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SEEPAGE STUDY OF THE TIMPANOGOS, WASATCH, SAGEBRUSH AND SPRING CREEK, UPPER CHARLESTON, AND LOWER CHARLESTON CANALS, WASATCH COUNTY, UTAH, 1989

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CONVERSION FACTORS

Multiply	By	To obtain
cubic foot per second	0.02832	cubic meter per second
cubic foot per second per mile	0.0176	cubic meter per second per kilometer
foot	0.3048	meter
mile	1.609	kilometer

Water temperature is given in degrees Celsius (^{o}C), which can be converted to degrees Fahrenheit (^{o}F) by the following equation:

$$^{o}F = 1.8\ (^{o}C) + 32$$

SEEPAGE STUDY OF THE TIMPANOGOS, WASATCH, SAGEBRUSH AND SPRING CREEK, UPPER CHARLESTON, AND LOWER CHARLESTON CANALS, WASATCH COUNTY, UTAH, 1989

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U.S. GEOLOGICAL SURVEY

ABSTRACT

A seepage study was made during 1989 on selected reaches of the Timpanogos, Wasatch, Sagebrush and Spring Creek, Upper Charleston, and Lower Charleston Canals in Wasatch County, Utah, to determine gains or losses in discharge. Fluctuations in discharge were adjusted using information from water-stage recorders operated at selected locations during each set of measurements. The investigation showed a net loss of about 14.9 cubic feet per second in the Timpanogos Canal: the upstream reach gained about 2.0 cubic feet per second, the two middle reaches together lost about 14.1 cubic feet per second, and the downstream reach lost about 2.8 cubic feet per second. The Wasatch Canal showed a net loss of about 8.2 cubic feet per second: the upstream reach lost about 3.7 cubic feet per second, the middle reach showed no gain or loss, and the downstream reach lost about 4.5 cubic feet per second. The Sagebrush and Spring Creek Canal showed a net loss of about 0.5 cubic foot per second: the upstream reach gained about 0.6 cubic foot per second, the middle reach showed no gain or loss, and the downstream reach lost about 1.1 cubic feet per second. The Upper Charleston Canal showed a net gain of about 4.0 cubic feet per second: the upstream reach gained about 5.0 cubic feet per second, and the downstream reach lost about 1.0 cubic foot per second. The Lower Charleston Canal showed a net gain of about 1.8 cubic feet per second: the upstream reach gained about 2.2 cubic feet per second, and the downstream reach lost about 0.4 cubic foot per second.

INTRODUCTION

This report gives the results of a seepage study for sections of the Timpanogos, Wasatch, Sagebrush and Spring Creek, Upper Charleston, and Lower Charleston Canals in Wasatch County, Utah. This study (tenth in a series) is part of the statewide water-resources program conducted by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights. Information on seepage gains or losses for canals is needed by water managers for distribution of irrigation water. A detailed investigation of a canal system can aid in locating the losing or gaining sections of the system.

The study included 10.8 miles of the Timpanogos Canal (fig. 1), 7.6 miles of the Wasatch Canal (fig. 2), 3.4 miles of the Sagebrush and Spring Creek Canal (fig. 3), 3.3 miles of the Upper Charleston Canal (fig. 4), and 1.9 miles of the Lower Charleston Canal (fig. 5). Water is diverted to the Timpanogos, Wasatch, and Lower Charleston Canals from the Provo River. Water is diverted to the Upper Charleston Canal from Spring Creek. The source of water for Sagebrush and Spring Creek Canal generally is from springs. Water from all of the canals primarily is used for irrigation.

METHODS OF INVESTIGATION

Seepage runs were made on the canals during the spring of 1989. A seepage run for purposes of this report includes from about 6 to 20 discharge measurements on the main canals, from about 0 to 60 discharge measurements at diversion turnouts and return-flow points, and estimates at locations where measurements are not possible. The sections of the canals selected for the study were examined for (1) the location of controls, turnouts or other diversion structures, and the availability of bridges; (2) the general condition of the canals (for example, whether cleaning or other maintenance had been performed recently); and (3) areas of natural and irrigation return flow to the canals.

Using the information from the reconnaissance study, sections of the canals were divided into reaches, and measuring sites were selected within each reach. Water-stage recorders were operated at selected sites, mainly at the upstream and downstream end of each reach.

Three sets of seepage runs were made on May 23, June 7, and June 19, 1989, at nine sites on the Timpanogos Canal. Four sets of seepage runs were made on May 23, June 7, June 19, and July 11, 1989, at seven sites on the Wasatch Canal. Four sets of seepage runs were made on May 24, June 20, July 25, and August 29, 1989, at six sites on the Sagebrush and Spring Creek Canal. Four sets of seepage runs were made on May 24, June 20, July 25, and August 29, 1989, at four sites on the Upper Charleston Canal. Four sets of seepage runs were made on May 25, June 21, July 26, and August 30, 1989, at four sites on the Lower Charleston Canal. All of these seepage runs included discharge measurements. Sites where a discharge measurement or estimate was made at least once are shown in figures 1 to 5.

Discharge measurements or estimates were made only at diversion turnouts and return-flow points that had discharge when the sites were visited. Site numbers (for example, T2 or R2) were assigned in downstream order to those diversion turnouts and return-flow points where flow occurred during at least one set of seepage runs. Continuous water-stage records were obtained for the upstream and downstream end of each reach and are shown in figures 6 to 10.

Discharge measurements were made with a current meter, using standard methods of the U.S. Geological Survey (Buchanan and Somers, 1969). Each person measuring discharge was assigned a reach in which the required number of measurements could be completed in a day. In each reach, discharge was measured at all assigned measuring sites, including the upstream and downstream end of the reach, all diversion turnouts, and all return-flow points. For each main channel discharge measurement, the date, time, and discharge, and specific conductance and water temperature, where collected, are listed in tables 1 to 5. For diversion turnouts and return-flow points, the date and discharge are also listed in tables 1 to 5.

PROCEDURE USED IN COMPUTING DISCHARGE GAINS AND LOSSES

The procedure used to compute the discharge gain or loss for the Timpanogos, Wasatch, Sagebrush and Spring Creek, Upper Charleston, and Lower Charleston Canals is described in the following pages. To make each computation, the stage and discharge at the upstream and downstream end of the reach, the discharge for all diversion turnouts and return-flow points, the change in discharge with time at the upstream end of each reach, the time when the discharge measurements were made at the upstream and downstream end of each reach, and the time-of-travel through the reach are needed.

The following data are collected in the field and used in the discharge gain or loss computations: Discharge at the upstream and downstream end of the reach, stage of the canal within the study section, and discharge for all diversion turnouts and return-flow points within the reach.

Once the above information has been collected, the discharge gain or loss within a selected reach can be computed using the following steps:

1. Determine the measured discharge (Qmb) and time of measurement (T1) at the upstream end of the reach.
2. Determine the measured discharge (Qmc) and time of measurement (T2) at the downstream end of the reach.
3. Determine the time-of-travel through the reach.
4. Compute the rate of change in discharge (Qch) at the upstream end of the reach.
5. Determine the comparable time of flow at the upstream end of the reach (T3) by subtracting the time-of-travel from the time of the measurement at the downstream end of the reach.
6. Determine the comparable discharge at the upstream end of the reach (Qch) using the time determined in number 5.
7. Adjust the comparable discharge (Qch) for all turnout and return discharge, which will yield an adjusted discharge at the downstream end of the reach (Qce).
8. Subtract the adjusted discharge from the measured discharge at the downstream end of the reach (Qmc – Qce). If this value is positive, the reach has a gain; if it is negative, the reach has a loss.

   As an example:

   (1) Qmb = 200 cubic feet per second at T1 = 0800 hours

   (2) Qmc = 205 cubic feet per second at T2 = 1000 hours

   (3) Time of travel for change in stage = 1 hour

   (4) Qch = 5 cubic feet per second per hour

(5) T3 = T2 – 1 = 0900 hours

(6) Qch at T3 = Qmb – Qch = 195 cubic feet per second

The value of Qch is then adjusted for each diversion turnout and return-flow discharge downstream in the reach. The adjusted discharge (Qce) is the expected discharge at the downstream end of the reach. The adjusted discharge (Qce) is subtracted from the measured discharge (Qmc) at the downstream end of the reach to determine if gain or loss is occurring.

The discharge gain or loss was plotted as a function of distance downstream from the upstream end of the reach. This was done for each set of seepage runs on the main canals (figs. 11-15).

In some instances, depending on the rate of gain or loss, or the scatter of plotted points, the canals were segmented into shorter reaches. The gain or loss in discharge at each main canal measuring site was plotted (figs. 11-15) as a function of distance from the upstream end of the newly defined reach. A straight line was fitted through the plotted points for each reach, and the average quantity and rate of gain or loss from the reach was determined from this line. The results are shown in table 6.

For a given reach, the gain or loss varied within each set of discharge measurements and among the several sets of measurements. This variation is shown by the scatter of the plotted points in figures 11 to 15. The scatter is attributed to one or more of the following: (1) poor measuring conditions, (2) changes in the rate of seepage loss from the canal, (3) changes in the rate of seepage return to the canal from ground water and unconsumed irrigation water, (4) the inability to adjust completely for fluctuations in discharge within a given reach, and (5) the possibility that a water user changed the volume of discharge in the diversion turnouts or return-flow points during the time of the discharge measurements.

EVALUATION OF THE CANAL SYSTEMS

Timpanogos Canal

Three sets of seepage runs were made at nine sites on the Timpanogos Canal near the diversion from the Provo River near Heber City (fig. 1). The upstream reach of the canal had a gain of about 2.0 cubic feet per second, the second reach had a loss of about 4.1 cubic feet per second, the third reach had a loss of about 10.0 cubic feet per second, and the downstream reach had a loss of about 2.8 cubic feet per second. The section of the canal studied had a net loss of about 14.9 cubic feet per second. Following is a brief description of each reach studied and the calculated changes in discharge (fig. 11 and table 1).

Reach TM1-TM2.—Site TM1 is a temporary gage where a water-stage recorder was operated to monitor changes in the canal, and is at the diversion from the Provo River. Site TM2 is about 1 mile south of TM1 next to U.S. Highway 40. The plot of discharge measurements for this reach had little scatter and showed a net gain of about 2.0 cubic feet per second or about 1.8 cubic feet per second per mile.

Reach TM2-TM4.—Site TM4 is about 2 miles southeast of Site TM2. The plot of discharge measurements for this reach had some scatter and showed a net loss of about 4.1 cubic feet per second or about 1.7 cubic feet per second per mile.

Reach TM4-TM6.—Site TM6 is about 0.7 mile northeast of Heber City. A water-stage recorder was operated about midway in this reach at Site TM5. The plot of discharge measurements for this reach had considerable scatter and showed a net loss of about 10.0 cubic feet per second or about 3.1 cubic feet per second per mile.

Reach TM6-TM9.—Site TM9 is a temporary gage where a water-stage recorder was operated to monitor changes in the canal and is about 2 miles southeast of the intersection of U.S. Highways 40 and 189. The plot of discharge measurements for this reach had little scatter and showed a net loss of about 2.8 cubic feet per second or about 0.7 cubic foot per second per mile.

Wasatch Canal

Four sets of seepage runs were made at seven sites on the Wasatch Canal near Heber City (fig. 2). The upstream reach lost 3.7 cubic feet per second, the middle reach had no gain or loss, and the downstream reach lost 4.5 cubic feet per second. The canal had a net loss of about 8.2 cubic feet per second. Following is a brief description of each reach studied and the calculated changes in discharge (fig. 12 and table 2).

Reach W1-W2.—Site W1 is a temporary gage where a water-stage recorder was operated to monitor changes in the canal at the diversion from Rock Creek. Site W2 is about 2 miles southeast of Site W1. The plot of discharge measurements for this reach had some scatter and showed a net loss of about 3.7 cubic feet per second or about 3.5 cubic feet per second per mile.

Reach W2-W5.—Site W5 is about 0.5 mile east of Heber City. The plot of discharge measurements for this reach had some scatter but showed no gain or loss in discharge.

Reach W5-W7.—Site W7 is a temporary gage where a water-stage recorder was operated to monitor changes in the canal, and is about 0.7 mile south of the intersection of State Highways 40 and 189. The plot of discharge measurements for this reach had little scatter and showed a net loss of about 4.5 cubic feet per second or about 2.1 cubic feet per second per mile.

Sagebrush and Spring Creek Canal

Four sets of seepage runs were made at six sites on the Sagebrush and Spring Creek Canal near Heber City (fig. 3). The upstream reach had a gain of about 0.6 cubic foot per second, the middle reach had no gain or loss, and the downstream reach had a loss of about 1.1 cubic feet per second. The canal had a net loss of about 0.5 cubic foot per second. Following is a brief description of each reach studied and the calculated changes in discharge (fig. 13 and table 3).

Reach S1-S2.—Site S1 is a temporary gage at Heber City where a water-stage recorder was operated to monitor changes in the canal. Site S2 is at State Highway 113 near Heber City. The plot of discharge measurements for this reach had little scatter and showed a net gain in discharge of about 0.6 cubic foot per second or about 1.1 cubic feet per second per mile.

Reach S2-S5.—Site S5 is about 1.3 miles northeast of Charleston. The plot of discharge measurements for this reach had some scatter but showed no gain or loss in discharge.

Reach S5-S6.—Site S6 is a temporary gage about 0.9 mile northeast of Charleston where a water-stage recorder was operated to monitor changes in the canal. The plot of discharge measurements for this reach had some scatter and showed a net loss of about 1.1 cubic feet per second, or about 2.0 cubic feet per second per mile.

Upper Charleston Canal

Four sets of seepage runs were made at four sites on the Upper Charleston Canal near Charleston (fig. 4). The upstream reach had a gain of about 5.0 cubic feet per second, and the downstream reach had a loss of about 1.0 cubic foot per second. The canal had a net gain of about 4.0 cubic feet per second. Following is a brief description of each reach studied and the calculated changes in discharge (fig. 14 and table 4).

