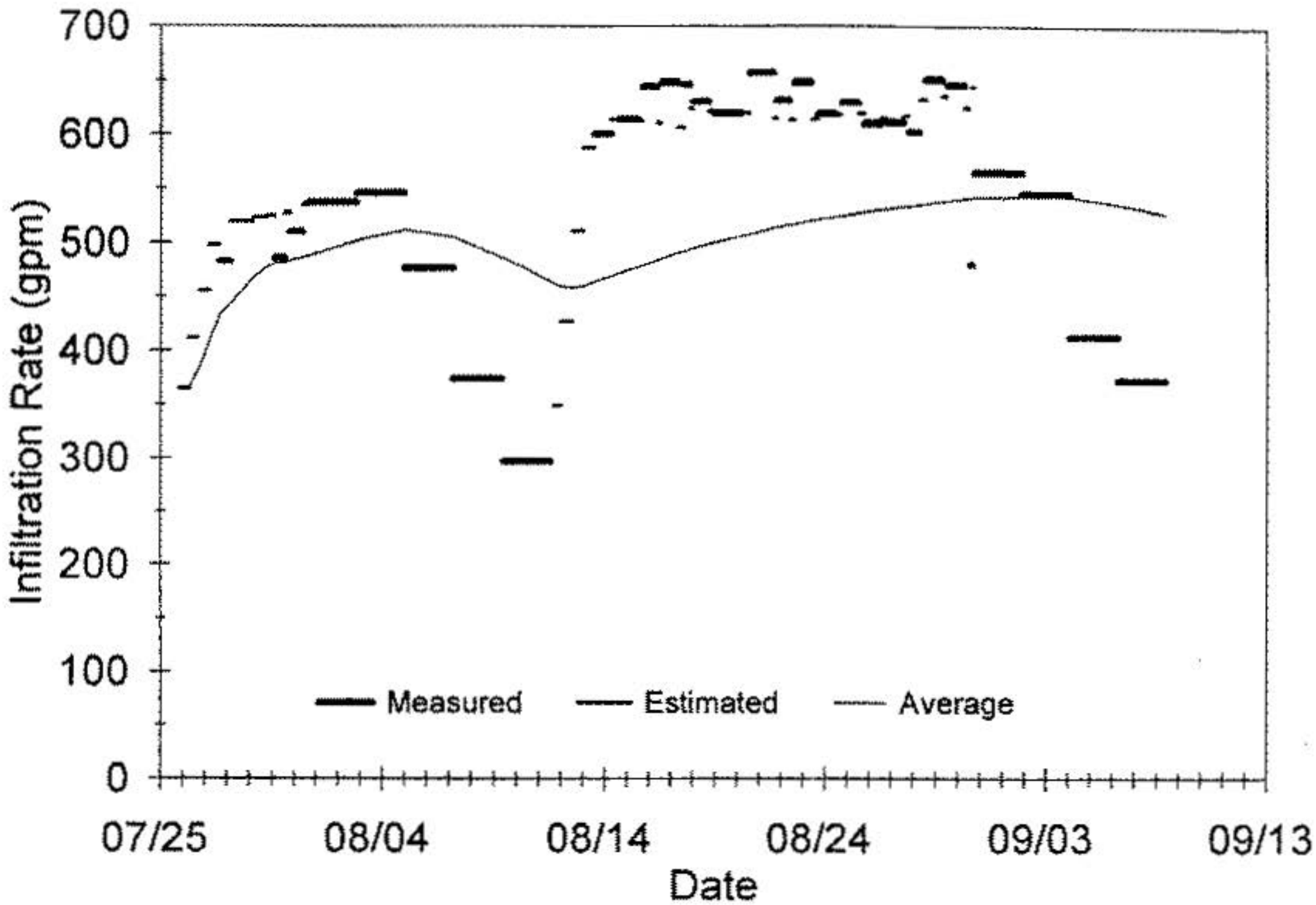

Figure 15. Time-weighted average infiltration rate.

4.4 Volume Balance Calculations

The volume balance was calculated as a check on the calculations and data used to determine infiltration rates and fluxes.

The volume balance for the infiltration basin was calculated by comparing the inputs and losses of water to and from the basin. These calculations apply to the period from July 25, when water was first placed into the basin, to September 8, when the water level fell below the pressure transducer.

The volume balance for the infiltration basin is:

- 38.6 million gal discharged into the pipeline
- 0.1 million gal to fill the pipeline
- 38.5 million gal discharged from the pipeline
- 0.1 million gal added to the basin from precipitation
- 4.9 million gal removed from the basin via evaporation
- 33.3 million gal removed from the basin via infiltration

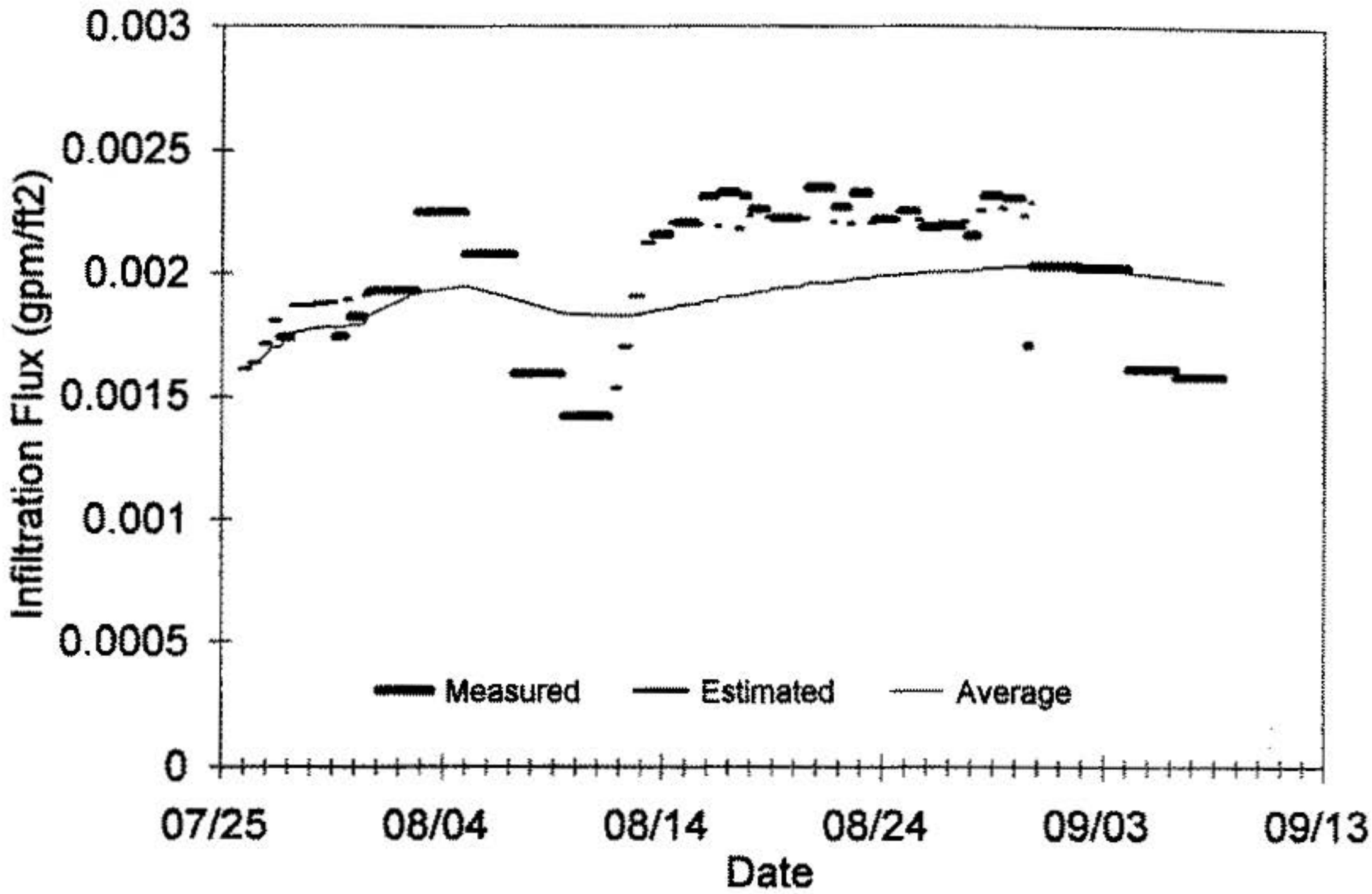

Figure 16. Time-weighted average infiltration flux.

- 1.8 million gal remaining in the basin on September 8
- 1.4-million-gal error.

The error is the difference between the volume of water added to the basin from the pipeline and precipitation, and the sum of the losses due to evaporation and infiltration and the volume that remained at the end of the test.

The 1.4-million-gal error is 3.6% of the volume of water discharged to the infiltration basin. This error probably arises from measurement errors in all of the parameters used in the infiltration rate calculations. Factors that could cause the observed error include the measured volume of water discharged into the basin being smaller than the true volume discharged, and the calculated volumes of water lost via evaporation or infiltration being larger than the true amounts. A 3.6% error is acceptable for this type of calculation. If all of the volume balance error is attributable to the volume of water that infiltrated, the revised infiltrated volume is 33.3 - 1.4 = 31.9 million gal. The difference between this value and the calculated infiltration volume is 4.2%, and the corresponding infiltration rates would also vary by 4.2%. A 4.2% uncertainty in infiltration rate values is acceptable.

5. CONCEPTUAL MODELS FOR THE VARIATION OF INFILTRATION RATE WITH STAGE

The variation in infiltration rate with basin stage was illustrated in Figures 12 and 13. Two mechanisms are hypothesized to account for this relationship. The first, suggested by Burgess (1995), attributes the greater infiltration rate at higher stage to the presence of basalt at ground surface, without an overlying soil layer, along a ridge in the infiltration basin. The fractured basalt is more permeable than the soil, and the infiltration rate increases with stage because more basalt is submerged at higher stage than at lower stage. This mechanism does not account for the variation of infiltration rate at stages below which exposed basalt would be submerged. Sharp changes in infiltration rate would be expected at stages at which exposed basalt was first submerged, yet no sharp breaks are apparent in the infiltration rate - stage regression.

An alternative mechanism is suggested here, namely that the variation in infiltration rate with stage occurs because the hydraulic gradient across the surficial soil layer varies with stage.

The soil is less permeable than the underlying fractured basalt; therefore, the infiltration flux into the subsurface is controlled by the infiltration flux through the soil layer. The dependence of infiltration flux on stage can be illustrated with a two-layer model consisting of a less permeable unit (the soil layer) overlying a more permeable unit (the basalt). The vertical flux through the soil layer is described by the Darcy equation

$$q = -K\frac{dH}{dZ} \tag{10}$$

where

q = flux

K = hydraulic conductivity

H = hydraulic head

Z = vertical spatial coordinate

d/d = differential operator.

Hydraulic head consists of two components, pressure potential (ψ) and elevation potential (Z):

$$H = \psi + Z \quad . \tag{11}$$

Pressure potential is defined as the pressure in water divided by water density and gravity.

After water was placed into the basin, the dry soils imbibed water and became saturated. The transient response is complex, but the steady-state response (after the soil reaches saturation throughout) is much less complex. For the case of a soil saturated with water throughout, with water just ponded at the upper surface (i.e., there is a thin film of water at the ground surface) and a freely draining lower surface, the distribution of hydraulic head and its components is illustrated by Figure 17. With water just ponded at the ground surface, the water table is at location 'A' and $\psi = 0$ at the soil surface since a water table is defined as a surface at atmospheric pressure (zero gauge pressure). It is assumed that water can freely drain into the basalt, which has a highly fractured or rubbly upper surface. Essentially, this implies that water drips from the lower surface of the soil layer into voids in the basalt. With this assumption, $\psi = 0$ at the lower surface of the soil layer and throughout the soil layer. The elevation component of hydraulic head is simply the height of points 3 and 2 above the elevation datum, point 1. The values of hydraulic head at points 1 and 2 are obtained by summing the pressure potential and elevation potential. Since pressure potential is zero, the hydraulic head is equal to the elevation component.

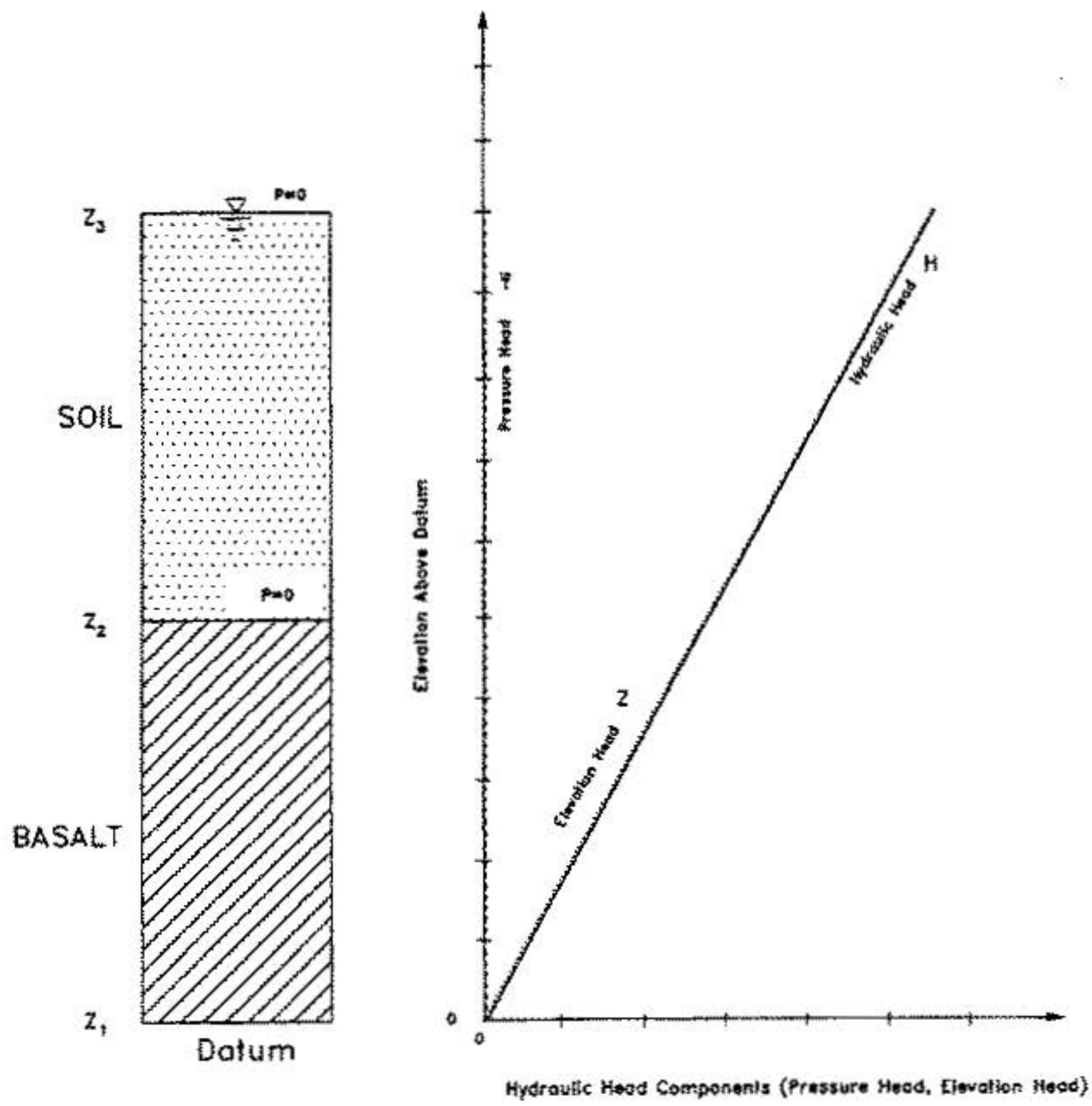

Figure 17. Hydraulic head profile with water ponded at the soil surface.

The hydraulic gradient is equal to the difference in hydraulic head between the top and bottom of the soil layer divided by the thickness of the soil layer. In this case,

$$\frac{dH}{dZ} = \frac{H_2 - H_1}{Z_2 - Z_1} = \frac{Z_2 - Z_1}{Z_2 - Z_1} = 1 \tag{12}$$

and the flux through the soil layer is

$$q = -K\frac{dH}{dZ} = -K \quad . \tag{13}$$

The negative sign indicates that flow is downward.

Thus, if water is just ponded at the soil surface, the infiltration flux at steady state is equal to the saturated hydraulic conductivity of the soil.

If the depth of ponding increases, ψ_1 increases in proportion to the depth of ponding, but ψ_2 remains zero. The hydraulic head at the top of the soil layer is described by

$$H_1 = \psi_1 + Z_1 = d + Z_1 \tag{14}$$

where

d = depth of ponding.

The hydraulic head at the bottom of the soil layer, H_2, is equal to Z_2.

Figure 18 shows the hydraulic head profile with different depths of ponding. Note that the hydraulic gradient across the soil layer increases as the depth of ponding increases. The relationship between hydraulic gradient and depth of ponding is

$$\frac{dH}{dZ} = \frac{H_2 - H_1}{Z_2 - Z_1} = \frac{Z_2 - (Z_1 + d)}{Z_2 - Z_1} = 1 - \frac{d}{Z_2 - Z_1} = 1 + \frac{d}{b} \tag{15}$$

where

b = thickness of the soil layer, $Z_1 - Z_2$.

The flux through the soil layer as a function of depth of ponding is therefore

$$q = -K\frac{dh}{dL} = -K\left(1 + \frac{d}{b}\right) \quad . \tag{16}$$

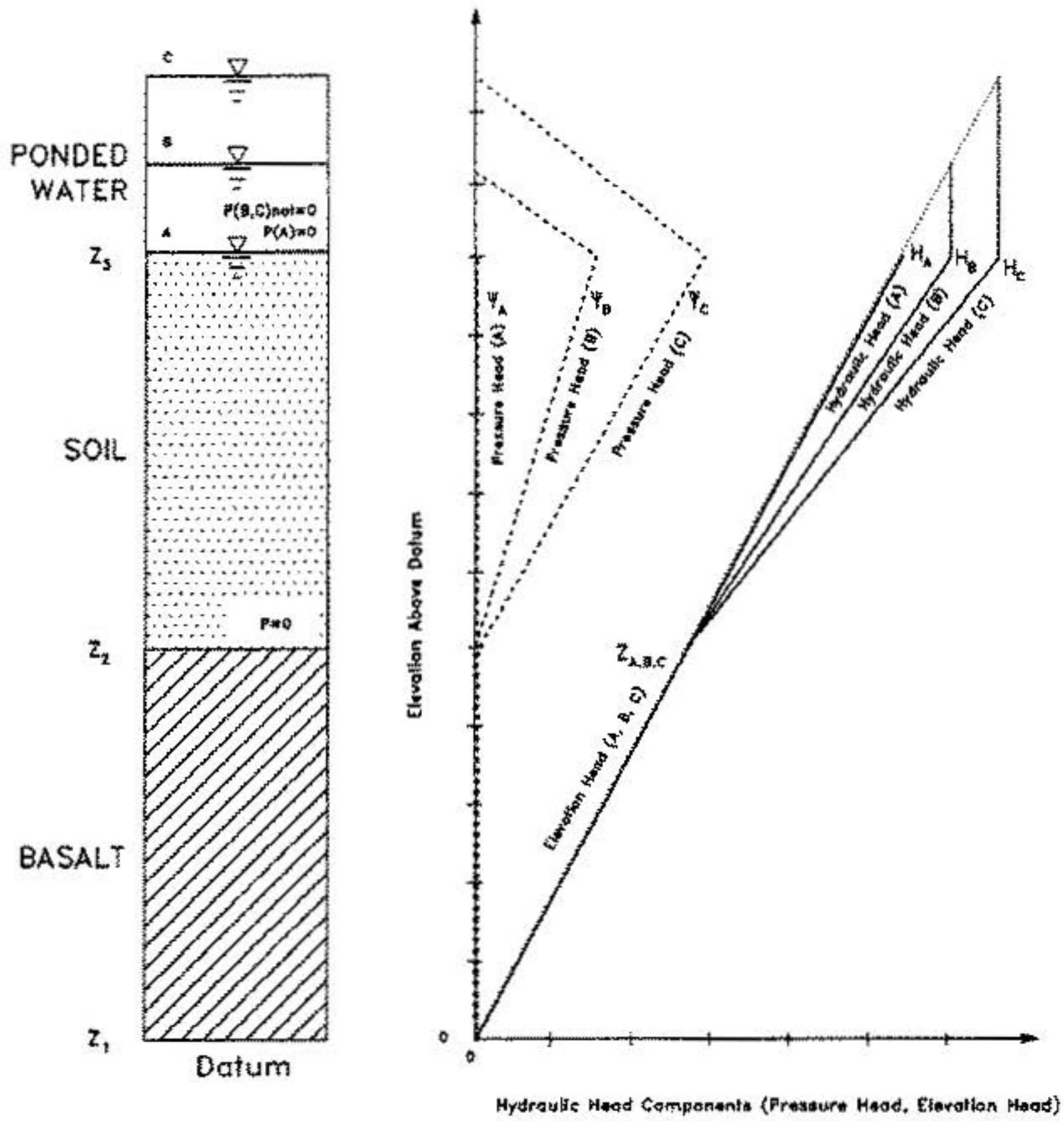

Figure 18. Hydraulic head profiles at different ponding depths.

This model shows that the infiltration flux has a non-zero value at a ponded depth of zero and increases linearly with ponded depth. These features are consistent with the characteristics of the relationship between stage and infiltration rate presented in Figures 12 and 13. In addition, this model predicts that the infiltration rate is inversely proportional to the thickness of the soil layer. This physically based model accounts for the observed variation of infiltration rate with stage without relying on the existence of zones of different permeability at different elevations.

To illustrate the validity of this model, the infiltration rate was calculated using reasonable parameter values for the infiltration basin. The hydraulic conductivity of the soil was taken as 7.5×10^{-7} m/s, the thickness of the soil layer was 1.5 m (5 ft), the depth of ponding was 0 to 1.5 m (0 to 5 ft), and the area of the basin was 6.5 acres. The calculated infiltration rate—stage relationship is compared to the observed relationship in Figure 19, with the assumption that the depth of ponding is equal to the stage. The good agreement between the calculated and observed data indicate that this model provides a reasonable description of the physical system. The values used do not take into account variations in soil thickness and surface topography throughout the basin, and therefore they should not be taken as representative values for the entire basin.

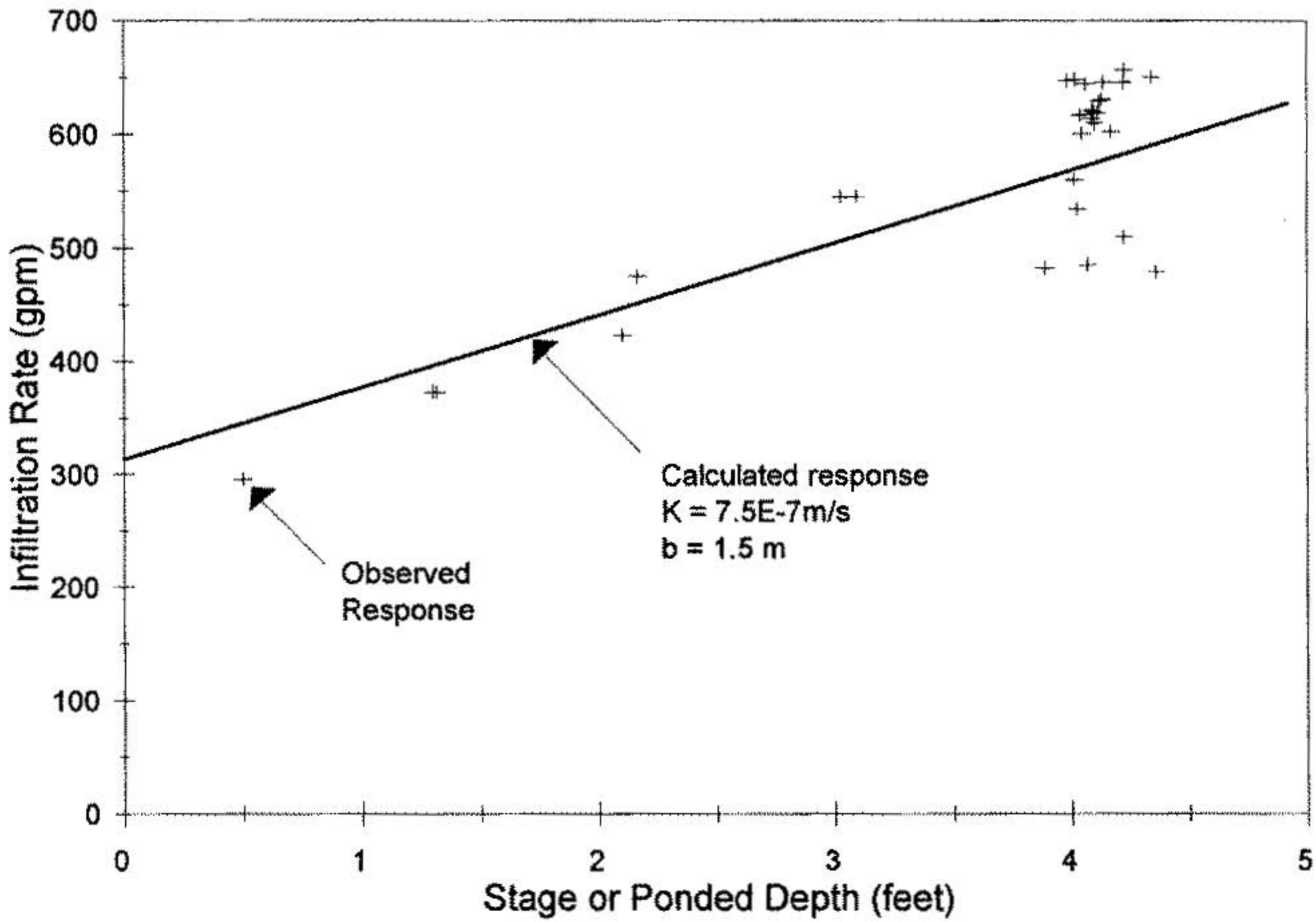

Figure 19. Observed and calculated infiltration rate:stage relationships.

6. SUMMARY

Volume balances for the LSAT and the LSIT are shown below. The values are in millions of gallons.

TEST WELL VOLUME BALANCE

Pumped from test well	148.3
Diverted to Spreading Area A	109.7
Discharged to Spreading Area A	109.6
Pipeline storage	0.1
Diverted to Infiltration Basin	38.6
Discharged to Infiltration basin	38.5
Pipeline storage	0.1

INFILTRATION BASIN VOLUME BALANCE

Inputs	
Discharged into basin	38.5
Precipitation	0.1
Total	38.6
Losses	
Evaporation	4.9
Infiltration	33.3
Total	38.2
Calculated volume in basin at end of test	0.4
Actual volume in basin at end of test	1.8
Volume balance error	1.4

The rate of infiltration from the basin varied with water level (stage) in the basin, and ranged from 297 to 657 gpm. The average rate for the entire experiment was 528 gpm. The infiltration flux also varied with stage and ranged from 1.42×10^{-3} to 2.35×10^{-3} gpm/ft^2. The time-weighted average infiltration flux for the entire experiment was 1.99×10^{-3} gpm/ft^2.

7. REFERENCES

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Appendix A

Flow Meter Installation and Programming Guide

Aquamaster
FLOWMETERS
MODEL 400R AND 500R

INSTALLATION

MANUAL with PROGRAMMING

GUIDE

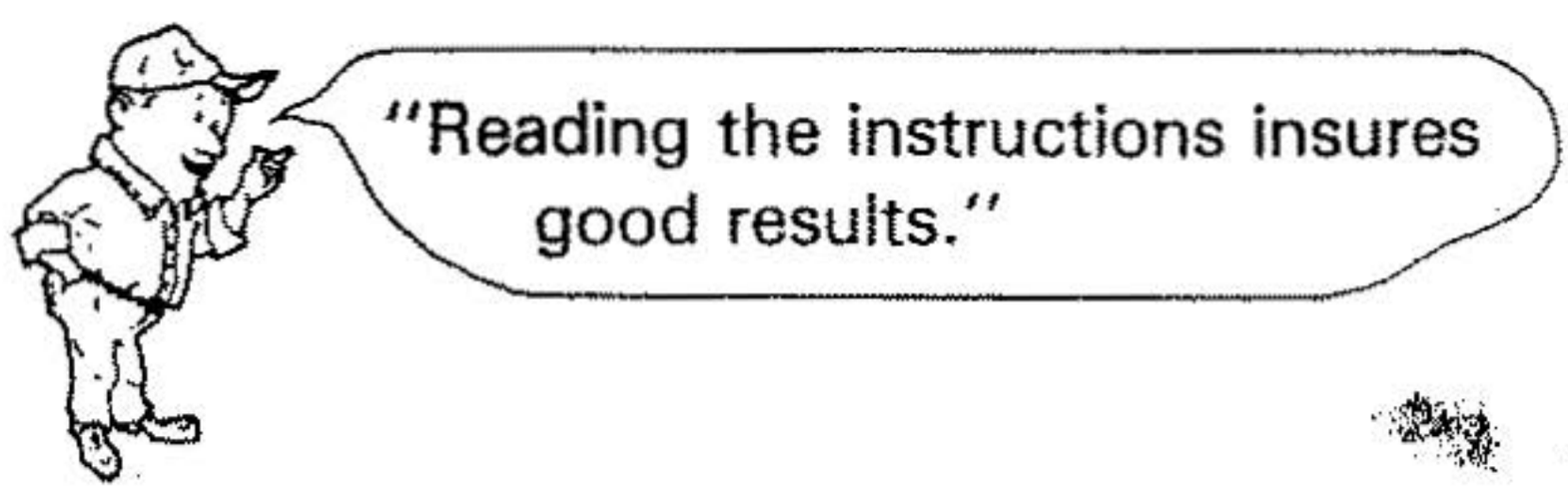

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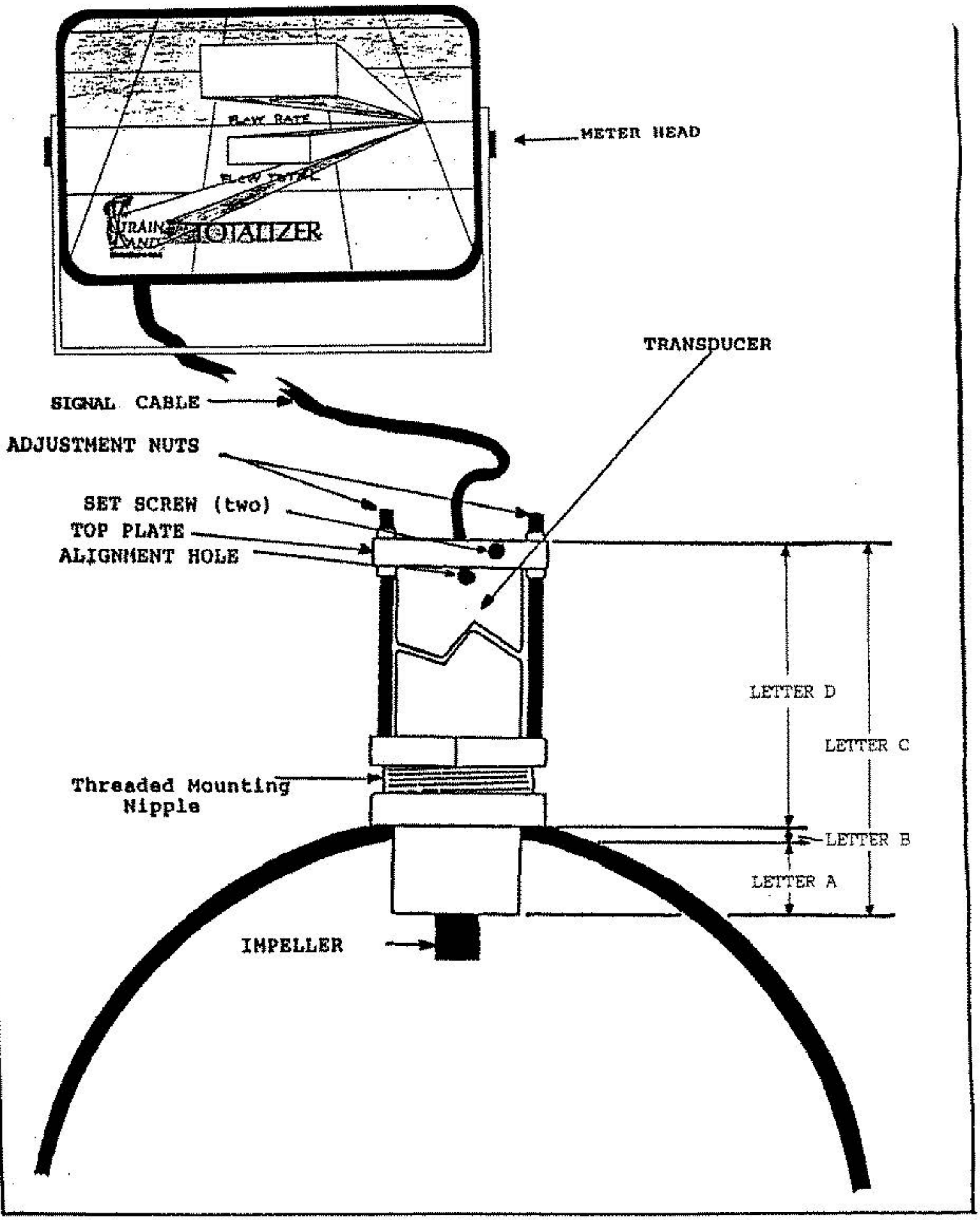
FIGURE 1


FLOW RATE
FLOW TOTAL
TRAIN AND TOTALIZER
METER HEAD
TRANSDUCER
SIGNAL CABLE
ADJUSTMENT NUTS
SET SCREW (two)
TOP PLATE
ALIGNMENT HOLE
LETTER D
LETTER C
Threaded Mounting Nipple
LETTER B
LETTER A
IMPELLER

SPECIFICATIONS

INSTALLATION;

Full pipe
Straight run;
Minimum 10 pipe diameters upstream
5 pipe diameters downstream

Pipe orientation;
To your convenience, top half of pipe
2 or 10 o'clock position if small sticks are present in water.
Horizontal or vertical upflows

PIPE SIZES;

1 1/2 inch to 24 inch (400R)
1 1/2 inch to 24 inch (500R)

PERFORMANCE;

Accuracy: + or - 2%
Flow range: 1 to 20 feet per second
Temperature: 170 degrees F
Pressure: 150 PSI

PIPE LINE CONNECTION;

2 inch NPT coupler

CABLE;

2 conductor shielded, 24 gauge or larger
15 feet provided
1000 feet maximum

MATERIALS;

Transducer: Brass, standard PVC, optional
Impeller: Kynar
Shaft: Carbide
Bearings: Ceramic

TOTALIZER;

Weather resistant cast aluminum enclosure
Rate displayed in liquid crystal display
Total displayed: electro-mechanical, standard
liquid crystal, optional
resettible total, optional
Battery life: estimated 5 year minimum
Environmental temperature range:
Operational, -20 F to 165 F
Storage, -40 F to 165 F

NOTE: Totalizers can be programmed to give the following readings:

Rate = GPM	Total = Gallons
Rate = GPM	Total = Acre-feet
Rate = CFS	Total = Acre feet
Rate = Liters	Total = Cubic Meters

1. INSTALLATION

The insertion impeller meter is designed to be installed into the line with its rotor at the average flow velocity point. Figure 2 (page 4) lists the recommended insertion depths for lines ranging from 2 through 40 inch diameters. Prior to installation, the installer should verify that the line size corresponds to the calibration tag on the side of the totalizer.

