ORNL/TM--9392

DE85 018087

ENVIRONMENTAL SCIENCES DIVISION

WEST CHESTNUT RIDGE HYDROLOGIC STUDIES

J. L. Elmore, D. D. Huff, and J. R. Jones

Environmental Sciences Division
Publication No. 2476

NUCLEAR AND CHEMICAL WASTE PROGRAMS
(Activity No. AR 051005K; ONL-WN13)

Date Published - August 1985

NOTICE: This document contains information of a preliminary nature. It is subject to revision or correction and therefore does not represent a final report.

Prepared for the
Office of Defense Waste and Byproducts Management

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Elmore, J. L. , D. D. Huff, and J. R. Jones. 1985.
West Chestnut Ridge hydrologic studies. ORNL/TM-9392.
Oak Ridge National Laboratory, Oak Ridge, Tennessee.
86 pp.

Preliminary site characterization work for the proposed West Chestnut Ridge Central Waste Disposal Facility included collection and analysis of data on stream flows, watershed areas, precipitation, water levels at piezometer sites, and physicochemical properties of surface water. Seven temporary water-flow-gaging installations were established and used to characterize runoff patterns in the study area. Chip-floating and regression techniques were used to estimate stream flows after some of the temporary structures were destroyed during high flows.

Stream flow fluctuations were quantified using coefficients of variation and percent change in total flow between adjacent sampling dates. The difference between precipitation and observed flows (net loss) was calculated for all stations.

Two headwater stations (4 and 6) exhibited lower flows per watershed area and channel length, and higher levels of fluctuation in flow than the other stations. These two stations were also similar in watershed area and flow magnitude.

Two other headwater stations (5 and 7) with comparable flows had total drainage areas that were similar in size and smaller than those of the other stations. Stations 5 and 7 exhibited high flows per

drainage area and section length, especially in the dry period of the year when flows were higher than at all other stations. Fluctuations in flows were lowest at these two stations. Data indicate that these two sections are fed by sources of dependable groundwater.

1. INTRODUCTION

As part of site characterization work for the proposed West Chestnut Ridge Central Waste Disposal Facility (CWDF) for low-level radioactive waste, a hydrologic study has been continuing since July 1982. Data collected include (1) watershed areas and stream flows from the major stream draining the area (Ish Creek) and from a minor stream north of Ish Creek, (2) limited water quality data on the two streams, (3) precipitation values, and (4) water-level measurements at piezometer sites near the junction of New Zion Patrol Road and the Tennessee Valley Authority (TVA) power line right-of-way. Although hydrologic studies of other Oak Ridge watersheds have been published (Ackerman 1949; McMaster 1967; Sheppard 1974; Edgar 1978), the only work on the Ish Creek catchment is presented in this report and two other reports resulting from this research (Huff et al. 1984; Huff and Frederick 1984). The Huff et al. (1984) report presents data collected in July 1982, and the present report gives data collected from July 1982 to September 1983. Information obtained after September 1983 is the major thrust of Huff and Frederick (1984).

2. SITE DESCRIPTION

Three streams drain the site of the proposed facility. The major drainage, Ish Creek, traverses the site to the southwest and empties into the Clinch River. Another drainage, located west of Ish Creek, has intermittent flow to the southwest into the Clinch River. The third drainage, located on the northern portion of the site, flows north into Grassy Creek.

3. MATERIALS AND METHODS

Temporary weirs were constructed at six locations on Ish Creek during the first two weeks of July 1982 (Fig. 1). These structures were used to allow collection of a timed-volume sample to measure discharge directly. Details of the construction and utilization of these weirs are contained in Huff et al. (1984). Because of high flows in the fall and winter, the temporary structures at the three downstream stations (1, 2, and 3) were destroyed, and it was necessary to use other techniques to estimate flows. In addition to the weirs, flow was monitored at a culvert on a tributary to Grassy Creek north of the Ish Creek watershed (Fig. 1).

One of the alternative techniques used to estimate stream flows was a stream cross section and chip-floating method. Initially, measurements were made to relate stream bed elevations along a cross section to a fixed datum, thus allowing calculation of cross-sectional area from water surface elevation. Water level was determined on each sampling trip by measuring down to the water surface from the fixed datum above the stream. Average velocity was determined from an empirical relation involving the rate at which the fastest chip traversed a short section of the stream located on either side of the cross section. The empirical relationship was based on two assumptions. First, it was assumed that the average velocity in the vertical section was a fixed fraction of the surface velocity. This assumption is often used when channel sections are too shallow to allow use of a current meter (Vennard 1962). The second assumption was that there was a fixed relationship between average velocity across the