Reach UC1-UC2.—Site UC1 is a temporary gage about 3 miles north of Charleston near State Highway 113, where a water-stage recorder was operated to monitor changes in the canal. Site UC2 is about 1.2 miles southwest of Heber City. The plot of discharge measurements for this reach had some scatter and showed a net gain of about 5.0 cubic feet per second or about 4.5 cubic feet per second per mile.

Reach UC2-UC4.—Site UC4 is a temporary gage about 0.3 mile east of Charleston where a water-stage recorder was operated to monitor changes in the canal. The plot of discharge measurements for this reach had some scatter and showed a net loss of about 1.0 cubic foot per second or about 0.5 cubic foot per second per mile.

Lower Charleston Canal

Four sets of seepage runs were made at four sites on the Lower Charleston Canal near Charleston (fig. 5). The upstream reach had a gain of about 2.2 cubic feet per second, and the downstream reach had a loss of about 0.4 cubic foot per second. The canal had a net gain of about 1.8 cubic feet per second. Following is a brief description of each reach studied and the calculated changes in discharge (fig. 15 and table 5).

Reach LC1-LC2.—Site LC1 is a temporary gage about 1 mile northeast of Charleston where a water-stage recorder was operated to monitor changes in the canal. Site LC2 is about 0.5 mile north of Charleston. The plot of discharge measurements for this reach had some scatter and showed a net gain of about 2.2 cubic feet per second or about 3.5 cubic feet per second per mile.

Reach LC2-LC4.—Site LC4 is a temporary gage about 0.1 mile south of Charleston where a water-stage recorder was operated to monitor changes in the canal. The plot of discharge measurements for this reach had little scatter and showed a net loss of about 0.4 cubic foot per second or about 0.3 cubic foot per second per mile.

SUMMARY

The upstream reach of the Timpanogos Canal had a gain in discharge, and the remaining three downstream reaches had losses in discharge. The canal had a net loss of about 14.9 cubic feet per second.

The upstream and downstream reaches of the Wasatch Canal had losses in discharge, and the middle reach had no gain or loss. The canal had a net loss of about 8.2 cubic feet per second.

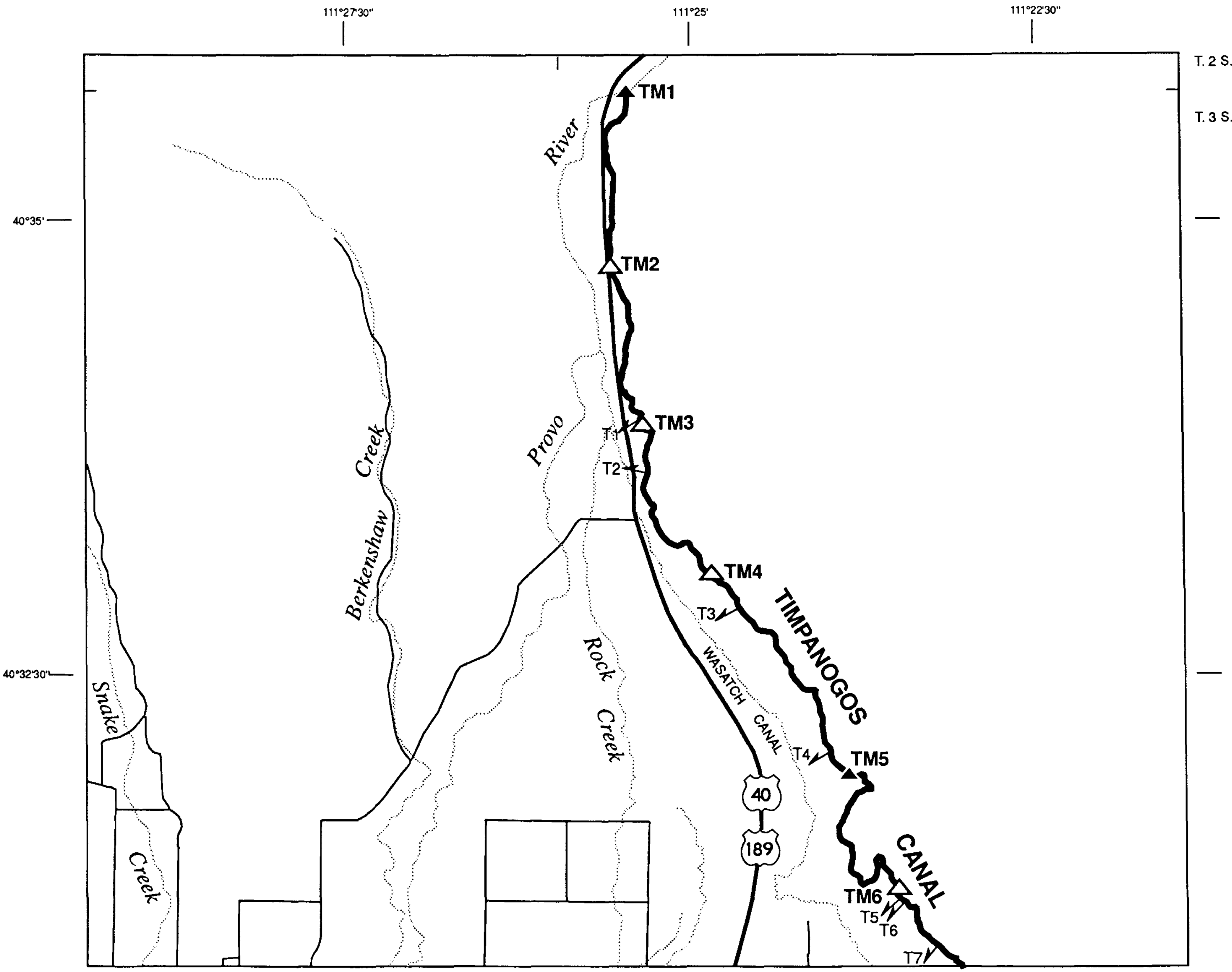
The upstream reach of the Sagebrush and Spring Creek Canal had a gain in discharge, the middle reach had no gain or loss, and the downstream reach had a loss in discharge. The canal had a net loss of about 0.5 cubic foot per second.

The upstream reach of the Upper Charleston Canal had a gain in discharge and the downstream reach had a loss in discharge. The canal had a net gain of about 4.0 cubic feet per second.

The upstream reach of the Lower Charleston Canal had a gain in discharge and the downstream reach had a loss in discharge. The canal had a net gain of about 1.8 cubic feet per second.

REFERENCE CITED

Buchanan, T.J., and Somers, W.P., 1969, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A8, 66 p.


111°27'30"
111°25'
111°22'30"
T. 2 S.
T. 3 S.
40°35'
40°32'30"
TM1
TM2
TM3
TM4
TM5
TM6
T1
T2
T3
T4
T5
T6
T7
River
Provo
Creek
Berkenshaw
Rock
Creek
Snake
Creek
WASATCH
CANAL
TIMPANOGOS
CANAL
40
189

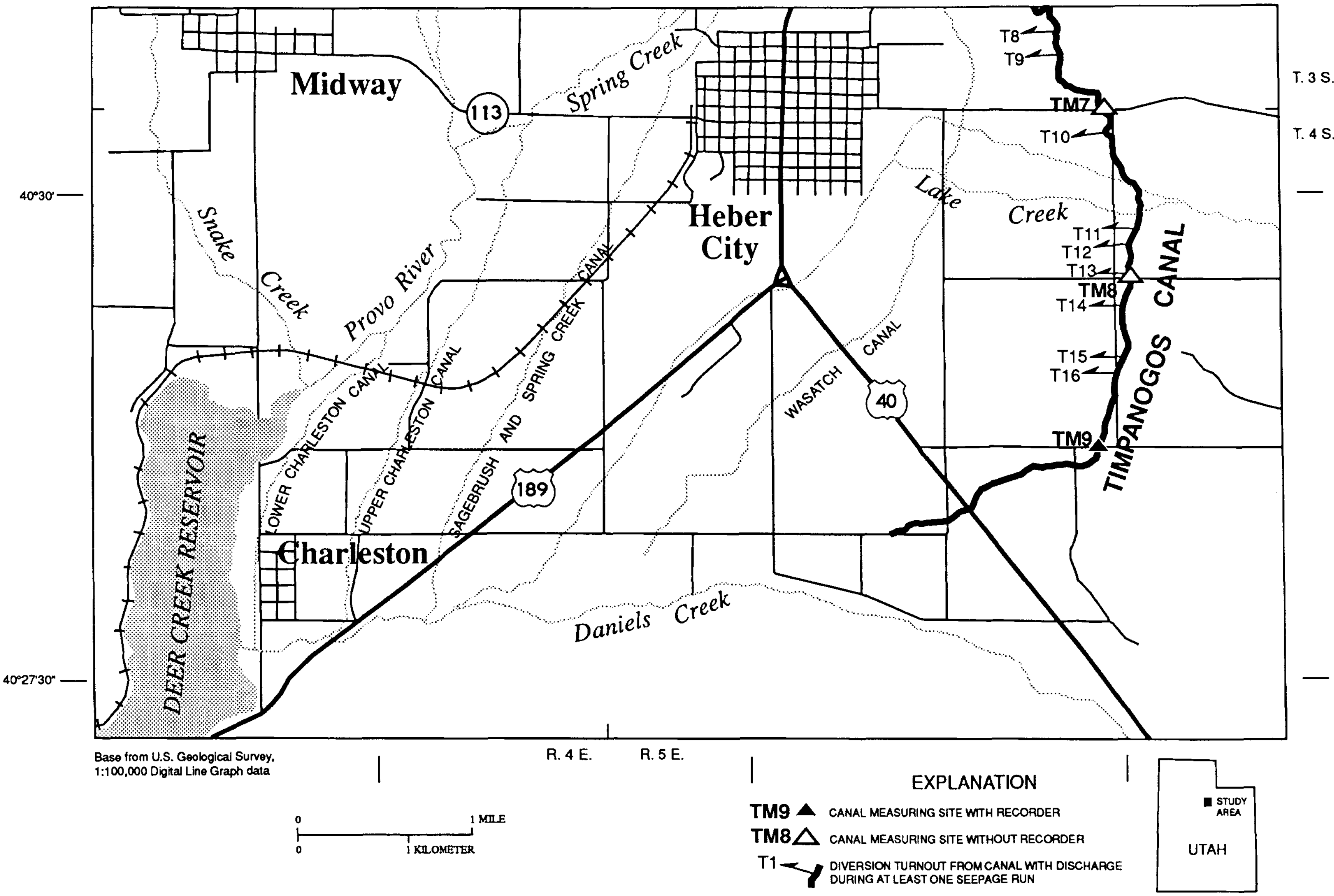
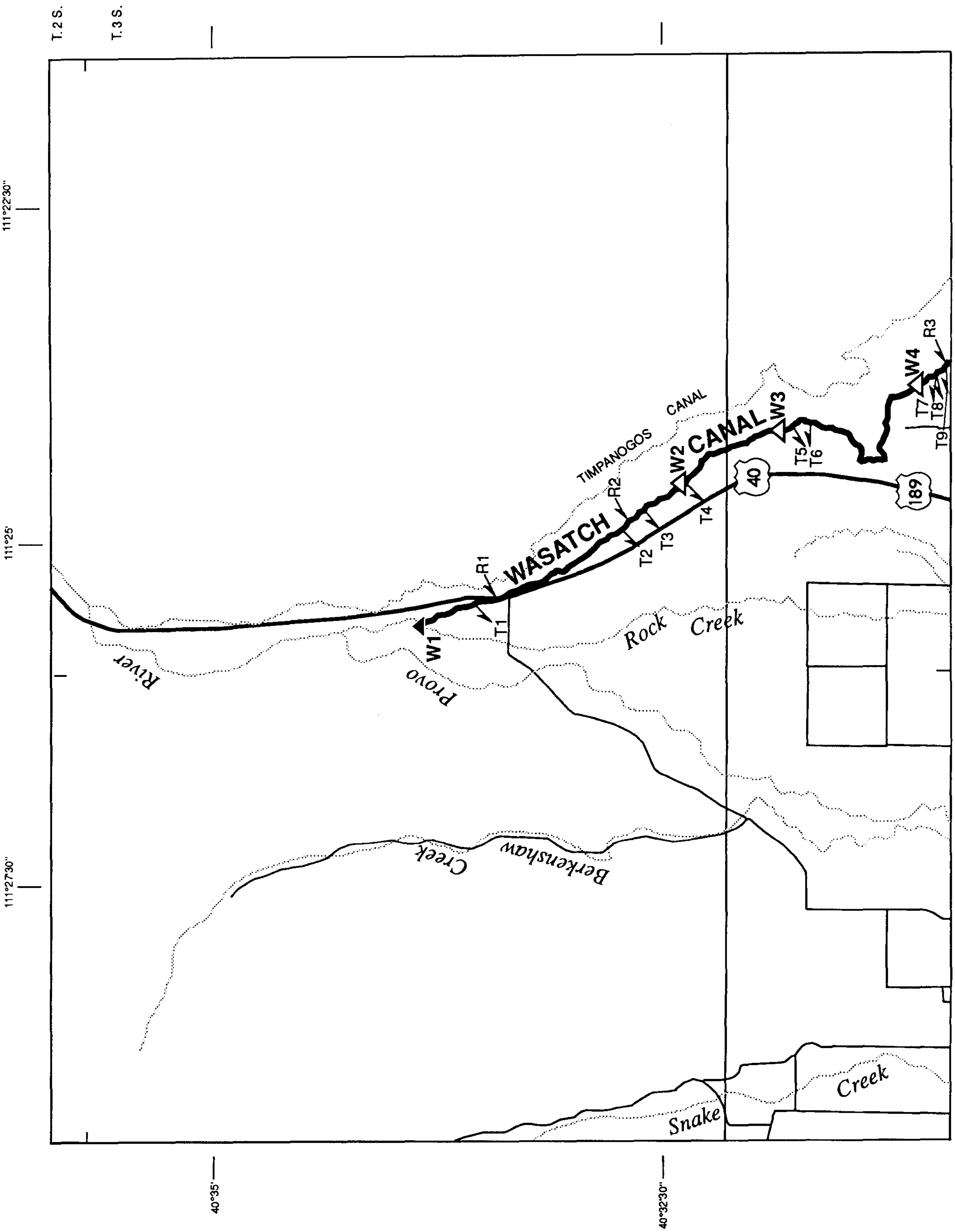


Figure 1.--Measuring sites on the Timpanogos Canal.