1.1 SITE SELECTION

Selecting the correct meter location is critical to the overall performance of the flowmeter. We recommend a location that meets this criteria:

A. Allows safe access for installation and operating personnel.
B. Provides a straight, unobstructed run of pipe that is equal to at least 10 times the diameter of the pipe on the upstream side and 5 times the diameter of the pipe on the downstream side of the meter.
C. Provides a full pipe of water at ALL times during meter operation.
D. Is free of violent vibrations.

1.2 SITE PREPARATION

The pipe should be prepared when there is no flow or pressure in the line. A 2 1/4 inch hole should be drilled or cut into the line with a hole saw or welder. Any slag or large burrs should be removed from the inside and outside surfaces of the pipe. The hole can be anywhere in the upper half of the pipe, but top mount installations are usually most convenient. (Mounting at a 2 or 10 o'clock position can help to avoid clogging by small sticks.) A 2 inch NPT coupler welded squarely on the pipe or saddle mounted over the hole work equally well.

1.3 ALIGNMENT

Apply pipe thread compound to the threads. Screw the transducer threaded mounting nipple into the NPT coupler and tighten significantly to prevent leaks. Loosen the two set screws on the top plate of the transducer with the allen wrench provided. Insert a screwdriver through the alignment holes to reposition the transducer tube. Position the tube so that the arrow on the "FLOW STICKER" points in the direction of the flow and the screwdriver appears to be aligned with the pipe. (See Diagram 1 on inside back cover.) This insures the impeller is properly aligned in the pipe. If transducer alignment holes are not directly in line with the direction of flow, the impeller will be incorrectly positioned in the stream flow and may cause incorrect readings. Tighten set screws.

1.4 INSERTION DEPTH

To determine the proper insertion depth refer to Figure 2. To obtain the installed length refer to Figure 1 and do this calculation:

6.375" (400R)	-	1.2"	-	.25"	=	4.925"
Total Stem Lgth.	(-)	Insertion Depth	(-)	Wall thickness	(=)	Installed Lgth.
Dimension C		Dimension A		Dimension B		Dimension D

Slide transducer down until "Dimension D" is obtained. Tighten the adjustment nuts. The meter is now operational. (See Diagram 2 on inside back

cover.)

NOTE: When installing a 500R the same calculations are performed, however, the total stem length (Dimension C) is 22.50".

FIGURE 2

GRAINLAND FLOWMETER INSERTION DEPTH CHART

LINE SIZE	INSERTION DEPTH
2"	.5"
3"	1.0"
4"	1.5"
5"	.625"
6"	.75"
8"	1.0"
10"	1.2"
12"	1.4"
14"	1.6"
16"	1.8"
18"	2.0"
20"	2.25"
24"	2.75"
30"	3.55"
36"	4.00"
40"	4.50"

NOTE: Insertion depths are based on the inside diameters of standard schedule 40 pipe. For non-standard pipe diameters, divide the I.D. of your pipe by 8 to obtain the insertion depth. See Section 5 for rescaling instructions. Correct insertion depth is critical to meter accuracy.

1.5 MOUNTING THE ENCLOSURE

The screws holding the mounting bracket to the enclosure can be removed by hand. There are two holes in the mounting bracket so that it can be fastened to a wall, panel, post, etc. Once the bracket is securely mounted, the enclosure can be positioned in the bracket so that it is convenient to use. (Though the enclosure is weather tight, the life of the instrument will be increased if it is placed out of the weather.)

1.6 INSTALLING THE CABLE

The transducer comes with 15 feet of cable. Up to 1000 feet of 2 conductor shielded cable can be added. String the cable from the transducer to the location of the housing, being careful to position the cable so that it will not be tripped over, driven over, etc. It is recommended that the cable be installed in tubing or conduit to protect it from rodent damage.

1.7 CONNECTING THE WIRES

The wires from the transducer and from the totalizer are connected by

simply plugging the connectors on the ends of the wires together. Be sur to push them tightly into one another so that they lock into position. The connectors are designed to fit together in only one position.

NOTE: If step 1.7 is done prior to transducer installation, a rate will appear on the rate indicator by manually spinning the impeller for approximately 6 seconds.

2. TROUBLE SHOOTING

2.1 NO RATE INDICATED: rotor clogged by debris, rotor damaged due to mishandling or foreign objects in the flow stream, flow rate below the minimum range of the meter or bearing failure due to normal wear, or high rate.

2.2 SUSPECTED MEASUREMENT ERROR: meter scaled for different sized line, incorrect installation depth, rotor partially clogged, turbulence in the line, or misalignment of the rotor.

2.3 BATTERY INDICATOR BLANK: Battery is dead. (IF BATTERY IS REPLACED BACKWARDS, SEVERE DAMAGE WILL OCCUR TO THE INSTRUMENT.)

2.4 DISPLAY BLANK: when meter is not running the display will only show the good battery indicator. If the meter should be running but no rate is displayed, refer to section 2.

3. CALIBRATION TO A STANDARD

No periodic recalibration is required, however, if the unit is to be installed in a line size different from its original calibration, or if a measurement error has been verified by a comparison to a "standard", the unit may be recalibrated in the field.

If the meter is installed in a poor measurement location or into a pipe of non-standard inside diameter, measurement accuracy may be degraded. If measurement error is suspected, the unit can be compared to a flow measurement "standard" and adjusted to agree with the "standard". Compare the two flow rates. If adjustment is required, remove the four screws nearest to the corners from the face of the totalizer and support the electronic board in one hand. (Do not remove the four inside screws) Note the settings of the rotary switches S1, S2, and S3. As an example, an 8 inch line normally requires settings as follows: S1 set to 4, S2 set to 4, and S3 set to 1. If the settings were to change to 442, both the flow rate and the totalizer would increase by one part out of 441 or .226%. Adjust the settings until the two flowmeters are in agreement.

4. ADJUSTMENTS FOR NON-SCHEDULE 40 LINE SIZE

Pages 6 and 7 are the programming charts which provide rotary switch settings for schedule 40 pipe and provide the initial settings for changing the general pipe size. (6 inch to 8 inch, or 2 inch to 12 inch, etc.)

It is very important the correct internal diameter of the line be programmed into the meter for accurate readings. The rotary switch settings from the programming charts will be increased or decreased by the same percentage change as the cross sectional area of the pipe changes.

EXAMPLE:

Schedule 40, 8 inch pipe has a cross sectional area of 50.00 sq. in. The pipe in which the meter is to be installed has an internal diameter of 8.2

inches.

Cross sectional area = Radius X Radius X 3.14
Radius = 1/2 of the diameter

For this example: 4.125 X 4.125 X 3.14 = 53.43

The calculations are as follows:

$$\frac{\text{Pipe AREA to be installed}}{\text{Pipe AREA of schedule 40 pipe}} = \frac{53.43 \text{ sq. in.}}{50.00 \text{ sq. in.}} = 1.068 \text{ or } 107\%$$

REMEMBER: If the new pipe is larger than schedule 40 the change will be greater than 1. If the new pipe is smaller than schedule 40 the change will be less than 1.

Now, take the Rotary Switch setting for schedule 40, 8 inch pipe from the programming chart, times the percent change which was just calculated. This will equal the new Rotary Switch setting. EXAMPLE:

Given Rotary Switch setting	X	Percent change	= New Setting		
441	X	1.07	= 471.87	or	472

Finally, turn the Rotary Switches to their new positions. This is done by inserting the small screwdriver provided into the slot on the switch and turning it until the arrow points to the correct number.

By doing these simple calculations, unlimited pipe size possibilities can be measured.

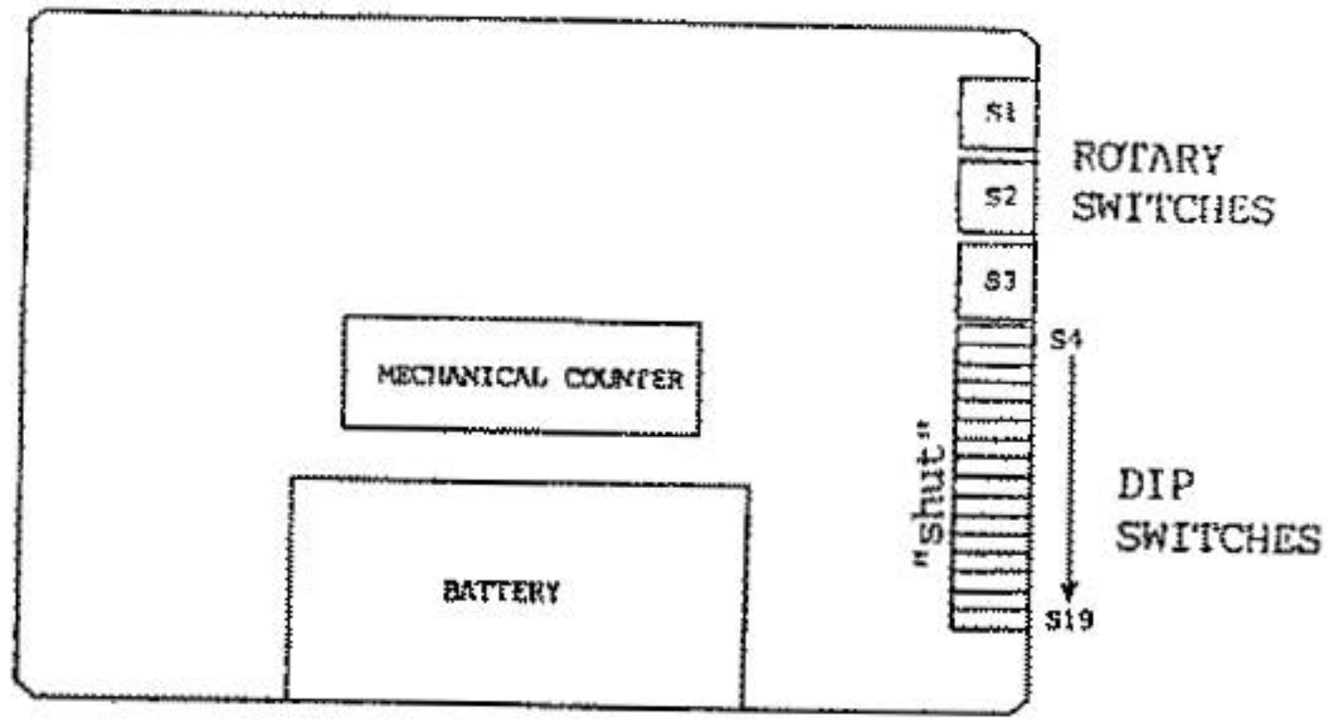
5. REPLACEMENT PARTS

Battery, 3.6 Volt C size, Lithium	---	15-51-20-210-000
Totalizer assembly	---	24620-01-01
Transducer, Brass, 400R Series	---	FTR-400B
PVC, 400R Series	---	FTR-400P
Brass, 500R Series	---	FTR-500B
Impeller and shaft	---	FM-IS-100

The diagram at right shows how the switches on the flowmeter circuit board are numbered:

Switches numbered S1, S2, and S3 are Rotary Switches. Switches numbered S4 to S19 are Dip Switches.

NOTE: DISREGARD THE NUMERALS PRINTED DIRECTLY ON THE DIP SWITCHES.



TO PROGRAM SWITCHES: The chart below shows how each switch on the circuit board is to be set. The Rotary Switch settings given are for schedule 40 pipe with inside diameters as listed. Turn the arrow on each Rotary Switch to the number that appears in the column under the switch number corresponding with the line size of your installation. An "O" in the column under a Dip Switch number indicates that switch is to be OPEN. An "S" in the column under a Dip Switch number indicates that switch is to be SHUT. To program, hold the circuit board according to the diagram above (BATTERY TOWARD BOTTOM). Using a small pointed object, depress the RIGHT HAND SIDE of the switches with an "O" for open, depress the LEFT HAND SIDE of the switches with an "S" for shut. The multipliers for Rate and Total on various line sizes are listed below.

PROGRAMMING CHART:

SWITCH NUMBER			S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19
		ID																			
SWITCH SETTINGS FOR THESE LINE SIZES WITH THE FOLLOW-ING PIPE INSIDE DIAMETER MEASURE-MENTS	2"	2.067"	3	2	7	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	3"	3.068"	7	4	2	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	4"	4.026"	9	6	2	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	6"	6.065"	2	4	5	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	8"	7.981"	4	4	1	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	10"	10.02"	7	1	8	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	12"	11.94"	9	9	9	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	14"	13.12"	1	2	5	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	16"	15.00"	1	6	3	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	18"	16.88"	2	1	1	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	20"	18.81"	2	6	2	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	24"	22.63"	3	7	8	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	30"	30.00"	6	6	4	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O
	36"	36.00"	9	5	6	O	O	O	O	O	O	O	O	O	O	O	O	S	O	O	O

2" TO 4" LINES DISPLAY: RATE = GPM TOTAL = GALLONS X 100

6" TO 12" LINES DISPLAY: RATE = GPM X 10 TOTAL = GALLONS X 1000

14" TO 36" LINES DISPLAY: RATE = GPM X 100 TOTAL = GALLONS X 10000

STEPS TO INSTALLATION OF 400R / 500R TRANSDUCER ON PIPE

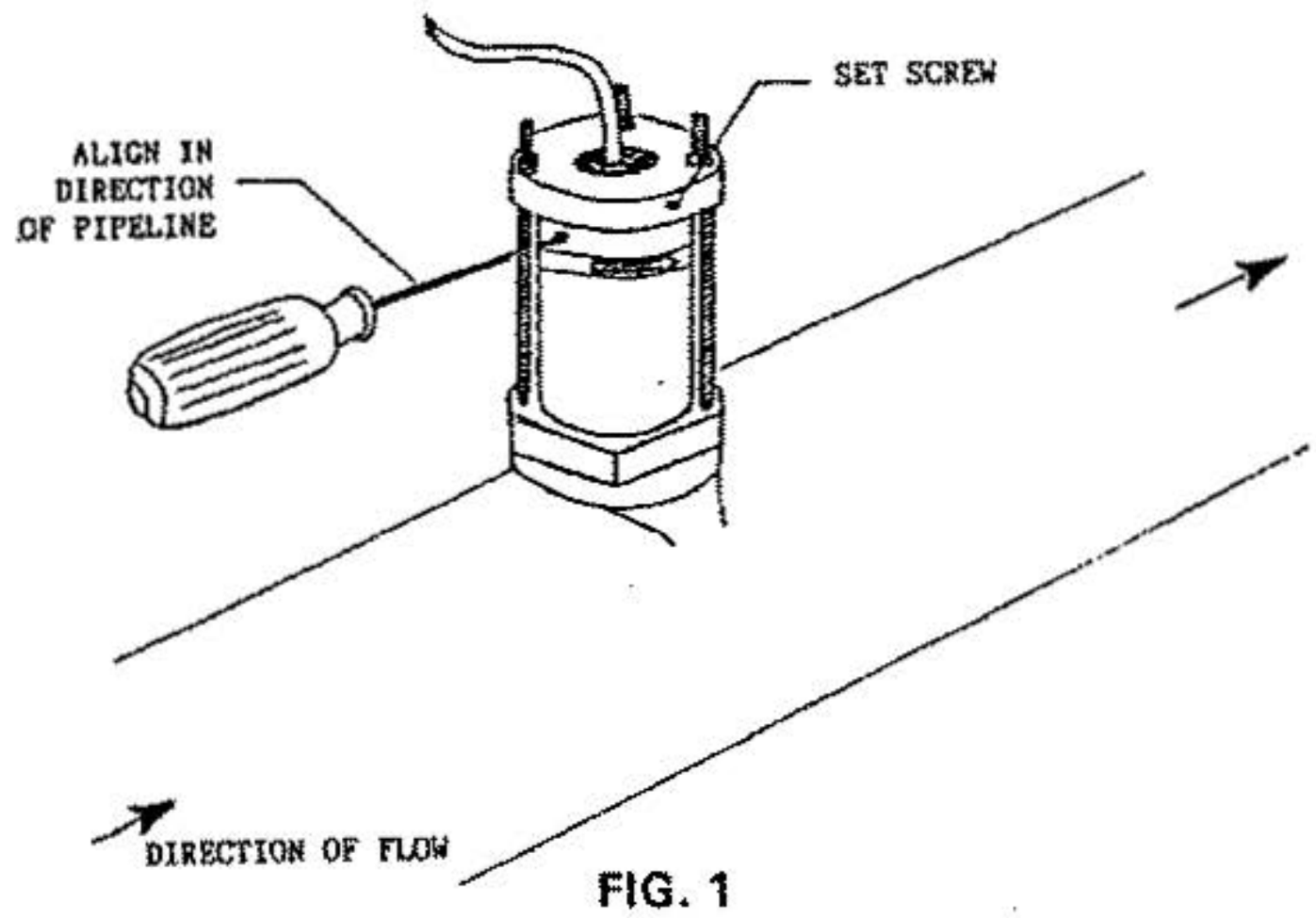
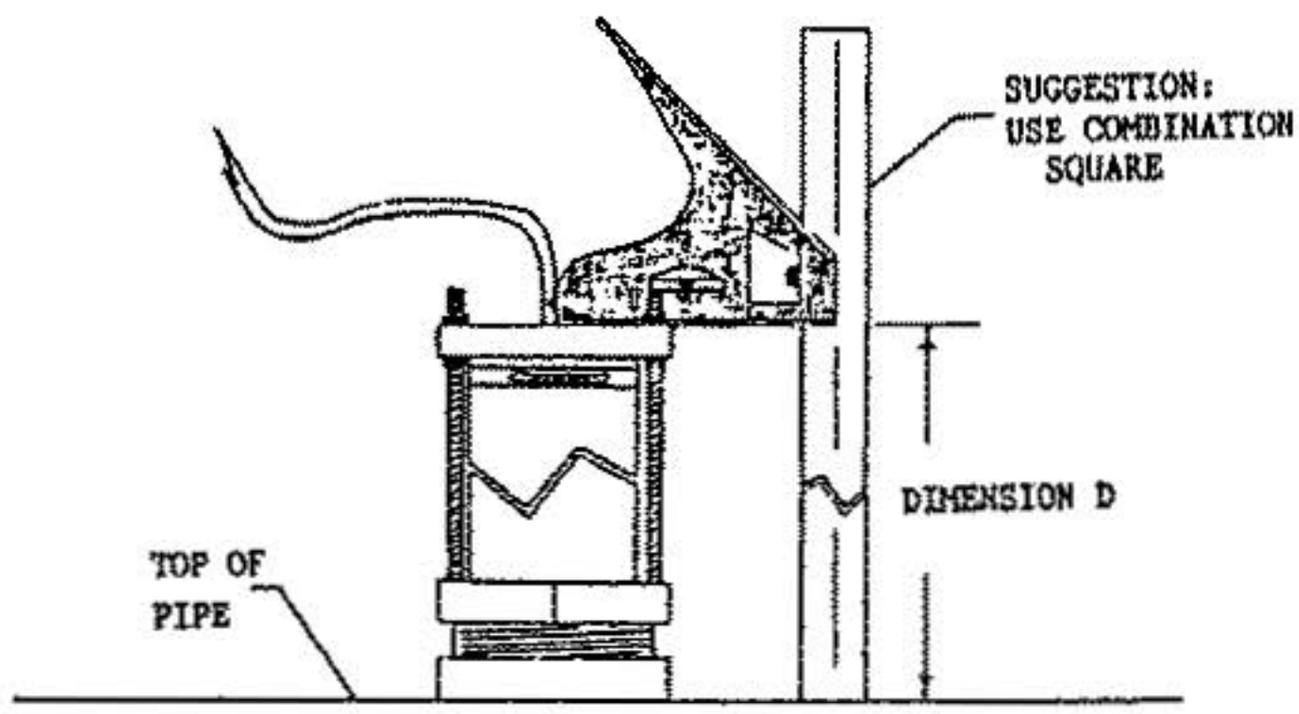


FIG. 1



EXAMPLE FOR 10" SCHEDULE 40 PIPE

6.375"	-	1.2"	-	.25"	=	4.925"
TOTAL STEM LENGTH	minus	INSERTION DEPTH	minus	WALL THICKNESS	equals	INSTALLED LENGTH (dimension D)
CONSTANT		VARIABLE from FIGURE 2 in manual		VARIABLE from STEP 4		VARIABLE

FIG. 2

1. Read Manual before starting.
2. Select location w/ 10 Pipe Diameters upstream and 5 down (10 pipe diameters = 10 X the diameter of the pipe).
3. Cut 2" hole in pipe and remove slag or burrs.
4. Measure ID of pipe and wall thickness for later use.
5. Mount 2" NPT coupler or saddle squarely over hole.
6. Screw transducer in coupler or saddle and tighten.
7. Loosen the set screws located in the top plate.
8. Rotate transducer tube so that a screwdriver inserted through alignment holes will run parallel with the pipe. Be sure water flows in direction of arrow. (See Fig. 1.)
9. Tighten set screws.
10. Calculate insertion depth using measurements from Step 4 and Section 1.4 in Manual. (Example in Fig. 2 for 10" schedule 40 pipe.)
11. Loosen adjustment nuts located on the 3 threaded rods.
12. Slide transducer up or down until dimension D is achieved. Dimension D: Distance from top plate to top of pipe. (See Fig. 2.)
13. Tighten adjustment nuts to lock transducer in position.

Appendix B

Field Records from the Water Management System

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<------	% OPEN	------>)	(<----------		PSIG		----------->)	(FEET)	
07/25/94	10:14	34540.43	-0.05	0	13	0	15												Pre-test values
07/25/94	10:23	34540.43	-0.04										0	0	0	0			
07/25/94	11:01	34540.46	-0.01							80	0	100							
07/25/94	11:20	34540.47	-0.00							0	80	100							
07/25/94	11:21	34540.47	0.00	32	13	0	15												Start of pumping test
07/25/94	11:22	34540.47	0.00										0	20	0				
07/25/94	11:23	34540.47	0.00							0	50	100							
07/25/94	11:25	34540.48	0.00	30	13	0	15												
07/25/94	11:26	34540.48	0.00										5	27	0	27			
07/25/94	11:26	34540.48	0.00	29	13	0	15												
07/25/94	11:27	34540.48	0.00	30	13	0	15												
07/25/94	11:32	34540.48	0.01	29	14	0	15												
07/25/94	11:34	34540.48	0.01							100	0	100							
07/25/94	11:35	34540.48	0.01	29	15	29	15												Flow to basin
07/25/94	11:35	34540.48	0.01										5	22	20	10			
07/25/94	11:39	34540.49	0.01	29	16	29	16												
07/25/94	11:43	34540.49	0.02										5	28	27	10			
07/25/94	11:50	34540.49	0.02	30	19	30	19												
07/25/94	12:03	34540.50	0.03	28	23	31	24												
07/25/94	12:04	34540.50	0.03							100	0	100							
07/25/94	12:05	34540.50	0.03										5	26	27	10			
07/25/94	12:10	34540.51	0.03							0	100	100							
07/25/94	12:10	34540.51	0.03	27	25	0	26												Flow to spreading area
07/25/94	12:14	34540.51	0.04	30	26	0	26												
07/25/94	12:39	34540.53	0.05	29	34	0	26												
07/25/94	12:49	34540.53	0.06							0	100	100							
07/25/94	12:50	34540.53	0.06	30	37	0	26												
07/25/94	12:53	34540.54	0.06					0	5										
07/25/94	12:54	34540.54	0.06	30	38	28	26												Flow to basin
07/25/94	12:54	34540.54	0.06					30	5										
07/25/94	12:54	34540.54	0.06							100	0	100							
07/25/94	13:57	34540.58	0.11	29	56	30	45												
07/25/94	13:57	34540.58	0.11							100	0	100							
07/25/94	14:22	34540.60	0.13	29	63	29	52												
07/25/94	14:24	34540.60	0.13										5	29	27	10			
07/25/94	14:45	34540.61	0.14										4	29	27	10			
07/25/94	14:46	34540.62	0.14							100	0	100							
07/25/94	14:47	34540.62	0.14	29	71	29	59												
07/25/94	15:12	34540.63	0.16									100							
07/25/94	15:12	34540.63	0.16					31	48										
07/25/94	19:15	34540.80	0.33					31	124										
07/25/94	20:08	34540.84	0.37									100							
07/25/94	20:10	34540.84	0.37														0		
07/25/94	20:10	34540.84	0.37					30	141										
07/25/94	20:13	34540.84	0.37															0.43	
07/25/94	20:19	34540.85	0.37										0	30	29	0			
07/25/94	20:21	34540.85	0.38							100	0								
07/25/94	20:22	34540.85	0.38	29	167	30	99												
07/25/94	21:07	34540.88	0.41															0.52	
07/25/94	21:10	34540.88	0.41					31	159										
07/26/94	00:12	34541.01	0.54										0	30	30	0			
07/26/94	00:13	34541.01	0.54	30	233	29	99												Totalizer 2 stuck
07/26/94	00:14	34541.01	0.54							100	0	100							
07/26/94	00:45	34541.03	0.56					31	225										
07/26/94	00:45	34541.03	0.56														0	0.88	

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	----->)	(<----		PSIG		----->)	(FEET)	
07/26/94	06:08	34541.26	0.78										0	30	30	0			
07/26/94	06:09	34541.26	0.78	29	293	30	99												
07/26/94	06:09	34541.26	0.78							100	0	100							
07/26/94	06:24	34541.27	0.79														0	1.42	
07/26/94	06:24	34541.27	0.79					32	331										
07/26/94	10:50	34541.45	0.98										0	30	29	10	0	1.80	
07/26/94	10:51	34541.45	0.98							100	0	100							
07/26/94	10:51	34541.45	0.98	29	357	28	184												
07/26/94	10:51	34541.45	0.98					31	418										
07/26/94	15:39	34541.65	1.18										0	30	29	10	0	2.20	
07/26/94	15:39	34541.65	1.18	30	446	29	276												
07/26/94	15:39	34541.65	1.18					32	514										
07/26/94	15:39	34541.65	1.18							100	0	100							
07/26/94	23:41	34541.99	1.51	29	579	29	412												
07/26/94	23:43	34541.99	1.52										0	31	30	10			
07/26/94	23:43	34541.99	1.52							100	0	100							
07/27/94	00:05	34542.00	1.53					30	660										
07/27/94	00:05	34542.00	1.53														0	2.82	
07/27/94	06:28	34542.27	1.80										0	30	30	8			
07/27/94	06:28	34542.27	1.80	29	614	29	533												
07/27/94	06:28	34542.27	1.80							100	0	100							
07/27/94	06:46	34542.28	1.81					31	785										
07/27/94	06:46	34542.28	1.81														0	3.32	
07/27/94	11:24	34542.48	2.00							100	0	100							
07/27/94	11:24	34542.48	2.00	29	682	29	622						0	30	29	10	0	3.68	
07/27/94	11:42	34542.49	2.01					31	878										
07/27/94	15:45	34542.66	2.18										0	30	29	10			
07/27/94	15:45	34542.66	2.18	30	758	29	689												
07/27/94	15:45	34542.66	2.18							100	0	100							
07/27/94	15:46	34542.66	2.18	28	759	0	689												Flow to spreading area
07/27/94	15:46	34542.66	2.18							0	100								
07/27/94	15:46	34542.66	2.18										0	31	10	31			
07/27/94	18:04	34542.75	2.28							0	100	100							
07/27/94	18:04	34542.75	2.28	28	799	0	689												
07/27/94	18:04	34542.75	2.28					0	953										
07/27/94	18:04	34542.75	2.28										0	31	10	31	0	3.95	
07/28/94	01:08	34543.05	2.57										0	22	10	22			
07/28/94	01:08	34543.05	2.57	29	920	0	689												
07/28/94	01:08	34543.05	2.57							0	100	100							
07/28/94	01:08	34543.05	2.57					0	953										
07/28/94	06:00	34543.25	2.78	27	973	8	689												Partial flow to basin. Valve
07/28/94	06:00	34543.25	2.78							70	30	100							adjustments 0305-
07/28/94	06:00	34543.25	2.78										0	15	15	12	0		0347 not recorded.
07/28/94	06:23	34543.27	2.79					9	968										
07/28/94	06:30	34543.27	2.80														0	3.84	
07/28/94	13:27	34543.56	3.09										0	14	14	11			
07/28/94	13:28	34543.56	3.09							100	30								
07/28/94	13:30	34543.56	3.09	27	1075	10	699												Totalizer 2 failed
07/28/94	13:37	34543.57	3.09					10	1012										
07/28/94	13:38	34543.57	3.10									100							
07/28/94	13:38	34543.57	3.10														0		
07/28/94	13:52	34543.58	3.10															3.97	
07/28/94	18:10	34543.76	3.28	28	1155	10	699												Flow to basin adjusted ca.
07/28/94	18:12	34543.76	3.29							100	30								2100, ca.2200 to~500gpm