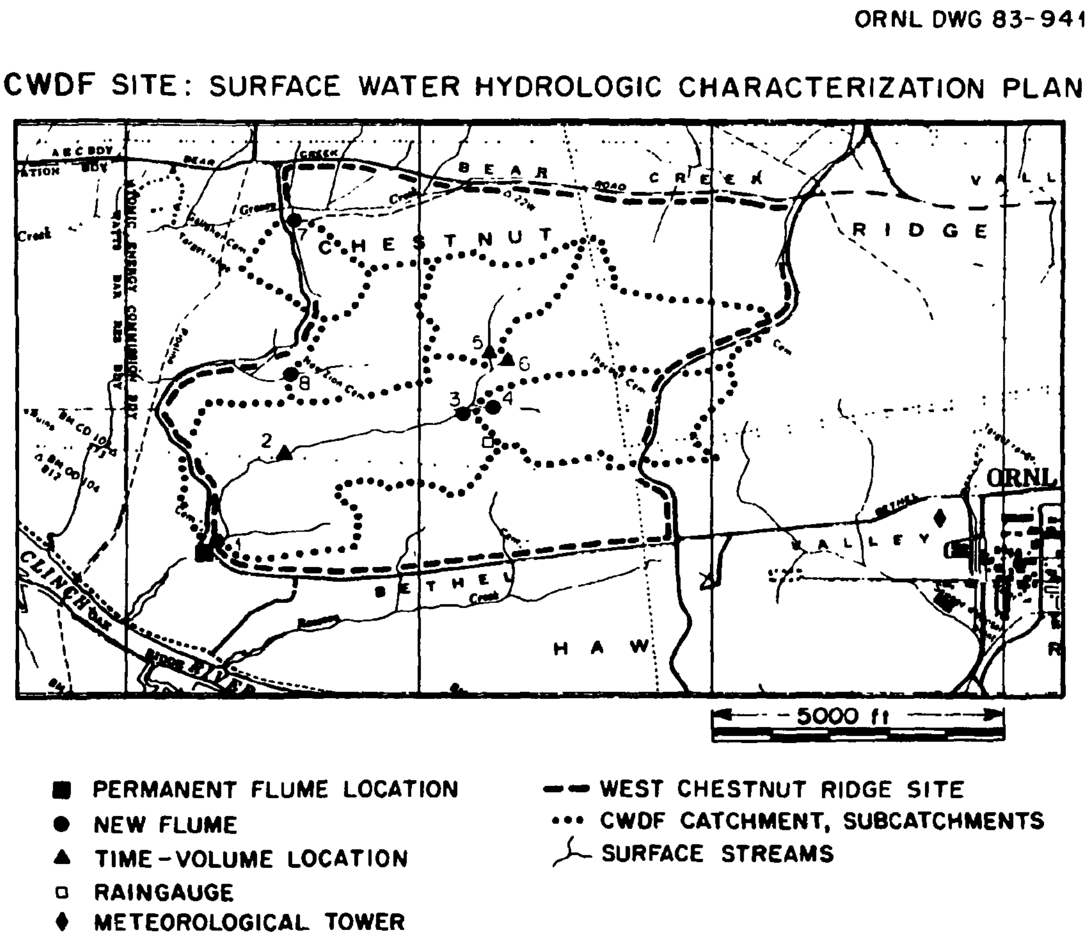


Fig. 1. Locations of stream flow monitoring points, rain gage installation, and 30-m meteorological observation tower at Oak Ridge National Laboratory. The solid circles indicate locations for continuous monitoring locations installed in September 1983. Stations 1-6 are located on Ish Creek.

entire channel and the maximum velocity that could be observed at any point. In other words, we assumed that maximum surface velocity determined by repeated measurement was a constant factor of average velocity across the full cross-sectional area. The constant was determined empirically at a site where discharge was accurately determined by volumetric measurement, then used in subsequent estimates. The ratio of average to maximum velocity for floating chip measurements was 0.57 in the results reported here. The product of area and mean velocity was used to estimate discharge.

Another technique used to supplement discharge measurements involved regression equations developed from data taken earlier in this study (Table 1). Flow data from stations 4 and 5 were used to estimate flows at station 3 (Fig. 1). Measured or calculated flows at station 3 were then used to estimate flows at station 2, and the measured or calculated flows at station 2 and 3 were used to estimate flows at station 1.

In September 1983, permanent weirs and automatic recording equipment were installed at three stations on Ish Creek (at previous temporary gaging sites 1, 3, and 4), at a site on a tributary to Grassy Creek north of Ish Creek (site 7), and at an additional station on an intermittent drainage to the Clinch River west of Ish Creek (site 8) (Fig. 1). Although not discussed in this report, these devices will provide continuous data of higher quality that will be useful in further characterization of the watershed.