T. 2 S.
T. 3 S.
111°22'30"
111°25'
111°27'30"
40°35'
40°32'30"
WASATCH CANAL
TIMPANOGOS CANAL
W1
W2
W3
W4
R1
R2
R3
T1
T2
T3
T4
T5
T6
T7
T8
T9
40
189
Provo River
Rock Creek
Berkenshaw Creek
Snake Creek

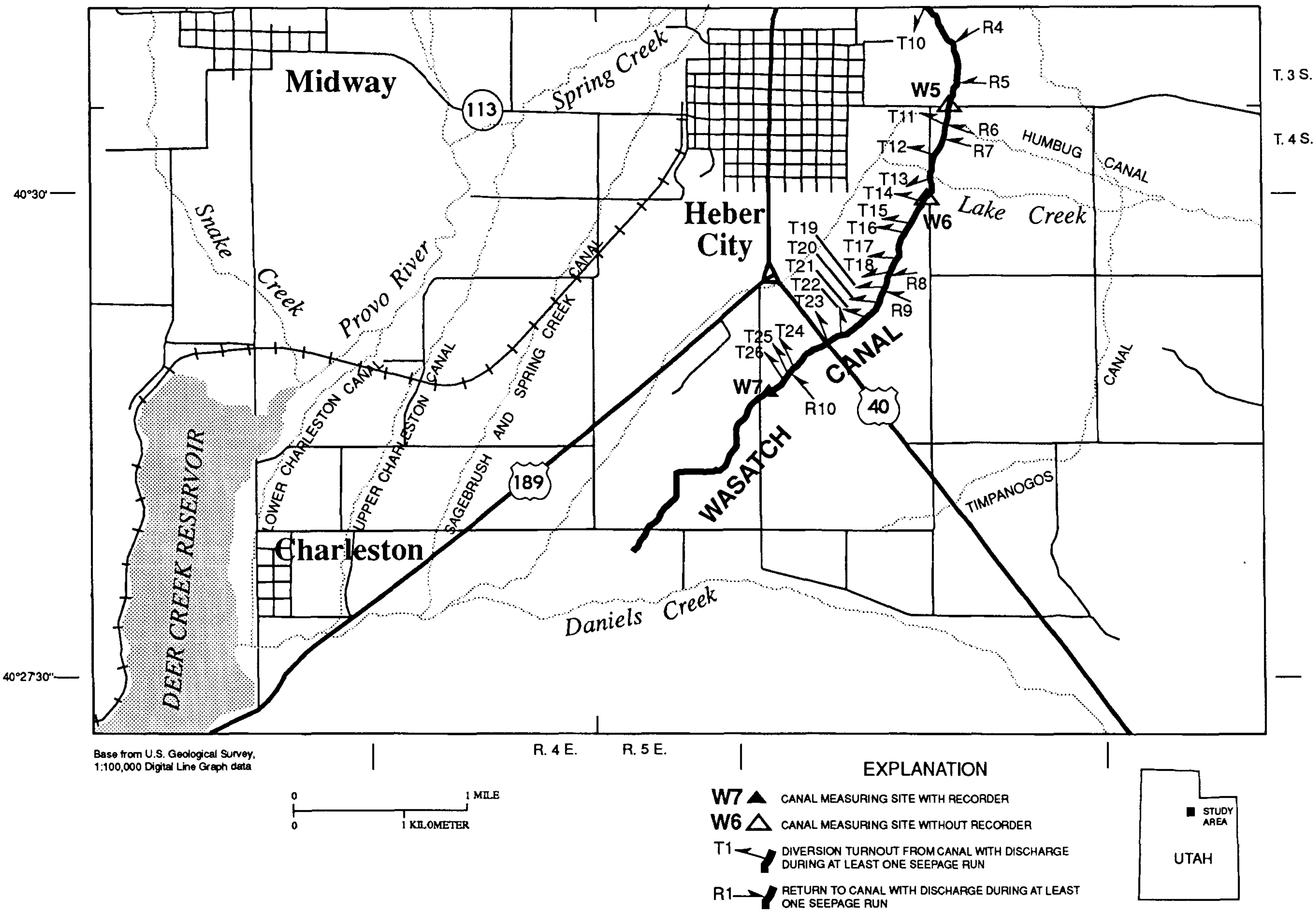


Figure 2.--Measuring sites on the Wasatch Canal.