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	----->)	(<----		PSIG		----->)	(FEET)	
07/28/94	18:14	34543.76	3.29										0	14	14	11			
07/28/94	18:25	34543.77	3.29					10	1041										
07/28/94	18:26	34543.77	3.30									100							
07/28/94	18:35	34543.77	3.30															4.05	
07/28/94	21:00	34543.88	3.40							100	45	100							
07/28/94	22:00	34543.92	3.44							100	50	100							
07/29/94	00:25	34544.02	3.54										0	14	14	14		4.10	
07/29/94	00:25	34544.02	3.54							100	50	100							
07/29/94	00:25	34544.02	3.54	29	1260	5	699												
07/29/94	00:40	34544.03	3.55					0	1072										
07/29/94	02:50	34544.12	3.65							100	80	100							
07/29/94	03:45	34544.16	3.68							15	100	100							
07/29/94	04:00	34544.17	3.69							0	100	100							
07/29/94	06:20	34544.26	3.79							15	100	100							
07/29/94	08:00	34544.33	3.86	30	1303	0	699												
07/29/94	08:03	34544.34	3.86							15	100								
07/29/94	08:04	34544.34	3.86										0	21	8	12			
07/29/94	08:14	34544.34	3.87									100							
07/29/94	08:30	34544.35	3.88					0	1084										
07/29/94	08:40	34544.36	3.89															4.05	
07/29/94	12:00	34544.50	4.03	28	1373	0	699												Flow to spreading area
07/29/94	12:02	34544.50	4.03							0	100								
07/29/94	12:04	34544.50	4.03										0	10	4	11			
07/29/94	12:20	34544.51	4.04					0	1084										
07/29/94	12:21	34544.51	4.04									100							
07/29/94	12:22	34544.52	4.04														0		
07/29/94	12:40	34544.53	4.05															4.02	
07/29/94	19:52	34544.83	4.35	28	1507	6	699												Partial flow to basin
07/29/94	19:52	34544.83	4.35										0	12	12	12			
07/29/94	19:52	34544.83	4.35							100	35	100							
07/29/94	20:03	34544.84	4.36														0	4.06	
07/29/94	20:03	34544.84	4.36					9	1108										
07/30/94	01:01	34545.04	4.57										0	13	13	13			
07/30/94	01:01	34545.04	4.57	29	1595	8	699												
07/30/94	01:01	34545.04	4.57							100	35	100							
07/30/94	01:01	34545.04	4.57					9	1135										
07/30/94	01:14	34545.05	4.58														0	4.12	
07/30/94	02:52	34545.12	4.65							100	35	100							
07/30/94	02:52	34545.12	4.65	26	1622	6	699												
07/30/94	02:52	34545.12	4.65										0	13	13	13	0	4.15	
07/30/94	02:52	34545.12	4.65					5	1144										
07/30/94	02:54	34545.12	4.65					6	1144										
07/30/94	02:54	34545.12	4.65										0	13	13	13	0	4.15	
07/30/94	02:54	34545.12	4.65	27	1623	5	699												
07/30/94	02:54	34545.12	4.65							100	100	100							
07/30/94	03:12	34545.13	4.66	29	1628	0	699												Flow to spreading area
07/30/94	03:12	34545.13	4.66							0	100	100							
07/30/94	03:12	34545.13	4.66										0	21	21	9	0	4.15	
07/30/94	03:12	34545.13	4.66					0	1144										
07/30/94	06:30	34545.27	4.80					0	1144										
07/30/94	06:30	34545.27	4.80										0	21	21	10	0	4.10	
07/30/94	06:30	34545.27	4.80							0	100	100							
07/30/94	06:30	34545.27	4.80	30	1633	0	699												
07/30/94	12:11	34545.51	5.03	30	1726	0	699												
07/30/94	12:13	34545.51	5.04							0	100								

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	----->)	(<----		PSIG		----->)	(FEET)	
07/30/94	12:15	34545.51	5.04										0	21	5	21			
07/30/94	12:22	34545.52	5.04					0	1144										
07/30/94	12:23	34545.52	5.04									100							
07/30/94	12:25	34545.52	5.04														0		
07/30/94	12:27	34545.52	5.05															4.00	
07/30/94	18:40	34545.78	5.30	29	1838	30	699												Flow to basin ca. 1400.
07/30/94	18:41	34545.78	5.31							100	0								No notes recorded.
07/30/94	18:42	34545.78	5.31										0	30	30	5			
07/30/94	18:57	34545.79	5.32					32	1225										
07/30/94	18:58	34545.79	5.32							100	0	100							
07/30/94	19:00	34545.79	5.32														0	4.26	
07/30/94	19:28	34545.81	5.34					32	1235										
07/30/94	19:28	34545.81	5.34	29	1852	30	699												
07/30/94	19:28	34545.81	5.34							100	0	100							
07/30/94	19:28	34545.81	5.34										0	30	30	0	0	4.28	
07/30/94	19:40	34545.82	5.35										0	31	12	31	0	4.30	
07/30/94	19:40	34545.82	5.35					0	1239										
07/30/94	19:40	34545.82	5.35	29	1856	0	699												Flow to spreading area
07/30/94	19:40	34545.82	5.35							0	100	100							
07/31/94	00:05	34546.00	5.53					0	1239										
07/31/94	00:05	34546.00	5.53	30	1939	0	699												
07/31/94	00:05	34546.00	5.53							0	100	100							
07/31/94	00:05	34546.00	5.53										0	31	12	31	0	4.27	
07/31/94	05:41	34546.24	5.76										0	31	12	31	0	4.16	
07/31/94	05:41	34546.24	5.76							0	100	100							
07/31/94	05:41	34546.24	5.76	30	1993	0	699												
07/31/94	05:41	34546.24	5.76					0	1239										
07/31/94	12:17	34546.51	6.04	29	2092	29	699												Water diverted to basin
07/31/94	12:18	34546.51	6.04							100	0								ca. 1015. Tracer
07/31/94	12:19	34546.51	6.04										0	30	30	5			injection ca. 1130.
07/31/94	12:28	34546.52	6.05					31											
07/31/94	12:28	34546.52	6.05									100							
07/31/94	17:19	34546.72	6.25	29	2180	0	699												Flow to spreading area
07/31/94	17:20	34546.72	6.25							0	100								ca. 1540, no notes
07/31/94	17:21	34546.72	6.25										0	32	10	22			recorded.
07/31/94	17:34	34546.73	6.26									100							
07/31/94	17:35	34546.73	6.26					0	1337										
07/31/94	22:30	34546.94	6.46							0	100	100							
07/31/94	22:30	34546.94	6.46										0	21	22	12			
08/02/94	01:10	34548.05	7.58														0	3.90	
08/02/94	01:12	34548.05	7.58									100							
08/02/94	01:12	34548.05	7.58					0	1337										
08/02/94	01:25	34548.06	7.59										0	22	0	22			
08/02/94	01:25	34548.06	7.59							0	100								
08/02/94	01:25	34548.06	7.59	30	2733	0	699												basin draining
08/02/94	07:54	34548.33	7.86	30	2846	0	699												
08/02/94	12:20	34548.51	8.04	29	2919	0	699												
08/02/94	21:00	34548.88	8.40										0	21	11	21	0		
08/02/94	21:00	34548.88	8.40					0	1337										
08/02/94	21:00	34548.88	8.40	29	3075	0	699												
08/02/94	21:00	34548.88	8.40							0	100	100							
08/02/94	21:19	34548.89	8.42															3.55	
08/03/94	00:11	34549.01	8.53	29	3127	0	699												
08/03/94	00:11	34549.01	8.53					0	1337										
08/03/94	00:11	34549.01	8.53										0	21	11	21	0		

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	---->)	(<----		PSIG		----->)	(FEET)	
08/03/94	00:11	34549.01	8.53							0	100	100							
08/03/94	00:23	34549.02	8.54															3.48	
08/03/94	05:00	34549.21	8.74					0	1337										
08/03/94	05:00	34549.21	8.74										0	22	12	22			
08/03/94	05:00	34549.21	8.74	30	3211	0	699												
08/03/94	05:00	34549.21	8.74							0	100	100							
08/03/94	05:05	34549.21	8.74															3.40	
08/03/94	13:50	34549.58	9.10															3.50	
08/03/94	13:58	34549.58	9.11										0	21	12	21	0		
08/03/94	13:58	34549.58	9.11	29	3365	0	699												
08/03/94	13:58	34549.58	9.11							0	100	100							
08/03/94	13:58	34549.58	9.11					0	1337										
08/03/94	19:17	34549.80	9.33					0	1337										
08/03/94	19:17	34549.80	9.33	29	3457	0	699												
08/03/94	19:18	34549.80	9.33							50	100	0							
08/03/94	19:19	34549.80	9.33										0	30	31	21	0		
08/03/94	19:26	34549.81	9.34															3.17	
08/04/94	01:30	34550.06	9.59	28	3561	0	699												
08/04/94	07:00	34550.29	9.82	29	3652	0	699												
08/04/94	07:00	34550.29	9.82											22	23	22			
08/04/94	12:23	34550.52	10.04										0	21	21	21	0	2.86	
08/04/94	12:35	34550.52	10.05					0	1337										
08/04/94	12:35	34550.52	10.05	29	3747	0	699												
08/04/94	19:24	34550.81	10.34	30	3856	0	699												
08/04/94	19:24	34550.81	10.34					0	1337										
08/04/94	19:25	34550.81	10.34										0	20	21	20	0	2.72	
08/05/94	00:20	34551.01	10.54										0	20	21	21	0	2.62	
08/05/94	00:20	34551.01	10.54							50	100	0							
08/05/94	00:20	34551.01	10.54	30	3949	0	699												
08/05/94	00:20	34551.01	10.54					0	1337										
08/05/94	06:40	34551.28	10.80										0	20	22	22	0	2.53	
08/05/94	06:40	34551.28	10.80							50	100	0							
08/05/94	06:40	34551.28	10.80	29	4022	0	699												
08/05/94	06:40	34551.28	10.80					0	1337										
08/05/94	11:44	34551.49	11.02							50	100	0							
08/05/94	11:44	34551.49	11.02	29	4083	0	699												
08/05/94	11:44	34551.49	11.02					0	1337										
08/05/94	11:44	34551.49	11.02										0	20	21	21	0	2.45	
08/05/94	15:40	34551.65	11.18					0	1337										
08/05/94	15:40	34551.65	11.18	30	4152	0	699												
08/05/94	15:40	34551.65	11.18										0	20	20	20	0	2.34	
08/05/94	15:44	34551.66	11.18							50	100	0							
08/05/94	20:10	34551.84	11.37										0	21	21	21	0	2.29	
08/05/94	20:10	34551.84	11.37							65	100	0							
08/05/94	20:17	34551.85	11.37					0	1337										
08/05/94	20:17	34551.85	11.37	30	4230	0	699												
08/06/94	08:50	34552.37	11.90															2.06	
08/06/94	11:20	34552.47	12.00							70	100	0							
08/06/94	11:20	34552.47	12.00										0	3	4	3	0	2.00	
08/06/94	11:20	34552.47	12.00					0	1337										
08/06/94	11:20	34552.47	12.00	0	4324	0	699												Pump failed 0602->1502.
08/06/94	12:44	34552.53	12.06															1.98	
08/06/94	13:11	34552.55	12.08							65	100	0							
08/06/94	13:15	34552.55	12.08										0	0	0	0	0		
08/06/94	13:15	34552.55	12.08					0	1337										

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	---->)	(<----		PSIG		---->)	(FEET)	
08/06/94	13:15	34552.55	12.08							0									
08/06/94	13:15	34552.55	12.08	0	4324	0	699												
08/06/94	18:01	34552.75	12.28							0	100	0							
08/06/94	18:01	34552.75	12.28					0	1337										
08/06/94	18:01	34552.75	12.28										0	28	0	28			
08/06/94	18:01	34552.75	12.28	28	4379	0	699												
08/06/94	18:28	34552.77	12.30															1.88	
08/06/94	18:47	34552.78	12.31							0	100	0							
08/06/94	18:47	34552.78	12.31										0	28	0	28	0		
08/06/94	18:47	34552.78	12.31	27	4388	0	699												
08/06/94	18:47	34552.78	12.31					0	1337										
08/07/94	00:45	34553.03	12.56										0	21	0	22	0	1.42	
08/07/94	06:20	34553.26	12.79															1.40	
08/07/94	06:55	34553.29	12.82										0	20	0	22	0		
08/07/94	07:00	34553.29	12.82							50	100								
08/07/94	08:46	34553.37	12.89										0	21	0	22	0		
08/07/94	08:46	34553.37	12.89							0	100	0							
08/07/94	08:46	34553.37	12.89	29	4488	0	699												
08/07/94	08:46	34553.37	12.89					0	1337										
08/07/94	08:54	34553.37	12.90															1.65	
08/07/94	12:01	34553.50	13.03					0	1337										
08/07/94	12:01	34553.50	13.03										0	20	0	21	0	1.60	
08/07/94	12:01	34553.50	13.03	28	4544	0	699												
08/07/94	12:01	34553.50	13.03							0	100	0							
08/07/94	12:35	34553.52	13.05							50	100	0							
08/07/94	13:37	34553.57	13.09										0	0	0	0	0	1.20	
08/07/94	18:10	34553.76	13.28					0	1337										
08/07/94	18:10	34553.76	13.28							0	100	0							
08/07/94	18:10	34553.76	13.28										0	20	0	21	0		
08/07/94	18:10	34553.76	13.28	29	4650	0	699												
08/07/94	18:23	34553.77	13.29															1.49	
08/07/94	19:24	34553.81	13.34							50	100	0							
08/07/94	21:04	34553.88	13.40										0	22	0	24	0		
08/07/94	21:16	34553.89	13.41															1.05	
08/08/94	00:40	34554.03	13.55							0	100	0							
08/08/94	00:45	34554.03	13.56	29	4737	0	699												
08/08/94	00:45	34554.03	13.56					0	1337										
08/08/94	06:55	34554.29	13.82					0	1337										
08/08/94	06:55	34554.29	13.82	28	4782	0	699												Totalizer 2 removed
08/08/94	06:55	34554.29	13.82							0	100	0							
08/08/94	13:37	34554.57	14.09					0	1337										Pump failed 0947-->1847
08/08/94	13:37	34554.57	14.09									0							
08/08/94	13:37	34554.57	14.09	0	4787														
08/08/94	21:04	34554.88	14.40	29	4858														
08/08/94	21:04	34554.88	14.40							0	100	0							
08/08/94	21:04	34554.88	14.40					0	1337										
08/09/94	00:30	34555.02	14.55	29	4919														
08/09/94	00:30	34555.02	14.55					0	1337										
08/09/94	00:32	34555.02	14.55							0	100	0							
08/09/94	00:34	34555.02	14.55										0	21	0	23			
08/09/94	06:30	34555.27	14.80							0	100	0							
08/09/94	06:30	34555.27	14.80	29	4960														
08/09/94	06:30	34555.27	14.80					0	1337										
08/09/94	06:30	34555.27	14.80										0	21	0	22	0		
08/09/94	12:02	34555.50	15.03										0	22	4	22	0	0.84	

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	---->)	(<----		PSIG		----->)	(FEET)	
08/09/94	12:08	34555.51	15.03	29	5039														
08/09/94	12:08	34555.51	15.03					0	1337										
08/09/94	12:09	34555.51	15.03							0	100	0							
08/09/94	17:06	34555.71	15.24										0	20	2	22	0	0.76	
08/09/94	17:16	34555.72	15.25	30	5127														
08/09/94	17:16	34555.72	15.25					0	1337										
08/09/94	17:17	34555.72	15.25							0	100	0							
08/10/94	01:30	34556.06	15.59							0	98	0							
08/10/94	01:30	34556.06	15.59	29	5243														
08/10/94	01:30	34556.06	15.59					0	1337										
08/10/94	01:30	34556.06	15.59										0	22	3	22	0		
08/10/94	02:25	34556.10	15.63															0.66	
08/10/94	06:21	34556.26	15.79					0	1337										
08/10/94	06:21	34556.26	15.79	29	5283														
08/10/94	06:21	34556.26	15.79										0	22	4	25	0		
08/10/94	06:21	34556.26	15.79							0	98	0							
08/10/94	06:26	34556.27	15.80															0.60	
08/10/94	12:27	34556.52	16.05										0	21	21	22	0		
08/10/94	12:27	34556.52	16.05	28	5366														
08/10/94	12:27	34556.52	16.05							20	100	0							
08/10/94	12:27	34556.52	16.05					0	1337										
08/10/94	12:37	34556.53	16.05															0.48	
08/10/94	17:42	34556.74	16.26															0.42	
08/10/94	18:32	34556.77	16.30										0	21	22	23	0		
08/10/94	23:30	34556.98	16.51					0	1337										
08/10/94	23:30	34556.98	16.51							20	100	0							
08/10/94	23:37	34556.98	16.51															0.38	
08/11/94	03:05	34557.13	16.66															0.30	
08/11/94	03:10	34557.13	16.66	30	5616														
08/11/94	03:10	34557.13	16.66					0	1337										
08/11/94	03:10	34557.13	16.66							20	100	0							
08/11/94	03:10	34557.13	16.66										0	21	22	23	0		
08/11/94	07:14	34557.30	16.83							20	100	0							
08/11/94	07:14	34557.30	16.83										0	22	22	22	0	0.24	
08/11/94	07:14	34557.30	16.83					0	1337										
08/11/94	07:14	34557.30	16.83	29	5688														
08/11/94	12:59	34557.54	17.07							20	100	0							
08/11/94	13:00	34557.54	17.07							100	0	100							
08/11/94	13:06	34557.55	17.07	29	5788														Flow to basin
08/11/94	13:09	34557.55	17.08										0	30	30	0	0	0.16	
08/11/94	13:19	34557.55	17.08					30	1342										
08/11/94	17:19	34557.72	17.25	30	5861														
08/11/94	17:19	34557.72	17.25					32	1420										
08/11/94	17:20	34557.72	17.25							100	0	100							
08/11/94	17:21	34557.72	17.25										0	30	30	5	0	0.62	
08/11/94	21:00	34557.88	17.40															1.02	
08/11/94	23:26	34557.98	17.50															1.26	
08/12/94	00:00	34558.00	17.53					31	1544										
08/12/94	00:00	34558.00	17.53	28	5978														
08/12/94	00:00	34558.00	17.53										0	30	30	5	0		
08/12/94	00:00	34558.00	17.53							100	0	100							
08/12/94	01:00	34558.04	17.57					29	1567										
08/12/94	01:00	34558.04	17.57															1.39	
08/12/94	03:20	34558.14	17.67	29	6037														

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	---->)	(<----		PSIG		---->)	(FEET)	
08/12/94	03:20	34558.14	17.67										0	30	31	5		1.60	
08/12/94	03:20	34558.14	17.67							100	0	100							
08/12/94	03:20	34558.14	17.67					31	1603										
08/12/94	13:00	34558.54	18.07	30	6202														
08/12/94	13:00	34558.54	18.07										0	30	30	5	0		
08/12/94	13:00	34558.54	18.07							100	0	100							
08/12/94	13:10	34558.55	18.08					31	1763										
08/12/94	18:00	34558.75	18.28							100	0	100							
08/12/94	18:00	34558.75	18.28	30	6288														
08/12/94	18:00	34558.75	18.28										0	30	31	5	0	2.80	
08/12/94	18:26	34558.77	18.30					30	1881										
08/12/94	23:40	34558.99	18.51					31	1984										
08/12/94	23:40	34558.99	18.51	29	6387														
08/12/94	23:40	34558.99	18.51										0	31	31	6	0		
08/12/94	23:40	34558.99	18.51							100	0	100							
08/12/94	23:50	34558.99	18.52															3.20	
08/13/94	07:08	34559.30	17.82															3.75	
08/13/94	07:10	34559.30	18.83										0	31	31	7	0		
08/13/94	07:10	34559.30	18.83					31	2118										
08/13/94	07:10	34559.30	18.83							100	0	100							
08/13/94	07:16	34559.30	18.83	29	6519														
08/13/94	13:20	34559.56	19.08										0	31	31	5	0	4.18	
08/13/94	13:29	34559.56	19.09					29	2233										
08/13/94	13:42	34559.57	19.10							100	0	100							
08/13/94	13:42	34559.57	19.10	29	6630														Flow to spreading area
08/13/94	14:00	34559.58	19.11							100	100	0							@ 1400
08/13/94	18:08	34559.76	19.28					0	2242										
08/13/94	18:08	34559.76	19.28										0	21	20	21	0		
08/13/94	18:08	34559.76	19.28							100	100	0							
08/13/94	18:08	34559.76	19.28	30	6706														
08/13/94	18:36	34559.78	19.30															4.12	
08/14/94	01:00	34560.04	19.57	29	6825														
08/14/94	01:02	34560.04	19.57										0	22	22	23	0		
08/14/94	01:02	34560.04	19.57							100	100	0							
08/14/94	01:09	34560.05	19.58					0	2242										
08/14/94	01:10	34560.05	19.58															4.00	
08/14/94	06:50	34560.28	19.81										0	21	22	25	0	3.90	
08/14/94	07:05	34560.30	19.82					0	2242										
08/14/94	07:05	34560.30	19.82							100	100	0							
08/14/94	07:11	34560.30	19.83	30	6930														2200 gpm to basin for
08/14/94	07:25	34560.31	19.84	30	6933														6 hours
08/14/94	07:25	34560.31	19.84										0	21	22	10			
08/14/94	07:25	34560.31	19.84							100	18	100							
08/14/94	07:30	34560.31	19.84					22	2245										
08/14/94	11:53	34560.50	20.02										0	21	22	0	0	4.09	
08/14/94	11:53	34560.50	20.02							100	18	100							
08/14/94	11:57	34560.50	20.03					22	2303										
08/14/94	12:08	34560.51	20.03	29	7015														
08/14/94	15:55	34560.51	20.03					0	2358	0	100	0							
08/14/94	21:58	34560.92	20.44										0	21	15	23	0	4.08	
08/15/94	05:00	34561.21	20.74	27	7298														Continuing flow to
08/15/94	05:00	34561.21	20.74										0	21	28	25	0	4.02	spreading area
08/15/94	05:00	34561.21	20.74							0	100								
08/15/94	07:55	34561.33	20.86															3.97	
08/15/94	09:00	34561.38	20.90															3.95	

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	----->)	(<----		PSIG		----->)	(FEET)	
08/15/94	09:30	34561.40	20.92					0	2358			0							
08/15/94	11:59	34561.50	21.03							0	100	0							
08/15/94	11:59	34561.50	21.03					0	2358										
08/15/94	11:59	34561.50	21.03	30	7393														
08/15/94	11:59	34561.50	21.03										0	21	12	22	0		
08/15/94	12:18	34561.51	21.04															3.89	
08/15/94	12:30	34561.52	21.05															3.89	
08/15/94	13:10	34561.55	21.08	29	7413														
08/15/94	13:10	34561.55	21.08					0	2358										
08/15/94	13:10	34561.55	21.08							0	100	100							
08/15/94	13:10	34561.55	21.08										0	21	12	22	0		
08/15/94	13:12	34561.55	21.08										0	29	29	0	0		
08/15/94	13:12	34561.55	21.08							100	0	100							
08/15/94	13:12	34561.55	21.08	29	7414														Flow to basin
08/15/94	13:20	34561.56	21.08					31	2360										
08/15/94	13:20	34561.56	21.08															3.88	
08/15/94	16:28	34561.69	21.21															4.29	Flow directed to spreading area ca. 1620. No notes recorded.
08/15/94	18:23	34561.77	21.29	29	7503														
08/15/94	18:23	34561.77	21.29							100	0	100							
08/15/94	18:23	34561.77	21.29					31	2455										
08/15/94	18:24	34561.77	21.29					0	2455										
08/15/94	18:24	34561.77	21.29							100	100	0							
08/15/94	18:24	34561.77	21.29	29	7503														Flow to spreading area
08/15/94	18:25	34561.77	21.29										0	20	20	20	0	4.20	
08/15/94	22:00	34561.92	21.44															4.14	
08/15/94	22:45	34561.95	21.47	29	7578														
08/15/94	22:45	34561.95	21.47							100	100	0							
08/15/94	22:45	34561.95	21.47										0	20	22	22	0		
08/15/94	22:45	34561.95	21.47					0	2454										
08/16/94	03:00	34562.13	21.65										0	20	22	22	0	4.10	
08/16/94	03:00	34562.13	21.65					0	2454										
08/16/94	03:00	34562.13	21.65							100	100	0							
08/16/94	03:00	34562.13	21.65	29	7629														
08/16/94	09:40	34562.40	21.93															3.92	
08/16/94	10:00	34562.42	21.94					0	2454										
08/16/94	10:00	34562.42	21.94	28	7713														
08/16/94	10:00	34562.42	21.94							100	100	0							
08/16/94	10:00	34562.42	21.94										0	21	22	22	0		
08/16/94	10:03	34562.42	21.95									100							
08/16/94	10:07	34562.42	21.95	29	7716														Flow to basin
08/16/94	10:09	34562.42	21.95							100	0	100							
08/16/94	10:10	34562.42	21.95										0	30	30	0	0		
08/16/94	10:24	34562.43	21.96					31	2459										
08/16/94	11:09	34562.46	21.99	29	7734	28	25												New meter 2 installed
08/16/94	12:14	34562.51	22.04							100	0	100							
08/16/94	12:14	34562.51	22.04										0	28	30	0	0	4.05	
08/16/94	12:14	34562.51	22.04	29	7756	29	48												
08/16/94	12:19	34562.51	22.04					30	2495										
08/16/94	14:00	34562.58	22.11															4.19	
08/16/94	14:03	34562.59	22.11					31	2527										
08/16/94	14:05	34562.59	22.11							100	0	100							
08/16/94	14:07	34562.59	22.12										0	29	31	0	0		
08/16/94	14:08	34562.59	22.12	29	7785	28	79												
08/16/94	14:10	34562.59	22.12							0	100	100							
08/16/94	14:10	34562.59	22.12	28	7786	0	79												Flow to spreading area

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	----->)	(<----		PSIG		----->)	(FEET)	
08/16/94	14:10	34562.59	22.12					0	2529										
08/16/94	14:10	34562.59	22.12										0	31	11	22	0		
08/16/94	18:10	34562.76	22.28							0	100	100							
08/16/94	18:10	34562.76	22.28										0	21	11	22	0		
08/16/94	18:11	34562.76	22.28					0	2529										
08/16/94	18:11	34562.76	22.28	27	7855	0	79												
08/16/94	18:18	34562.76	22.29															4.08	
08/17/94	01:20	34563.06	22.58							0	100	100							
08/17/94	01:20	34563.06	22.58										0	20	12	22	0	3.98	
08/17/94	01:20	34563.06	22.58					0	2529										
08/17/94	01:20	34563.06	22.58	28	7968	0	79												
08/17/94	06:30	34563.27	22.80										0	20	12	25	0	3.86	
08/17/94	06:30	34563.27	22.80							0	100	100							
08/17/94	06:30	34563.27	22.80					0	2529										
08/17/94	06:30	34563.27	22.80	30	8002	0	79												
08/17/94	08:45	34563.38	22.89															3.80	
08/17/94	08:53	34563.37	22.90										0	21	12	23	0		
08/17/94	08:53	34563.37	22.90					0	2529										
08/17/94	08:53	34563.37	22.90							0	100	100							
08/17/94	08:53	34563.37	22.90	29	8019	0	79												
08/17/94	09:00	34563.38	22.90	29	8019	30	80												Flow to basin
08/17/94	09:00	34563.38	22.90							100	0	100							
08/17/94	09:00	34563.38	22.90										0	30	30	10	0		
08/17/94	09:13	34563.38	22.91					30	2533										
08/17/94	09:18	34563.39	22.91															3.81	
08/17/94	12:20	34563.51	23.04										0	29	31	0	0		
08/17/94	12:20	34563.51	23.04							100	0	100							
08/17/94	12:20	34563.51	23.04	30	8078	31	141												
08/17/94	12:30	34563.52	23.05															4.04	
08/17/94	12:30	34563.52	23.05					31	2593										
08/17/94	14:56	34563.62	23.15							100	0	100							
08/17/94	14:56	34563.62	23.15										0	29	30	0	0	4.20	
08/17/94	15:02	34563.63	23.15	29	8123	30	189												
08/17/94	15:02	34563.63	23.15					31	2538										
08/17/94	15:05	34563.63	23.16										0	22	12	23	0	4.20	
08/17/94	15:05	34563.63	23.16	29	8124	0	190												Flow to spreading area
08/17/94	15:05	34563.63	23.16							0	100	100							
08/17/94	18:15	34563.76	23.29										0	21	12	22	0	4.14	
08/17/94	18:15	34563.76	23.29							0	100	100							
08/17/94	18:16	34563.76	23.29					0	2641										
08/17/94	18:16	34563.76	23.29	30	8179	0	190												
08/17/94	21:40	34563.90	23.43															4.08	
08/17/94	21:40	34563.90	23.43							0	0	100							
08/17/94	21:40	34563.90	23.43		8237		190												Flow to basin
08/17/94	21:40	34563.90	23.43					33	2641										
08/18/94	00:00	34564.00	23.53					31	2684										
08/18/94	00:00	34564.00	23.53							100	0	100							
08/18/94	00:00	34564.00	22.53	30	8242	29	235												Totalizer 1 stuck
08/18/94	00:00	34564.00	23.53										0	30	31	0		4.20	
08/18/94	01:20	34564.06	23.58										0	25	12	28	0	4.32	
08/18/94	01:20	34564.06	23.58							0	100	100							
08/18/94	01:20	34564.06	23.58					0	2709										
08/18/94	01:20	34564.06	23.58	29	8242	0	257												Flow to spreading area
08/18/94	06:20	34564.26	23.79										0	22	12	25	0	4.20	
08/18/94	06:20	34564.26	23.79							0	100	100							

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	----->)	(<----		PSIG		----->)	(FEET)	
08/18/94	06:20	34564.26	23.79					0	2709										
08/18/94	06:20	34564.26	23.79	30	8242	0	257												
08/18/94	12:01	34564.50	24.03										0	22	11	24	0	4.09	
08/18/94	12:01	34564.50	24.03							0	100	100							
08/18/94	12:07	34564.50	24.03	29	8299	0	257												
08/18/94	12:07	34564.50	24.03					0	2709										
08/18/94	18:25	34564.77	24.29					0	2709										
08/18/94	18:25	34564.77	24.29										0	20	11	22	0	3.95	
08/18/94	18:30	34564.77	24.30							0	100	100							
08/18/94	18:32	34564.77	24.30	28	8410	0	257												
08/18/94	18:33	34564.77	24.30	30	8411	30	257												Flow to basin
08/18/94	18:34	34564.77	24.30										0	29	29	0	0		
08/18/94	18:34	34564.77	24.30							100	0	100							
08/18/94	18:39	34564.78	24.30					30	2711										
08/19/94	00:45	34565.03	24.56	29	8498	0	373												Flow to spreading area
08/19/94	00:45	34565.03	24.56					0	2827										
08/19/94	00:50	34565.03	24.56							0	100	100							
08/19/94	00:50	34565.03	24.56										0	22	12	25	0	4.36	
08/19/94	06:35	34565.27	24.80										0	20	12	25	0		
08/19/94	06:35	34565.27	24.80					0	2827										
08/19/94	06:35	34565.27	24.80	28	8522	0	373												
08/19/94	06:35	34565.27	24.80							0	100	100							
08/19/94	13:15	34565.55	25.08										0	20	12	24	0	4.20	
08/19/94	13:15	34565.55	25.08					0	2827										
08/19/94	13:15	34565.55	25.08	31	8609	0	373												
08/19/94	13:15	34565.55	25.08							0	100	100							
08/19/94	19:13	34565.80	25.33	28	8710	0	373												
08/19/94	19:13	34565.80	25.33					0	2827										
08/19/94	19:15	34565.80	25.33							0	100	100							
08/19/94	19:15	34565.80	25.33										0	21	11	24	0	4.00	
08/20/94	05:00	34566.21	25.74	30	8843	30	373												Flow to basin
08/20/94	05:00	34566.21	25.74										0	30	30	0	0	3.86	
08/20/94	05:00	34566.21	25.74							100	0	100							
08/20/94	05:00	34566.21	25.74					0	2827										
08/20/94	13:10	34566.55	26.08										0	30	30	0	0	4.36	
08/20/94	13:10	34566.55	26.08							100	0	100							
08/20/94	13:10	34566.55	26.08					31	2976										
08/20/94	13:10	34566.55	26.08	29	8940	29	521												
08/20/94	15:00	34566.63	26.15	30	8974	29	554												Flow to spreading area
08/20/94	15:05	34566.63	26.16							0	100	100							@ 1505
08/20/94	15:05	34566.63	26.16															4.50	
08/20/94	18:05	34566.75	26.28	29	9023	0	554												
08/20/94	18:05	34566.75	26.28							0	100	100							
08/20/94	18:05	34566.75	26.28										0	21	15	21	0	4.41	
08/20/94	18:05	34566.75	26.28					0	3011										
08/21/94	05:30	34567.23	26.76							0	100	100							
08/21/94	05:30	34567.23	26.76	29	9223	0	554												
08/21/94	05:30	34567.23	26.76					0	3011										
08/21/94	05:30	34567.23	26.76										0	21	15	25	0	4.20	
08/21/94	09:00	34567.38	26.90							0	100	100							
08/21/94	09:00	34567.38	26.90	29	9288	0	554												
08/21/94	09:00	34567.38	26.90					0	3011										
08/21/94	09:00	34567.38	26.90										0	22	12	23	0	4.11	
08/21/94	12:12	34567.51	27.04										0	21	12	22	0	4.07	
08/21/94	12:12	34567.51	27.04	30	9337	0	554												