Table 1. Regression equations used to estimate flows at stations 3, 2, and 1 in Ish Creek

---

Station 3

$$\hat{Q}_3 = -0.623 + 1.8605\ (Q_4) + 2.9473\ (Q_5)$$

$\hat{Q}_3$ = estimated flow at station 3

Q_4 = flow at station 4

Q_5 = flow at station 5

Station 2

$$\hat{Q}_2 = 0.2507 + 1.7337\ (\hat{Q}_3)$$

$\hat{Q}_2$ = estimated flow at station 2

Station 1

$$\hat{Q}_1 = 2.06\ \hat{Q}_2 - 1.06\ \hat{Q}_3$$

$\hat{Q}_1$ = estimated flow at station 1

In addition to information on stream flows, precipitation data were collected with a continuous recording rain gage located in the West Chestnut Ridge basin (Fig. 1). The rain gage is of the weighing-bucket type and produces a chart of cumulative rainfall over a recording period of up to 8 d. Data are taken from the chart in break-point format, that is, at points where the weight (rainfall intensity) changes significantly. Intervals may be as short as 10 min or as long as one week, depending on rainfall patterns. The data are stored in computer files that can be summarized into hourly or daily totals using existing computer software developed for this purpose. Summaries were obtained by processing all break-point data and recording only positive rainfall increments, thus eliminating problems with determining evaporative loss.

Limited water quality data were collected at stations on April 18, 1983, and September 11, 1983, corresponding to high and low flows, with a Hydrolab Digital 4041 equipped with probes for temperature, conductivity, and pH determinations.

Water-table levels were observed at ten wells near the junction of New Zion Patrol Road and the TVA power line right-of-way (Fig. 2). Observations were made every other week by lowering an electric tape down the well and recording the distance from the measuring point on the casing to the water level. Because the variable of most interest was depth to water, that value was computed for each site and date.