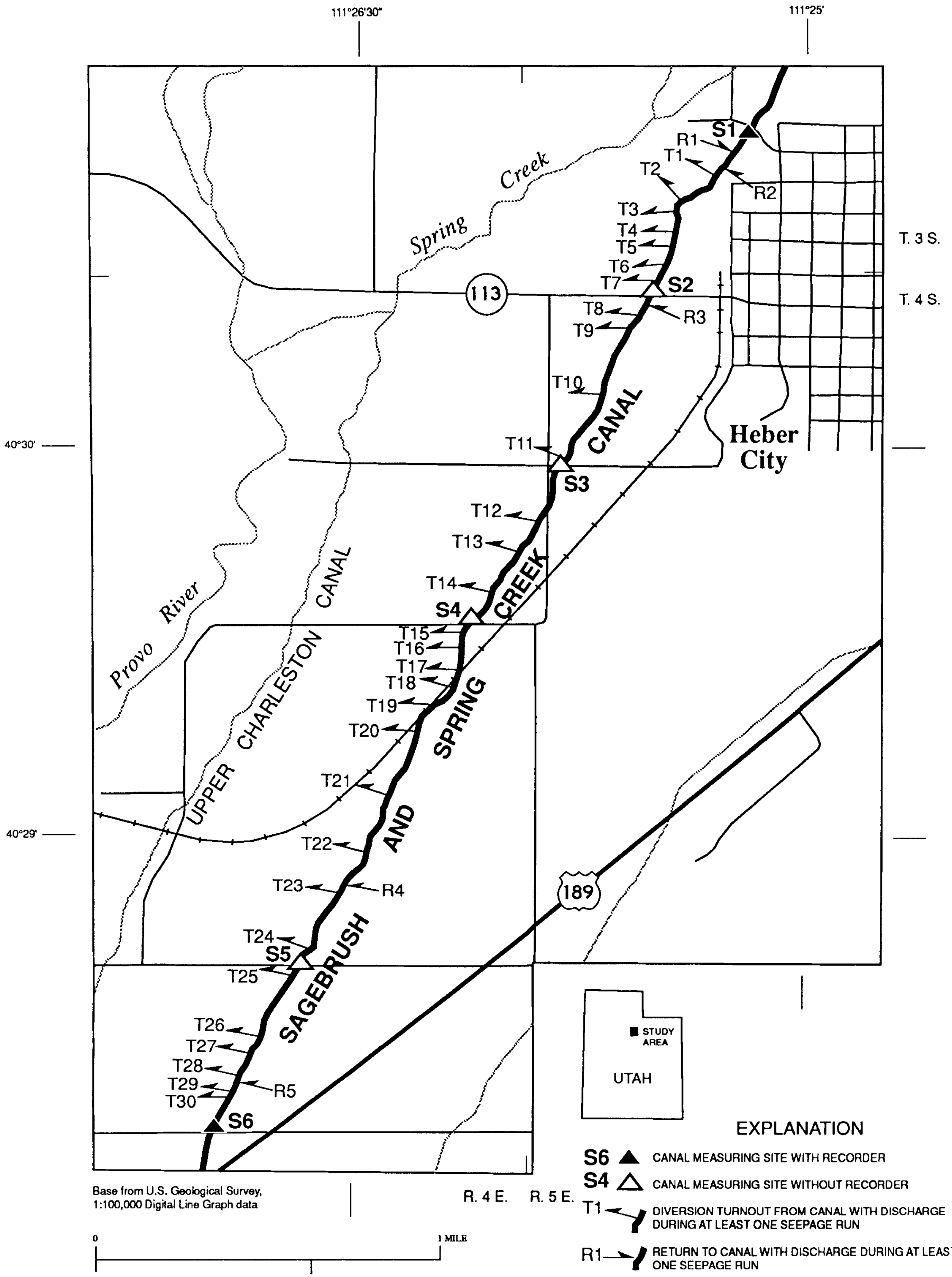


Figure 3.--Measuring sites on the Sagebrush and Spring Creek Canal

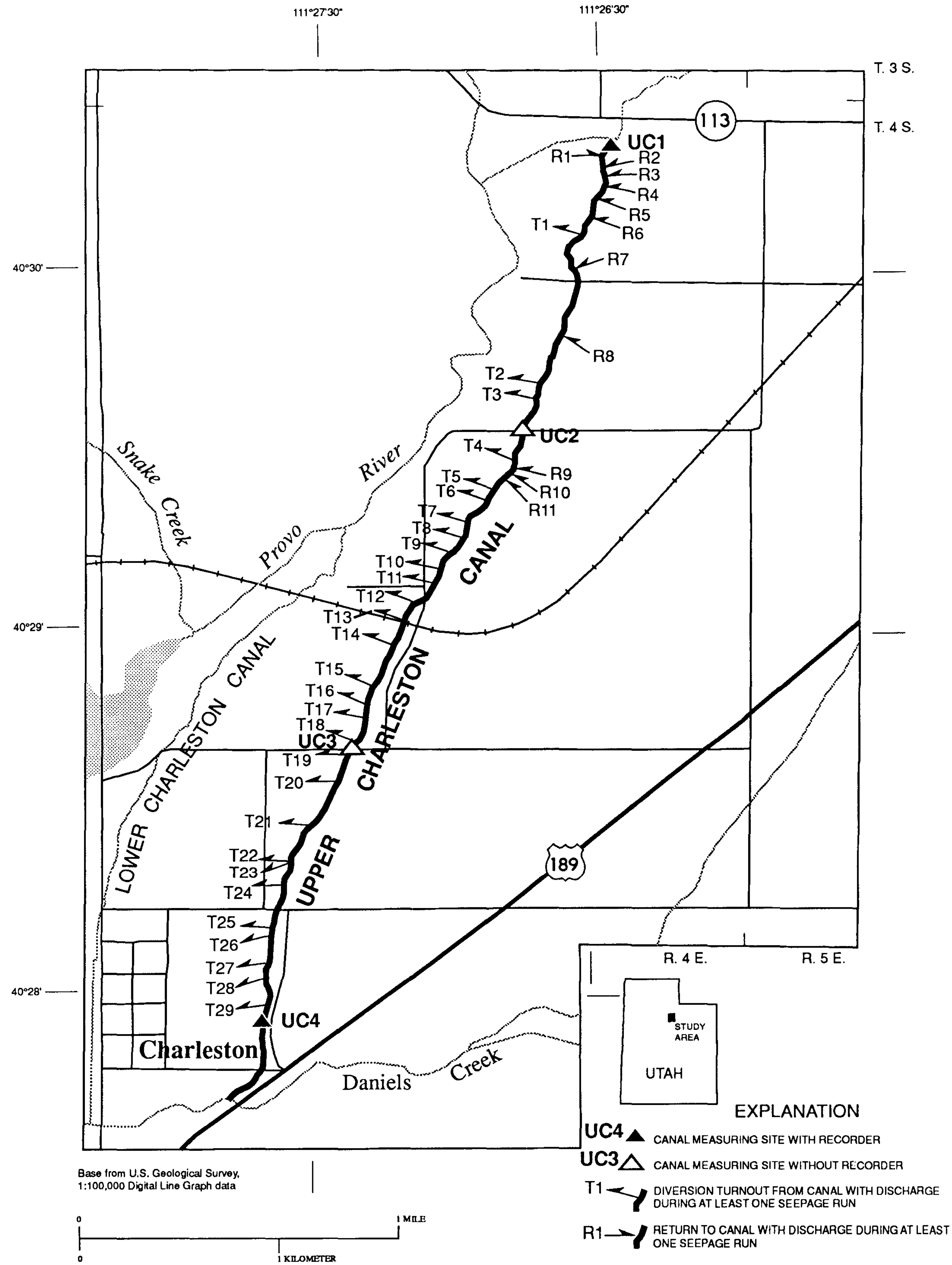


Figure 4.--Measuring sites on the Upper Charleston Canal

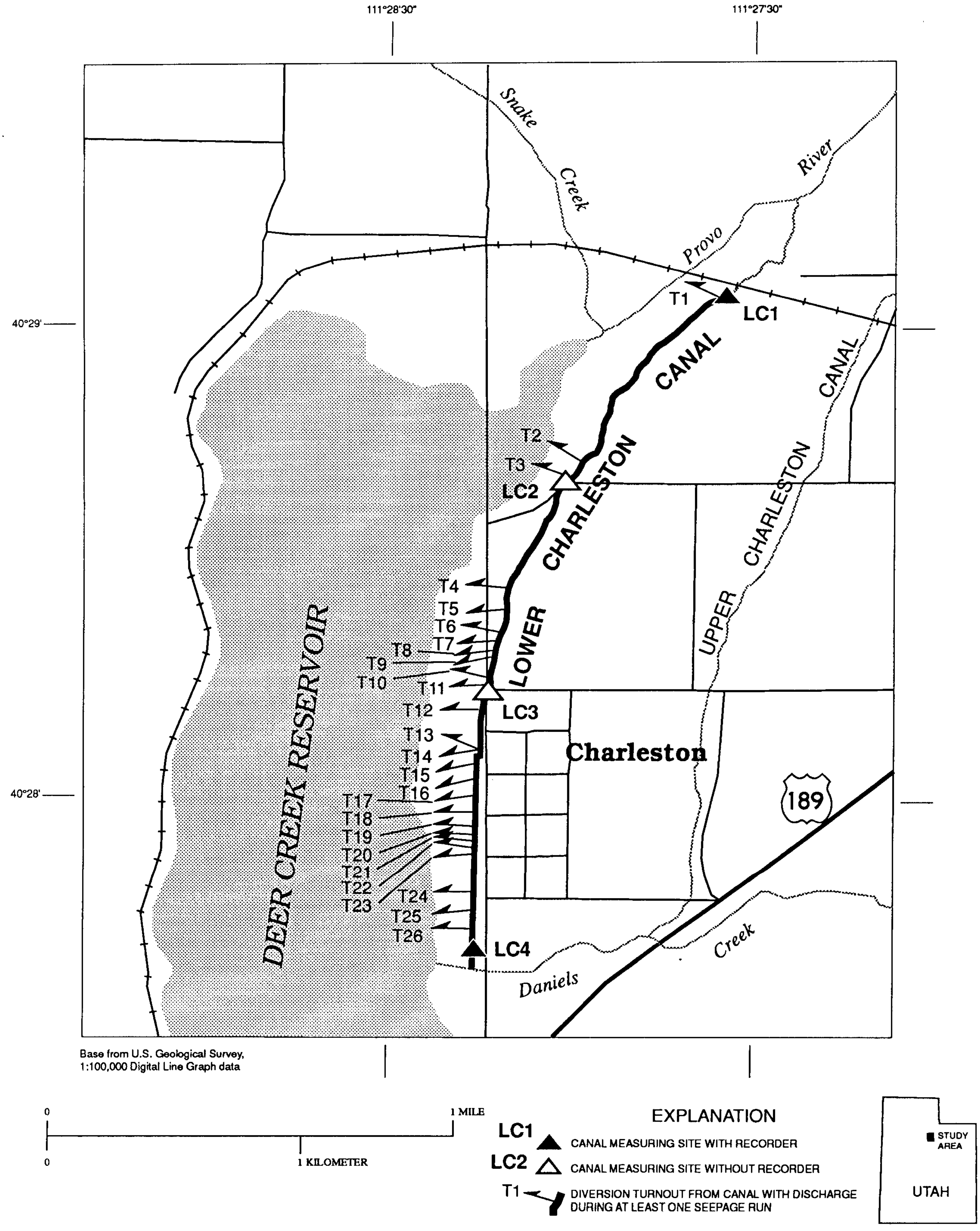


Figure 5.--Measuring sites on the Lower Charleston Canal

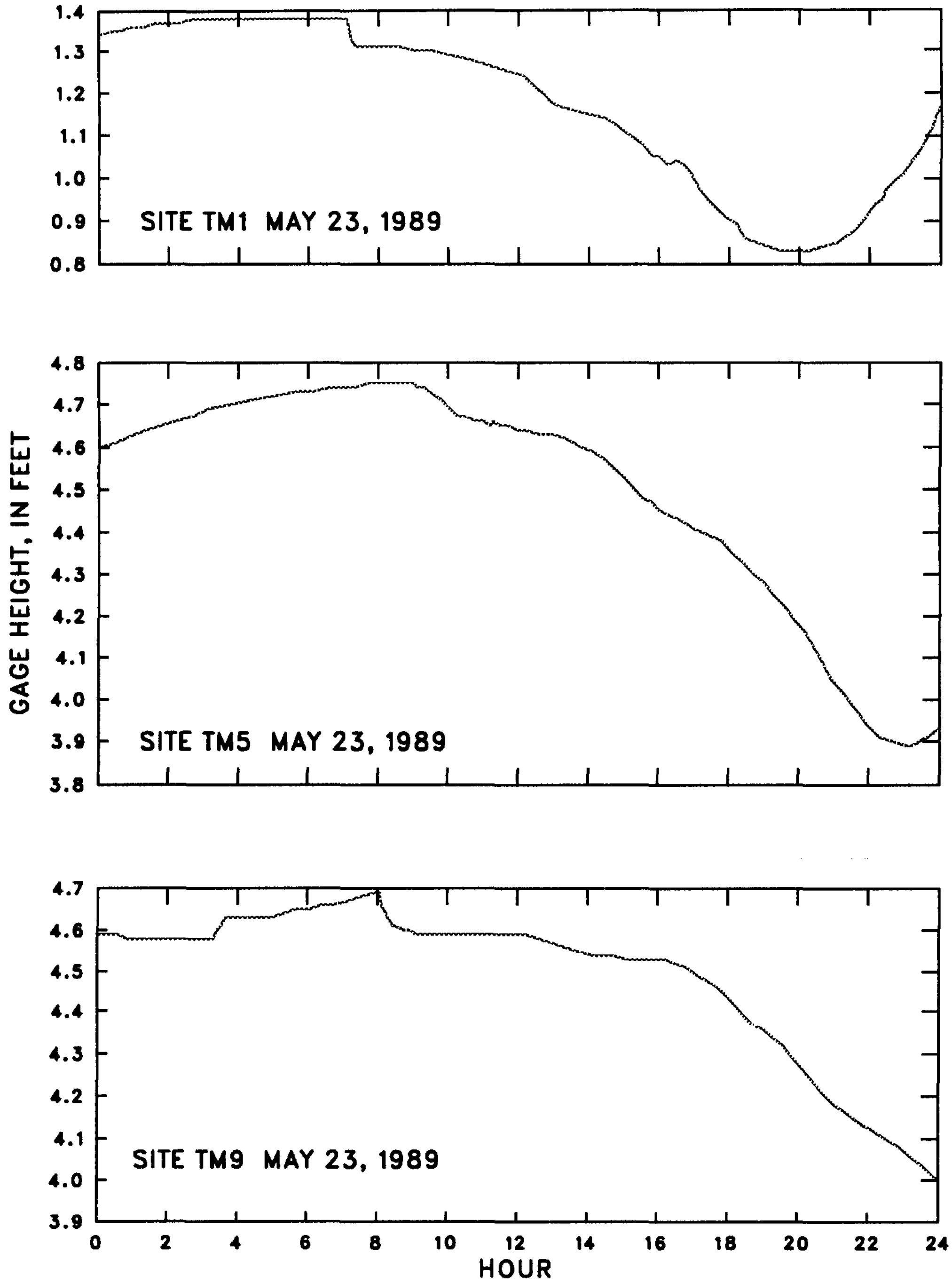


Figure 6.—Gage heights at recorder sites during discharge measurements on the Timpanogos Canal, 1989.

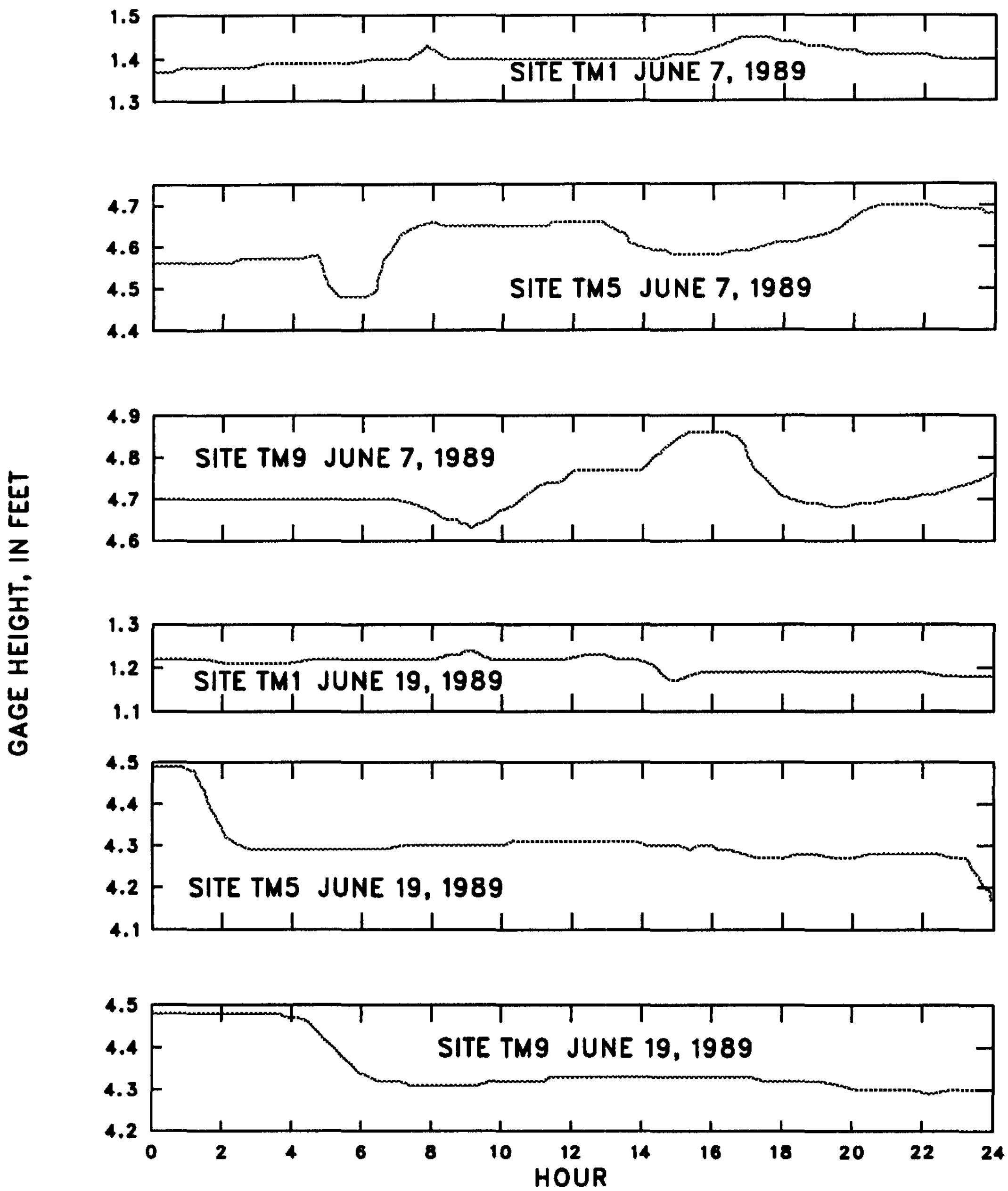


Figure 6.—Gage heights at recorder sites during discharge measurements on the Timpanogos Canal, 1989—Continued.

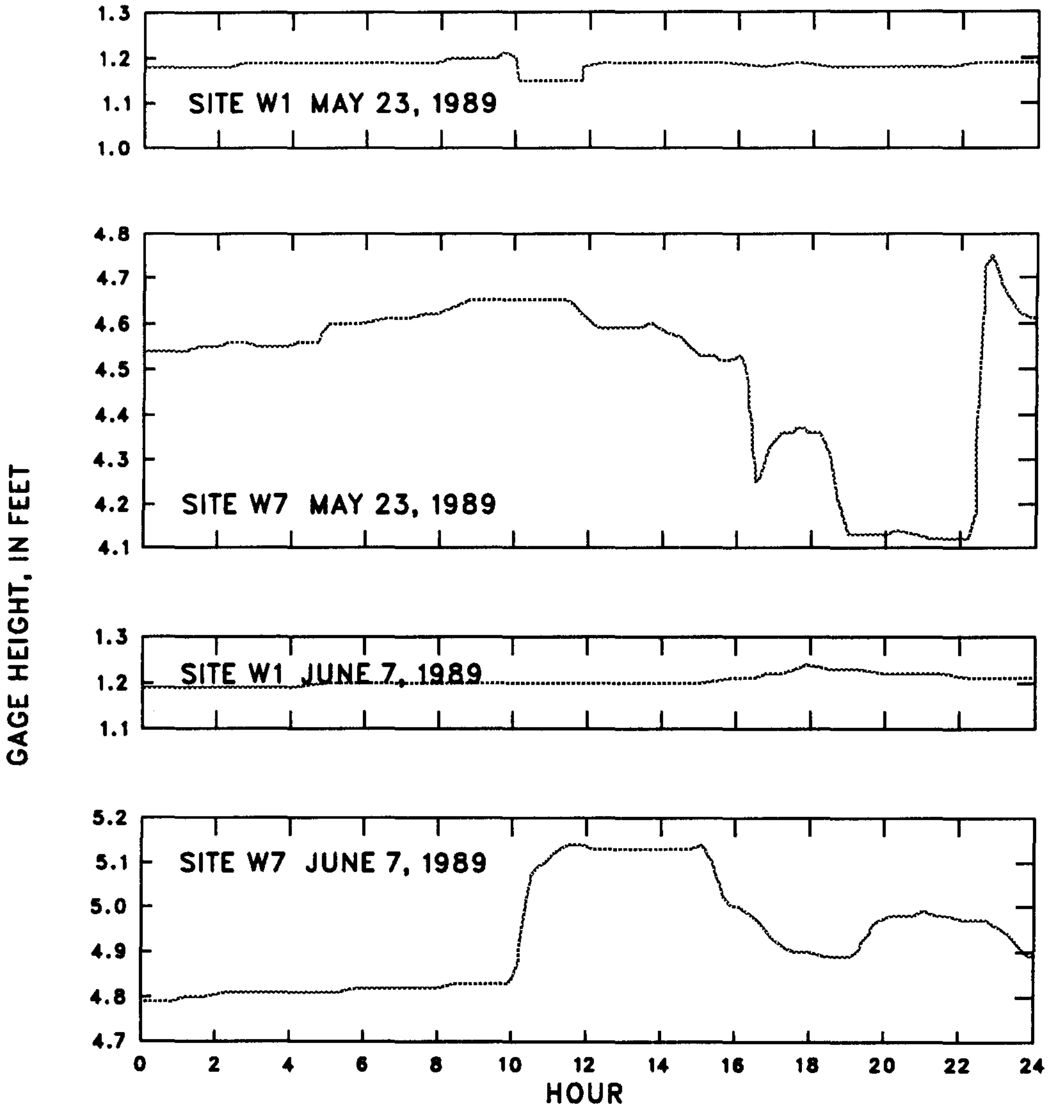


FIGURE 7.—Gage heights at recorder sites during discharge measurements on the Wasatch Canal, 1989.