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<----	% OPEN	---->)	(<----		PSIG		----->)	(FEET)	
08/21/94	12:12	34567.51	27.04							0	100	100							
08/21/94	12:12	34567.51	27.04					0	3011										
08/21/94	16:50	34567.70	27.23															3.96	
08/21/94	16:58	34567.71	27.23	30	9417	0	554												
08/21/94	16:58	34567.71	27.23					0	3011										
08/21/94	16:58	34567.71	27.23							0	100	100							
08/21/94	16:59	34567.71	27.23										0	22	11	22	0		
08/21/94	17:00	34567.71	27.24	29	9418	29	555												Flow to basin
08/21/94	17:00	34567.71	27.24							100	0	100							
08/21/94	17:03	34567.71	27.24										0	29	29	0	0		
08/21/94	17:11	34567.72	27.24					31	3015										
08/21/94	20:20	34567.85	27.37															4.20	
08/21/94	20:22	34567.85	27.38					31	3074										
08/21/94	20:25	34567.85	27.38							100	0	100							
08/21/94	20:25	34567.85	27.38										0	31	31	0	0		
08/21/94	20:27	34567.85	27.38	30	9477	31	617												
08/21/94	20:28	34567.85	27.38							0	100	100							
08/21/94	20:29	34567.85	27.38										0	21	19	26	0		
08/21/94	20:30	34567.85	27.38	29	9478	0	618												Flow to spreading area
08/21/94	20:30	34567.85	27.38					0	3076										
08/22/94	00:10	34568.01	27.53							0	100	100							
08/22/94	00:10	34568.01	27.53										0	22	13	25	0		
08/22/94	00:30	34568.02	27.55	28	9546	0	618												
08/22/94	00:30	34568.02	27.55					0	3076										
08/22/94	00:35	34568.02	27.55															4.12	
08/22/94	05:50	34568.24	27.77										0	22	13	25	0	4.00	
08/22/94	06:00	34568.25	27.78							0	100	100							
08/22/94	06:00	34568.25	27.78					0	3076										
08/22/94	06:00	34568.25	27.78	29	9643	0	618												
08/22/94	10:20	34568.43	27.96							0	100	100							
08/22/94	10:20	34568.43	27.96	30	9721	0	618												
08/22/94	10:20	34568.43	27.96										0	22	12	23	0	3.90	
08/22/94	10:20	34568.43	27.96					0	3076										
08/22/94	10:35	34568.44	27.97	30	9721	30	618												Flow to basin
08/22/94	10:35	34568.44	27.97							100	0	100							
08/22/94	10:35	34568.44	27.97										0	30	31	0	0		
08/22/94	10:35	34568.44	27.97					31	3078										
08/22/94	10:44	34568.45	27.97															3.90	
08/22/94	12:12	34568.51	28.04							100	0	100							
08/22/94	12:12	34568.51	28.04					31	3110										
08/22/94	12:12	34568.51	28.04										0	30	31	0	0	4.00	
08/22/94	12:32	34568.52	28.05	29	9755	30	653												
08/22/94	15:19	34568.64	28.17										0	29	30	0	0	4.20	
08/22/94	15:19	34568.64	28.17							100	0	100							
08/22/94	15:19	34568.64	28.17					31	3165										
08/22/94	15:30	34568.65	28.17	29	9807	30	707												
08/22/94	15:33	34568.65	28.18	29	9808	0	708												Flow to spreading area
08/22/94	15:33	34568.65	28.18							0	100	100							
08/22/94	15:33	34568.65	28.18					0	3167										
08/22/94	15:33	34568.65	28.18										0	22	12	25	0		
08/22/94	15:48	34568.66	28.19															4.20	
08/22/94	18:11	34568.76	28.28							0	100	100							
08/22/94	18:11	34568.76	28.28					0	3167										
08/22/94	18:11	34568.76	28.28										0	21	12	23	0	4.20	
08/22/94	18:11	34568.76	28.28	29	9853	0	708												

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<------	% OPEN	------>)	(<----------		PSIG		----------->)	(FEET)	
08/23/94	00:00	34569.00	28.53					0	3167										
08/23/94	00:00	34569.00	28.53	30	9951	0	708												
08/23/94	00:00	34569.00	28.53										0	22	12	25	0	4.05	
08/23/94	00:00	34569.00	28.53							0	100	100							
08/23/94	09:21	34569.39	28.92					0	3167										
08/23/94	09:21	34569.39	28.92	29	9985	0	708												
08/23/94	09:21	34569.39	28.92							0	100	100							
08/23/94	09:21	34569.39	28.92										0	21	12	23	0	3.85	
08/23/94	09:33	34569.40	28.93							100	0	100							
08/23/94	09:33	34569.40	28.93										0	30	30	15	0		
08/23/94	09:33	34569.40	28.93					31	3169										
08/23/94	09:33	34569.40	28.93	29	9986	30	708												Flow to basin
08/23/94	09:42	34569.40	28.93															3.85	
08/23/94	11:42	34569.49	29.01					31	3208										
08/23/94	11:42	34569.49	29.01							100	0	100							
08/23/94	11:42	34569.49	29.01										0	30	31	0	0	4.00	
08/23/94	11:54	34569.50	29.02	30	10027	30	751												
08/23/94	16:29	34569.69	29.21							100	0	100							
08/23/94	16:29	34569.69	29.21					31	3297										
08/23/94	16:29	34569.69	29.21										0	30	30	0	0	4.30	
08/23/94	16:39	34569.69	29.22	29	10109	30	837												
08/23/94	16:41	34569.70	29.22	29	10110	0	837												Flow to spreading area
08/23/94	16:41	34569.70	29.22					0	3299										
08/23/94	16:41	34569.70	29.22							0	100	100							
08/23/94	16:41	34569.70	29.22										0	21	10	23	0		
08/23/94	16:50	34569.70	29.23															4.31	
08/24/94	00:24	34570.02	29.54					0	3299										
08/24/94	00:24	34570.02	29.54	30	10244	0	837												
08/24/94	00:24	34570.02	29.54										0	22	15	22	0	4.20	
08/24/94	00:24	34570.02	29.54							0	100	100							
08/24/94	10:15	34570.43	29.95					0	3299										
08/24/94	10:15	34570.43	29.95										0	20	12	22	0	3.97	
08/24/94	10:15	34570.43	29.95							0	100	100							
08/24/94	10:23	34570.43	29.96	30	10303	0	837												
08/24/94	12:12	34570.51	30.04										0	20	12	22	0	3.91	
08/24/94	12:12	34570.51	30.04					0	3299										
08/24/94	12:12	34570.51	30.04	29	10335	0	837												
08/24/94	12:12	34570.51	30.04							0	100	100							
08/24/94	12:15	34570.51	30.04							100	0	100							
08/24/94	12:15	34570.51	30.04										0	30	30	0	0	3.91	
08/24/94	12:15	34570.51	30.04	29	10336	30	838												Flow to basin
08/24/94	12:38	34570.53	30.05					31	3306										
08/24/94	16:20	34570.68	30.21							0	100	0							
08/24/94	17:58	34570.75	30.28	29	10440	30	948												
08/24/94	18:10	34570.76	30.28										0	30	31	0	0	4.30	
08/24/94	18:10	34570.76	30.28							100	0	100							
08/24/94	18:11	34570.76	30.28					30	3409										
08/24/94	18:20	34570.76	30.29										0	21	12	23	0	4.30	
08/24/94	18:20	34570.76	30.29					0	3411										
08/24/94	18:21	34570.76	30.29	29	10441	0	948												Flow to spreading area
08/25/94	01:08	34571.05	30.57					0	3411										
08/25/94	01:08	34571.05	30.57										0	23	13	23	0	4.20	
08/25/94	01:08	34571.05	30.57							0	100	0							
08/25/94	01:08	34571.05	30.57	26	10551	0	948												
08/25/94	04:40	34571.19	30.72	26	10591	0	948												

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<——	% OPEN	——>)	(<——		PSIG		——>)	(FEET)	
08/25/94	04:40	34571.19	30.72					0	3411										
08/25/94	04:40	34571.19	30.72							0	100	0							
08/25/94	04:40	34571.19	30.72										0	22	13	23	0	4.15	
08/25/94	09:00	34571.38	30.90							0	100	100							
08/25/94	09:00	34571.38	30.90										0	21	12		0	4.00	
08/25/94	09:04	34571.38	30.90		10642	0	948												Flowrate indicator #1 failed 0800 hours
08/25/94	09:04	34571.38	30.90					0	3411										
08/25/94	12:23	34571.52	31.04										0	21	12	23	0	3.97	
08/25/94	12:36	34571.53	31.05							0	100	100							
08/25/94	12:36	34571.53	31.05					0	3411										
08/25/94	12:36	34571.53	31.05		10688	0	948												
08/25/94	12:46	34571.53	31.06										0	29	30	12			
08/25/94	12:46	34571.53	31.06		10702	25	949												Flow to basin
08/25/94	12:46	34571.53	31.06							100	0	100							
08/25/94	18:02	34571.75	31.28							100	0	100							
08/25/94	18:02	34571.75	31.28										0	30	31	12	0	4.30	
08/25/94	18:02	34571.75	31.28		10791	28	1038												
08/25/94	18:10	34571.76	31.28		10792	0	1039												Flow to spreading area
08/25/94	18:10	34571.76	31.28										0	21	12	22	0	4.30	
08/25/94	18:10	34571.76	31.28							0	100	100							
08/26/94	03:45	34572.16	31.68							0	100	100							
08/26/94	03:45	34572.16	31.68		10885	0	1039												
08/26/94	03:45	34572.16	31.68										0	29	15	32	0	4.15	
08/26/94	13:15	34572.55	32.08										0	28	12	30	0	3.92	
08/26/94	13:19	34572.55	32.08							0	100	100							
08/26/94	13:19	34572.55	32.08		10971	0	1038												
08/26/94	13:23	34572.56	32.08										0	30	31	10			
08/26/94	13:23	34572.56	32.08							100	0	100							
08/26/94	13:27	34572.56	32.09		10973	28	1039												Flow to basin
08/26/94	19:00	34572.79	32.32							0	100	100							
08/26/94	19:06	34572.80	32.32										0	36	37	0	0	4.28	
08/26/94	19:07	34572.80	32.32		11067	28	1134												Flow to spreading area
08/26/94	19:07	34572.80	32.32					30	3441										
08/27/94	07:00	34573.29	32.82										0	20	15	23	0	4.06	
08/27/94	12:23	34573.52	33.04										0	20	15	23	0	3.98	
08/27/94	13:30	34573.56	33.09							100	0	100							
08/27/94	13:32	34573.56	33.09					30	3443										
08/27/94	13:32	34573.56	33.09		11315		1134												Flow to basin
08/27/94	13:35	34573.57	33.09										0	32	32	10	0	3.96	
08/27/94	19:13	34573.80	33.33										0	28	10	23	0	4.30	
08/27/94	19:15	34573.80	33.33							0	100	100							
08/27/94	19:15	34573.80	33.33		11412	28	1225												Flow to spreading area
08/27/94	19:15	34573.80	33.33					31	3506										
08/28/94	01:58	34574.08	33.61		11519	0	1225												
08/28/94	01:58	34574.08	33.61										0	22	3	25	0		
08/28/94	01:58	34574.08	33.61					0	3508										
08/28/94	01:58	34574.08	33.61							0	100	100							
08/28/94	07:22	34574.31	33.83										0	21	12	25	0	4.10	
08/28/94	07:30	34574.31	33.84		11604	0	1225												Flow to basin
08/28/94	07:30	34574.31	33.84					0	3510										
08/28/94	07:30	34574.31	33.84							100	0	100							
08/28/94	14:30	34574.60	34.13			28	1353												Flow to spreading area
08/28/94	14:30	34574.60	34.13							0	100	100							
08/28/94	14:30	34574.60	34.13															4.52	
08/28/94	16:00	34574.67	34.19															4.50	

DATE	TIME	SERIAL TIME	ELAPSED TIME	METER 1 RATE	METER 1 TOTAL	METER 2 RATE	METER 2 TOTAL	METER 3 RATE	METER 3 TOTAL	VALVES BF-1	VALVES BF-2	VALVES BF-3	PRESSURE GAGES #1	#2	#3	#4	#5	STAFF GAGE	COMMENTS
(M/D/Y)	(H:M)	(DAYS)	(DAYS)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(100 GPM)	(10^4 GAL)	(<------	% OPEN	------>)	(<----------		PSIG		----------->)	(FEET)	
08/29/94	08:00	34575.33	34.86							100	0	100							
08/29/94	08:00	34575.33	34.86										0	22	13	28	0	4.20	
08/29/94	08:00	34575.33	34.86					0	3635										
08/29/94	08:00	34575.33	34.86		11988	0	1354												Flow to basin
08/29/94	11:52	34575.49	35.02										0	29	30	10	0	4.47	
08/29/94	11:55	34575.50	35.02							0	100	100							
08/29/94	11:55	34575.50	35.02		12058		1427												Flow to spreading area
08/29/94	11:55	34575.50	35.02					31	3707										
08/30/94	07:50	34576.33	35.85										0	20	20	20	0	4.10	
08/30/94	07:50	34576.33	35.85							0	100	100							
08/30/94	07:50	34576.33	35.85		12332	0	1428												
08/30/94	07:51	34576.33	35.85		12332	28	1428												Flow to basin
08/30/94	07:51	34576.33	35.85							100	0	100							
08/30/94	11:39	34576.49	36.01										0	30	31	0	0	4.30	
08/30/94	11:39	34576.49	36.01							100	0	100							
08/30/94	11:39	34576.49	36.01					31	3780										
08/30/94	11:39	34576.49	36.01		12397	28	1504												
08/30/94	13:06	34576.55	36.07					31	3805										
08/30/94	13:06	34576.55	36.07										0	30	31	0	0	4.40	
08/30/94	13:06	34576.55	36.07							100	0	100							
08/30/94	13:06	34576.55	36.07		12421	28	1527												
08/30/94	13:16	34576.55	36.08										0	21	12	22	0	4.40	
08/30/94	13:16	34576.55	36.08		12421	0	1527												Flow to spreading area
08/30/94	13:16	34576.55	36.08					0	3807										
08/30/94	13:16	34576.55	36.08							0	100	100							
08/30/94	15:38	34576.65	36.18					0	3807										
08/30/94	15:38	34576.65	36.18		12461	0	1527												
08/30/94	15:38	34576.65	36.18										0	21	10	22	0	4.38	
08/30/94	15:38	34576.65	36.18							0	100	100							
08/30/94	15:48	34576.66	36.19										0	30	30	0	0	4.38	
08/30/94	15:48	34576.66	36.19		12462	27	1527												Flow to basin
08/30/94	15:48	34576.66	36.19							100	0	100							
08/30/94	16:04	34576.67	36.20					31	3812										
08/30/94	18:15	34576.76	36.29		12505	0	1575												End of pumping test
08/30/94	18:15	34576.76	36.29										0	0	12	0	0	4.52	
08/30/94	18:15	34576.76	36.29					0	3854										
08/30/94	18:15	34576.76	36.29							0	0	100							

Appendix C

Falling Limb Regressions

SERIAL TIME (DAYS)	MONTH	DAY	HOUR	MINUTE	STAGE	FALLING LIMB	STAGE HAT (FEET)	REGRESSION SUMMARY	
34542.66	7	27	15	45	3.981	max 1	3.983	Regression Output:	
								Constant	13397.13
34543.13	7	28	3	0	3.800	min	3.801	Std Err of Y Est	0.003303
								R Squared	0.996298
								No. of Observations	124
								Degrees of Freedom	122
								X Coefficient(s) -0.38773	
								Std Err of Coef. 0.00214	
34544.16	7	29	3	55	4.163	max 2	4.139	Regression Output:	
								Constant	8344.75
34544.77	7	29	18	35	4.028	min	3.992	Std Err of Y Est	0.019821
								R Squared	0.825287
								No. of Observations	177
								Degrees of Freedom	175
								X Coefficient(s) -0.24145	
								Std Err of Coef. 0.008398	
34545.13	7	30	3	5	4.150	max 3	4.156	Regression Output:	
								Constant	13017.55
34545.60	7	30	14	20	3.974	min	3.980	Std Err of Y Est	0.003306
								R Squared	0.995934
								No. of Observations	136
								Degrees of Freedom	134
								X Coefficient(s) -0.37671	
								Std Err of Coef. 0.002079	
34545.82	7	30	19	40	4.337	max 4	4.339	Regression Output:	
								Constant	13635.67
34546.42	7	31	10	5	4.102	min	4.102	Std Err of Y Est	0.001461
								R Squared	0.999575
								No. of Observations	164
								Degrees of Freedom	162
								X Coefficient(s) -0.39459	
								Std Err of Coef. 0.000639	
34546.65	7	31	15	40	4.484	max 5a	4.483	Regression Output:	
								Constant	14467.86
34548.84	8	2	20	10	3.554	min	3.567	Std Err of Y Est	0.005744
								R Squared	0.999532
								No. of Observations	632
								Degrees of Freedom	630
								X Coefficient(s) -0.41866	
								Std Err of Coef. 0.000361	

SERIAL TIME (DAYS)	MONTH	DAY	HOUR	MINUTE	STAGE	FALLING LIMB	STAGE HAT (FEET)	REGRESSION SUMMARY	
34548.84	8	2	20	10	3.554	max 5b	3.556	Regression Output:	
								Constant	14792.16
34551.03	8	5	0	40	2.618	min	2.620	Std Err of Y Est	0.002947
								R Squared	0.999882
								No. of Observations	631
								Degrees of Freedom	629
								X Coefficient(s)	-0.42805
								Std Err of Coef.	0.000186
34551.03	8	5	0	40	2.618	max 5c	2.615	Regression Output:	
								Constant	14373.6
34553.22	8	7	5	10	1.707	min	1.705	Std Err of Y Est	0.003254
								R Squared	0.999848
								No. of Observations	631
								Degrees of Freedom	629
								X Coefficient(s)	-0.41593
								Std Err of Coef.	0.000205
34553.22	8	7	5	10	1.707	max 5d	1.704	Regression Output:	
								Constant	12781.62
34555.40	8	9	9	41	0.903	min	0.895	Std Err of Y Est	0.006292
								R Squared	0.999076
								No. of Observations	454
								Degrees of Freedom	452
								X Coefficient(s)	-0.36986
								Std Err of Coef.	0.000529
34555.50	8	9	12	2	0.840	max 5e	0.841	Regression Output:	
								Constant	11432.28
34557.55	8	11	13	9	0.160	min	0.164	Std Err of Y Est	0.016324
								R Squared	0.995372
								No. of Observations	10
								Degrees of Freedom	8
								X Coefficient(s)	-0.33081
								Std Err of Coef.	0.007975
34559.59	8	13	14	11	4.202	max 6	4.208	Regression Output:	
								Constant	15946.92
34560.30	8	14	7	11	3.879	min	3.882	Std Err of Y Est	0.002844
								R Squared	0.999143
								No. of Observations	69
								Degrees of Freedom	67
								X Coefficient(s)	-0.46131
								Std Err of Coef.	0.00165

SERIAL TIME (DAYS)	MONTH	DAY	HOUR	MINUTE	STAGE	FALLING LIMB	STAGE HAT (FEET)	REGRESSION SUMMARY	
34560.67	8	14	15	59	4.287	max 7	4.287	Regression Output:	
34561.53	8	15	12	44	3.880	min	3.879	Constant	16312.8
								Std Err of Y Est	0.002115
								R Squared	0.999693
								No. of Observations	84
								Degrees of Freedom	82
								X Coefficient(s)	-0.47188
								Std Err of Coef.	0.000914
34561.77	8	15	18	29	4.227	max 8	4.219	Regression Output:	
34562.42	8	16	9	59	3.900	min	3.900	Constant	17082.12
								Std Err of Y Est	0.002213
								R Squared	0.999459
								No. of Observations	63
								Degrees of Freedom	61
								X Coefficient(s)	-0.49413
								Std Err of Coef.	0.001472
34562.59	8	16	14	14	4.178	max 9	4.176	Regression Output:	
34563.37	8	17	8	59	3.788	min	3.791	Constant	17457.34
								Std Err of Y Est	0.002754
								R Squared	0.999446
								No. of Observations	76
								Degrees of Freedom	74
								X Coefficient(s)	-0.50497
								Std Err of Coef.	0.001382
34563.62	8	17	14	59	4.200	max 10	4.206	Regression Output:	
34563.91	8	17	21	44	4.067	min	4.065	Constant	17267
								Std Err of Y Est	0.003713
								R Squared	0.992802
								No. of Observations	28
								Degrees of Freedom	26
								X Coefficient(s)	-0.49945
								Std Err of Coef.	0.00834
34564.06	8	18	1	29	4.303	max 11	4.299	Regression Output:	
34564.76	8	18	18	14	3.965	min	3.963	Constant	16656.65
								Std Err of Y Est	0.004495
								R Squared	0.997983
								No. of Observations	68
								Degrees of Freedom	66
								X Coefficient(s)	-0.48178
								Std Err of Coef.	0.002666

SERIAL TIME (DAYS)	MONTH	DAY	HOUR	MINUTE	STAGE	FALLING LIMB	STAGE HAT (FEET)	REGRESSION SUMMARY	
34565.04	8	19	0	59	4.374	max		Regression Output:	
						12		Constant	16463.26
34566.21	8	20	4	59	3.812	min		Std Err of Y Est	0.003437
								R Squared	0.999557
								No. of Observations	113
								Degrees of Freedom	111
								X Coefficient(s) -0.47617	
								Std Err of Coef. 0.000952	
34566.63	8	20	15	14	4.469	max	4.483	Regression Output:	
						13		Constant	16782.74
34567.71	8	21	16	59	3.964	min	3.963	Std Err of Y Est	0.004963
								R Squared	0.998952
								No. of Observations	104
								Degrees of Freedom	102
								X Coefficient(s) -0.48539	
								Std Err of Coef. 0.001556	
34567.86	8	21	20	44	4.189	max	4.184	Regression Output:	
						14		Constant	17445.23
34568.44	8	22	10	29	3.896	min	3.895	Std Err of Y Est	0.001996
								R Squared	0.999468
								No. of Observations	56
								Degrees of Freedom	54
								X Coefficient(s) -0.50455	
								Std Err of Coef. 0.001584	
34568.66	8	22	15	44	4.216	max	4.210	Regression Output:	
						15		Constant	17967.08
34569.40	8	23	9	29	3.832	min	3.826	Std Err of Y Est	0.005095
								R Squared	0.998009
								No. of Observations	72
								Degrees of Freedom	70
								X Coefficient(s) -0.51963	
								Std Err of Coef. 0.002774	
34569.70	8	23	16	44	4.317	max	4.313	Regression Output:	
						16		Constant	17287.89
34570.51	8	24	12	14	3.913	min	3.907	Std Err of Y Est	0.002389
								R Squared	0.999606
								No. of Observations	79
								Degrees of Freedom	77
								X Coefficient(s) -0.49996	
								Std Err of Coef. 0.001132	

SERIAL TIME (DAYS)	MONTH	DAY	HOUR	MINUTE	STAGE	FALLING LIMB	STAGE HAT (FEET)	REGRESSION SUMMARY	
34570.77	8	24	18	29	4.314	max 17	4.308	Regression Output:	
34571.53	8	25	12	44	3.937	min	3.929	Constant	17217.15
								Std Err of Y Est	0.003157
								R Squared	0.99921
								No. of Observations	74
								Degrees of Freedom	72
								X Coefficient(s)	-0.4979
								Std Err of Coef.	0.001649
34571.78	8	25	18	44	4.284	max 18	4.284	Regression Output:	
34572.54	8	26	12	59	3.911	min	3.909	Constant	17042.8
								Std Err of Y Est	0.001914
								R Squared	0.999704
								No. of Observations	74
								Degrees of Freedom	72
								X Coefficient(s)	-0.49284
								Std Err of Coef.	0.001
34572.80	8	26	19	14	4.274	max 19	4.268	Regression Output:	
34573.56	8	27	13	29	3.915	min	3.904	Constant	16570.57
								Std Err of Y Est	0.00287
								R Squared	0.999296
								No. of Observations	74
								Degrees of Freedom	72
								X Coefficient(s)	-0.47917
								Std Err of Coef.	0.001499
34573.82	8	27	19	44	4.287	max 20	4.284	Regression Output:	
34574.31	8	28	7	29	4.051	min	4.051	Constant	16445.57
								Std Err of Y Est	0.001536
								R Squared	0.99952
								No. of Observations	48
								Degrees of Freedom	46
								X Coefficient(s)	-0.47554
								Std Err of Coef.	0.001536
34574.61	8	28	14	44	4.528	max 21	4.518	Regression Output:	
34575.33	8	29	7	59	4.165	min	4.164	Constant	17038.99
								Std Err of Y Est	0.003523
								R Squared	0.99888
								No. of Observations	70
								Degrees of Freedom	68
								X Coefficient(s)	-0.49269
								Std Err of Coef.	0.002001

SERIAL TIME (DAYS)	MONTH	DAY	HOUR	MINUTE	STAGE	FALLING LIMB	STAGE HAT (FEET)	REGRESSION SUMMARY	
34575.55	8	29	13	14	4.425	max 22	4.411	Regression Output:	
34576.33	8	30	7	59	4.024	min	4.018	Constant	17381.91
								Std Err of Y Est	0.004246
								R Squared	0.998671
								No. of Observations	76
								Degrees of Freedom	74
								X Coefficient(s)	-0.5026
								Std Err of Coef.	0.002132
34576.55	8	30	13	14	4.379	max 23		Regression Output:	
34576.66	8	30	15	44	4.336	min		Constant	14974.86
								Std Err of Y Est	0.001707
								R Squared	0.988413
								No. of Observations	11
								Degrees of Freedom	9
								X Coefficient(s)	-0.43297
								Std Err of Coef.	0.015624
34576.77	8	30	18	29	4.501	max 24 a	4.496	Regression Output:	
34578.84	9	1	20	14	3.531	min	3.528	Constant	16140.92
								Std Err of Y Est	0.00442
								R Squared	0.999755
								No. of Observations	200
								Degrees of Freedom	198
								X Coefficient(s)	-0.46668
								Std Err of Coef.	0.00052
34578.85	9	1	20	29	3.528	max 24 b	3.521	Regression Output:	
34581.09	9	4	2	14	2.531	min	2.527	Constant	15357.24
								Std Err of Y Est	0.004083
								R Squared	0.999802
								No. of Observations	216
								Degrees of Freedom	214
								X Coefficient(s)	-0.44402
								Std Err of Coef.	0.000428
34581.10	9	4	2	29	2.528	max 24 c	2.515	Regression Output:	
34583.26	9	6	6	14	1.695	min	1.692	Constant	13201.13
								Std Err of Y Est	0.005317
								R Squared	0.999509
								No. of Observations	208
								Degrees of Freedom	206
								X Coefficient(s)	-0.38167
								Std Err of Coef.	0.000589

SERIAL TIME (DAYS)	MONTH	DAY	HOUR	MINUTE	STAGE	FALLING LIMB	STAGE NAT (FEET)
34583.27	9	6	6	29	1.690	max 24 d	1.696
34585.43	9	8	10	14	0.923	min	0.933

REGRESSION SUMMARY

Regression Output:

Constant	12245.57
Std Err of Y Est	0.004898
R Squared	0.999516
No. of Observations	208
Degrees of Freedom	206
X Coefficient(s)	-0.35404
Std Err of Coef.	0.000543

Appendix D

Basin Volume-Stage and Surface Area-Stage Relationships

Appendix D

Basin Volume-Stage and Surface Area-Stage Relationships

The attached interoffice correspondence from M. A. McQueen to S. L. Barrie describes the calculation of the basin elevation-volume relationship. Elevations are referred to an arbitrary datum, and a stage of 0.0 ft lies at an elevation of 1.34 ft.

To determine the basin volume-stage relationship from the volume-elevation relationship, linear interpolation was used to calculate values of volume at the desired stages. The interpolated values are tabulated below.

The surface area-stage relationship was determined from the data reported by McQueen by dividing the volume of water in an incremental elevation slice by the difference in elevation, and assigning the resulting average surface area to the midpoint elevation for that slice. Linear interpolation was used to calculate values at the desired stages.

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To Bob Starr	From Miles McQueen
Co. EG&G	Co.
Dept.	Phone # 526-5872
Fax # 6-0875	Fax #

INTEROFFICE CORRESI

Date: June 20, 1994

To: S. L. Barrie, MS 3920

From: M. A. McQueen, MS 3904

Subject: INFILTRATION BASIN INCREMENTAL VOLUME CALCULATION - MAM-01-94

We were provided 750 geographic points with their associated elevations relative to the lowest point in the infiltration basin. The supplied sample points were mostly in the interior of the basin although there were a few on the external side of the berm as well as four completely outside the basin. The points were mostly uniformly spaced across the basin, however, sample spacing did vary at some locations in the interior and along the basin wall, see Figure 1. Since the sampling was not of uniform spatial separation, I decided to model the surface as a triangulated irregular network (TIN) with linear interpolation instead of as a lattice. Within our modeling tool there are a limited set of commands for manipulating TINS. The most important command for our purposes was the VOLUME command.

VOLUME provides the cubic feet of soil from a user supplied base elevation value to the top of the soil surface. Of course this command by itself did not provide basin water volume information. Fortunately, with some preprocessing of the points and a few simple calculations I was able to calculate, as requested, basin volumes in 3 inch elevation increments beginning at the bottom of the basin and proceeding to the top of the berm (6.9 feet).

The process I used for estimating basin water volumes is as follows:

1. Remove all points external to the top of the berm, see Figure 2.
2. Create a basin surface model using only those points remaining after step 1, see Figure 3.
3. Determine the planimetric area (A) of the surface model from a top view, see figure 4.
4. Calculate the volume of a quarter foot of height in the planimetric area, see Figure 5. $V_{s_exp} = .25 \times A$
5. In quarter foot elevation increments calculate the total volume of soil ($V_{s_tot_i}$) above each elevation i to the surface of the basin, see Figure 6.
6. Determine the volume of soil which was left behind with each quarter foot elevation increase, see Figure 7.
   $V_{s_act_i+1} = V_{s_tot_i} - V_{s_tot_i+1}$
7. Calculate the water volume space in the basin in quarter foot elevation increments, see Figure 8.
   $V_{w_act_i+1} = V_{s_exp} - V_{s_act_i+1}$

8. Calculate the total basin water volume at elevation k+1 by summing all of the lower elevation, quarter foot increment, water volumes determined in step 7, see Figure 9.
$V_{w_tot_k+1} = Sum_{i=0\ to\ k}\ [V_{w_act_i+1}]$

In Table 1 you will find the total basin water volume for each quarter foot elevation interval as well as the values for each of the other variables used in the process.

You should note that in creating the initial basin surface used in this analysis two portions of the surface came to my attention. The first is a point with elevation 0 and the second is a wedge shaped portion of the basin which apparently was not sampled, see Figure 10. I contacted Ken Beard about this but he had not done the sampling and was not sure whom to contact in order to verify the initial sample points and area. Depending on what your required basin volume accuracy is you might wish to track down the initial data and verify that the identified point belonged in the data and that the wedge shape area was not ever sampled. Be aware that if the identified point were removed from the analysis the resulting basin water volume estimate would only decrease by approximately 220 cubic feet. Also be aware that the identified point is the only basin sample point at elevation 0 and thus, if it were removed from the analysis the requested quarter foot water volume calculations would have to be redone.