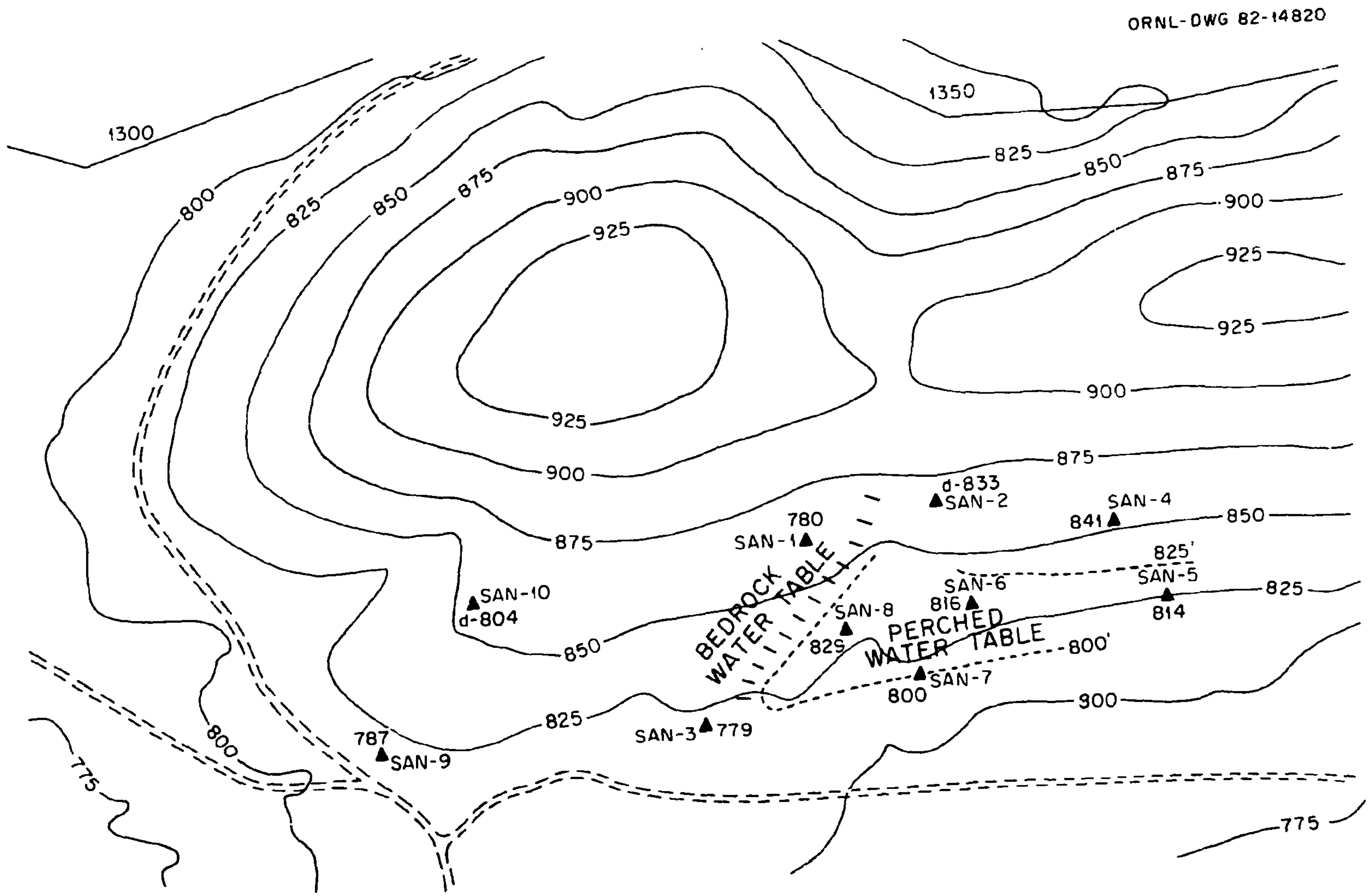


Fig. 2. Piezometric surface map beneath existing piezometers (SAN-1 through SAN-10), March 31, 1982. (Taken from R. H. Ketelle, "Report on Preliminary Site Characterization of the West Chestnut Ridge Site," ORNL/NFW-82/21, October 26, 1982).

4. RESULTS

Flow rates were highest at all stations from late fall through spring. Measured values ranged from 1.6 L/s at station 7 on January 24, 1983, to 139 L/s at station 1 on November 22, 1982 (Table 2, Fig. 3). In contrast, flow rates were much lower during summer and early fall, ranging from no flow at stations 4 and 6 on several dates in late summer 1983 to 14.5 L/s at station 1 on July 25, 1983. On all sampling dates, flows were greatest at station 1, followed by station 2, and then station 3 as would be expected based on contributing area. Flows at stations 4 and 6 were usually similar on any given sampling date, with greater values at station 6 on 16 of 24 dates compared. Flows at station 5 were higher than those at stations 4 and 6 from early summer through midfall; however, the opposite was true from late fall through spring. Flows at station 7 appeared to behave similarly to those at station 5.

Time-weighted annual mean flows were calculated for two 12-month periods, one beginning July 1982 and the other beginning October 1982 (Table 3). Flows measured on a semiweekly sampling date were assumed to represent the period of time from the midpoint before the sampling date to the midpoint following the sampling date. These values were probably underestimates because of loss of storm flow data as a result of the discrete sampling schedule and the inability to volumetrically gage the highest flows at some stations. Mean values did not vary appreciably between the two 12-month periods (Table 3). Flows were greatest at station 1, followed by stations 2, 3, 6, 4, 5, and 7. Values at stations 4 and 6 and stations 5 and 7 were similar.

Annual mean flow was plotted against drainage area above the station in Fig. 4. A reasonably smooth function resulted. Plots of the same data on semi-log and log-log axes, however, did not produce straight lines. Data from stations 4 and 6 and stations 5 and 7 cluster together.