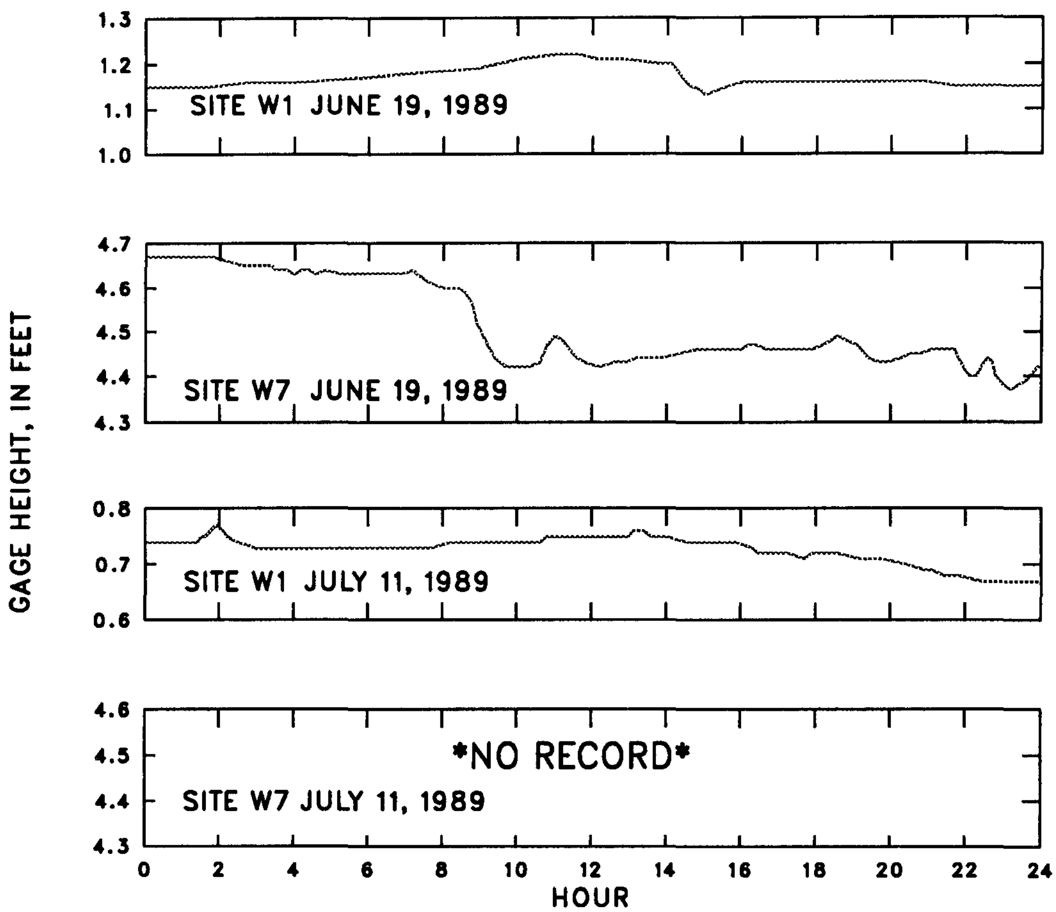


Figure 7.—Gage heights at recorder sites during discharge measurements on the Wasatch Canal, 1989——Continued.

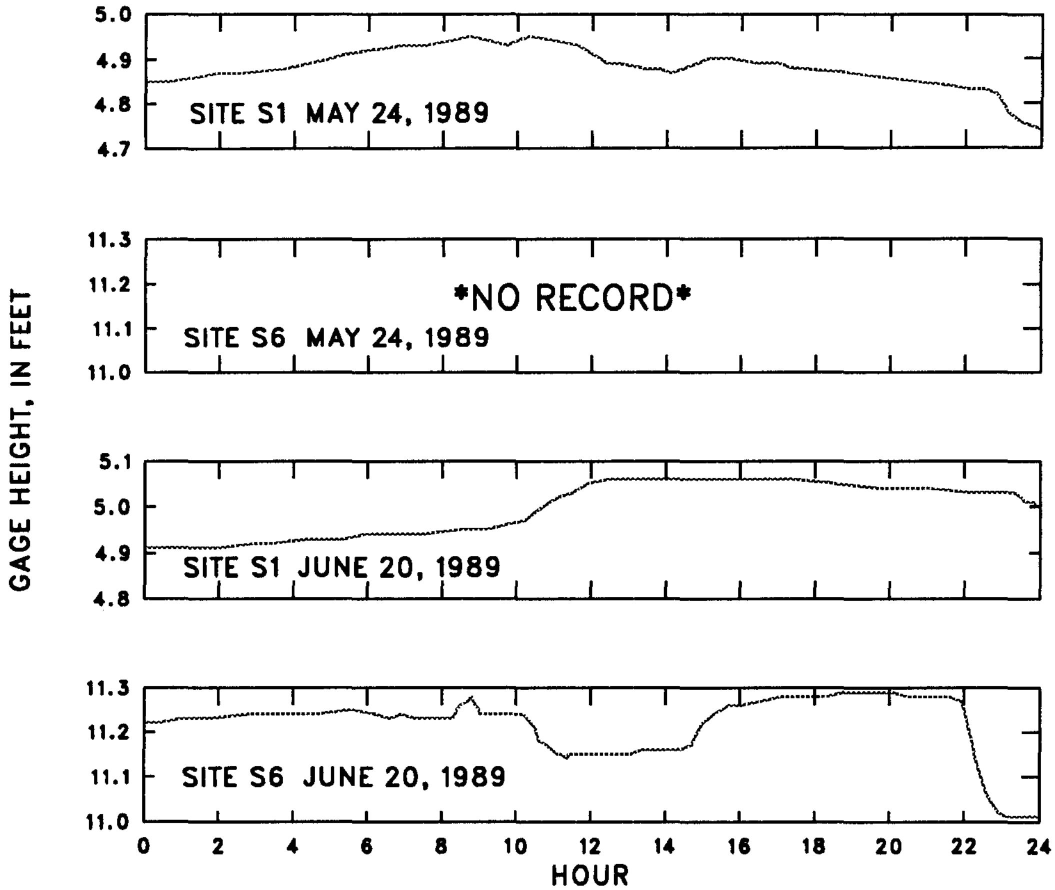


Figure 8.—Gage heights at recorder sites during discharge measurements on the Sagebrush and Spring Creek Canal, 1989.

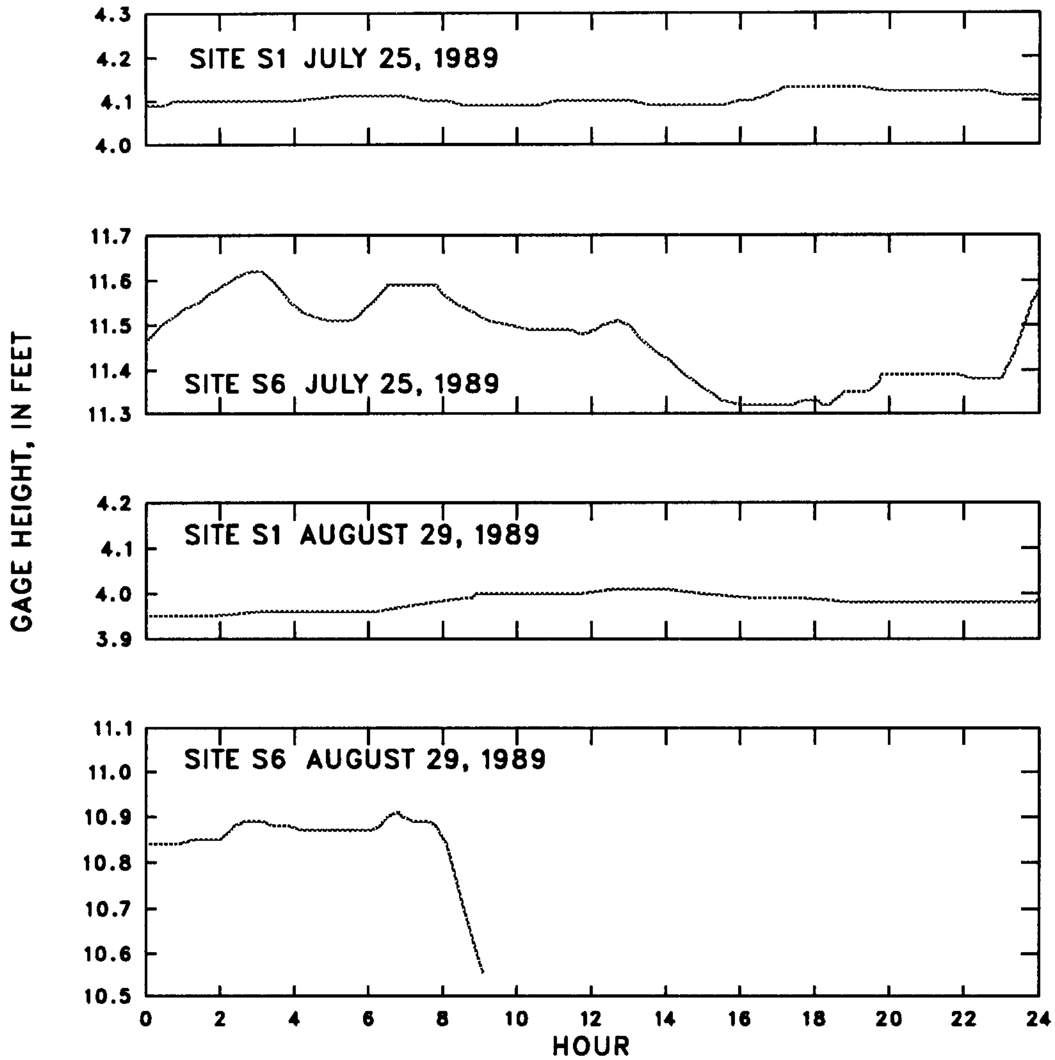


Figure 8.—Gage heights at recorder sites during discharge measurements on the Sagebrush and Spring Creek Canal, 1989—Continued.

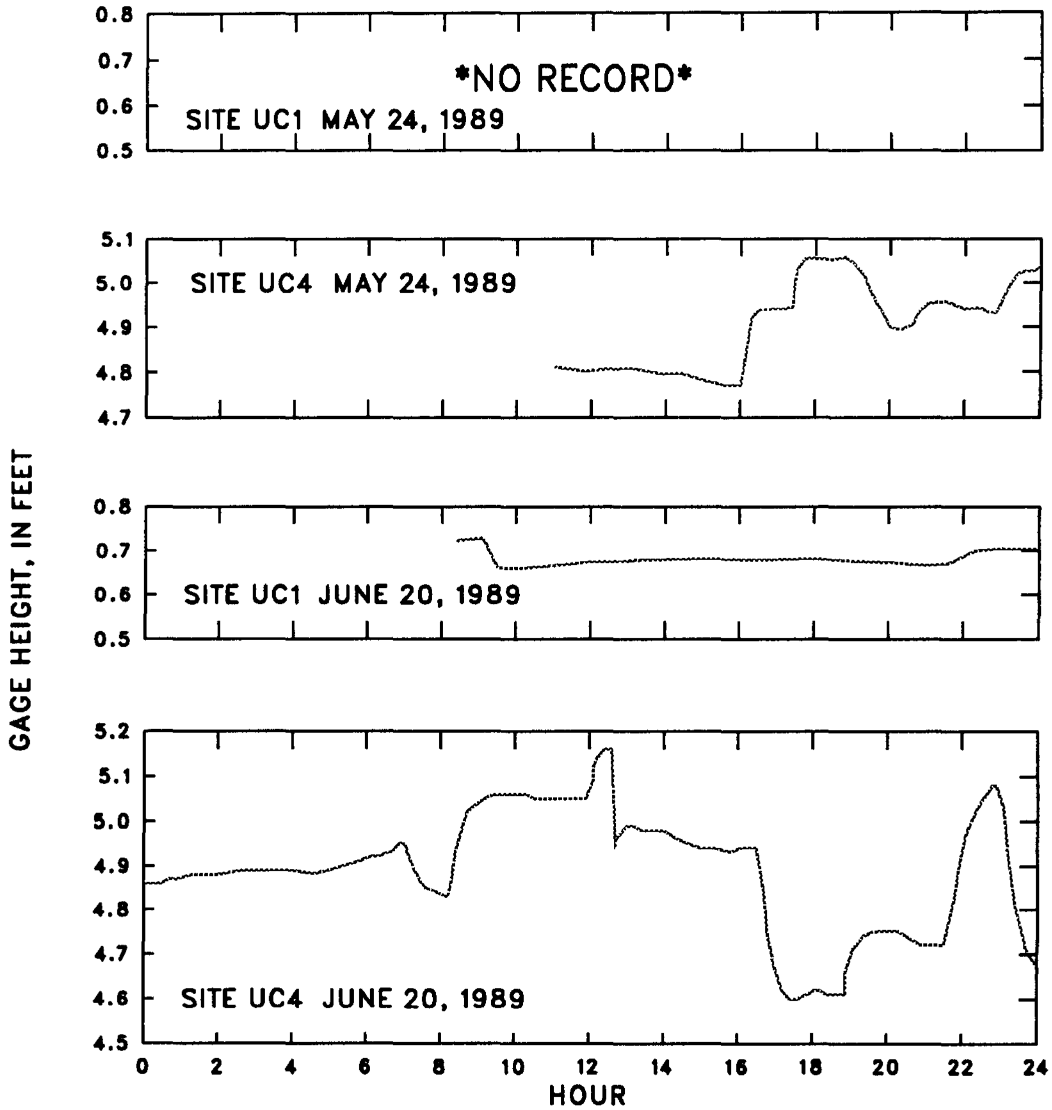


Figure 9.—Gage heights at recorder sites during discharge measurements on the Upper Charleston Canal, 1989.