You should also note that error analysis has not been done to bound the possible water volume error induced by using the discrete set of basin points and a TIN to model the continuous surface of the basin. If the possible 220 cubic feet error mentioned above is of concern to you then I would suggest further error analysis. If I can be of any more help please let me know.

cb

Enclosure
(as stated)

cc: G. D. Mecham, MS 3920
R. A. Smith, MS 3860
M. A. McQueen Letter File

SENT BY:Xerox Telecopier 7020 ; 6-28-94 ; 9:53AM ; 2085286802→ Miles McGuire 208 526 0875;#14

[illegible] ft Elevation Increment = .25 ft Expected Volume Change = .25 x A Dirt =

Volume at Surface at z = Ø, Vo = 512381.375

Elevation from Bottom ft		Dirt Volume at Specified Elevation $V_{s_tot_k}$	Actual Dirt Volume change $V_{s_act_k+1}$	Expected Dirt Volume change V_{s_exp}				Change in Pond Volume $V_{w_act_k+1}$	Total Pond Volume ft³ $V_{w_tot_k+1}$
0.00		512381.4							Ø
0.25		439222.2	73159.2	73168.8				6.6	6.6
0.50		366111.5	73110.7					55.1	61.7
0.75		294473.8	71637.7					1528.1	1589.8
1.00		239316.4	55157.4					18008.4	19598.2
1.25		206008.6	33307.8					39858.0	59456.2
1.50		180603.1	25405.5					47760.3	107216.5
1.75		158341.8	22261.3					50904.5	158121.0
2.00		138094.1	20247.7					52918.1	211039.1
2.25		119661.5	18432.6					54733.2	265772.3
2.50		103207.1	16454.4					56711.4	322483.7
2.75		88853.4	14354.7					58811.1	381294.8
3.00		76468.0	12384.4					60781.4	442076.2
3.25		65640.7	10827.3					62338.5	504414.7
3.50		56266.7	9374.0					63791.8	568206.5
3.75		48037.2	8229.5					64936.3	633142.8
4.00		40803.8	7233.4					65932.4	699075.2
4.25		34475.5	6328.3					66837.5	765912.7
4.50		28978.5	5497.0					67668.8	833581.5
4.75		24104.8	4873.7					68292.1	901873.6

Table 1

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Elevation ↓ from bottom ft		Dirt volume at specified volume $V_{s_tot_i}$	Actual Dirt Volume change $V_{s_act_i+1}$	Expected Dirt Volume change V_{d_exp}				Actual Change in Pond Volume $V_{w_act_i+1}$	Total Pond Volume ft³ $V_{w_tot_i+1}$
5.0		19720.7	4384.1	73165.8				68781.7	970655.3
5.25		15792.7	3928.0	↓				69237.8	1039893.1
5.50		12297.8	3494.9					69670.9	1109564.0
5.75		9236.6	3061.2					70104.6	1179668.6
6.00		6612.8	2623.8					70542.0	1250210.6
6.25		4430.2	2182.6					70983.2	1321193.8
6.50		2692.7	1737.5					71428.3	1392622.1
6.75		1404.0	1288.7					71877.1	1464499.2
7.00		566.4	837.6	↓				72328.2	1536827.4
6.90		847.7	556.3	43899.5				43343.2	1507842.3

Table 1 (continued)

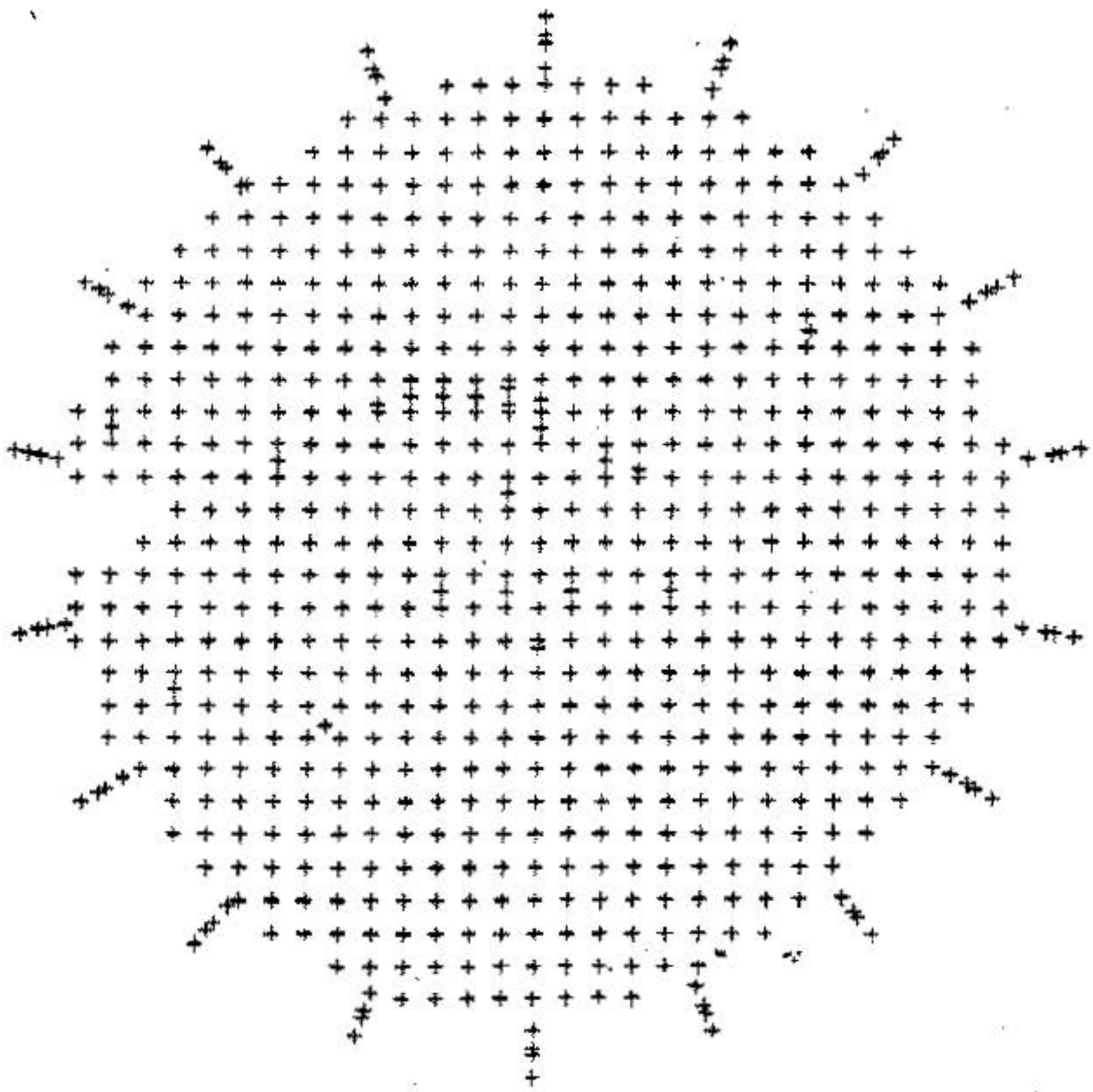


Figure 1. All Infiltration Basin Geographic Elevation Points.

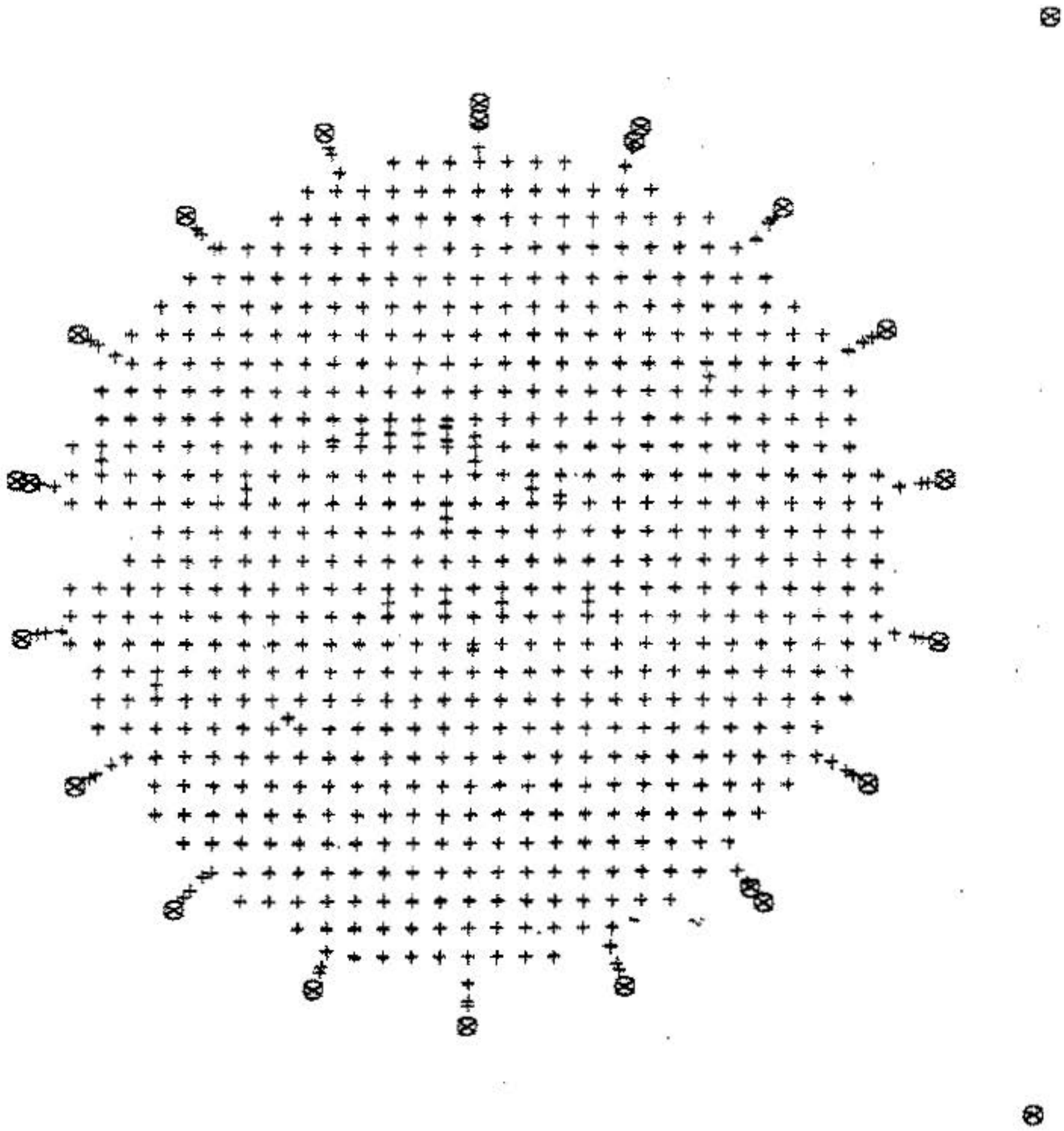
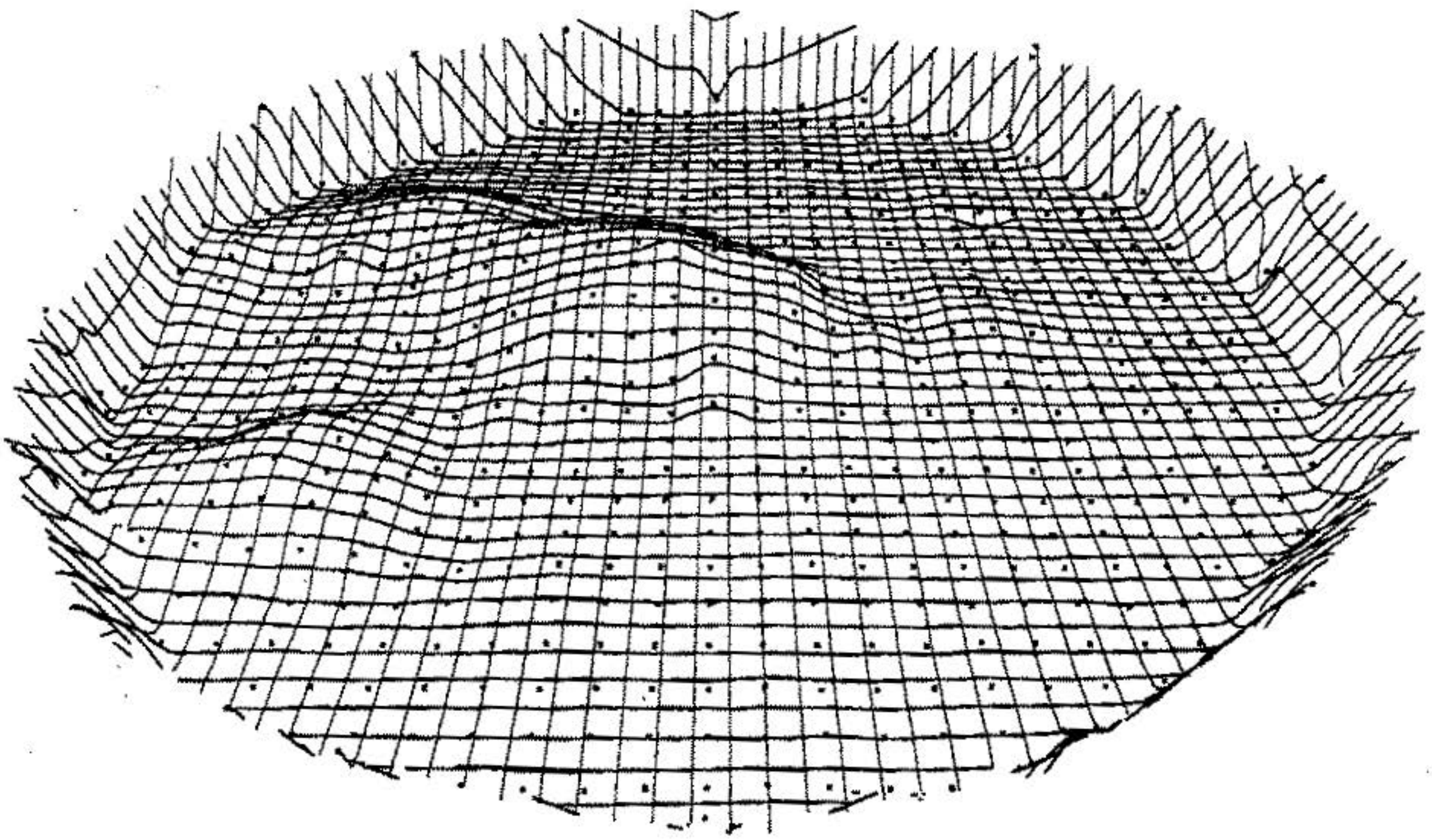


Figure 2. External Basin Points Removed From Analysis.



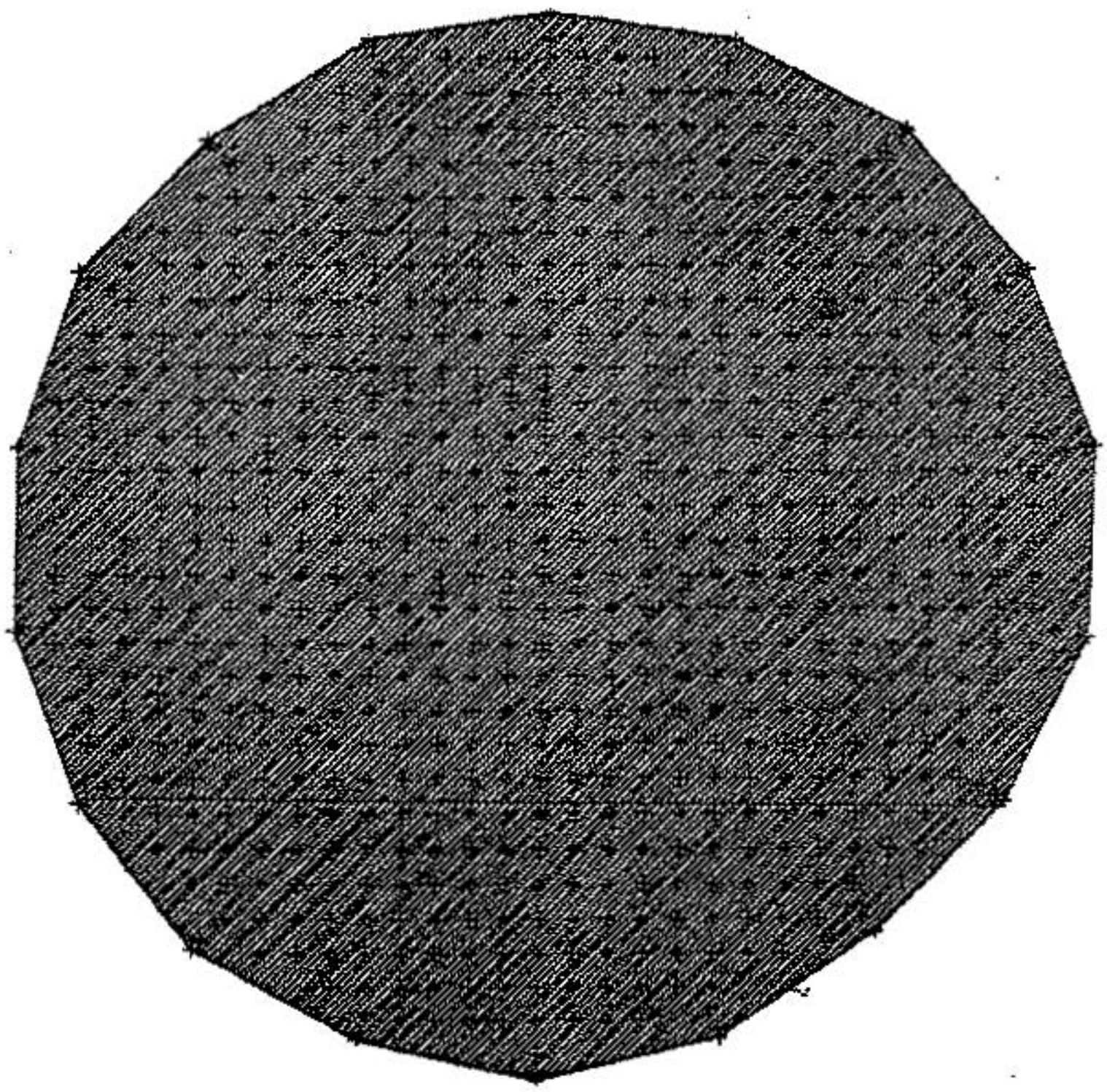
Z-Scale x 10

Figure 3. TIN Surface Model of Interior Basin Surface With Sample Points.

LEGEND

+ Points Used in Analysis

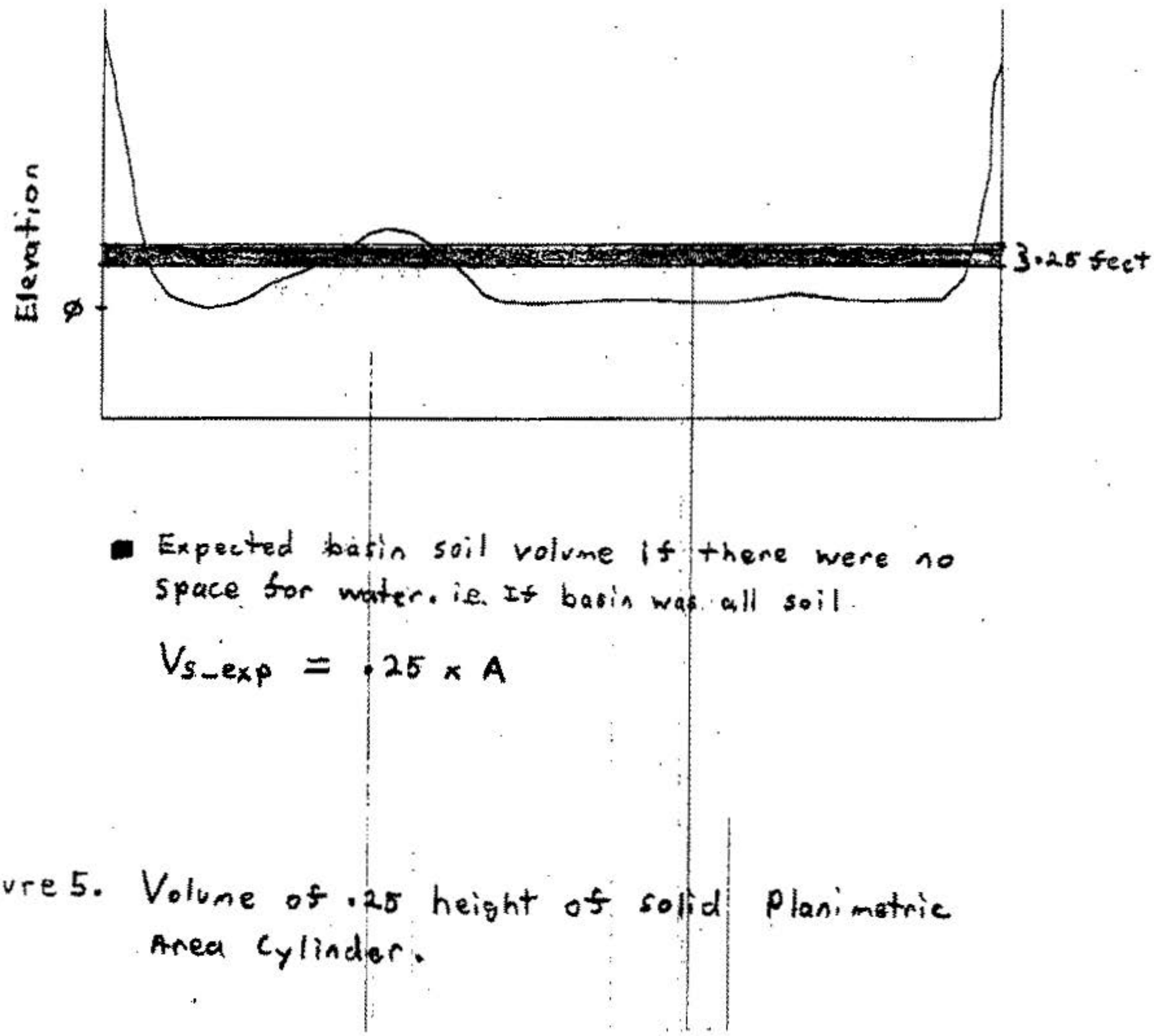
Planimetric Area



Planimetric Area (A) = 292,663.2 Square Feet

Figure 4. Planimetric Area: Elevation 0, Horizontal Cut.

Basin profile not to scale

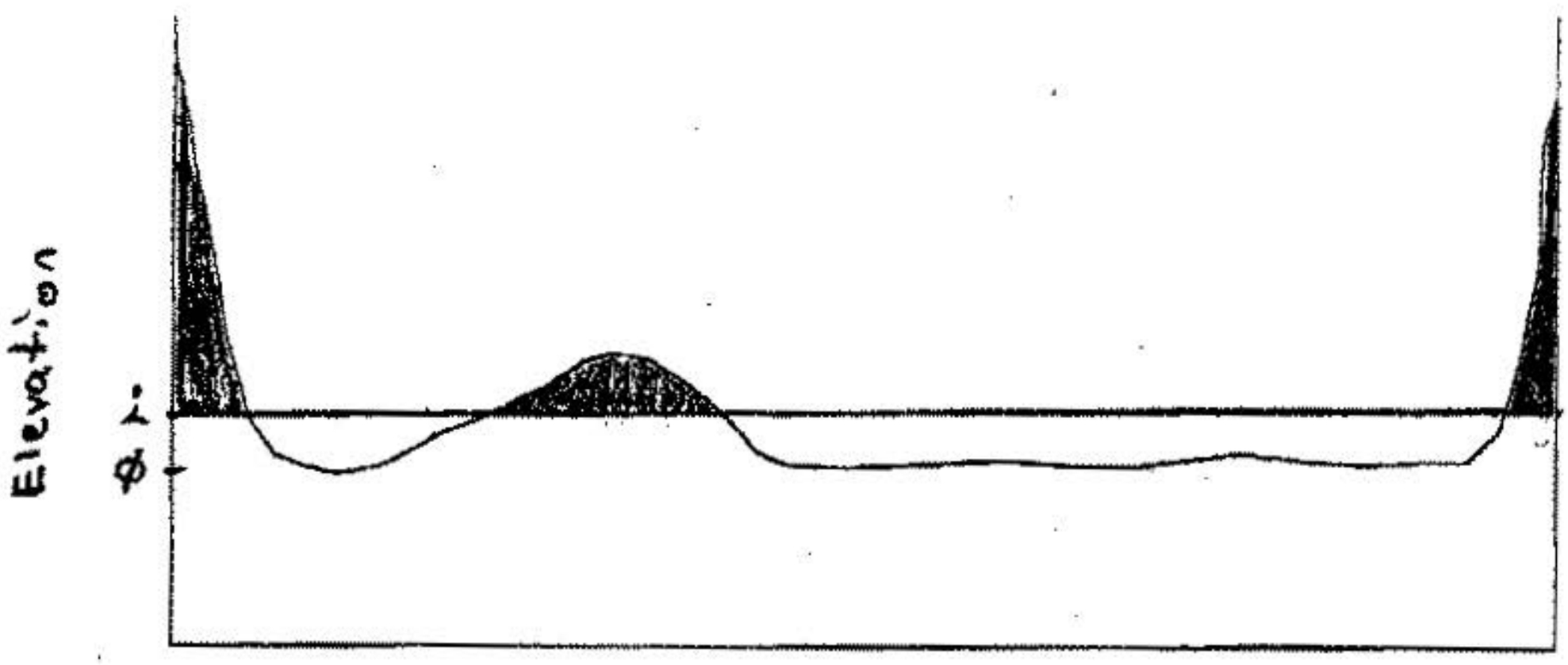


■ Expected basin soil volume if there were no space for water. i.e. If basin was all soil.

$$V_{s_exp} = .25 \times A$$

Figure 5. Volume of .25 height of solid Planimetric Area Cylinder.

Basin profile not to scale



➡ Basin soil volume above elevation i

$V_{S_tot_i}$

Figure 6. Total volume of soil above elevation i

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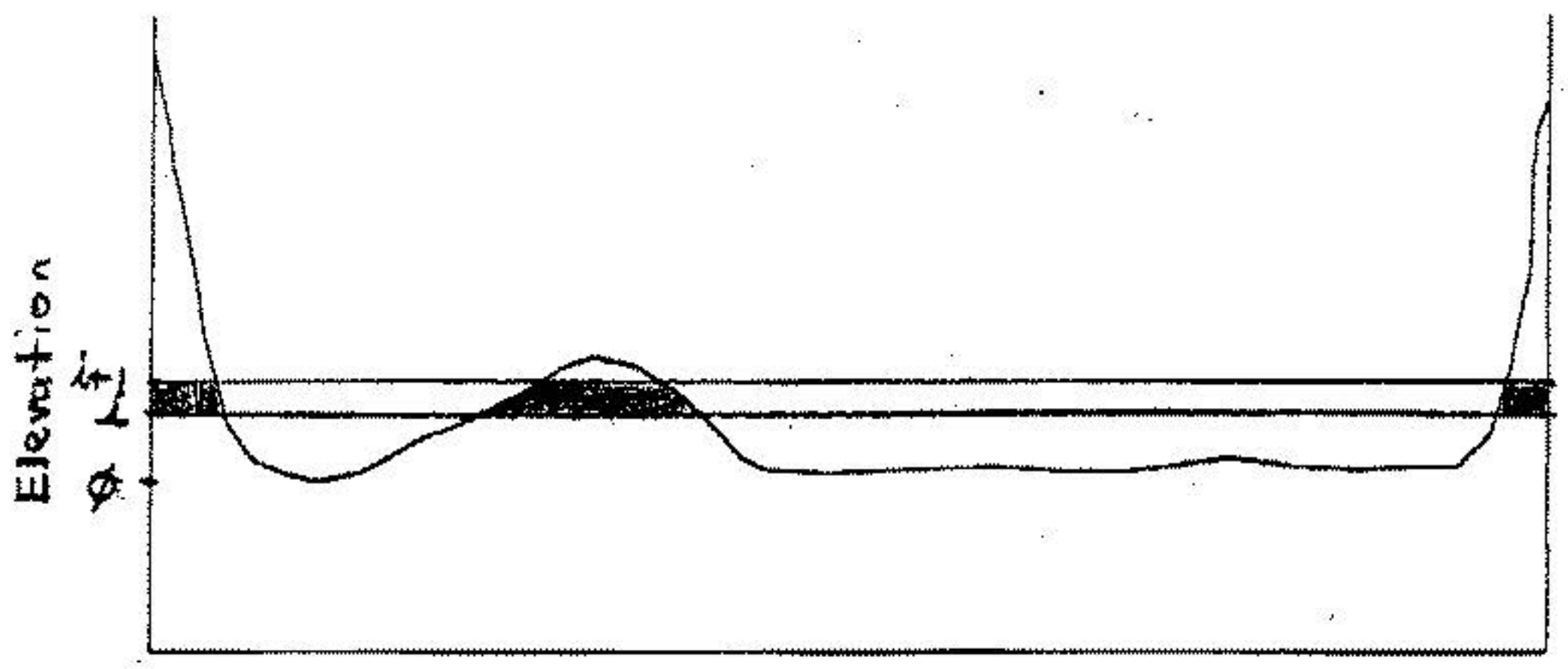
Basin profile not to scale

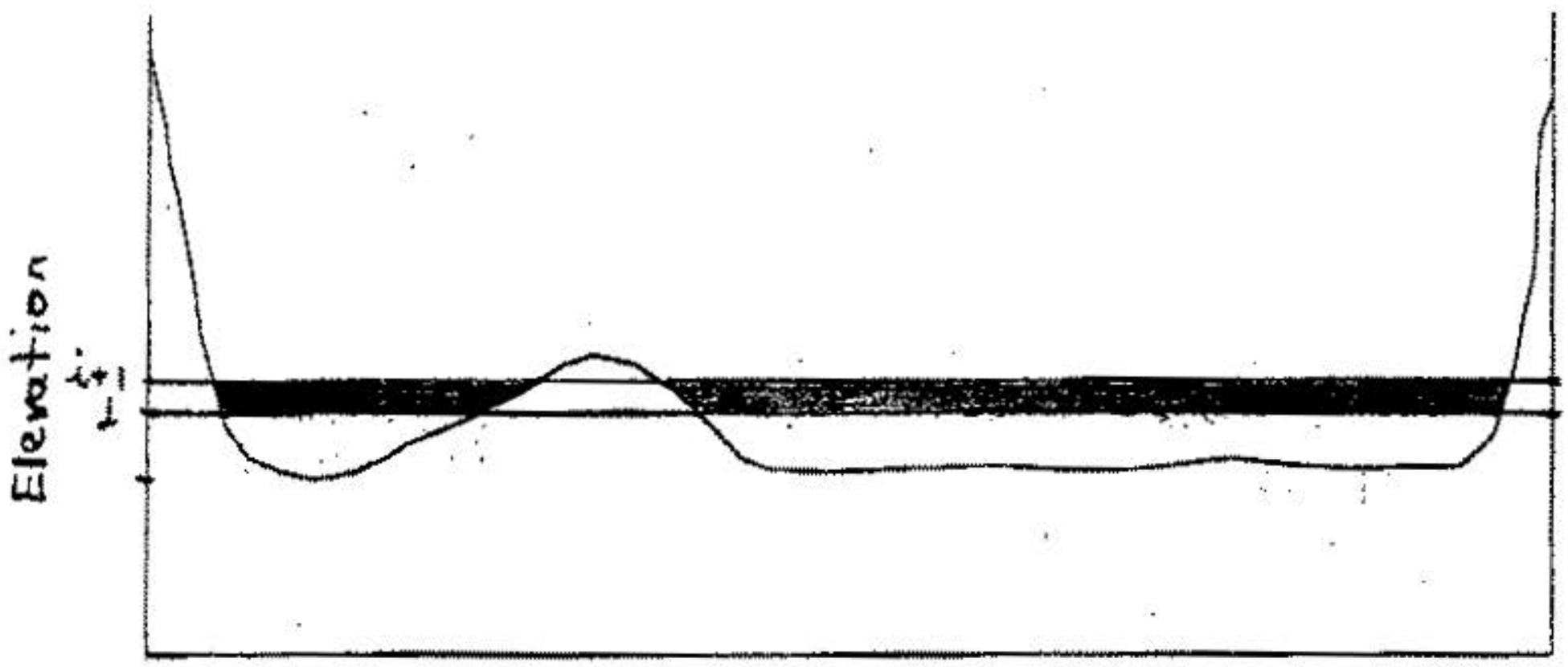


■ Basin soil volume between elevation i and elevation $i+1$

$$V_{s_act_i+1} = V_{s_tot_i} - V_{s_tot_i+1}$$

Figure 7. Actual volume of soil between elevation i and elevation $i+1$.