Table 2. Flows (L/s) at Ish Creek gaging stations

Station No.	Date													
	7/15/82	7/20/82	8/3/82	9/22/82	10/8/82	10/25/82	11/22/82	12/10/82	12/20/82	1/7/83	1/24/83	2/7/83	2/22/83	3/7/83
1	2.018	2.985	4.946	1.997	6.00	3.083	139.06[a]	79.62[a]	82[a]	39.64[b]	28[a]	125.56[b]	34.76[b]	56.60[b]
2	1.576	2.424	3.403	1.878	4.208	2.780	52.11[a]	29.86[a]	56[a]	28[a]	19[a]	78.69[b]	21.83[b]	35.68[b]
3	0.722	1.377	1.891	0.845	2.172	1.467	29.91[a]	17.083	28.08	16[a]	9.61	49.72[b]	18.84[b]	21.77[a]
4	0.037	0.048	0.303	0.127	0.092	0.278	10.789	6.647	8.42	4.57	3.26	10.91	3.57	5.97
5	0.392	0.695	0.669	0.394	0.853	0.541	3.545	2.473	5.60	2.68	1.73	6.75	2.25	3.83
6	0.078	0.295	0.548	0.088	0.223	0.257	12.577	6.752	8.20	5.45	3.60	14.93	4.34	7.09
7		0.738	0.694	0.485	0.584	0.501	1.841	1.780	3.13	2.23	1.59	4.35	2.32	2.89
	3/21/83	4/3/83	4/18/83	5/2/83	6/6/83	6/13/83	6/28/83	7/11/83	7/25/83	8/8/83	8/22/83	9/6/83	9/19/83	9/30/83
1	69.71[b]	38.16[b]	52.50[b]	62.38[b]		8.516	4.829[a]	2.494[a]	14.49[a]	2.785[a]	1.335[a]	2.089[a]	1.498[a]	1.642[a]
2	30.21[b]	18.29[a]	-	45.60[a]		5.773[a]	3.227[a]	1.616[a]	10.325[a]	1.816[a]	0.816[a]	1.336[a]	0.928[a]	1.027[a]
3	22.90[a]	10.40[a]	45.02[b]	26.16[b]		3.185[a]	1.717[a]	0.788[a]	5.811[a]	0.903[a]	0.326[a]	0.626[a]	0.391[a]	0.448[a]
4	7.35	3.17				0.721	0.370	0.039	0.423	0.016	0	0.014		0
5	3.34	1.74			1.46	0.837	0.349	0.454	1.916	0.508	0.322	0.415	0.344	0.363
6	6.60	3.57	7.46	3.57	2.10	1.045	0.945	0	0.284	0	0	0	0	0
7	2.36	1.75	2.95	2.36		1.301	1.009	0.656	0.967	0.628	0.477	0.518	0.466	0.392

[a]Estimates from regressions.

[b]Estimates from chip-floating technique.