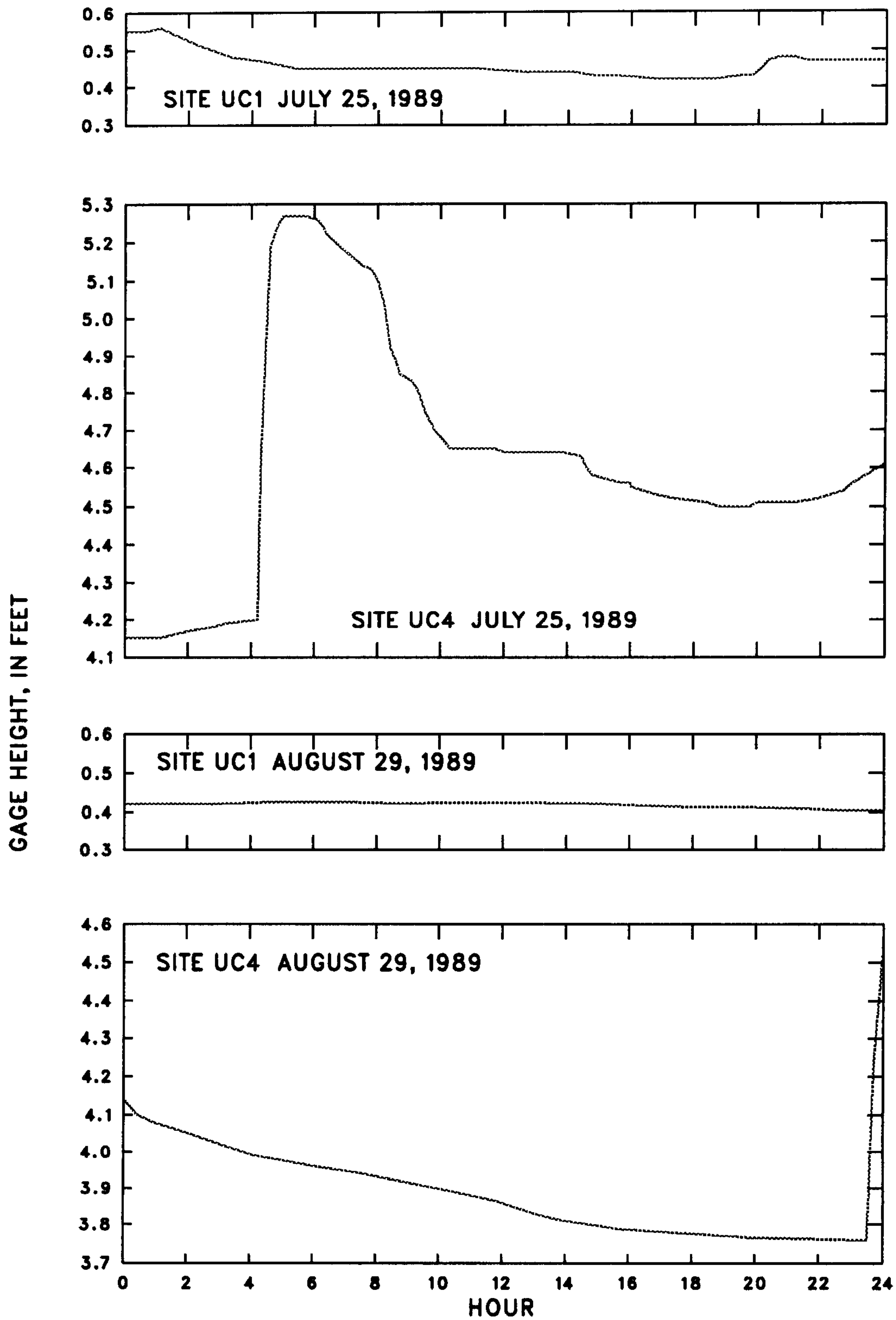


Figure 9.—Gage heights at recorder sites during discharge measurements on the Upper Charleston Canal, 1989—Continued.

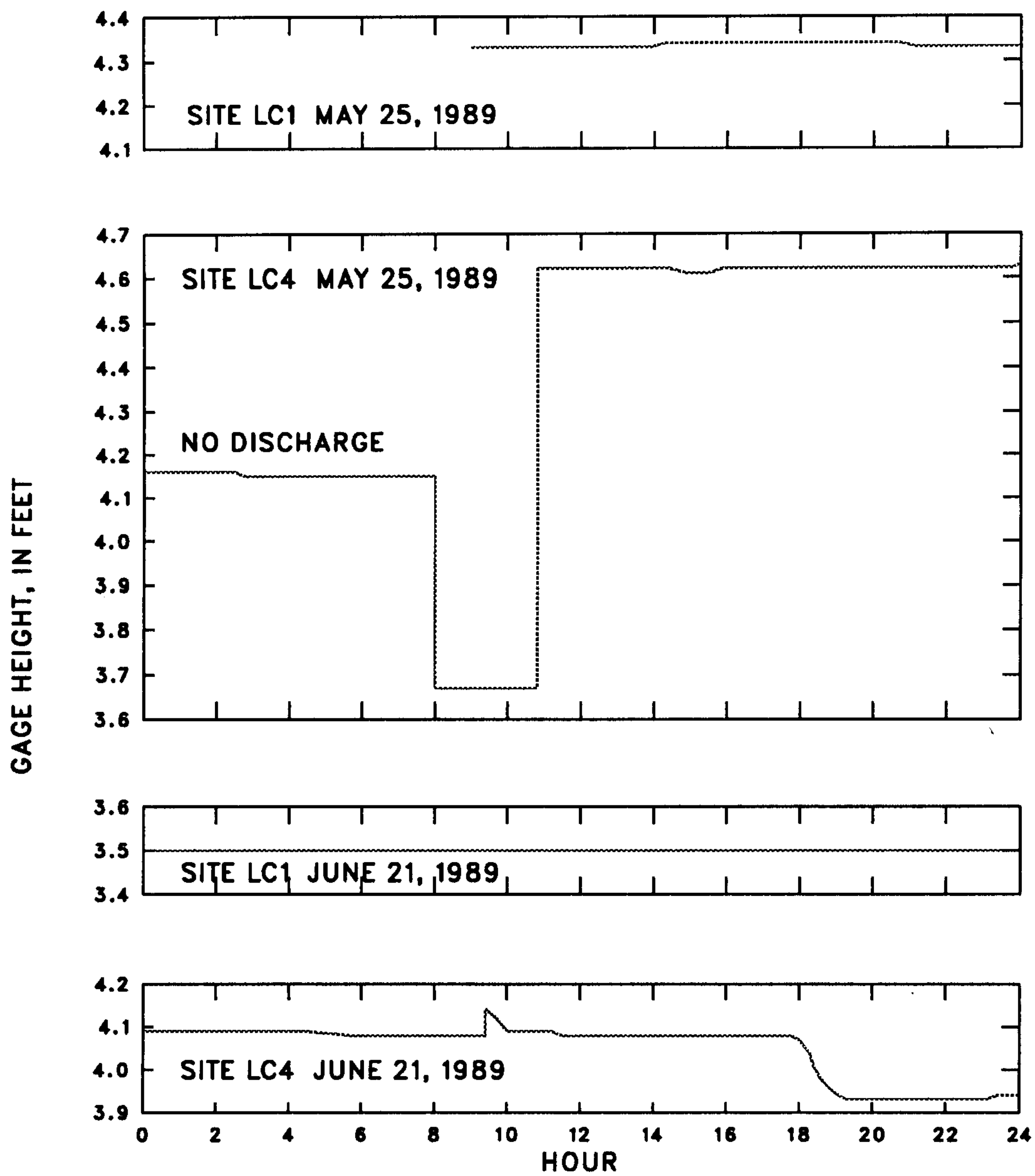


Figure 10.—Gage heights at recorder sites during discharge measurements on the Lower Charleston Canal, 1989.

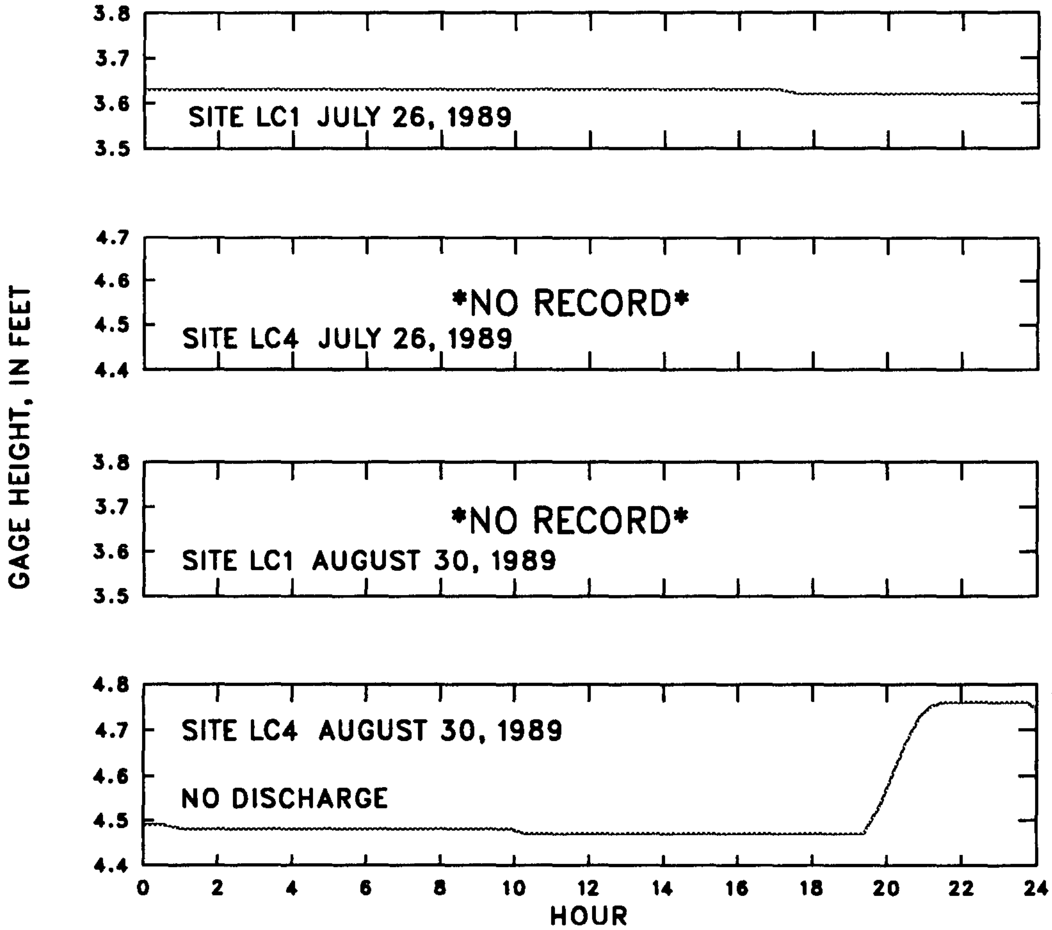


Figure 10.—Gage heights at recorder sites during discharge measurements on the Lower Charleston Canal, 1989—Continued.

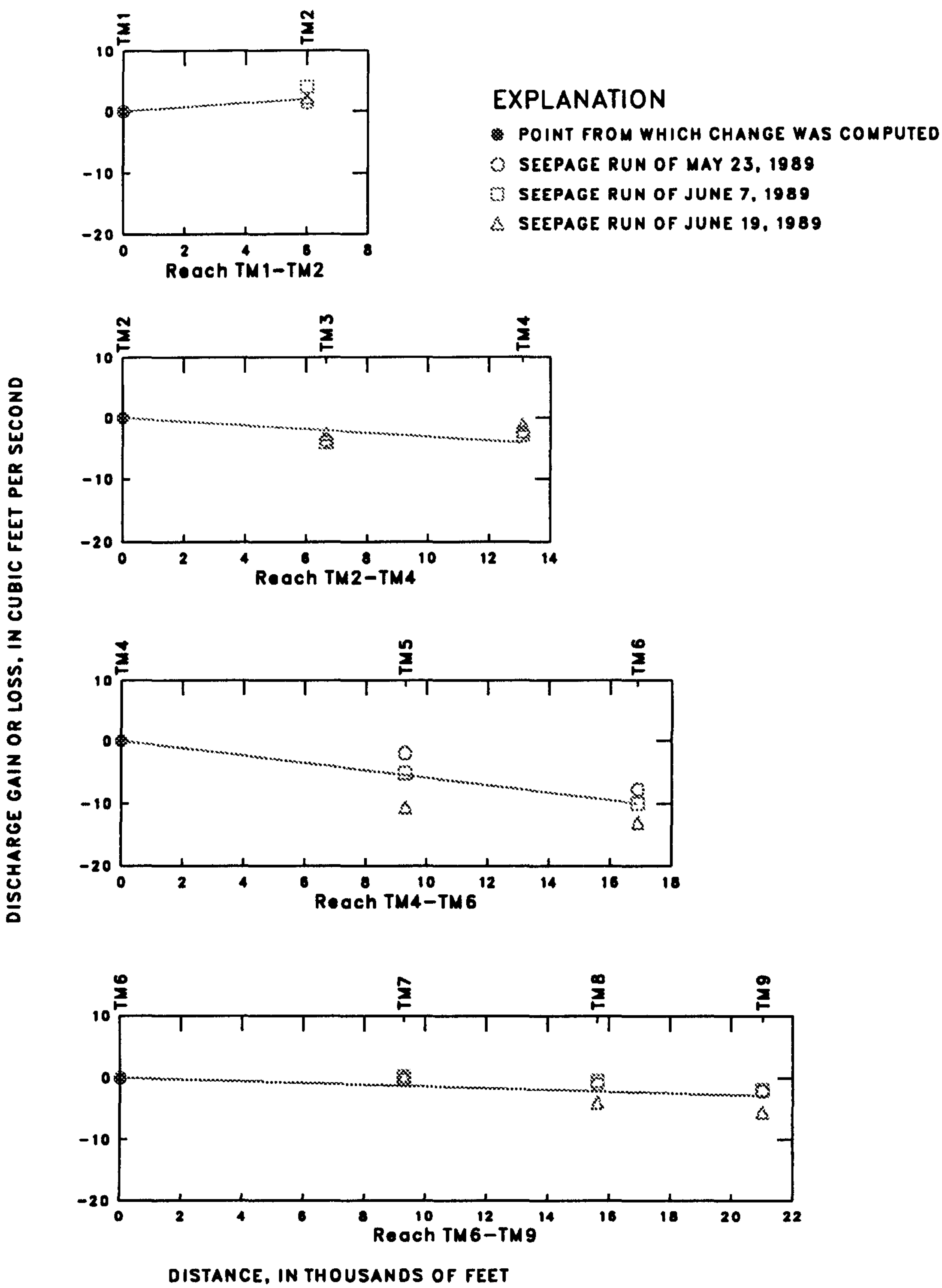


Figure 11.—Discharge gain or loss for reaches of the Timpanogos Canal, 1989.