Basin profile not to scale

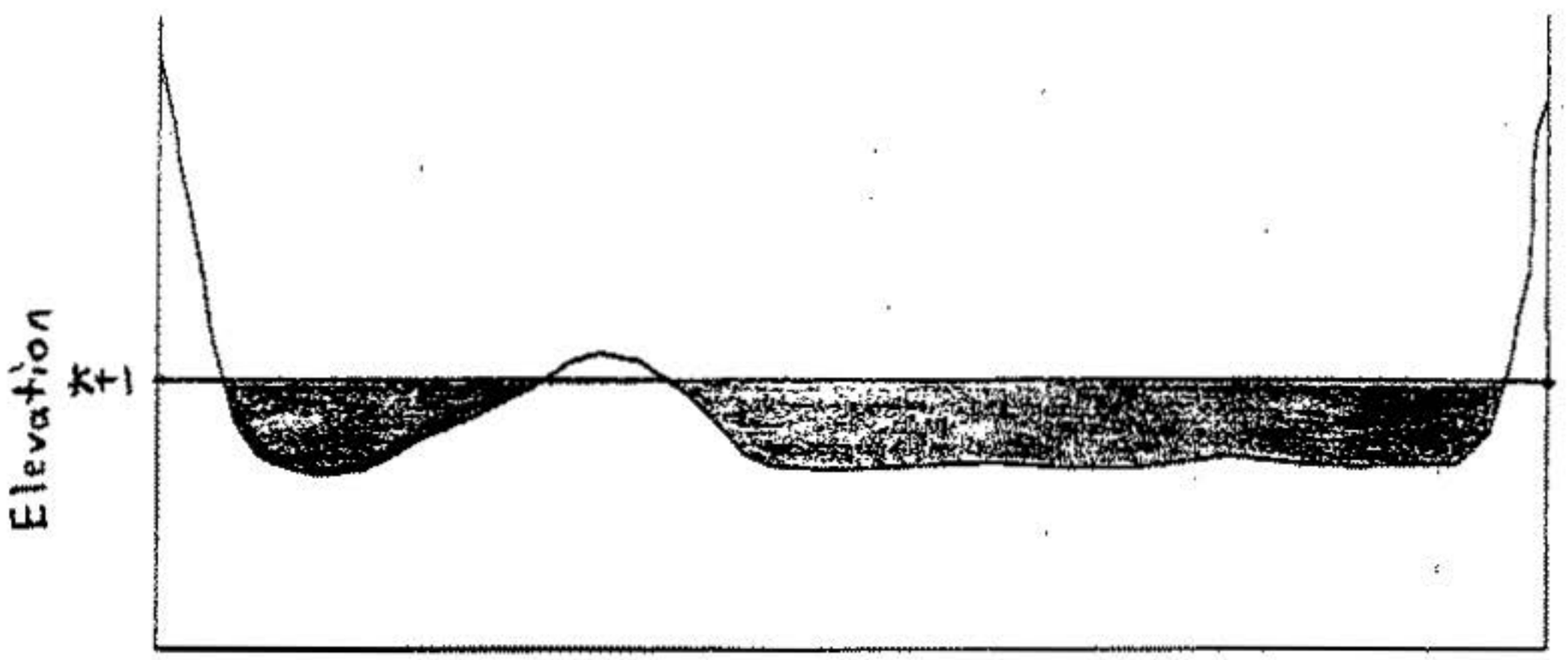


■ Basin water volume between elevation i and elevation $i+1$

$$V_{w_act_i+1} = V_{s_exp} - V_{s_act_i+1}$$

Figure 8. Actual basin water volume between elevation i and elevation $i+1$.

Basin profile not to scale



■ Basin water volume at elevation k+1

$$V_{w_tot_k+1} = \sum_{i=0}^{k} V_{w_act_i+1}$$

Figure 9. Total basin water volume at elevation k+1.

LEGEND

+ Points Used in Analysis

⊗ Questionable Point Used in Analysis

〰 Questionable Area With No Sample Points

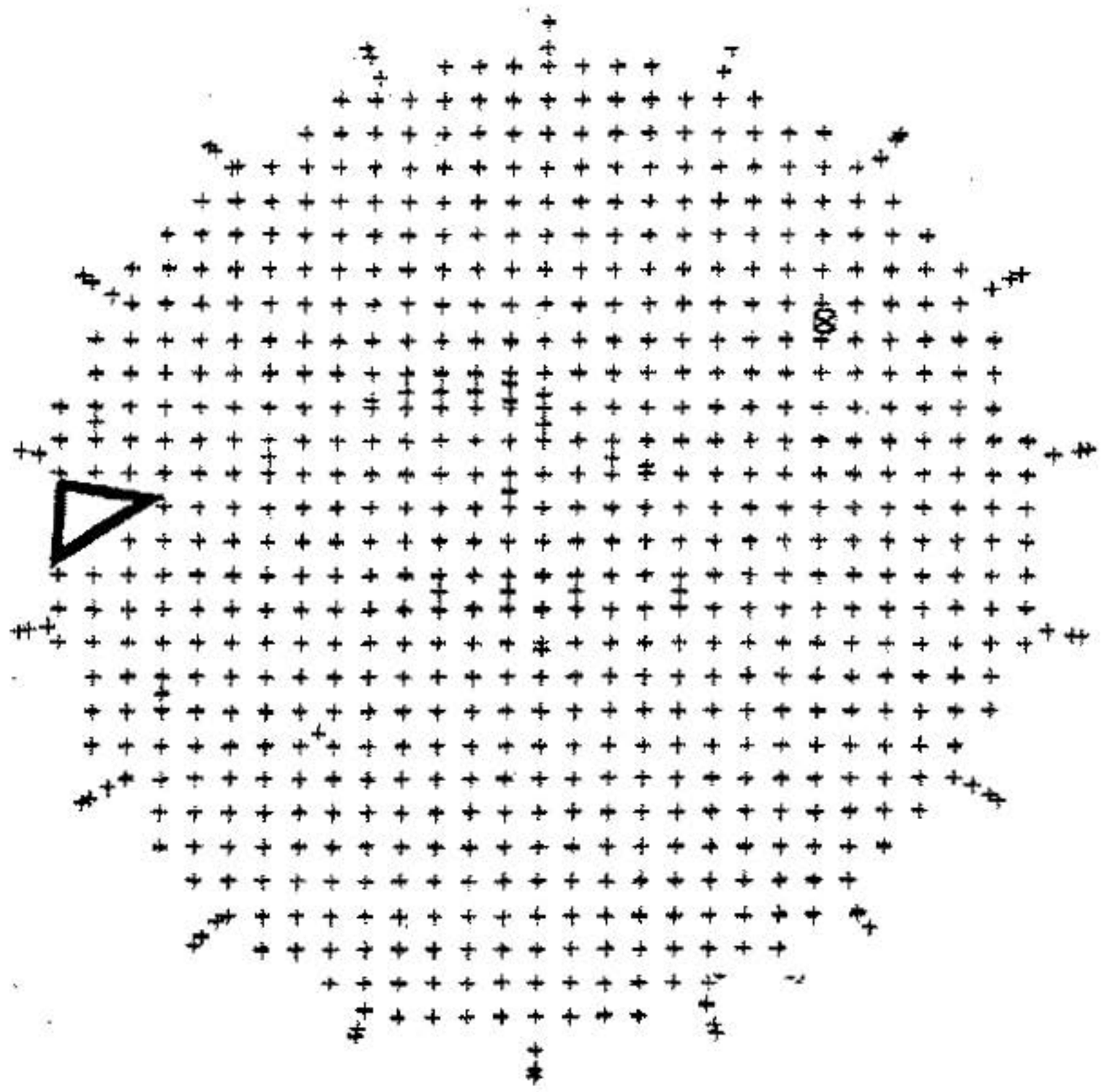
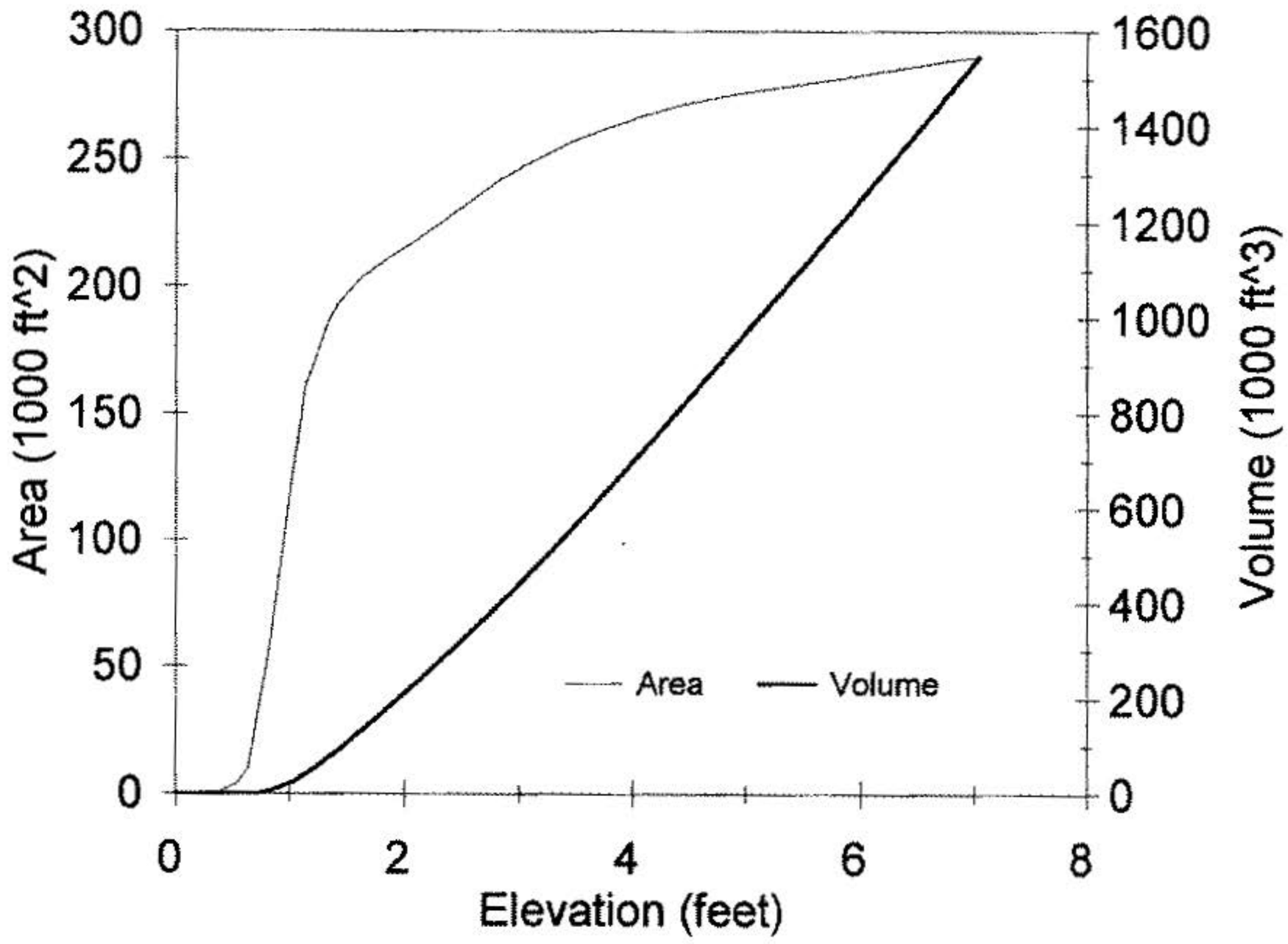


Figure 10. Point and Area of Basin In Question.


300
250
200
150
100
50
0
Area (1000 ft^2)
1600
1400
1200
1000
800
600
400
200
0
Volume (1000 ft^3)
Area
Volume
0
2
4
6
8
Elevation (feet)

Elevation (ft)	Cylinder Volume Above Elev (ft^3)	Soil Vol Above Elev (ft^3)	Basin Vol Above Elev (ft^3)	Basin Vol Below Elev (ft^3)	Mid-Slice Surface Area (ft^2)	Mid-Slice Surface Area (acres)
0.00	2121808.1	512381.4	1609427	0	0	0.00
0.25	2048642.3	439222.2	1609420	7	26	0.00
0.50	1975476.5	366111.5	1609365	62	220	0.01
0.75	1902310.7	294473.8	1607837	1590	6112	0.14
1.00	1829144.9	239316.4	1589829	19598	72034	1.65
1.25	1755979.1	206008.6	1549971	59456	159432	3.66
1.50	1682813.3	180603.1	1502210	107216	191041	4.39
1.75	1609647.5	158341.8	1451306	158121	203618	4.67
2.00	1536481.7	138094.1	1398388	211039	211672	4.86
2.25	1463315.9	119661.5	1343654	265772	218933	5.03
2.50	1390150.1	103207.1	1286943	322484	226846	5.21
2.75	1316984.3	88852.4	1228132	381295	235244	5.40
3.00	1243818.5	76468.0	1167351	442076	243126	5.58
3.25	1170652.8	65640.7	1105012	504415	249354	5.72
3.50	1097487.0	56266.7	1041220	568206	255167	5.86
3.75	1024321.2	48037.2	976284	633143	259745	5.96
4.00	951155.4	40803.8	910352	699075	263730	6.05
4.25	877989.6	34475.5	843514	765913	267350	6.14
4.50	804823.8	28978.5	775845	833581	270675	6.21
4.75	731658.0	24104.8	707553	901874	273168	6.27
5.00	658492.2	19720.7	638771	970655	275127	6.32
5.25	585326.4	15792.7	569534	1039893	276951	6.36
5.50	512160.6	12297.8	499863	1109564	278684	6.40
5.75	438994.8	9236.6	429758	1179669	280418	6.44
6.00	365829.0	6612.8	359216	1250211	282168	6.48
6.25	292663.2	4430.2	288233	1321194	283933	6.52
6.50	219497.4	2692.7	216805	1392622	285713	6.56
6.75	146331.6	1404.0	144928	1464499	287508	6.60
7.00	73165.8	566.4	72599	1536827	289313	6.64
7.25	0.0	0.0	0	1609427	290398	6.67

Staff Gage (ft)	Elevation (ft)	Surface Area (ft^2)	Surface Area (acres)	Basin Volume (ft^3)	Basin Volume (gal)	Surface Area (E3 ft^2)	Basin Volume (E3 ft^3)
	0	0	0.00	0	0	0	0
	0.04	8.39936	0.00	1	8	0.0084	0.00106
	0.14	38.028	0.00	4	28	0.03803	0.00369
	0.24	115.628	0.00	6	47	0.11563	0.00633
	0.34	193.228	0.00	26	198	0.19323	0.02643
	0.44	1752.31	0.04	48	363	1.75231	0.04847
	0.54	4109.11	0.09	306	2290	4.10911	0.30619
	0.64	10067.7	0.23	917	6862	10.0677	0.91743
	0.74	36436.1	0.84	1529	11434	36.4361	1.52867
	0.84	62804.6	1.44	8073	60385	62.8046	8.07281
	0.94	94757.2	2.18	15276	114266	94.7572	15.2762
	1.04	129717	2.98	25975	194296	129.717	25.9755
	1.14	161329	3.70	41919	313552	161.329	41.9187
	1.24	173972	3.99	57862	432807	173.972	57.8619
0.0	1.34	186616	4.28	76650	573341	186.616	76.6499
0.1	1.44	194311	4.46	95754	716240	194.311	95.754
0.2	1.54	199342	4.58	115361	862902	199.342	115.361
0.3	1.64	204101	4.69	135723	1015208	204.101	135.723
0.4	1.74	207323	4.76	156085	1167514	207.323	156.085
0.5	1.84	210545	4.83	177171	1325243	210.545	177.171
0.6	1.94	213560	4.90	198339	1483574	213.56	198.339
0.7	2.04	216464	4.97	219796	1644077	216.464	219.796
0.8	2.14	219408	5.04	241690	1807839	219.408	241.69
0.9	2.24	222573	5.11	263583	1971600	222.573	263.583
1.0	2.34	225738	5.18	286188	2140689	225.738	286.188
1.1	2.44	229029	5.26	308873	2310370	229.029	308.873
1.2	2.54	232389	5.33	331893	2482563	232.389	331.893
1.3	2.64	235717	5.41	355418	2658526	235.717	355.418
1.4	2.74	238870	5.48	378942	2834489	238.87	378.942
1.5	2.84	242022	5.56	403176	3015757	242.022	403.176
1.6	2.94	244745	5.62	427489	3197615	244.745	427.489
1.7	3.04	247236	5.68	452050	3381336	247.236	452.05
1.8	3.14	249703	5.73	476986	3567853	249.703	476.986
1.9	3.24	252028	5.79	501921	3754370	252.028	501.921
2.0	3.34	254353	5.84	527380	3944800	254.353	527.38
2.1	3.44	256357	5.89	552896	4135665	256.357	552.896
2.2	3.54	258189	5.93	578596	4327900	258.189	578.596
2.3	3.64	259984	5.97	604571	4522189	259.984	604.571
2.4	3.74	261578	6.01	630545	4716479	261.578	630.545
2.5	3.84	263172	6.04	656878	4913451	263.172	656.878
2.6	3.94	264671	6.08	683251	5110720	264.671	683.251
2.7	4.04	266119	6.11	709769	5309073	266.119	709.769
2.8	4.14	267549	6.14	736504	5509051	267.549	736.504
2.9	4.24	268880	6.17	763239	5709029	268.88	763.239
3.0	4.34	270210	6.20	790273	5911245	270.21	790.273
3.1	4.44	271323	6.23	817341	6113710	271.323	817.341
3.2	4.54	272321	6.25	844508	6316921	272.321	844.508
3.3	4.64	273286	6.27	871825	6521251	273.286	871.825
3.4	4.74	274069	6.29	899142	6725581	274.069	899.142
3.5	4.84	274853	6.31	926635	6931229	274.853	926.635
3.6	4.94	275601	6.33	954148	7137024	275.601	954.148
3.7	5.04	276331	6.34	981733	7343365	276.331	981.733
3.8	5.14	277061	6.36	1009428	7550524	277.061	1009.43
3.9	5.24	277748	6.38	1037124	7757684	277.748	1037.12
4.0	5.34	278441	6.39	1064975	7966010	278.441	1064.97

Staff Gage (ft)	Elevation (ft)	Surface Area (ft^2)	Surface Area (acres)	Basin Volume (ft^3)	Basin Volume (gal)	Surface Area (E3 ft^2)	Basin Volume (E3 ft^3)
4.1	5.44	279135	6.41	1092843	8174465	279.135	1092.84
4.2	5.54	279829	6.42	1120781	8383439	279.829	1120.78
4.3	5.64	280523	6.44	1148823	8593192	280.523	1148.82
4.4	5.74	281223	6.46	1176864	8802945	281.223	1176.86
4.5	5.84	281923	6.47	1205064	9013876	281.923	1205.06
4.6	5.94	282627	6.49	1233280	9224938	282.627	1233.28
4.7	6.04	283333	6.50	1261568	9436527	283.333	1261.57
4.8	6.14	284040	6.52	1289961	9648909	284.04	1289.96
4.9	6.24	284752	6.54	1318354	9861291	284.752	1318.35
5.0	6.34	285464	6.55	1346908	10074871	285.464	1346.91
5.1	6.44	286180	6.57	1375479	10288585	286.18	1375.48
5.2	6.54	286898	6.59	1404122	10502835	286.898	1404.12
5.3	6.64	287617	6.60	1432873	10717892	287.617	1432.87
5.4	6.74	288338	6.62	1461624	10932948	288.338	1461.62
5.5	6.84	289060	6.64	1490537	11149219	289.06	1490.54
5.6	6.94	289595	6.65	1519469	11365625	289.595	1519.47
5.7	7.04	290029	6.66	1548443	11582355	290.029	1548.44

Appendix E

Meteorological Report

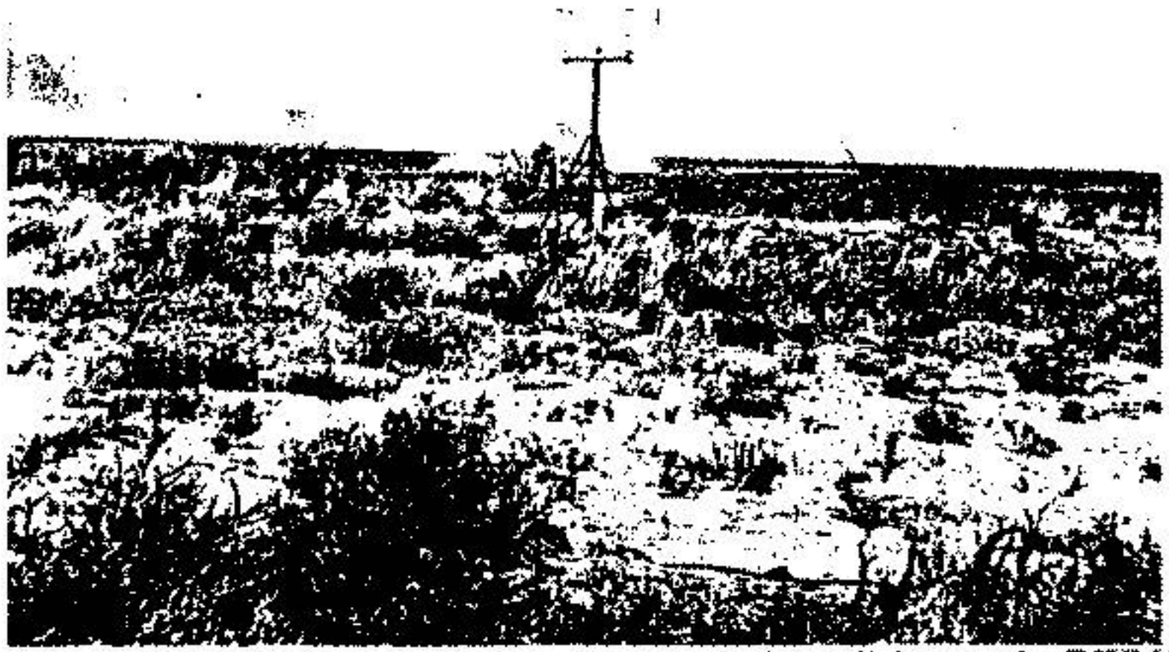


Figure E-1. Meteorological station with buildings at the RWMC in the background.

(a)

(b)

(c)

Figure E-2a. Panorama looking north (a), clockwise through south (d) to north-northwest (g).

(d)

(e)

(f)

(g)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES

ARL Field Research Division
1750 Foote Drive
Idaho Falls, ID 83402-4901

October 25, 1994

Dr. Robert Starr
Lockheed Idaho Technologies Company
P O Box 1625
Idaho Falls, ID 83415

Dear Dr. Starr,

Attached is the final memo report describing our meteorological measurements for and calculations of evaporation to support the 1994 Large Scale Aquifer Stress and Infiltration Test. The EG&G purchase order to us is # C94-170844.

From our measurements and calculations, we determined that appproximately 39 inches of water ± 20% evaporated from the LST pond, while we measured input of 0.41 inches precipitation to the pond. In the report we also suggest three activities to reduce uncertainty in future evaporation measurements and calculations.

We appreciated the opportunity to participate in the Test and look forward to working with you on future tests.

Sincerely,

C Ray Dickson

C. Ray Dickson, Director

10-24-94

Report of Precipitation Measurements and Evaporation Calculations To Support the Large-Scale Aquifer Stress And Infiltration Test of 1994

David H. George
NOAA-Air Resources Laboratory
Field Research Division
1750 Foote Drive
Idaho Falls, Idaho 83402

1. Equipment Description

All equipment was known good at the time of installation.

Precipitation Gage:

Precipitation was measured with an 8 inch diameter Climatronics heated tipping bucket precipitation gage. The heaters were not operated as the likelihood of significant frozen precipitation, such as hail, at the site is very low.

Wind Speed:

Wind Speed was measured with a Met One three cup anemometer identical to those used in the INEL Meteorological Measuring Network. Specifications are given in Exhibit 1. Wind speed was measured at two meters height above ground to simplify evaporation calculations.

Data Logger:

Data were acquired at 1 Hz by a Campbell Scientific CR-10 data logger enclosed in a weather tight cabinet. The CR-10 and its algorithms were identical to those used in the INEL Meteorological Measuring Network. The CR-10 produced a 5 minute average wind speed and accumulated precipitation totals in each five minute period. CR-10 specifications are given in Exhibit 2.

2. Installation and Checkout

Wind Speed equipment was installed on a 2 m tripod and the precipitation gage was placed on the ground on Friday July 15. The precipitation gage was bolted to a 1 ft square by 2 in thick concrete block and each wind tripod leg was bolted to a 1 ft diameter round by 2 in thick concrete block. The tripod cross arm and precipitation gage were leveled. Dirt bags were place atop the concrete blocks to hold the equipment in case of unusually strong winds.

Standard NOAA/Air Resources Laboratory Physical and Safety Audit forms (Exhibit 3, 4 pages) document the installation.

The equipment was located to the north-northwest of the LTS pond, and about 40 feet west-northwest of wells CO2C11 and CO2C12 (see Exhibit 4). The first of the attached photos (Exhibit 5) shows the meteorological equipment installation from the south looking north from the LST pond toward the RWMC. The seven 360° photos show the typical desert vegetation and topography of the measuring site.

The equipment was run-in through the weekend, verified for proper operation on Monday July 18 and declared operational.

3. Calibration Check and Teardown

Equipment calibration was checked at teardown on Monday September 12 and the equipment removed. The wind speed sensor starting torque and bearing condition checked within limits. The precipitation gage calibration was checked with a known quantity of water and found to require a +14.4% correction, in line with preinstallation corrections. Exhibit 6, Semiannual Calibration and Maintenance Form, documents the result of the calibration checks.

4. Bench Calibration

The precipitation gage calibration was also bench checked after teardown at NOAA/ARL as bench measurements can be more easily and accurately performed than those in the field. The precipitation correction was determined to be +16.7 %. This correction factor was used in data reduction and reporting. Given that only 0.35 in precipitation was recorded uncorrected from three occurrences during the test period, the difference between field and bench correction factors yields only 0.01 in difference in total precipitation.

5. Measured Precipitation

Four precipitation events occurred during the test period:

July 31	0.13 in corrected
August 10	0.01 in
August 10	0.02 in
August 20	0.2[illegible] in
Total Precipitation	0.41 in corrected

6. Evaporation Computations

Evaporation was computed using the empirical relationship developed and published by de Bruin (1978).

The relationship is given by

$$LE = [\ \alpha/\alpha\text{-}1\ ]\ [\ \gamma/s + \gamma\ ]\ f(u)\ (e_s - e)$$

where LE is the latent heat flux from a water surface

α is the empirical Priestly and Taylor constant of value 1.26 (Stewart and Rouse 1977)

γ is the psychrometric constant

s is the slope of the saturation vapor pressure-temperature curve

f(u) is an empirical wind speed-height relationship (Sweers 1976)

e_s is the saturation vapor pressure

e is the vapor pressure.

Wind speed was measured north-northwest of the Large-Scale Test pond at 2m above ground, while 2 m temperature and relative humidity to derive e and e_s (Lowe, 1977) were measured at the INEL Meteorological Measuring Network tower at RWMC. We assume the temperature and relative humidity at the two measuring stations should be very similar given the uniform desert surface from the LST pond to RWMC and the normal occurrence of at least light winds over the area.

5 Day Averaging Period	Average Daily Evaporation	Total 5 Day Evaporation	
7/18-22	2.0 cm/d	3.90 in	
7/23-27	1.5	2.95	
7/28-8/1	1.5	2.91	
8/2-6	1.7	3.35	
8/7-11	1.8	3.64	
8/12-16	1.5	3.04	
8/17-21	1.6	3.13	
8/22-26	2.0	3.93	
8/27-30	1.7	3.27	
8/31-9/4	2.1	4.13	
9/5-9	1.8	3.62	
9/10-11*	1.1	0.89	* two day period
Total 7/18-9/11		38.76 in	

Evaporation was calculated over 5 day averages, except for the final two days of the test. Total evaporation for the period July 18 through September 11 was 38.76 inches. The following table lists calculated evaporation. Calculated Average Daily Evaporation was rounded to the nearest 0.1 cm. Total 5 Day calculated Evaporation in inches is computed to three decimal places and rounded.

These evaporation calculations compare within factors of two to three with actual evaporation pan measurements made at the U.S. Department of Agriculture Research Station at Kimberly, Idaho, about 95 miles to the southwest. The Kimberly location is in an irrigated and hence more moist area than the INEL. Review of the Kimberly indicates that average wind speeds at Kimberly were approximately 75% of the wind speeds at the LST pond. Both factors indicate increased evaporation at the INEL versus Kimberly. The wind speed difference alone might account for up to a 60% greater evaporation rate at the LST pond.

7. Error Estimate:

We believe that the calculated evaporation for the LST site is representative of actual evaporation within ±20% of the true value based on the following considerations:

Wind speed is the driving factor in the evaporation calculations. The 95% confidence limits of 10 m wind speeds are reported to be ± 10% and are independent of averaging time for times greater than one day (McMillan, 1973).

Confidence limits of wind speeds at 2 m are likely to be wider than those at 10 m due to a larger effect of surface friction and roughness.

The vertical wind gradient is also stronger for smaller bodies of water, such as the LST pond (McMillan, (1973).

Wind speed, temperature and relative humidity were measured at distances removed from the LST pond rather than directly over the pond.

8. Suggestions for Future Evaporation Measures:

1. As a minimum, evaporation should be measured directly with a standard Class A Evaporation Pan. This includes wind speed measurements over the evaporation pan surface and eliminates the need for calculations which employ second order empirically derived relationships.

2. Pond temperature, and near surface air temperature, humidity and wind speed should be measured directly, and the same empirically derived relationships used to calculate evaporation.

3. Evaporation Pan and empirically based calculated evaporation should be compared to provide a better error estimate.

References:

de Bruin, H.A.R., 1978: A simple model for shallow lake evaporation. *J. Appl. Meteor.*, 17, 1132-1134.

Lowe, Paul R., 1977: *J. Appl. Meteor.*, 16, 100-103.

McMillan, W., 1973: Cooling from open water surfaces: Final Report, Part 1: Lake Trawsfynydd cooling investigation. scientific Services Department, CECG Manchester, No. NW/SSD/RR/1204/73.

Sweers, H.E., 1976: A nomogram to estimate the heat-exchange coefficient at the air-water interface as a function of wind speed and temperature; a critical survey of some literature. *J. Hydrol.*, 30, 375-401.

Stewart, R. B., and W.R. Rouse, 1977: Substantiation of the Priestly and Taylor parameter α = 1.26 for potential evaporation at high latitudes. *J. Appl. Meteor.*, 16, 649-650.

Exhibit 1

5397 WIND SPEED SENSOR

1.0 GENERAL INFORMATION

1.1 The 5397 Wind Speed Sensor uses a durable, three-cup anemometer assembly and optical link with a 8-slot chopper disk to produce a pulsed output whose frequency is proportional to wind speed. An internal heater reduces moisture for extended bearing life. This sensor is usually used in conjunction with the 191 Crossarm Assembly and a translator module, but may also be used directly with a variety of data loggers.

1.2 The Sensor Cable has a quick-connect connector with vinyl jacketed, shielded cable. Cable length is given in -XX feet on the end of each cable part number. A 1953-XX cable is used with translators having terminal strip connections.

Table 1-1
Model 5397 Wind Speed Sensor Specifications

Performance Characteristics

Maximum Operating Range	0-60 meters/sec. or 0-125 mph
Starting Speed	.27 meters/sec or 0.6 mph
Calibrated Range	0-50 meters/sec or 0-100 mph
Accuracy	±1% or 0.15 mph, whichever is greater
Temperature Range	-50°C to +85°C
Response	Distance constant less than 5 feet of flow*

*The distance traveled by the air after a sharp-edged gust has occurred for the anemometer to reach 63% of the new speed.

Electrical Characteristics

Power Requirements	12V DC at 3.5 mA
Output Signal	11-volt pulse
Output Impedance	100 ohms maximum
Heater Power Requirement	12V DC at 350 mA

Physical Characteristics

Weight	1.5 pounds
Finish	Anodized aluminum
Mounting	Use with 191 Mounting Arm
Cabling	1953-XX Cable (XX is cable length in feet)

Optional Accessories

a. External heater assembly for extreme low temperature operation.
b. Ice Skirt for extreme icing environments.

2.0 INSTALLATION

2.1 Mount the cup assembly and secure with the allen head set screw, check to see that the cup assembly rotates freely.

2.2 Install the sensor in the end of the Model 191 Mounting Arm (the end without the bushing).

2.3 Tighten the locking set screw. Do not over-tighten. Apply a small amount of silicone grease to set screws to prevent freezing in corrosive environments.

2.4 Connect the cable assembly to the keyed sensor receptacle and tape it to the mounting arm.

2.5 Wiring. The cable assembly contains six wires. Typical wiring hookup is shown in Figure 2-1. Four of the wires connect to the translator module, the other two wires are connected to the heater power supply. The heater power supply may be located in the translator or as part of an auxiliary power supply. (Refer to system wiring diagram.)

CR10 MEASUREMENT AND CONTROL MODULE OVERVIEW

Campbell Scientific Inc. provides three documents to aid in understanding and operating the CR10:

1. *This Overview*
2. *The CR10 Operator's Manual*
3. *The CR10 Prompt Sheet*

This Overview introduces the concepts required to take advantage of the CR10's capabilities. Hands-on programming examples start in Section OV5. Working with a CR10 will help the learning process, so don't just read the examples, do them. If you want to start this minute, go ahead and try the examples, then come back and read the rest of the Overview.

The sections of the Operator's Manual which should be read to complete a basic understanding of the CR10 operation are the Programming Sections 1-3, the portions of the data retrieval Sections 4 and 5 appropriate to the method(s) you are using (see OV6), and Section 14 which covers installation and maintenance.

Section 6 covers details of serial communications. Sections 7 and 8 contain programming examples. Sections 9-12 have detailed descriptions of each programming instruction, and Section 13 goes into detail on the CR10 measurement procedures.