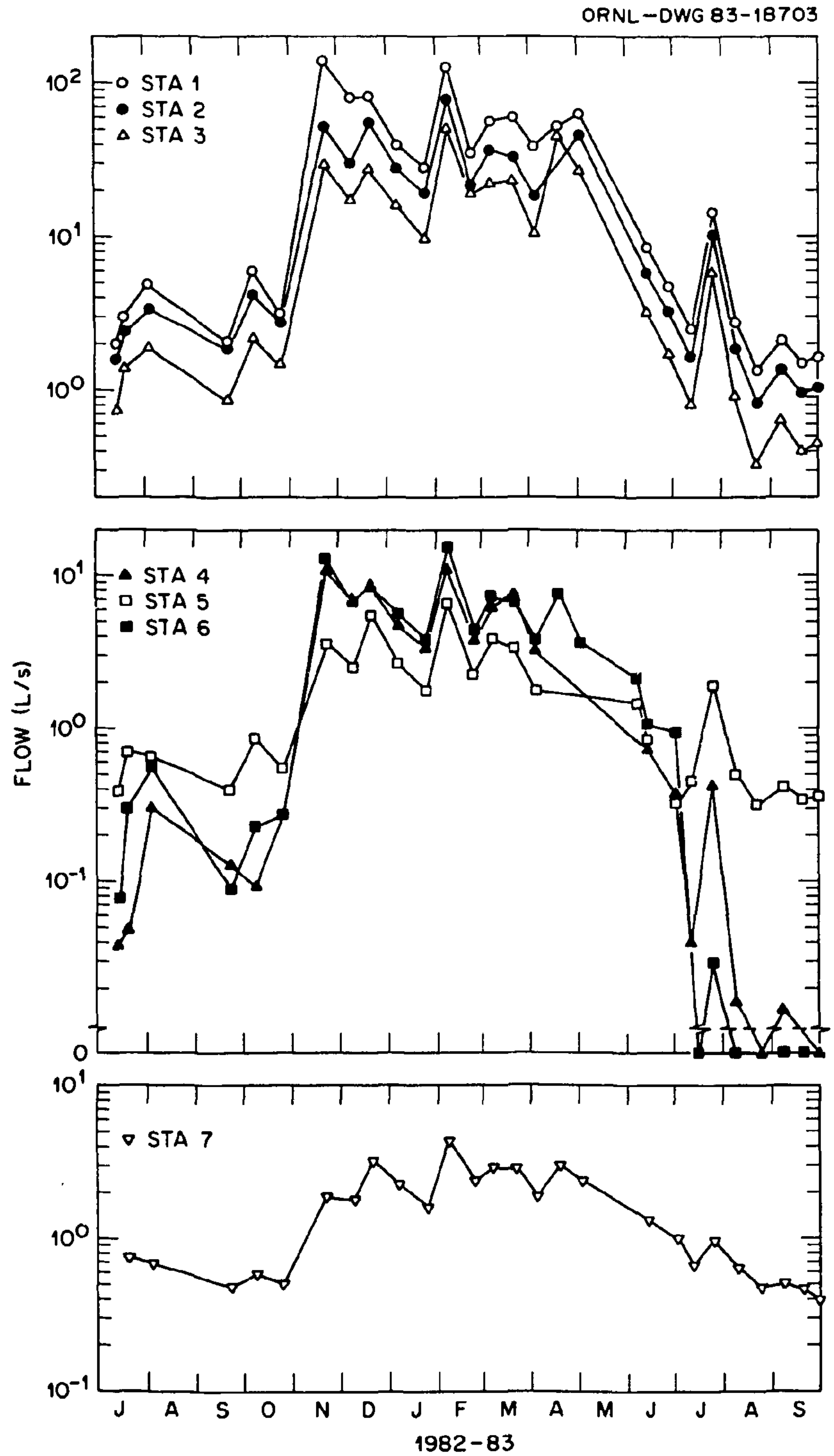


Fig. 3. Flows at Ish Creek monitoring stations.

Table 3. Weighted annual mean flows at stations on Ish Creek

Station No.	Annual mean flow (L/s)	
	7/15/82 - 7/11/83	10/8/82 - 9/30/83
1	38.92	39.09
2	21.83	21.89
3	13.95	13.98
4	3.16	3.14
5	1.90	1.92
6	3.94	3.88
7	1.63	1.62

ORNL-DWG 83-18746

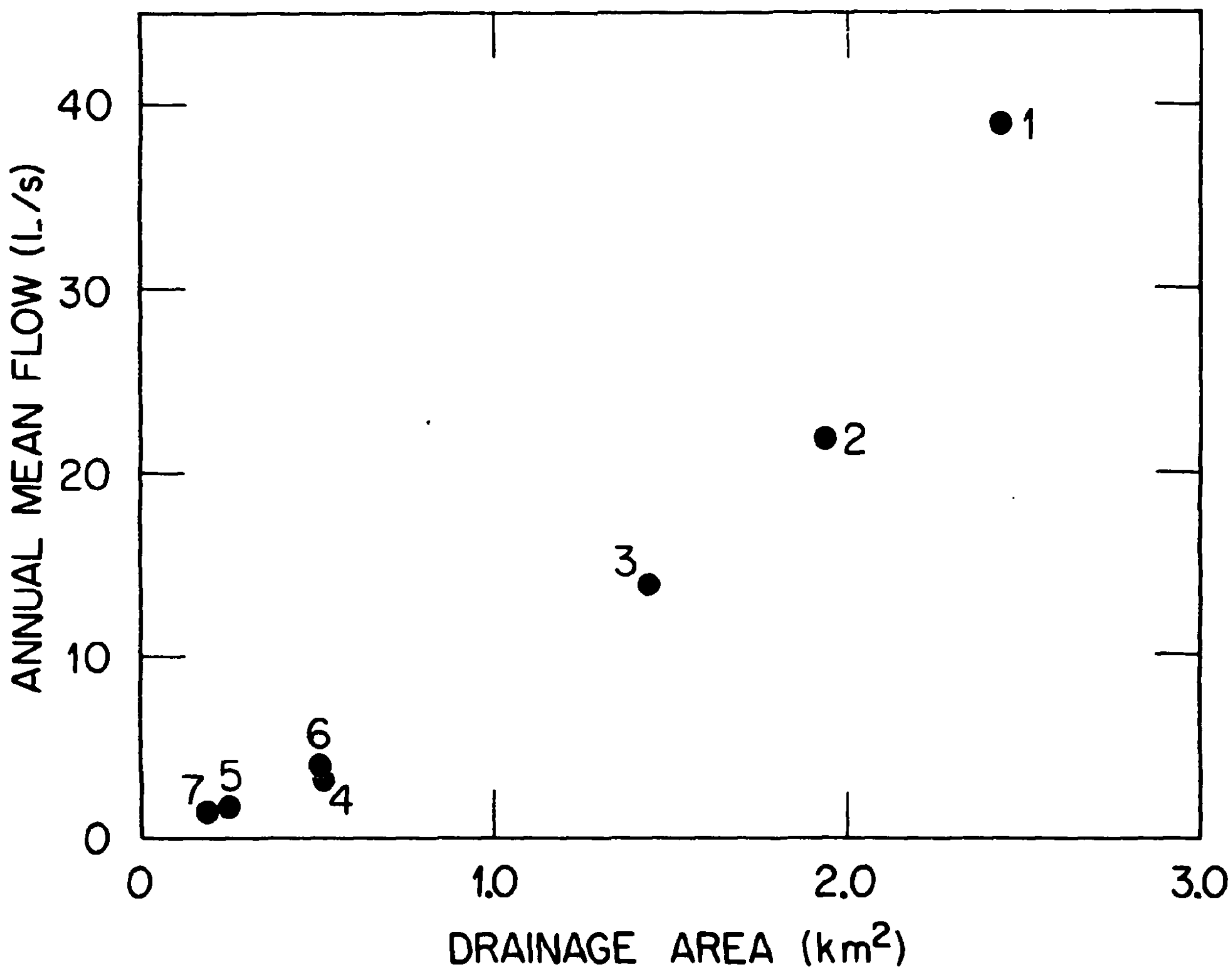


Fig. 4. Annual mean flows at Ish Creek monitoring stations plotted against drainage areas above the stations.