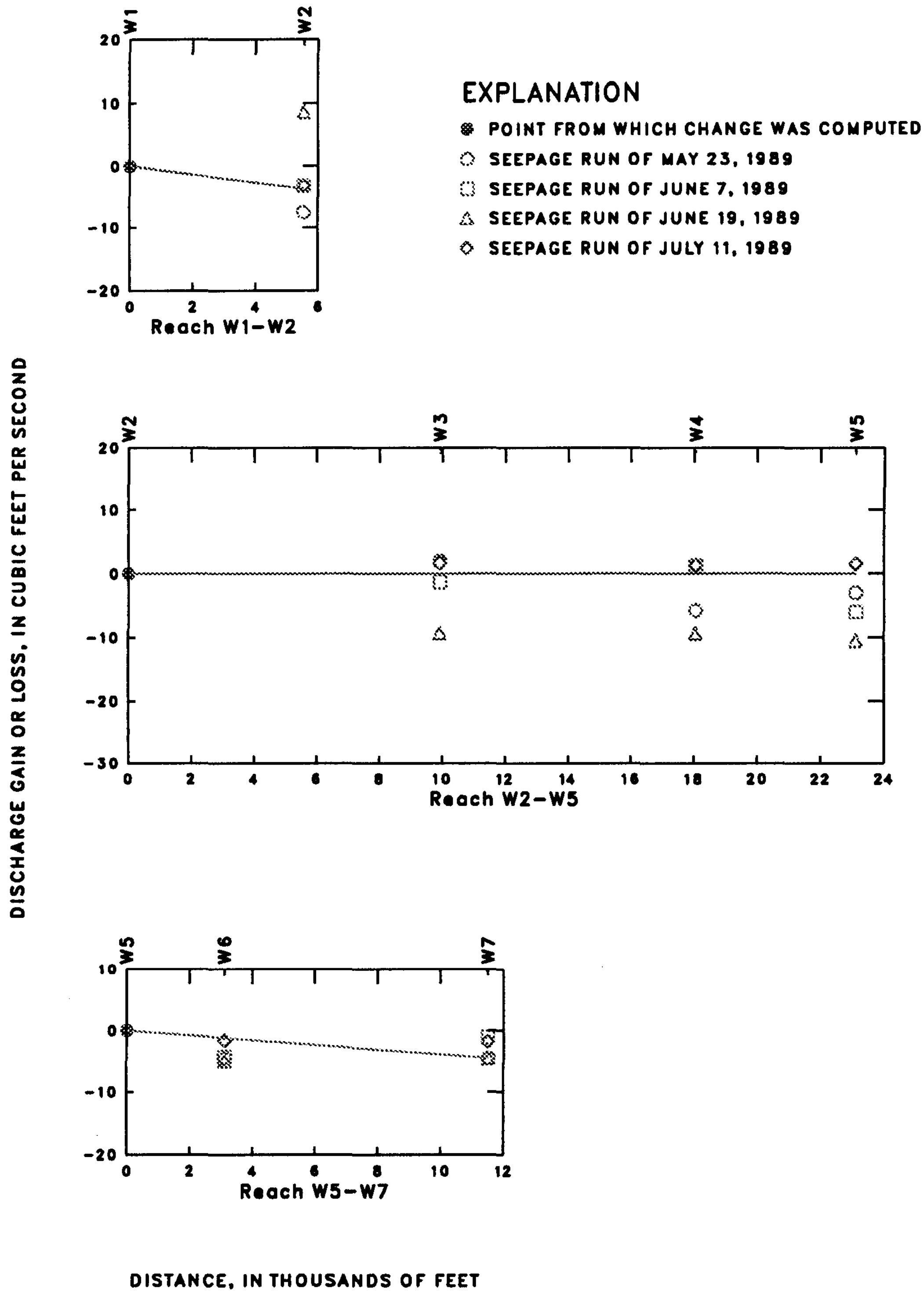


Figure 12.—Discharge gain or loss for reaches of the Wasatch Canal, 1989.

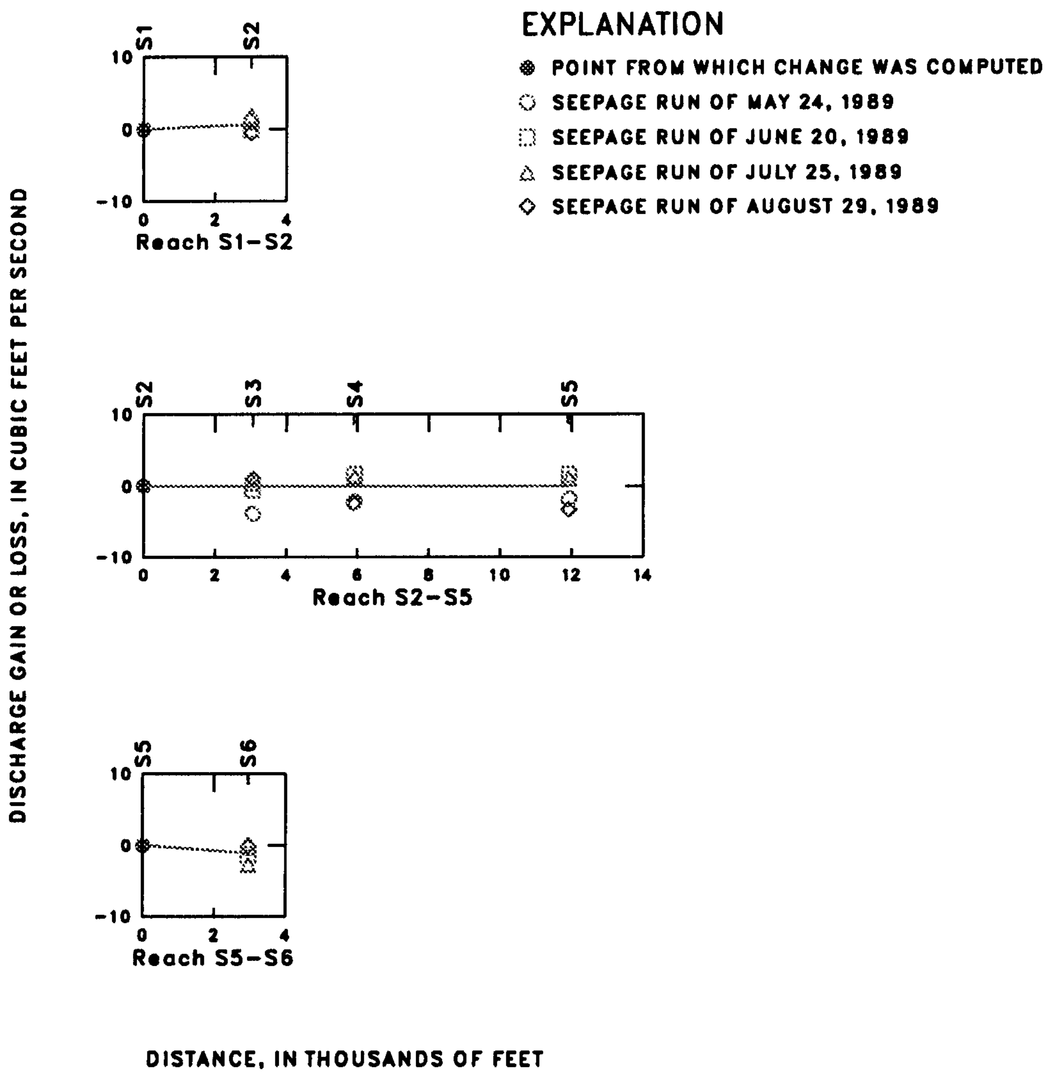


Figure 13.—Discharge gain or loss for reaches of the Sagebrush and Spring Creek Canal, 1989.

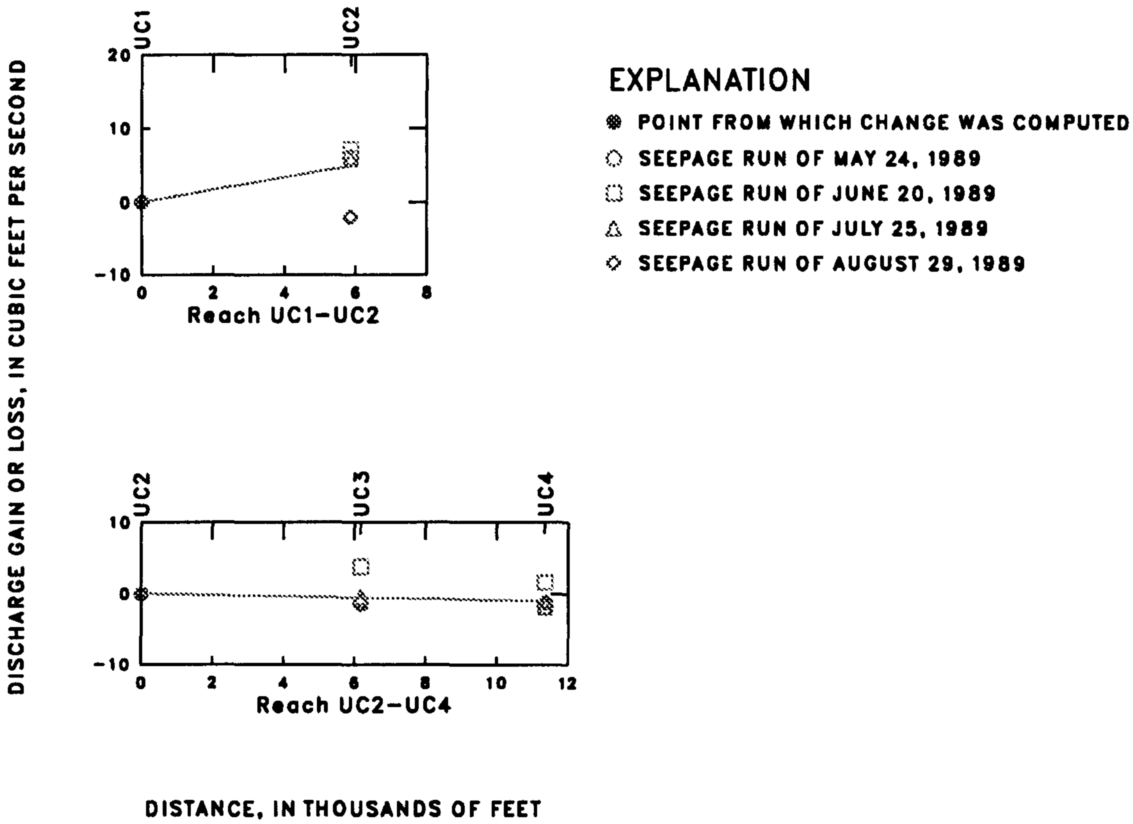


Figure 14.—Discharge gain or loss for reaches of the Upper Charleston Canal, 1989.

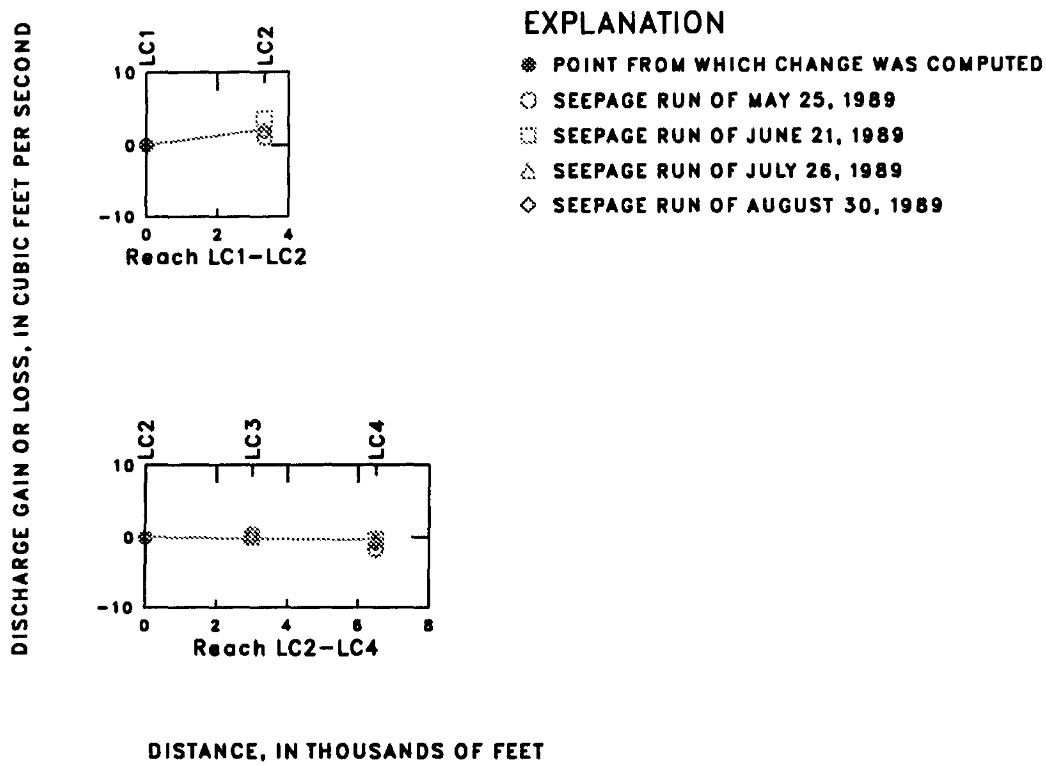


Figure 15.—Discharge gain or loss for reaches of the Lower Charleston Canal, 1989.