The Prompt Sheet is an abbreviated description of the programming instructions. Once familiar with the CR10, it is possible to program it using only the Prompt Sheet as a reference, consulting the manual if further detail is needed.

Read the Selected Operating Details and Cautionary Notes at the front of the Manual before using the CR10.

OV1. PHYSICAL DESCRIPTION

The CR10 is a fully programmable datalogger/controller in a small, rugged, sealed module. Programming is very similar to Campbell Scientific's 21X and CR7 dataloggers. Some fundamental physical differences are listed below.

- The CR10 does not have an integral keyboard/display. The user accesses the CR10 with the portable CR10KD Keyboard Display or with a computer or terminal (Section OV2).

- The CR10 does not have an integral terminal strip. A removable wiring panel, the CR10WP (Figure OV1.1-1) performs this function and attaches to the two D-type connectors located at the end of the module.

- The power supply is external to the CR10. This gives the user a wide range of options (Section 14) for powering the CR10.

OV1.1 WIRING PANEL - MODEL CR10WP

The CR10WP Wiring Panel and CR10 datalogger make electrical contact through the two D-type connectors at the (left) end of the CR10.

The Wiring Panel contains a 9-pin Serial I/O port used when communicating with the datalogger and provides terminals for connecting sensor, control, and power leads to the CR10. It also provides transient protection and reverse polarity protection. Figure OV1.1-2 shows the panel and the instructions used to access the various terminals.

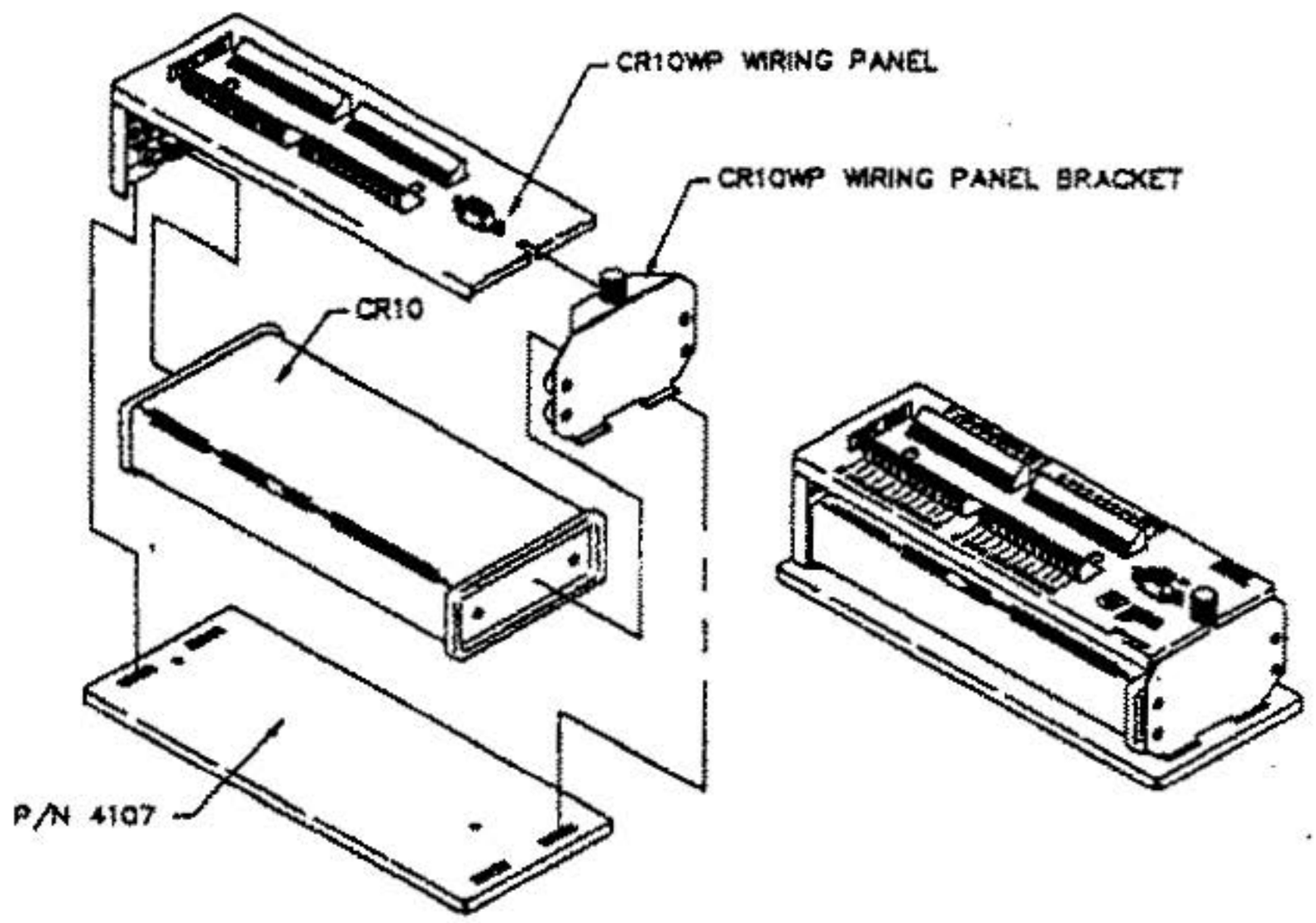


FIGURE OV1.1-1. CR10 and Wiring Panel

OV1.1.1 ANALOG INPUTS

The terminals labeled 1H to 6L are analog inputs. These numbers refer to the high and low inputs to the differential channels 1 through 6. In a differential measurement, the voltage on the H input is measured with respect to the voltage on the L input. When making single-ended measurements, either the H or L input may be used as an independent channel to measure voltage with respect to the CR10 analog ground (AG). The single-ended channels are numbered sequentially starting with 1H; e.g., the H and L sides of differential channel 1 are single-ended channels 1 and 2; the H and L sides of differential channel 2 are single-ended channels 3 and 4, etc. The single-ended channel numbers do NOT appear on the panel.

OV1.1.2 SWITCHED EXCITATION OUTPUTS

The terminals labeled E1, E2, and E3 are precision, switched excitation outputs used to supply programmable excitation voltages for resistive bridge measurements. DC or AC excitation at voltages between -2500 mV and +2500 mV are user programmable (Section 9).

OV1.1.3 PULSE INPUTS

The terminals labeled P1 and P2 are the pulse counter inputs for the CR10. They are programmable for switch closure, high frequency pulse or low level AC (Section 9, Instruction 3).

OV1.1.4 DIGITAL I/O PORTS

Terminals C1 through C8 are digital Input/Output ports. On power-up they are configured as input ports, commonly used for reading the status of an external signal. High and low conditions are: 3V < high < 5.5V; -0.5V < low < 0.8V.

Configured as outputs the ports allow on/off control of external devices. A port can be set high (5V ± 0.1V), set low (<0.1V), toggled or pulsed (Sections 3, 8.3, and 12).

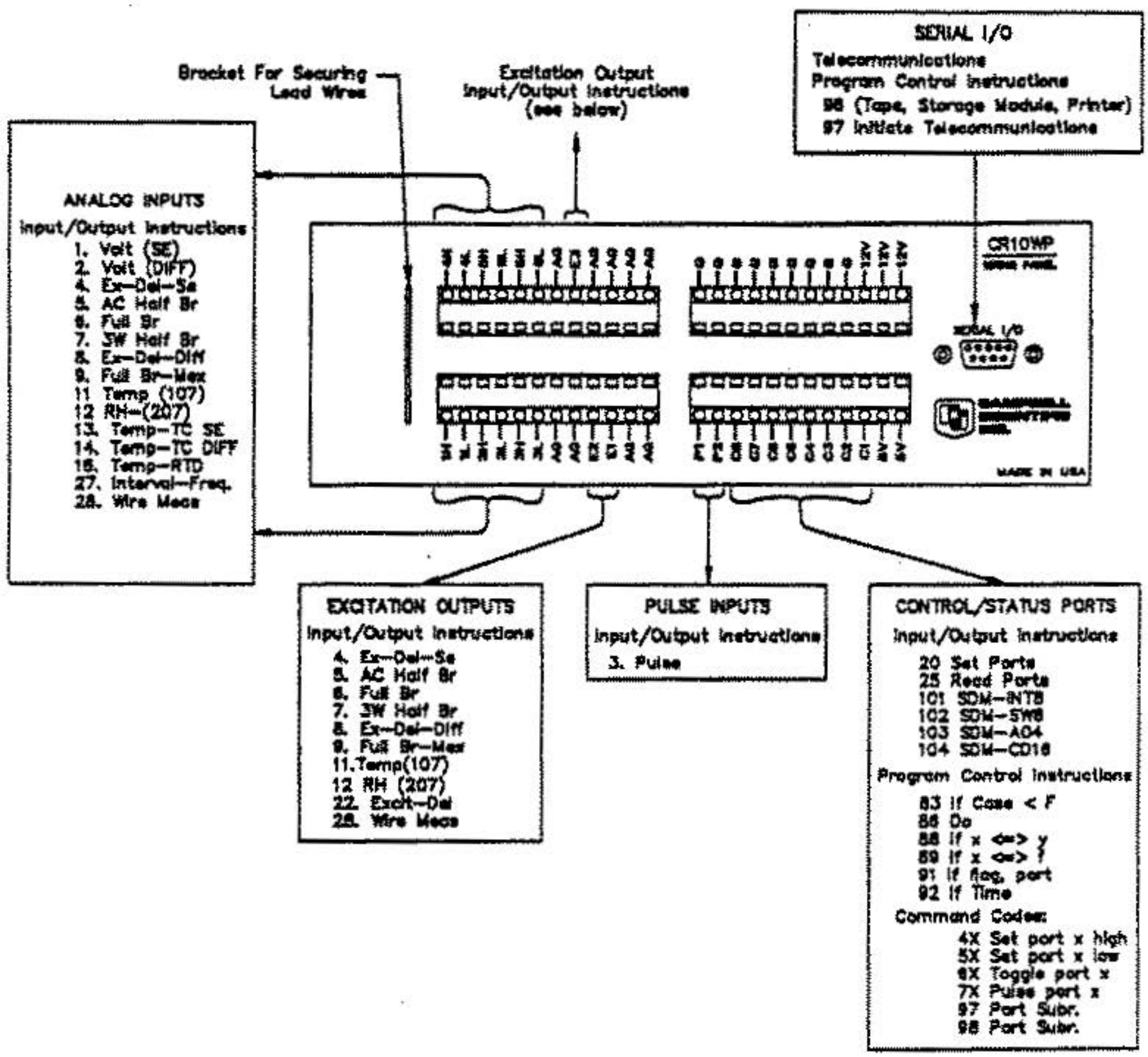


FIGURE OV1.1-2. CR10 Wiring Panel/Instruction Access

OV1.1.5 ANALOG GROUND (AG)

The AG terminals are analog grounds, used as the reference for single-ended measurements and excitation return.

OV1.1.6 12V AND POWER GROUND (G) TERMINALS

The 12V and power ground (G) terminals are used to supply 12V DC power to the datalogger. The extra 12V and G terminals can be used to connect other devices requiring 12V power.

The G terminals are also used to tie cable shields to ground, and to provide a ground reference for pulse counters and binary inputs. For protection against transient voltage spikes, power ground should b nnected to a good earth ground (Section 14.3.1).

OV1.1.7 5V OUTPUTS

The two 5V (±0.2%) outputs are commonly used to power peripherals such as the QD1 Incremental Encoder Interface, AVW1 or AVW4 Vibrating Wire Interface.

The 5V outputs are common with pin 1 on the 9 pin serial connector; 200 mA is the maximum combined output.

OV1.1.8 SERIAL I/O

The 9 pin serial I/O port contains lines for serial communication between the CR10 and external devices such as computers, printers, Storage Modules, etc. **This port does NOT have the same configuration as the 9 pin serial ports currently used on many personal computers.** It has a 5VDC power line which is used to power peripherals such as the SM192 or SM716 Storage Module or the DC112 Phone Modem. The same 5VDC supply is used for the 5V outputs on the lower terminal strip. Section 6 contains technical details on serial communication.

OV1.2 CONNECTING POWER TO THE CR10

The CR10 can be powered by any 12VDC source. First connect the positive lead from the power supply to one of the 12V terminals and then connect the negative lead to one of the power ground (G) terminals. The Wiring Panel power connection is reverse polarity protected. See Section 14 for details on power supply connections.

> **CAUTION:** The metal surfaces of the CR10, CR10WP Wiring Panel, and CR10KD Keyboard Display are at the same potential as power ground. To avoid shorting 12 volts to ground, connect the 12 volt lead first, then connect the ground lead.

OV2. MEMORY AND PROGRAMMING CONCEPTS

The CR10 must be programmed before it will make any measurements. A program consists of a group of instructions entered into a **program table**. The program table is given an **execution interval** which determines how frequently that table is executed. When the table is executed, the instructions are executed in sequence from beginning to end. After executing the table, the CR10 waits the remainder of the execution interval and then executes the table again starting at the beginning.

The interval at which the table is executed generally determines the interval at which the sensors are measured. The interval at which data are stored is separate from how often the table is executed, and may range from samples every execution interval to processed summaries output hourly, daily, or on longer or irregular intervals.

Figure OV2.1-1 represents the measurement, processing, and data storage sequence, and the types of instructions used to accomplish these tasks.

OV2.1 INTERNAL MEMORY

The CR10 has 64K bytes of Random Access Memory (RAM), divided into five areas. The use of the Input, Intermediate, and Final Storage in the measurement and data processing sequence is shown in Figure OV2.1-1. While the total size of these three areas remains constant, memory may be reallocated between the areas to accommodate different measurement and processing needs (*A Mode, Section 1.5). The size of the 2 additional memory areas, system and program, are fixed. The five areas of RAM are:

1. **Input Storage** - Input Storage holds the results of measurements or calculations. The *6 Mode is used to view Input Storage locations for checking current sensor readings or calculated values. Input Storage defaults to 28 locations. Additional locations can be assigned using the *A Mode (Section 1.5).

2. **Intermediate Storage** - Certain Processing Instructions and most of the Output Processing Instructions maintain intermediate results in Intermediate Storage. Intermediate storage is automatically accessed by the instructions and cannot be accessed by the user. The default allocation is 64 locations. The number of locations can be changed using the *A Mode.

3. **Final Storage** - Final processed values are stored here for transfer to printer, tape, solid state Storage Module or for retrieval via telecommunication links. Values are stored in Final Storage only by the Output Processing Instructions and only when the Output Flag is set in the users program. Approximately 29,900 locations are allocated to Final Storage on power up. This number is reduced if Input or Intermediate Storage is increased.

INEL LARGE SCALE AQUIFER STRESS & INFILTRATION TEST

LOCATION LST DATE _____ BY _____ Exhibit 3

SITE APPEARANCE

1.	Is the site clean of weeds and rubbish within a 50' radius of all guy wires and tower bases?	
2.	Is there a fence enclosing the tower and guy wires? If yes indicate what type and how tall.	
3.	Are there barb wire strands on top of the fence? If yes indicate how many and draw an elevation sketch of the fence and tower.	
4.	Is the fence in good condition? If no indicate why.	
5.	Is there evidence of vandalism?	
6.	Were all gates and climb prevention doors locked and secure?	
7.	Is there anti-climb protection installed at least 8' above the last external projectile?	
8.	Indicate what type of fall protection is in place. (cable or rail)	
9.	If a cable fall protection is used, is the shock absorber in good condition?	

NOTES:

6-3-92

MESONET PHYSICAL AND SAFETY AUDIT CHECKLIST

WIND DIRECTION AND SPEED

ID# LST LOCATION LARGE-SCALE AQUIFER TEST DATE _____ BY _____

	ELEMENT	DESIRE OR STANDARD	ACTUAL
1.	Height AGL	~~10 m (33 ft)~~ 2 m/6'7" (79")	79½"
2.	Boom Orientation	NW-SE	332°/152° TRUE (15.5° VARIATION)
3.	Boom Length	>2x Tower Face	N/A MOUNTED ATOP TRIPOD
4.	Boom Condition	Secure Straight	

NOTES: _____

6-3-92

MESONET PHYSICAL AND SAFETY AUDIT CHECKLIST

RAINGAGE

ID# LST LOCATION LARGE SCALE AQUIFER TEST DATE _____ BY _____

	ELEMENT	DESIRE OR STANDARD	ACTUAL
1.	Ground Surface	Natural Vegetation or Gravel	
2.	Foundation	Concrete	CONCRETE PAD
3.	Opening Diameter		8"
4.	Horizontal Opening	Horizontal	YES
5.	Height Above Foundation	30 cm (12 in) min	
6.	Height AGL	30 cm (12 in) min	
7.	Distance to Tower		
8.	Distance to Nearest Obstruction	> 2x Obstruction Height	
9.	Foundation Condition Cracks or chips Settling Erosion Bolts tight and corrosion free		
10	Conduit	Separate signal and electrical Solid Connectors	NO CONDUIT? TEMPO INSTALLATION. NO POWER AS NO HEAT REQUIRED.

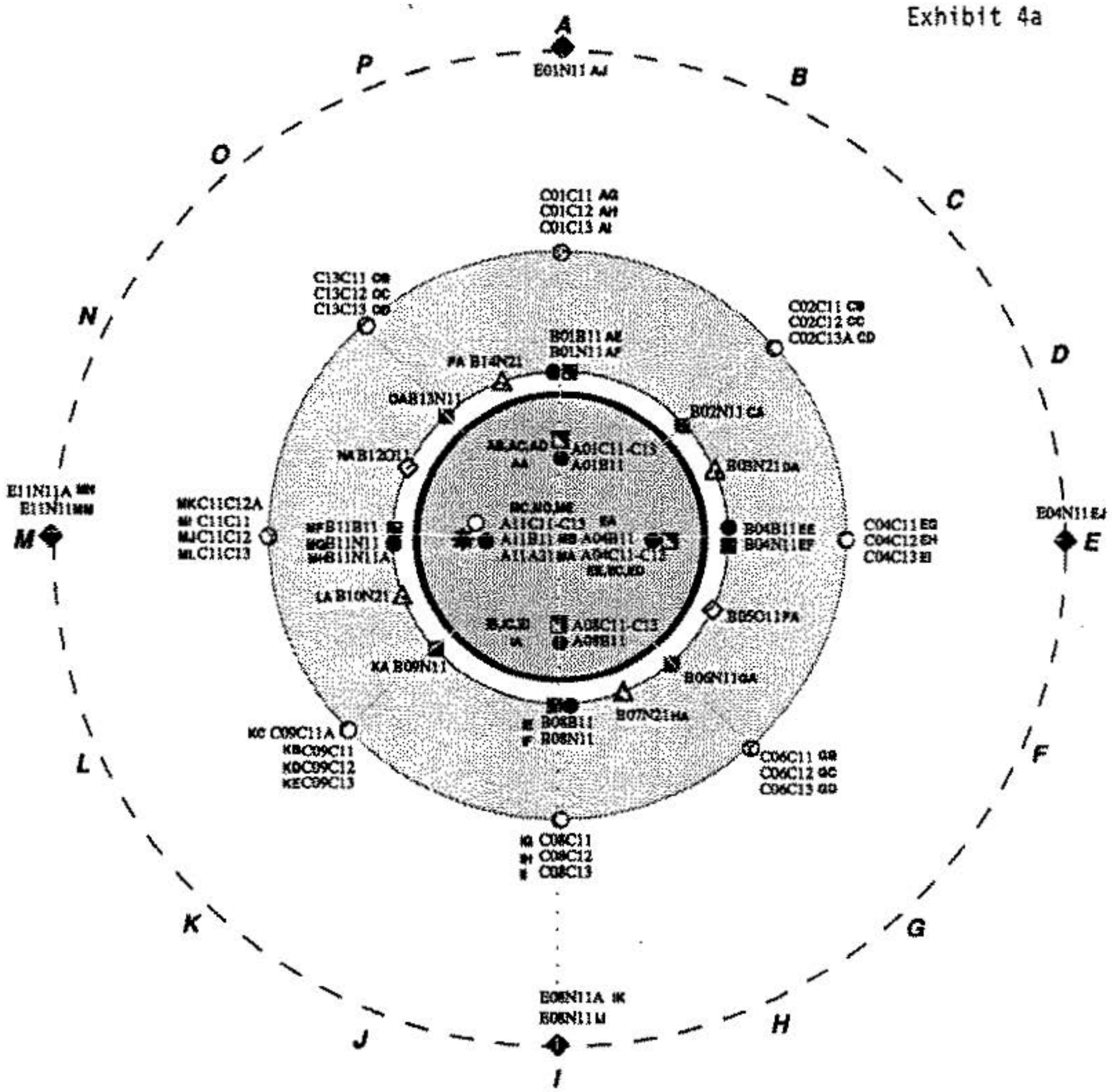
NOTES: _____

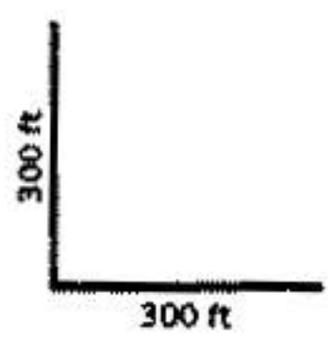
LOCATION LARGE SCALE AQUIFER TEST DATE 2-18-94 BY DAVID GEORGE

LIST ALL REPAIRS THAT WERE MADE OR ARE RECOMMENDED:

NONE

Exhibit 4a





- 180' neutron probe wells (4" pvc) (N)
- 180' neutron probe wells (4" steel) (N)
- 135' backfilled holes (4" open hole) (F)
- Cluster of 3 wells, all above 180' (C) (4" pvc, pending test of Solonist)
- Cluster of 4 wells, one below the (C) interbed (pending acceptable method)
- Acker holes to 135' - 180' (1" pvc) (A)
- Open for packers (F)
- Aquifer well (Q)

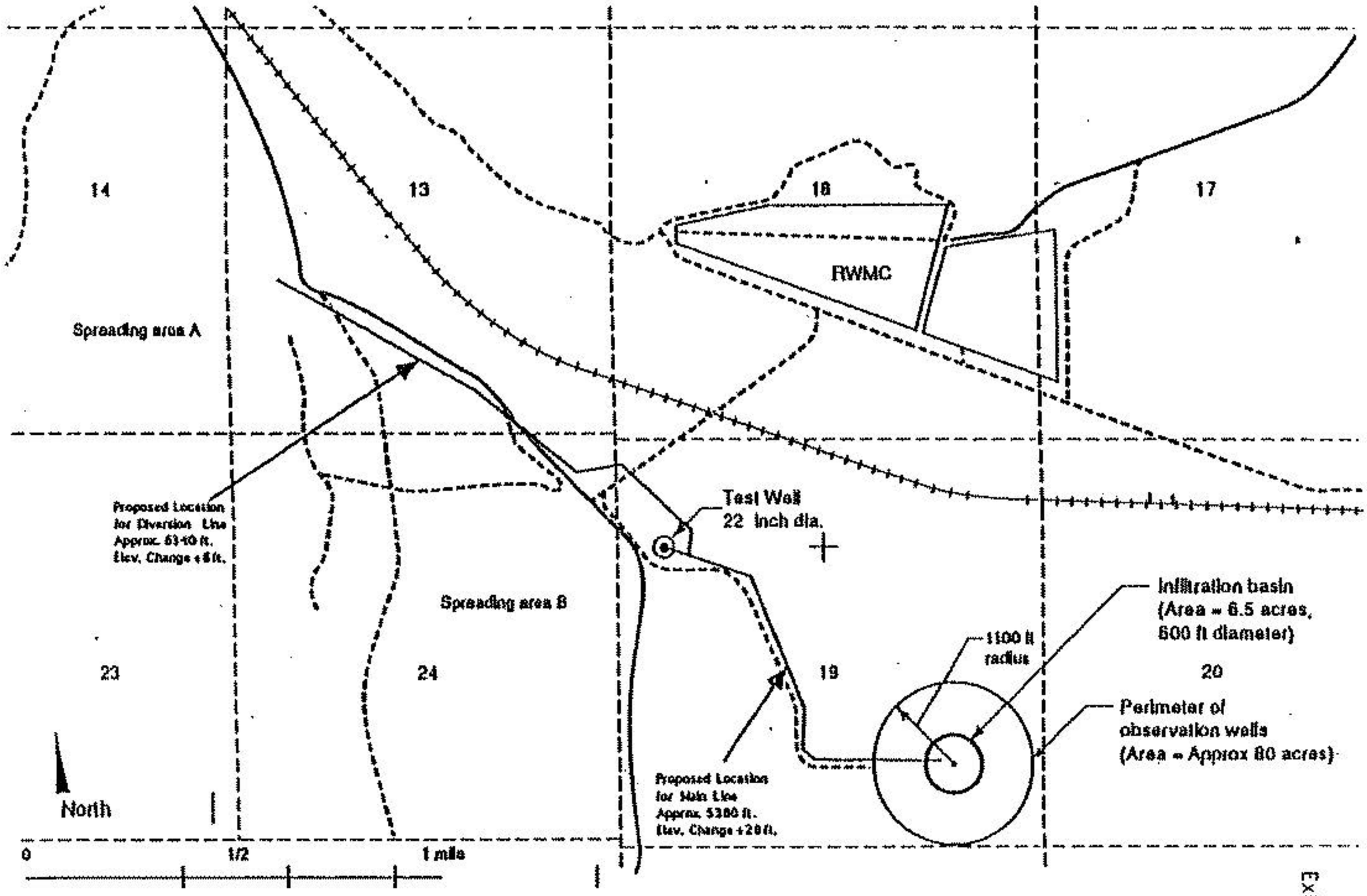


Figure 1
Site Map

Exhibit 4b

Exhibit 6

APPENDIX 14-2 SEMIANNUAL CALIBRATION AND MAINTENANCE FORM

Station RCMS - TEST Date Start 9-12-94 Date End 9-12-94

System RTMS Time Start _____ Time End _____

Wind Direction Calibration - Top of tall towers

Old serial# _____ New serial# _____
Wintek translator serial# _____

1. Check orientation on known point. Correct if off.
   Old value _____ Corrected to _____
2. This test will check that the torque is within the .11 oz.in. spec.
3. Remove wind vane and check torque with calibration counterweight. If torque in wind direction unit is great enough to lift counterweight past vertical then replace unit. Make this check with unit in horizontal position.
   Checked OK ✓ Replaced unit _____
4. Replace wind vane and check linearity. Using linearity plate, set the wind vane at 180 degrees. Then step through *0, 45, 90, 135, 225, 270, 315, *360 degrees. Actual values should be within ± 5 degrees.
   180 ✓ 225 ✓ 270 ✓ 315 ✓

   *360 ✓ *0 ✓ 45 ✓ 90 ✓ 135 ✓
   * 0 and 360 only valid on Wintek system.

   Checked OK ✓ Replaced unit _____
5. If unit is replaced reorient to known point.

Wind Direction Calibration 10/15 meters

Old serial# 251 New serial# _____
Wintek translator serial# _____

1. Check orientation on known point. Correct if off.
   Old value _____ Corrected to _____
2. This test will check that the torque is within the .11 oz.in. spec.
3. Remove wind vane and check torque with calibration counterweight. If torque in wind direction unit is great enough to lift counterweight past vertical then replace unit. Make this check with unit in horizontal position.
   Checked OK ✓ Replaced unit _____
4. Replace wind vane and check linearity. Using linearity plate, set the wind vane at 180 degrees. Then step through *0, 45, 90, 135, 225, 270, 315, *360 degrees. Actual values should be within ± 5 degrees.
   180 _____ 225 _____ 270 _____ 315 _____

   *360 _____ *0 _____ 45 _____ 90 _____ 135 _____

   * 0 and 360 only valid on Wintek system.

   Checked OK _____ Replaced unit UNIT HAD BROKEN INTERNAL LEAD. NO IDEA OF WHEN FAILURE OCCURRED. ALL DIRECTION DATA UNUSEABLE
5. If unit is replaced reorient to known point.

Station RAMC-TEST Date 9/12/94

Wind Speed Calibration - Top of tall tower

Old serial# _____ New serial# _____
Wintek translator serial#_____

1. This test will check that the torque is within the .003 oz.in. spec.
2. Remove cups and check torque with calibration counterweight. If torque in wind speed unit is great enough to lift weight past vertical then replace unit. Make this check with unit in horizontal position.

Checked OK _____ Replaced unit _____

Wind Speed Calibration 10/15 meters

Old serial# 387 New serial# _____
Wintek translator serial#_____

1. This test will check that the torque is within the .003 oz.in. spec.
2. Remove cups and check torque with calibration counterweight. If torque in wind speed unit is great enough to lift weight past vertical then replace unit. Make this check with unit in horizontal position.

Checked OK ✓ Replaced unit _____

Temperature Calibration - Top of tall towers

Clip calibration thermometer to intake of asperator and compare reading to keypad reading. Average reading for 5 min. Replace if error is greater than ± 1 degree C.

Thermometer _____ Keypad _____
Wintek translator serial#_____
Difference (Thermometer - Keypad) _____

Temperature Calibration 10/15 meters

Clip calibration thermometer to intake of asperator and compare reading to keypad reading. Average reading for 5 min. Replace if error is greater than ± 1 degree C.

Thermometer _____ Keypad _____
Wintek translator serial#_____

Difference (Thermometer - Keypad) _____

Temperature Calibration 2 meters

Clip calibration thermometer to intake of asperator and compare reading to keypad reading. Average reading for 5 min. Replace if error is greater than ± 1 degree C. Replace if delta T for lower level is ± .1 degree C different than delta T at upper levels.

Thermometer _____ Keypad _____

Difference (Thermometer - Keypad) _____

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES

ARL Field Research Division
1750 Foote Drive
Idaho Falls, ID 83402-4901

February 6, 1995

Dr. Robert Starr
Lockheed Idaho Technologies Company
P O Box 1625
Idaho Falls, ID 83415

Dear Bob,

Thanks for alerting me to the confusion caused by the evaporation table in the October 25, 1994 memo report for the Large Scale Aquifer Stress and Infiltration Test.

This memo addresses two points which I should have made clear:

1. The data day for evaporation computations was 24 hours beginning at noon July 18, 1995 and ending at noon August 12, 1995. This was not clearly stated in the report.

2. Computations were made of evaporation to include those dates and times. An error was made in preparing the report evaporation table in that the last complete midnight to midnight day was August 11, however computations were continued to noon on the 12th to complete the noon-to-noon computation, thus matching the noon July 18 start date/time.

   Included with this memo is a copy of the computation summary, not in the October 25, 1994 report because we didn't believe such detail added to the report. It indicates the computations were made through noon August 12. We also verified that computed evaporation was reported correctly.

   The report table should therefore be amended as italicized on the next page.

You asked earlier today about the times of precipitation. They were as follows:

July 31	7 pm through 8:25 pm	0.13 inches
August 10	9:05 pm through 9:10 pm	0..01 inches
August 10	11:55 pm through midnight	0.02 inches
August 20	5:25 pm through 6:40 pm	0.25 inches

Note that all times are MDT.

Station LST Date 9/12/94

Rain Gage Calibration

Serial# _____

1. Remove and clean tipping bucket.
2. Wet down funnel. Reinstall funnel.
3. Measure ~~220~~.0 ml of water into drip bottle. 150.0 ml
4. Drip at a rate no faster than 1 tip/30sec into funnel. Allow 10 tips to occur.
5. Stop flow of water and measure remaining liquid.
6. Measured amount should be between 34.7 and 54.7ml. Check bucket and fix if incorrect amount.

Number of tips. 10

Amount of water left 0.78 ml ⇒ 0.72 ml used

* Note: This test checks the tipping bucket calibration of 185.3 ml per .1 inches of precipitation/ (12" GAGE).

Relative Humidity Calibration

Old serial#_____ New serial# _____

System RH _____ Actual RH _____ (as based on dry bulb and wet bulb)

DB _____ WB _____

Replace if greater than ± 5% error.

Barometric Calibration

Old serial#_____ New serial#_____

System value _____ Actual value _____

Replace if off by ± .043 inches of mercury.

Comments: DESIGED FROM 8" GAGE: $0.1'' \times \pi (4\,in)^2 (2.54\,cm/in)(2.54\,cm/in)^2 = 82.37\,cc$

$\frac{82.37}{72} = 1.144$ OR +14.4% CORRECTION

9/23/94 BENCH TEST: 150ml AVAILABLE = 70.6 ml USED + 79.4 ml REMAINING

Signatures: $\frac{82.37}{70.6} = 1.167$ OR +16.7 CORRECTION

ET performing maintenance [signature] Date 9-12-94

Engineer reviewing report _____ Date _____

QAO reviewing report _____ Date _____

LST Computed Evaporation Table: Corrected Computation Dates

5 Day Averaging Period#	Average Daily Evaporation	Total 5 Day Evaporation	
7/18-22	2.0 cm/d	3.90 in	
7/23-27	1.5	2.95	
7/28-8/1	1.5	2.91	
8/2-6	1.7	3.35	
8/7-11	1.8	3.64	
8/12-16	1.5	3.04	
8/17-21	1.6	3.13	
8/22-26	2.0	3.93	
8/27-31	1.7	3.27	
9/1-9/5	2.1	4.13	
9/6-10	1.8	3.62	
9/11-12*	1.1	0.89	* two day period
Total 7/18-9/12		38.76 in	

 # Data and computation days are 24 hours beginning at noon

Please accept my apologies for the confusion caused by the incorrect dates in the report table.