Two statistics were used to analyze the relative degree of fluctuation of stream flow at the sampling stations: coefficients of variatic ,tandard deviation/mean) and percent change in flow between adjacent sampling dates. Coefficients of variation ranged from 71% at station 7 to 131% at station 4 (Table 4). Stations 1, 2, and 3 had similar values of 120 - 122%, whereas values at stations 4 and 6 were higher, and those at stations 5 and 7 were lower.

Fluctuations in flows between adjacent sampling dates varied widely (Table 5). Means of absolute values, however, exhibited the same trends as the coefficients of variation. Values at stations 4 and 6 were higher and those at stations 5 and 7 were lower than those at stations 1, 2, and 3. Unlike the previous analysis, fluctuations in flows at station 1 were considerably higher than those at stations 2 and 3, and the value at station 7 was only about half that of station 5.

Flows per total contributing area, section area (area between stations), total channel length, and section channel length on each sampling date are presented in Appendices A and B. Flows per total contributing area and per total channel length were usually greater at station 1 than at station 2, and less than those of station 2 at station 3. Values for these two variables were usually lowest at stations 4 and 6 and highest at stations 5 and 7. Flows at stations 5 and 7 were usually higher than those at the other stations during the dry period of the year, July through September. During the wetter portions of the year, however, flows at stations 5 and 7 varied greatly in their rank among stations, but were often around the level of stations 2 and 3.

Table 4. Coefficients of variation of flow rates at gaging stations on Ish Creek from July 1982 to September 1983

Station No.	Coefficient of variation (%)
1	122
2	120
3	121
4	131
5	100
6	127
7	71

Table 5. Percent change[a] in total flow between adjacent sampling dates

Dates	Stations 1	2	3	4	5	6	7
7/15-7/20/82	50	54	91	30	77	278	
7/20-8/3/82	66	40	37	531	-4	86	-6
8/3-9/22/82	-60	-45	-55	-58	-41	-84	-30
9/22-10/8/82	200	124	157	-28	116	153	20
10/8-10/25/82	-49	-34	-32	202	-36	15	-14
10/25-11/22/82	4410	1774	1939	3781	555	4794	267
11/22-12/10/82	-43	-43	-43	-38	-30	-46	-3
12/10-12/20/82	3	88	64	27	126	21	76
12/20/82-1/7/83	-52	-50	-40	-29	-52	-34	-29
1/7-1/24/83	-29	-32	-40	-29	-35	-34	-29
1/24-2/7/83	348	314	417	235	290	315	174
2/7-2/22/83	-72	-72	-62	-67	-67	-71	-47
2/22-3/7/83	63	63	16	67	70	63	24
3/7-3/21/83	23	-15	5	23	-13	-7	-18
3/21-4/3/83	-45	-39	-54	-57	-48	-46	-26
4/3-4/18/83	38		333			109	68
4/18-5/2/83	19		-42			-52	-20
5/2-6/6/83						-41	
6/6-6/13/83					-43	-50	
6/13-6/28/83	-43	-44	-46	-49	-58	-10	-22
6/28-7/11/83	-48	-50	-54	-89	30	-100	-35
7/11-7/25/83	481	539	637	985	322	(+)[b]	47
7/25-8/8/3	-81	-82	-84	-96	-73	-100	-35
8/8-8/22/83	-52	-55	-64	-100	-37	0	-24
8/22-9/6/83	56	64	92	(+)[b]	29	0	9
9/6-9/19/83	-28	-30	-38		-17	0	-10
9/19-9/30/83	10	11	14		6	0	19
$\frac{\Sigma\lvert X\rvert}{N}$[c]	255(25)[d]	159(23)[d]	178(25)[d]	326(20)[d]	91(24)[d]	296(22)[d]	44(24)[d]

[a] Percent change = $\frac{\text{(flow on latter date)} - \text{(flow on former date)}}{\text{flow on former date}}$

[b] Flow increased from zero flow.