Table 1.—*Measurements made on the Timpanogos Canal*

[--, not measured]

Site number: TM, canal; T, diversion turnout.

Discharge: e, estimated.

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
TM1	05-23-89	0810	69.7	--	--
TM2		0900	70.7	--	--
T1			0.3		
TM3		0950	66.4	--	--
T2			.3e		
TM4		1030	66.9	--	--
TM5		1125	64.6	--	--
TM5		0810	68.9	85	9.0
TM6		0950	63.1	87	10.0
T6			2.2		
T7			1.0e		
TM7		1030	59.6	90	10.0
T10			.4		
T11			6.4		
TM8		1110	52.1	87	11.0
T14			.3		
T15			5.6		
T16			7.1		
TM9		1145	38.0	115	11.0
TM1	06-07-89	0805	74.3	--	--
TM2		0910	78.3	--	--
TM3		0940	74.2	--	--
T2			.2e		
TM4		1025	75.2	--	--
T3			.1e		
T4			4.1		
TM5		1125	67.0	--	--
TM5		0840	64.6	115	10.0
TM6		0935	61.0	120	10.0

Table 1.—*Measurements made on the Timpanogos Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
T5	06-07-89		0.5		
T6			2.3		
T7			1.1		
T9			.1e		
TM7		1010	57.2	130	11.0
T10			.8		
T11			4.7		
T12			4.1		
TM8		1045	46.9	120	11.5
T14			.2		
T15			5.1		
TM9		1125	40.2	125	12.5
TM1	06-19-89	0840	62.1	145	14.5
TM2		0948	64.2	155	15.0
TM3		1020	61.5	--	--
TM4		1120	63.0	155	16.5
T6			.4		
TM5		1220	52.7	145	16.5
TM5		0815	51.2	150	13.5
TM6		0915	49.5	150	14.0
T6	06-19-89		1.1		
T8			.5		
T9			1.8		
TM7		0950	46.4	150	14.5
T10			.1		
T11			4.5e		
T13			4.3		
TM8		1020	33.3	150	14.5
T15			4.3		
TM9		1055	27.4	155	16.0

Table 2.—*Measurements made on the Wasatch Canal*

[--, not measured]

Site number: W, canal; T, diversion turnout; R, return flow.

Discharge: e, estimated.

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
W1	05-23-89	0835	104.1	81	8.0
T1			0.1e		
R1			1.0e		
W2		0930	97.4	96	8.0
T4			4.4		
W3		1020	94.9	89	8.0
W4		1100	87.2	95	8.5
T7			.5e		
T9			4.4		
R4			.5e		
W5		1150	85.6	99	9.5
T11			43.4		
W6		1240	37.6	95	10.0
T14			.1e		
T15			.4		
T19			8.0		
T20			1.2		
T21			1.0		
T25			8.5		
W7		1320	18.5	93	12.0
W1	06-07-89	0815	102.0	120	9.0
T1			4.1		
R1			1.0e		
T2			.1e		
W2		0855	95.6	120	9.5
W3		0955	94.3	125	10.0
T5			3.1		
T6			3.3		
W4		1050	90.3	125	10.0
T7			4.9		

Table 2.—*Measurements made on the Wasatch Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
R3	06-07-89		0.1e		
R4			.5e		
R5			.1e		
W5		1120	79.0	130	11.0
T11			40.5		
R6			.7		
R7			.1		
W6		1155	35.0	130	11.5
T15			.2		
T16			2.6		
T17			.2		
T18			.8		
R8			.5e		
R9			.5e		
T20			.2		
T22			.8		
T23			.1		
T24			3.6		
R10			2.4		
T26			.2		
W7		1230	32.9	125	14.0
W1	06-19-89	1140	99.4	155	15.0
T1			4.9		
R1			1.0e		
R2			1.0e		
T3			3.3		
W2		1145	101.8	165	15.0
W3		1225	92.5	155	16.0
W4		1225	92.4	160	16.0
T10			3.9		

Table 2.—*Measurements made on the Wasatch Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
W5		1305	87.4	155	17.0
T11			44.1		
T12			8.4		
W6		1300	29.8	160	16.0
T15			5.1		
T17	06-19-89		0.1e		
T20			.1e		
T22			.2		
T23			.1e		
T24			7.5		
T25			7.3		
R10			4.8		
W7		1235	14.7	160	18.5
W1	7-11-89	0850	47.2	295	14.5
T1			2.2		
R1			.5e		
WT3			.1e		
W2		0925	42.2	295	15.0
W3		1000	43.9	295	15.0
W4		1035	43.5	295	16.0
T7			.2		
T8			.4e		
W5		1110	43.1	300	16.0
T11			32.5		
T13			8.7		
W6		1130	.3e	--	--
W7		1130	.1e	--	--

Table 3.—*Measurements made on the Sagebrush and Spring Creek Canal*

[--, not measured]

Site number: S, canal; R, return flow; T, diversion turnout.

Discharge: e, estimated.

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
S1	05-24-89	0815	57.6	--	--
R2			9.9		
T1			2.1		
T2			0.7		
T3			.8		
T4			.8		
T6			1.3		
T7			.3		
S2		0915	62.5	--	--
R3			.6		
T8			4.8		
T9			8.1		
T10			.1		
S3		--	46.2	--	--
T12			.3		
T13			6.5		
T14			1.2		
S4		--	38.7	--	--
T18			.5		
T19			.1		
T20			9.6		
R4			.5e		
T23			1.0e		
S5		--	29.6	--	--
T25			1.7		

Table 3.—*Measurements made on the Sagebrush and Spring Creek Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
T26	05-24-89		1.5e		
R5			0.5e		
T29			1.0e		
T30			1.5e		
S6		1130	24.0	--	--
S1	06-20-89	0820	35.6	300	13.0
R1			.2e		
R2			8.3		
T1			2.7		
T2			.1e		
T3			.1e		
T4			.3		
S2		0905	40.8	315	13.0
T10			1.0		
T11			5.2		
S3		0940	34.1	310	13.5
T13			5.3		
T14			.8		
T15			1.1		
S4		--	29.0	300	14.0
T16			.1e		
T17			.1e		
T18			6.8		
T21			.1e		
T22			1.1		
S5		--	20.8	315	14.0
T28			.7e		
S6		1125	18.8	310	15.0
S1	07-25-89	0850	17.8	390	13.0
R1			1.4		

Table 3.—*Measurements made on the Sagebrush and Spring Creek Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
R2	07-25-89		6.5		
T1			1.2		
T4			0.5		
T5			.7		
T6			.2		
S2		0940	24.9	400	13.0
T9			7.8		
S3		1020	17.5	400	13.5
T13			.6		
T14			.9		
S4		--	16.9	400	14.5
T22			1.3		
T24			1.0e		
S5		1110	14.4	400	14.5
T25			.6		
T29			.2		
S6		1125	10.9	390	15.0
S1	08-29-89	0845	14.0	410	10.0
R1			.7		
R2			3.3		
T1			1.2		
T4			.1e		
T6			.4		
S2		--	15.8	410	11.0
T8			.8		

Table 3.—*Measurements made on the Sagebrush and Spring Creek Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
T9	08-29-89		0.4		
S3		--	15.0	410	11.0
T13			5.6		
S4		--	6.6	--	--
T18			5.4		
S5		--	.3e	--	--
S6		1035	.3	390	13.5

Table 4.—*Measurements made on the Upper Charleston Canal*

[--, not measured]

Site: UC, canal; R, return flow; T, diversion turnout.

Discharge: e, estimated.

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
UC1	05-24-89	0830	35.7	240	10.0
R1			0.5e		
R2			.1e		
R3			.1e		
R4			.5e		
R6			.2e		
T1			.5e		
R7			.1e		
T2			.2		
T3			2.5		
UC2		0950	40.1	250	10.0
T4			1.7		
R8			1.0e		
R9			1.0e		
R10			2.0e		
T5			.1e		
T6			3.0e		
T7			.3		
T8			8.4		
T9			4.2		
T12			1.0e		
T14			1.0e		
T15			1.2		
T18			1.3		
UC3		1030	20.6	250	10.5
T19			1.0e		
T23			1.0e		
T25			.1e		
T27			.1e		
T28			.1e		

Table 4.—*Measurements made on the Upper Charleston Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
T29	05-24-89		1.0e		
UC4		1105	16.7	250	11.5
UC1	06-20-89	0820	21.5	275	14.0
T1			0.1e		
T2			.1e		
UC2		0915	28.4	300	13.0
R8			1.5e		
T12			1.0e		
T15			1.0e		
T16			1.0e		
T17			1.0e		
UC3		0950	29.7	305	13.5
T21			.3e		
T22			.4e		
T24			3.3		
T26			1.0e		
T27			.1e		
T29			1.0e		
UC4		1025	21.4	300	14.0
UC1	07-25-89	0835	10.2	--	--
R4			.1e		
T1			.1e		
R11			.1e		
T3		0920	.2		
UC2		0935	16.1	--	--
T6			.1e		
T11			.7e		
T12			.2e		
T13			1.0e		
T14			.3e		

Table 4.—*Measurements made on the Upper Charleston Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
UC3	07-25-89	1010	13.3	--	--
T19			1.2e		
T20			0.7e		
T23			1.1e		
T26			1.1e		
T27			.1e		
UC4		1050	7.8	--	--
UC1	08-29-89	0850	13.8	395	11.0
R4			.2e		
R5			.1e		
T1			.2e		
R6			.3e		
T2			.1e		
T3			.1e		
UC2		0925	11.9	395	11.0
T10			9.1		
T13			.5e		
T18			1.1		
UC3		1000	0	--	--
C4		1010	0	--	--

Table 5.—*Measurements made on the Lower Charleston Canal*

[--, not measured]

Site number: LC, canal; T, diversion turnout.

Discharge: e, estimated.

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
LC1	05-25-89	0910	10.0	415	10.0
LC2		1000	11.0	430	10.5
T4			0.3		
T7			.1e		
T9			.6		
T10			.5e		
T11			.1e		
LC3		1035	9.8	430	11.5
T12			.1e		
T13			.1e		
T14			.1e		
T15			.1e		
T16			.2		
T18			.3		
T19			.1e		
T20			.1e		
T24			.3		
T25			.1e		
T26			6.0		
LC4		1110	.2e	--	
LC1	06-21-89	0900	8.6	--	11.0
LC2		0935	12.2	--	11.0
T3			2.4		
T5			.7		
T6			.2e		
T7			1.7		
T11			.8		
LC3		1005	6.4	--	11.5
T15			.9		
T16			.1e		

Table 5.—*Measurements made on the Lower Charleston Canal*—Continued

Site number	Date of measurement	Time (24 hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
T18	06-21-89		0.1e		
T25			.5		
T26			.1		
LC4		1025	4.4	--	11.5
LC1	07-26-89	0900	10.1	400	12.5
T3			.8		
LC2		0940	11.5	415	13.0
T5			.4		
T6			.6e		
T7			1.8		
T8			.5		
T9			3.4		
T11			4.		
LC3		--	.1e	415	13.5
LC4		--	.1e	--	--
LC1	08-30-89	0855	8.4	415	12.0
T1			1.8		
T2			.2		
T3			.6		
LC2		0930	7.8	425	12.5
T11	08-30-89		.1		
LC3		1000	7.9	425	13.0
T16			.1e		
T17			.1e		
T21			.1e		
T22			2.0		
T23			4.6		
LC4		--	0	--	--

Table 6.—*Seepage gains or losses determined from discharge measurements for reaches of the canals*

Reach	Length (feet)	Average gains (+) or losses (-) (from figs. 11-15): Cubic feet per second	Average gains (+) or losses (-) (from figs. 11-15): Cubic feet per second per mile
	Timpanogos Canal		
TM1-TM2	6,019	+2.0	+1.8
TM2-TM4	13,094	-4.1	-1.7
TM4-TM6	16,896	-10.0	-3.1
TM6-TM9	21,014	-2.8	-0.7
Total	57,023	-14.9	
	Wasatch Canal		
W1-W2	5,544	-3.7	-3.5
W2-W5	23,126	0.0	0.0
W5-W7	11,510	-4.5	-2.1
Total	40,180	-8.2	
	Sagebrush and Spring Creek Canal		
S1-S2	3,010	+0.6	+1.1
S2-S5	11,932	0.0	0.0
S5-S6	2,957	-1.1	-2.0
Total	17,899	-0.5	
	Upper Charleston Canal		
UC1-UC2	5,861	+5.0	+4.5
UC2-UC4	11,352	-1.0	-0.5
Total	17,213	+4.0	
	Lower Charleston Canal		
LC1-LC2	3,326	+2.2	+3.5
LC2-LC4	6,495	-0.4	-0.3
Total	9,821	+1.8	