Yours truly,

David H. George

Appendix F

Calculation of Infiltration Rates from Hydrograph Falling Limbs

Appendix F

Calculation of Infiltration Rates from Hydrograph Falling Limbs

This spreadsheet calculates infiltration rates from falling limbs of the infiltration basin hydrograph. The structure of the spreadsheet can be understood by reviewing the entries for line segment 1, which corresponds to Falling Limb 1. The first column contains the line segment label. The second contains the serial time computed by the spreadsheet for the beginning and ending times of the falling limb, and the duration of the falling limb. The next four columns are the date and time. The seventh column contains the maximum and minimum stage estimated using the regression line fit through the data. The eighth column contains the surface areas of water in the basin at the specified stages, and the average of the two areas. The next two columns contain the evaporation rate in different units, and the eleventh column contains the volume of water that evaporated from the basin during the duration of this line segment. The next two columns contain the precipitation amount and volume, which are both zero in this case; only nonzero values have entries. The fourteenth column includes the volumes of water in the basin at the specified stages, and the fifteenth contains the difference in the two volumes. Note that this corresponds to the negative of the delta basin volume value (ΔV) in Equations 1 and 2. The sixteenth column contains the volume of water that infiltrated, calculated as the difference in basin volume (Column 15) minus the evaporation volume (Column 11) plus the volume of precipitation (Column 13). The final two columns contain the infiltration rate in different units, calculated as the infiltration volume (Column 16) divided by the duration of the falling limb (Column 2), with the appropriate units conversions.

Line Segment	Serial Time (days)	Month	Day	Hour	Minute	Estimated Stage (feet)	Surface Area (ft^3)	Evaporation Rate (cm/d)	Evaporation Rate (in/d)	Evaporation Volume (ft^3)	Precipitation Quantity (in)	Precipitation Volume (ft^3)	Basin Volume (ft^3)	Delta Volume (ft^3)	Infil. Volume (ft^3)	Infiltration Rate (ft^3/d)	Rate (gpm)
1	34542.66	7	27	15	45	3.98	278302	1.50	0.590	6400			1059406	49977	43577	92965	482
	34543.13	7	28	3	0	3.80	277061						1009428				
	0.47						277682										
3	34545.13	7	30	3	5	4.16	279551	1.48	0.582	6341			1109606	50201	43860	93568	486
	34545.60	7	30	14	20	3.98	278302						1059405				
	0.47						278927										
4	34545.82	7	30	19	40	4.34	280803	1.48	0.582	8157			1160039	67196	59039	98285	510
	34546.42	7	31	10	5	4.10	279135						1092843				
	0.60						279969										
5a	34546.65	7	31	15	40	4.48	281713	1.51	0.596	30250	0.13	3018	1199424	253530	226298	103442	537
	34548.84	8	2	20	10	3.57	275377						945894				
	2.19						278545										
5b	34548.84	8	2	20	10	3.56	275302	1.70	0.670	29745			943143	259874	230129	105194	546
	34551.03	8	5	0	40	2.62	211737						683269				
	2.19						243520										
5c	34551.03	8	5	0	40	2.62	211737	1.70	0.670	28046			683269	228725	200679	91732	476
	34553.22	8	7	5	10	1.71	247483						454544				
	2.19						229610										
5d	34553.22	8	7	5	10	1.70	247236	1.83	0.720	30854			452050	188467	157613	72046	374
	34555.40	8	9	9	41	0.90	222573						263583				
	2.19						234905										
5e	34555.50	8	9	12	2	0.84	220706	1.85	0.728	25963	0.03	523	250666	142364	116923	57133	297
	34557.55	8	11	13	9	0.16	197531						108302				
	2.05						209119										
6	34559.59	8	13	14	11	4.21	279898	1.54	0.608	10004			1123585	92000	81996	115759	601
	34560.30	8	14	7	11	3.88	277611						1031585				
	0.71						278755										
7	34560.67	8	14	15	59	4.29	280454	1.54	0.608	12223			1146019	114434	102211	118220	614
	34561.53	8	15	12	44	3.88	277611						1031585				
	0.86						279033										
8	34561.77	8	15	18	29	4.22	279968	1.54	0.608	9125			1126389	89265	80140	124088	644
	34562.42	8	16	9	59	3.90	277748						1037124				
	0.65						278858										

Line Segment	Serial Time (days)	Month	Day	Hour	Minute	Estimated Stage (feet)	Surface Area (ft^3)	Evaporation Rate (cm/d)	Evaporation Rate (in/d)	Evaporation Volume (ft^3)	Precipitation Quantity (in)	Precipitation Volume (ft^3)	Basin Volume (ft^3)	Delta Volume (ft^3)	Infil. Volume (ft^3)	Infiltration Rate (ft^3/d)	Rate (gpm)
9	34562.59	8	16	14	14	4.18	279690	1.54	0.608	11018			1115193	108534	97516	124821	648
	34563.37	8	17	8	59	3.79	276988						1006659				
	0.78						278339										
10	34563.62	8	17	14	59	4.21	279898	1.59	0.626	4100			1123585	39102	35002	124453	646
	34563.91	8	17	21	44	4.07	278927						1084483				
	0.28						279413										
11	34564.06	8	18	1	29	4.30	280523	1.59	0.626	10170			1148823	94988	84818	121530	631
	34564.76	8	18	18	14	3.96	278164						1053835				
	0.70						279344										
12	34565.04	8	19	0	59	4.37	281013	1.59	0.626	16985			1168452	156254	139269	119374	620
	34566.21	8	20	4	59	3.81	277130						1012198				
	1.17						279072										
13	34566.63	8	20	15	14	4.48	281783	1.59	0.626	15670	0.25	5833	1199424	145589	135752	126526	657
	34567.71	8	21	16	59	3.96	278164						1053835				
	1.07						279974										
14	34567.86	8	21	20	44	4.18	279690	1.59	0.626	8330			1115193	78069	69739	121726	632
	34568.44	8	22	10	29	3.90	277748						1037124				
	0.57						278719										
15	34568.66	8	22	15	44	4.21	279898	2.00	0.786	13495			1123585	105848	92353	124871	648
	34569.40	8	23	9	29	3.83	277267						1017737				
	0.74						278583										
16	34569.70	8	23	16	44	4.31	280593	2.00	0.786	14859			1151627	111718	96859	119211	619
	34570.51	8	24	12	14	3.91	277817						1039909				
	0.81						279205										
17	34570.77	8	24	18	29	4.31	280593	2.00	0.786	13910			1151627	106148	92238	121299	630
	34571.53	8	25	12	44	3.93	277956						1045479				
	0.76						279275										
18	34571.78	8	25	18	44	4.28	280384	2.00	0.786	13901			1143215	103306	89405	117573	610
	34572.54	8	26	12	59	3.91	277817						1039909				
	0.76						279101										
19	34572.80	8	26	19	14	4.27	280315	1.97	0.775	13708			1140410	103286	89578	117801	611
	34573.56	8	27	13	29	3.90	277748						1037124				
	0.76						279032										

Line Segment	Serial Time (days)	Month	Day	Hour	Minute	Estimated Stage (feet)	Surface Area (ft^3)	Evaporation Rate (cm/d)	Evaporation Rate (in/d)	Evaporation Volume (ft^3)	Precipitation Quantity (in)	Precipitation Volume (ft^3)	Basin Volume (ft^3)	Delta Volume (ft^3)	Infil. Volume (ft^3)	Infiltration Rate (ft^3/d)	Rate (gpm)
20	34573.82	8	27	19	44	4.28	280384	1.66	0.654	7460			1143215	64306	56846	116111	603
	34574.31	8	28	7	29	4.05	278788						1078909				
	0.49						279586										
21	34574.61	8	28	14	44	4.52	282064	1.66	0.654	11000			1210707	101101	90101	125358	651
	34575.33	8	29	7	59	4.16	279551						1109606				
	0.72						280808										
22	34575.55	8	29	13	14	4.41	281293	1.66	0.654	11919			1179684	109135	97216	124436	646
	34576.33	8	30	7	59	4.02	278580						1070549				
	0.78						279937										
23	34576.55	8	30	13	14	4.38	281083	1.66	0.654	1595			1171256	11217	9622	92372	479
	34576.66	8	30	15	44	4.34	280803						1160039				
	0.10						280943										
24 a	34576.77	8	30	18	29	4.50	281923	1.75	0.689	34580			1205064	270175	235595	108867	565
	34578.93	9	1	22	25	3.53	275077						934889				
	2.16						278500										
24 b	34578.93	9	1	22	25	3.52	275001	2.10	0.826	40117			932138	267348	227231	105002	545
	34581.10	9	4	2	21	2.53	263622						664790				
	2.16						269312										
24 c	34581.10	9	4	2	21	2.51	263322	2.10	0.826	38008			659515	209921	171913	79440	412
	34583.26	9	6	6	17	1.69	246987						449594				
	2.16						255155										
24 d	34583.26	9	6	6	17	1.70	247236	1.87	0.735	31166			452050	186207	155041	71644	372
	34585.43	9	8	10	14	0.93	222889						265843				
	2.16						235063										

TOTALS:			
(ft3)	509096	9373	3408562
(gal)	3808551	70121	25499450
(10^6 gal)	3.81	0.07	25.50

Appendix G

Calculation of Infiltration Rate Estimates for Rising Limbs

Line Segment	Serial Time (days)	Month	Day	Hour	Minute	Estimated Stage (feet)	Surface Area (ft^3)	Evaporation Rate (cm/d)	(in/d)	Volume (ft^3)	Infiltration Estimate (gpm)	(ft^3/d)	Volume (ft^3)
0-1a	34540.84	7	25	20	13	0.51	210846	1.50	0.590	5027	365	70182	31689
	34541.29	7	26	7	3	1.50	242022						
	0.45						226434						
0-1b	34541.29	7	26	7	4	1.50	242022	1.50	0.590	4858	411	79110	31150
	34541.69	7	26	16	31	2.29	259805						
	0.39						250913						
0-1c	34541.76	7	26	18	20	2.36	260941	1.50	0.590	5684	456	87725	38075
	34542.20	7	27	4	45	3.15	271822						
	0.43						266381						
0-1d	34542.20	7	27	4	50	3.16	271922	1.50	0.590	6105	498	95780	43234
	34542.65	7	27	15	40	3.97	278233						
	0.45						275077						
1-2	34543.13	7	28	3	5	3.79	276968	1.49	0.585	13992	520	100033	103159
	34544.16	7	29	3	50	4.19	279760						
	1.03						278374						
2	34544.16	7	29	3	55	4.14	279413	1.48	0.582	8266	523	100766	61579
	34544.77	7	29	18	35	3.99	278372						
	0.61						278893						
2-3	34544.78	7	29	18	40	4.04	278719	1.48	0.582	4700	525	101084	35099
	34545.13	7	30	3	0	4.15	279482						
	0.35						279100						
3-4	34545.60	7	30	14	25	3.97	278233	1.48	0.582	2918	528	101614	21875
	34545.82	7	30	19	35	4.33	280733						
	0.22						279483						
4-5	34546.43	7	31	10	15	4.10	279135	1.48	0.582	3019	535	103007	22860
	34546.65	7	31	15	35	4.48	281783						
	0.22						280459						
5-6a	34557.72	8	11	17	21	0.67	215593	1.85	0.728	4503	349	67152	21918
	34558.05	8	12	1	11	1.41	239185						
	0.33						227389						
5-6b	34558.06	8	12	1	26	1.43	239815	1.81	0.714	7459	426	82089	41044
	34558.56	8	12	13	26	2.42	261897						
	0.50						250856						

Line Segment	Serial Time (days)	Month	Day	Hour	Minute	Estimated Stage (feet)	Surface Area (ft^3)	Evaporation Rate (cm/d)	(in/d)	Volume (ft^3)	Infiltration Estimate (gpm)	(ft^3/d)	Volume (ft^3)
5-6c	34558.57	8	12	13	41	2.45	262375	1.54	0.608	6646	510	98228	48091
	34559.06	8	13	1	26	3.32	273443						
	0.49						267909						
5-6d	34559.07	8	13	1	41	3.34	273599	1.54	0.608	7157	588	113140	57749
	34559.58	8	13	13	56	4.21	279896						
	0.51						276749						
6-7	34560.31	8	14	7	26	3.88	277611	1.54	0.608	4888	614	118188	40874
	34560.66	8	14	15	44	4.27	280315						
	0.35						278963						
7-8	34561.56	8	15	13	29	3.90	277748	1.54	0.608	2796	612	117857	23326
	34561.76	8	15	18	14	4.21	279898						
	0.20						278823						
8-9	34562.43	8	16	10	14	3.91	277817	1.54	0.608	2206	610	117509	18361
	34562.58	8	16	13	59	4.16	279551						
	0.16						278684						
9-10	34563.38	8	17	9	14	3.80	277061	1.57	0.617	3280	607	116801	26767
	34563.61	8	17	14	44	4.18	279690						
	0.23						278376						
10-11	34563.92	8	17	21	59	4.08	278996	1.59	0.626	1976	624	120057	16258
	34564.05	8	18	1	14	4.29	280454						
	0.14						279725						
11-12	34564.77	8	18	18	29	3.96	278164	1.59	0.626	3798	621	119590	31143
	34565.03	8	19	0	44	4.36	280943						
	0.26						279553						
12-13	34566.22	8	20	5	14	3.81	277130	1.59	0.626	5922	620	119259	48449
	34566.62	8	20	14	59	4.47	281713						
	0.41						279421						
13-14	34567.72	8	21	17	14	3.98	278302	1.59	0.626	1971	615	118309	16021
	34567.85	8	21	20	29	4.19	279760						
	0.14						279031						
14-15	34568.45	8	22	10	44	3.91	277817	1.89	0.743	3419	613	118025	23359
	34568.65	8	22	15	29	4.22	279968						
	0.20						278893						

Line Segment	Serial Time (days)	Month	Day	Hour	Minute	Estimated Stage (feet)	Surface Area (ft^3)	Evaporation Rate (cm/d)	(in/d)	Volume (ft^3)	Infiltration Estimate (gpm)	(ft^3/d)	Volume (ft^3)
15-16	34569.41	8	23	9	44	3.84	277336	2.00	0.786	5139	614	118149	33229
	34569.69	8	23	16	29	4.31	280593						
	0.28						278964						
16-17	34570.52	8	24	12	29	3.93	277956	2.00	0.786	4383	618	119000	28510
	34570.76	8	24	18	14	4.31	280593						
	0.24						279274						
17-18	34571.54	8	25	12	59	3.96	278164	2.00	0.786	4194	619	119214	27320
	34571.77	8	25	18	29	4.31	280593						
	0.23						279378						
18-19	34572.55	8	26	13	14	3.90	277748	2.00	0.786	4378	615	118315	28346
	34572.79	8	26	18	59	4.26	280245						
	0.24						278997						
19-20	34573.57	8	27	13	44	3.92	277687	1.66	0.654	3645	617	118705	28440
	34573.81	8	27	19	29	4.29	280454						
	0.24						279170						
20-21	34574.32	8	28	7	44	4.06	278857	1.66	0.654	4299	633	121829	34264
	34574.60	8	28	14	29	4.52	282064						
	0.28						280461						
21-22	34575.34	8	29	8	14	4.20	279829	1.66	0.654	3028	636	122417	24228
	34575.54	8	29	12	59	4.46	281643						
	0.20						280736						
22-23	34576.34	8	30	8	14	4.04	278719	1.66	0.654	3018	625	120289	23807
	34576.54	8	30	12	59	4.36	280943						
	0.20						279831						
23-24	34576.67	8	30	15	59	4.35	280873	1.66	0.654	1438	645	124064	11631
	34576.76	8	30	18	14	4.50	281923						
	0.09						281398						
TOTALS													
(ft3)										144111			1041854
(gal)										1078095			7794109
(10^6 gal)										1.08			7.79

Appendix H

Calculation of Infiltration Flux Values

Line Segment	Date (m/d/y)	Time (h:m)	Serial Time (days)	Delta Time (days)	Surface Area and Average (ft^2)	Measured Infiltration Rate (gpm)	Estimated Infiltration Rate (gpm)	Infiltration Flux (Infiltration Rate/Surface Area) (gpm/ft^2)	(cm/s)	(m/s)	Time-Weighted Average Infiltration Flux (gpm/ft^2)	(cm/s)	(m/s)
0-1a rising	07/25/94 07/26/94	20:13 07:03	34540.84 34541.29	0.452	210846 242022 226434		365	1.61E-03	1.09E-04	1.09E-06	1.61E-03	1.09E-04	1.09E-06
0-1b rising	07/26/94 07/26/94	07:04 16:31	34541.29 34541.69	0.394	242022 259806 250913		411	1.64E-03	1.11E-04	1.11E-06	1.62E-03	1.10E-04	1.10E-06
0-1c rising	07/26/94 07/27/94	16:20 04:45	34541.76 34542.20	0.434	260941 271822 266381		456	1.71E-03	1.16E-04	1.16E-06	1.65E-03	1.12E-04	1.12E-06
0-1d rising	07/27/94 07/27/94	04:50 15:40	34542.20 34542.65	0.451	271922 278233 275077		498	1.81E-03	1.23E-04	1.23E-06	1.69E-03	1.15E-04	1.15E-06
1	07/27/94 07/28/94	15:45 03:00	34542.66 34543.13	0.469	278302 277061 277682	482		1.74E-03	1.18E-04	1.18E-06	1.70E-03	1.16E-04	1.16E-06
1-2 rising	07/28/94 07/29/94	03:05 03:50	34543.13 34544.16	1.031	276988 279760 278374		520	1.87E-03	1.27E-04	1.27E-06	1.76E-03	1.19E-04	1.19E-06
2 falling	07/29/94 07/29/94	03:55 16:35	34544.16 34544.77	0.611	279413 278372 278893		523	1.88E-03	1.27E-04	1.27E-06	1.77E-03	1.21E-04	1.21E-06
2-3 rising	07/29/94 07/30/94	16:40 03:00	34544.78 34545.13	0.347	278719 279482 279100		525	1.88E-03	1.28E-04	1.28E-06	1.78E-03	1.21E-04	1.21E-06
3	07/30/94 07/30/94	03:05 14:20	34545.13 34545.60	0.469	279551 278302 278927	486		1.74E-03	1.18E-04	1.18E-06	1.78E-03	1.21E-04	1.21E-06
3-4 rising	07/30/94 07/30/94	14:25 19:35	34545.60 34545.82	0.215	278233 280733 279483		528	1.89E-03	1.28E-04	1.28E-06	1.78E-03	1.21E-04	1.21E-06
4	07/30/94 07/31/94	19:40 10:05	34545.82 34546.42	0.601	280803 279135 279969	510		1.82E-03	1.24E-04	1.24E-06	1.79E-03	1.21E-04	1.21E-06

Line Segment	Date (m/d/y)	Time (h:m)	Serial Time (days)	Delta Time (days)	Surface Area and Average (ft^2)	Measured Infiltration Rate (gpm)	Estimated Infiltration Rate (gpm)	Infiltration Flux (Infiltration Rate/Surface Area) (gpm/ft^2)	(cm/s)	(m/s)	Time-Weighted Average Infiltration Flux (gpm/ft^2)	(cm/s)	(m/s)
4-5	07/31/94	10:15	34546.43	0.222	279135		535	1.91E-03	1.30E-04	1.30E-06	1.79E-03	1.22E-04	1.22E-06
rising	07/31/94	15:35	34546.65		281783								
					280459								
5a	07/31/94	15:40	34546.65	2.188	281713	537		1.93E-03	1.31E-04	1.31E-06	1.83E-03	1.24E-04	1.24E-06
	08/02/94	20:10	34548.84		275377								
					278545								
5b	08/02/94	20:10	34548.84	2.188	275302	546		2.24E-03	1.52E-04	1.52E-06	1.92E-03	1.30E-04	1.30E-06
	08/05/94	00:40	34551.03		211737								
					243520								
5c	08/05/94	00:40	34551.03	2.188	211737	476		2.07E-03	1.41E-04	1.41E-06	1.95E-03	1.32E-04	1.32E-06
	08/07/94	05:10	34553.22		247483								
					229610								
5d	08/07/94	05:10	34553.22	2.188	247236	374		1.59E-03	1.08E-04	1.08E-06	1.89E-03	1.29E-04	1.29E-06
	08/09/94	09:41	34555.40		222573								
					234905								
5e	08/09/94	12:02	34555.50	2.047	220706	297		1.42E-03	9.63E-05	9.63E-07	1.83E-03	1.25E-04	1.25E-06
	08/11/94	13:09	34557.55		197531								
					209119								
5-6a	08/11/94	17:21	34557.72	0.326	215593		349	1.53E-03	1.04E-04	1.04E-06	1.83E-03	1.24E-04	1.24E-06
rising	08/12/94	01:11	34558.05		239185								
					227389								
5-6b	08/12/94	01:26	34558.06	0.500	239815		426	1.70E-03	1.15E-04	1.15E-06	1.82E-03	1.24E-04	1.24E-06
rising	08/12/94	13:26	34558.56		261897								
					250856								
5-6c	08/12/94	13:41	34558.57	0.490	262375		510	1.90E-03	1.29E-04	1.29E-06	1.83E-03	1.24E-04	1.24E-06
rising	08/13/94	01:26	34559.06		273443								
					267909								
5-6d	08/13/94	01:41	34559.07	0.510	273599		588	2.12E-03	1.44E-04	1.44E-06	1.84E-03	1.25E-04	1.25E-06
rising	08/13/94	13:56	34559.58		279898								
					276749								
6	08/13/94	14:11	34559.59	0.708	279898	601		2.16E-03	1.46E-04	1.46E-06	1.85E-03	1.25E-04	1.25E-06
	08/14/94	07:11	34560.30		277611								
					278755								

Line Segment	Date (m/d/y)	Time (h:m)	Serial Time (days)	Delta Time (days)	Surface Area and Average (ft^2)	Measured Infiltration Rate (gpm)	Estimated Infiltration Rate (gpm)	Infiltration Flux (Infiltration Rate/Surface Area) (gpm/ft^2)	(cm/s)	(m/s)	Time-Weighted Average Infiltration Flux (gpm/ft^2)	(cm/s)	(m/s)
6-7	08/14/94	07:26	34560.31	0.346	277611		614	2.20E-03	1.49E-04	1.49E-06	1.85E-03	1.26E-04	1.26E-06
rising	08/14/94	15:44	34560.66		280315								
					278963								
7	08/14/94	15:59	34560.67	0.865	280454	614		2.20E-03	1.49E-04	1.49E-06	1.87E-03	1.27E-04	1.27E-06
	08/15/94	12:44	34561.53		277611								
					279033								
7-8	08/15/94	13:29	34561.56	0.198	277748		612	2.20E-03	1.49E-04	1.49E-06	1.87E-03	1.27E-04	1.27E-06
rising	08/15/94	18:14	34561.76		279898								
					278823								
8	08/15/94	18:29	34561.77	0.646	279968	644		2.31E-03	1.57E-04	1.57E-06	1.88E-03	1.28E-04	1.28E-06
	08/16/94	09:59	34562.42		277748								
					278858								
8-9	08/16/94	10:14	34562.43	0.156	277817		610	2.19E-03	1.49E-04	1.49E-06	1.89E-03	1.28E-04	1.28E-06
rising	08/16/94	13:59	34562.58		279551								
					278684								
9	08/16/94	14:14	34562.59	0.781	279690	648		2.33E-03	1.58E-04	1.58E-06	1.90E-03	1.29E-04	1.29E-06
	08/17/94	08:59	34563.37		276988								
					278339								
9-10	08/17/94	09:14	34563.38	0.229	277061		607	2.18E-03	1.48E-04	1.48E-06	1.91E-03	1.29E-04	1.29E-06
rising	08/17/94	14:44	34563.61		279690								
					278376								
10	08/17/94	14:59	34563.62	0.281	279898	646		2.31E-03	1.57E-04	1.57E-06	1.91E-03	1.30E-04	1.30E-06
	08/17/94	21:44	34563.91		278927								
					279413								
10-11	08/17/94	21:59	34563.92	0.135	278996		624	2.23E-03	1.51E-04	1.51E-06	1.91E-03	1.30E-04	1.30E-06
rising	08/18/94	01:14	34564.05		280454								
					279725								
11	08/18/94	01:29	34564.06	0.698	280523	631		2.26E-03	1.53E-04	1.53E-06	1.92E-03	1.31E-04	1.31E-06
	08/18/94	18:14	34564.76		278164								
					279344								
11-12	08/18/94	18:29	34564.77	0.260	278164		621	2.22E-03	1.51E-04	1.51E-06	1.93E-03	1.31E-04	1.31E-06
rising	08/19/94	00:44	34565.03		280943								
					279553								

Line Segment	Date (m/d/y)	Time (h:m)	Serial Time (days)	Delta Time (days)	Surface Area and Average (ft^2)	Measured Infiltration Rate (gpm)	Estimated Infiltration Rate (gpm)	Infiltration Flux (Infiltration Rate/Surface Area) (gpm/ft^2)	(cm/s)	(m/s)	Time-Weighted Average Infiltration Flux (gpm/ft^2)	(cm/s)	(m/s)
12	08/19/94 08/20/94	00:59 04:59	34565.04 34566.21	1.167	281013 277130 279072	620		2.22E-03	1.51E-04	1.51E-06	1.94E-03	1.32E-04	1.32E-06
12-13 rising	08/20/94 08/20/94	05:14 14:59	34566.22 34566.62	0.406	277130 281713 279421		620	2.22E-03	1.51E-04	1.51E-06	1.94E-03	1.32E-04	1.32E-06
13	08/20/94 08/21/94	15:14 16:59	34566.63 34567.71	1.073	281783 278164 279974	657		2.35E-03	1.59E-04	1.59E-06	1.96E-03	1.33E-04	1.33E-06
13-14 rising	08/21/94 08/21/94	17:14 20:29	34567.72 34567.85	0.135	278302 279760 279031		615	2.20E-03	1.50E-04	1.50E-06	1.96E-03	1.33E-04	1.33E-06
14	08/21/94 08/22/94	20:44 10:29	34567.86 34568.44	0.573	279690 277748 278719	632		2.27E-03	1.54E-04	1.54E-06	1.97E-03	1.34E-04	1.34E-06
14-15 rising	08/22/94 08/22/94	10:44 15:29	34568.45 34568.65	0.198	277817 279968 278893		613	2.20E-03	1.49E-04	1.49E-06	1.97E-03	1.34E-04	1.34E-06
15	08/22/94 08/23/94	15:44 09:29	34568.66 34569.40	0.740	279898 277267 278583	648		2.33E-03	1.58E-04	1.58E-06	1.98E-03	1.34E-04	1.34E-06
15-16 rising	08/23/94 08/23/94	09:44 16:29	34569.41 34569.69	0.281	277336 280593 278964		614	2.20E-03	1.49E-04	1.49E-06	1.98E-03	1.35E-04	1.35E-06
16	08/23/94 08/24/94	16:44 12:14	34569.70 34570.51	0.813	280593 277817 279205	619		2.22E-03	1.50E-04	1.50E-06	1.99E-03	1.35E-04	1.35E-06
16-17 rising	08/24/94 08/24/94	12:29 18:14	34570.52 34570.76	0.240	277956 280593 279274		618	2.21E-03	1.50E-04	1.50E-06	1.99E-03	1.35E-04	1.35E-06
17	08/24/94 08/25/94	18:29 12:44	34570.77 34571.53	0.760	280593 277956 279275	630		2.25E-03	1.53E-04	1.53E-06	2.00E-03	1.36E-04	1.36E-06

Line Segment	Date (m/d/y)	Time (h:m)	Serial Time (days)	Delta Time (days)	Surface Area and Average (ft^2)	Measured Infiltration Rate (gpm)	Estimated Infiltration Rate (gpm)	Infiltration Flux (Infiltration Rate/Surface Area) (gpm/ft^2)	(cm/s)	(m/s)	Time-Weighted Average Infiltration Flux (gpm/ft^2)	(cm/s)	(m/s)
17-18 rising	08/25/94 08/25/94	12:59 18:29	34571.54 34571.77	0.229	278164 280593 279378		619	2.22E-03	1.51E-04	1.51E-06	2.00E-03	1.36E-04	1.36E-06
18	08/25/94 08/26/94	18:44 12:59	34571.78 34572.54	0.760	280384 277817 279101	610		2.19E-03	1.48E-04	1.48E-06	2.00E-03	1.36E-04	1.36E-06
18-19 rising	08/26/94 08/26/94	13:14 18:59	34572.55 34572.79	0.240	277748 280245 278997		615	2.20E-03	1.50E-04	1.50E-06	2.00E-03	1.36E-04	1.36E-06
19	08/26/94 08/27/94	19:14 13:29	34572.80 34573.56	0.760	280315 277748 279032	611		2.19E-03	1.49E-04	1.49E-06	2.01E-03	1.36E-04	1.36E-06
19-20 rising	08/27/94 08/27/94	13:44 19:29	34573.57 34573.81	0.240	277867 280454 279170		617	2.21E-03	1.50E-04	1.50E-06	2.01E-03	1.37E-04	1.37E-06
20	08/27/94 08/28/94	19:44 07:29	34573.82 34574.31	0.490	280384 278788 279586	603		2.16E-03	1.46E-04	1.46E-06	2.01E-03	1.37E-04	1.37E-06
20-21 rising	08/28/94 08/28/94	07:44 14:29	34574.32 34574.60	0.281	278857 282064 280461		633	2.26E-03	1.53E-04	1.53E-06	2.01E-03	1.37E-04	1.37E-06
21	08/28/94 08/29/94	14:44 07:59	34574.61 34575.33	0.719	282064 279551 280808	651		2.32E-03	1.57E-04	1.57E-06	2.02E-03	1.37E-04	1.37E-06
21-22 rising	08/29/94 08/29/94	08:14 12:59	34575.34 34575.54	0.198	279829 281643 280736		636	2.27E-03	1.54E-04	1.54E-06	2.02E-03	1.37E-04	1.37E-06
22	08/29/94 08/30/94	13:14 07:59	34575.55 34576.33	0.781	281293 278580 279937	646		2.31E-03	1.57E-04	1.57E-06	2.03E-03	1.38E-04	1.38E-06
22-23 rising	08/30/94 08/30/94	08:14 12:59	34576.34 34576.54	0.198	278719 280943 279831		625	2.23E-03	1.52E-04	1.52E-06	2.03E-03	1.38E-04	1.38E-06

Line Segment	Date (m/d/y)	Time (h:m)	Serial Time (days)	Delta Time (days)	Surface Area and Average (ft^2)	Measured Infiltration Rate (gpm)	Estimated Infiltration Rate (gpm)	Infiltration Flux (Infiltration Rate/Surface Area) (gpm/ft^2)	(cm/s)	(m/s)	Time-Weighted Average Infiltration Flux (gpm/ft^2)	(cm/s)	(m/s)
23	08/30/94 08/30/94	13:14 15:44	34576.55 34576.66	0.104	281083 280803 280943	479		1.71E-03	1.16E-04	1.16E-06	2.03E-03	1.38E-04	1.38E-06
23-24 rising	08/30/94 08/30/94	15:59 18:14	34576.67 34576.76	0.094	280873 281923 281398		645	2.29E-03	1.56E-04	1.56E-06	2.03E-03	1.38E-04	1.38E-06
24 a	08/30/94 09/01/94	18:29 22:25	34576.77 34578.93	2.164	281923 275077 278500	565		2.03E-03	1.38E-04	1.38E-06	2.03E-03	1.38E-04	1.38E-06
24 b	09/01/94 09/04/94	22:25 02:21	34578.93 34581.10	2.164	275001 263622 269312	545		2.02E-03	1.37E-04	1.37E-06	2.03E-03	1.38E-04	1.38E-06
24 c	09/04/94 09/06/94	02:21 06:17	34581.10 34583.26	2.164	263322 246987 255155	412		1.62E-03	1.10E-04	1.10E-06	2.01E-03	1.36E-04	1.36E-06
24 d	09/06/94 09/08/94	06:17 10:14	34583.26 34585.43	2.164	247236 222889 235063	372		1.58E-03	1.07E-04	1.07E-06	1.99E-03	1.35E-04	1.35E-06