[c] $\lvert\Sigma\rvert X$ = sum of absolute value of the percent change in total flow between dates.
N = sample size.

[d] Values in parentheses represent sample sizes.

Flow per section area followed the same general trends as those discussed previously for total area and total length. Flows per section area at stations 4, 5, 6, and 7, however, were roughly similar from early January to April 1983.

Flow per section length usually followed the same patterns as section area flows. Values at station 7 were consistently higher than those of other stations from July to October during both years. Flows at station 5 were usually about the level of those of station 2 or 3 during this period. Stations 4 and 6 consistently exhibited the two lowest flows during July to October, and one of these stations had the lowest flow on most dates.

Precipitation data for 1983 are presented in Appendix C. Monthly values ranged from a low of 26 mm in August to a high of 163 mm in April. Mean monthly rainfall for January through May was 104 mm, whereas the value for June through October was 62 mm.

Precipitation data from Ish Creek (and from Walker Branch, when data were not available for Ish Creek) were compared with runoff per unit area to compute runoff coefficients (ratio of runoff to precipitation) and net loss (difference between precipitation and runoff) for each of the flow measuring sites (Table 6). For comparative purposes, the runoff coefficient and net loss values at Walker Branch for the same period were 0.62 and 42.2 cm, respectively. Thus, the data in Table 6 suggest that there are appreciably greater net losses at Ish Creek than at Walker Branch. However, note that the data here are derived from periodic rather than continuous measurements. The data are biased toward underestimating actual

Table 6. Comparison of runoff per unit area, runoff coefficient, and net loss among measuring sites for the period October 1982–September 1983. Precipitation for the period was 111.8 cm; net loss at Walker Branch Watershed was 42.2 cm for the same period.

Station No.	Area (km^2)	Runoff (cm)	Runoff/ precipitation	Net loss (cm)
1	2.44	50.5	0.45	61.3
2	1.94	35.6	0.32	76.2
3	1.45	30.4	0.27	81.4
4	0.54	18.3	0.16	93.5
5	0.25	24.2	0.22	87.6
6	0.52	23.5	0.21	88.3
7	0.19	26.9	0.24	84.9

runoff. Thus, the absolute values should not be given much weight. Instead, Table 6 serves to characterize the relative differences among stations and shows that site 1 had the highest relative yield of all the sites.

Surface water quality data from Ish Creek on two dates are shown in Table 7. Water temperature of the April sample ranged from 9.6°C at station 1 to 11.7°C at station 3. Conductivity ranged from 26 µS/cm at station 6 to 195 uS/cm at station 7. Values for pH ranged from 5.9 at station 6 to 8.4 at station 7. A single reading for dissolved oxygen was taken at station 4 with a value of 8.1 mg/L.

Water temperature on September 11, 1983, ranged from 18.4°C at station 7 to 23.4°C at station 3. Conductivity was lowest at station 4 with a value of 27 µS/cm and highest at station 7 with a reading of 288 µS/cm. Values for pH ranged from 6.0 at station 6 to 7.4 at station 7.

Depth to water and well depths of the ten wells sampled are shown in Table 8. Wells 2, 3, and 10 were dry on each sampling date, and well 9 was dry on 13 of 19 dates. The other wells had water in them throughout the sampling period; however, the water level showed a decline throughout the period from May 23 to September 30. The minimum depth to water in all wells was on May 23 following 4 d of precipitation totaling 84 mm.

Table 7. Values of physicochemical variables at Ish Creek gaging stations

April 18, 1983

	Stations						
	1	2	3	4	5	6	7
Water temperature (°C)	9.6	10.1	11.7	10.5	11.1	10.5	10.6
Conductivity (μS/cm)	125	92	50	63	66	26	195
pH	7.5	6.7	6.3	6.5	6.5	5.9	8.4
Dissolved oxygen (mg/L)				8.1			

September 11, 1983

	Stations						
	1	2	3	4	5	6	7
Water temperature (°C)	21.5	20.5	23.4	21.3	21.7	22.3	18.4
Conductivity (μS/cm)	282	229	164	27	54	41	288
pH	7.1	7.3	7.2	6.3	7.0	6.0	7.4

Table 8. Well depths and depths to water at ten West Chestnut Ridge well sites sampled twice monthly from January through September 1983

Date	SAN-1	SAN-2	SAN-3	SAN-4	SAN-5	SAN-6	SAN-7	SAN-8	SAN-9	SAN-10
WELLS DEPTHS (FT.)										
	98.08	43.48	23.89	37.44	36.28	44.79	61.58	42.04	40.79	54.31
DEPTH TO WATER (FT.)										
01/17/83	94.12	43.30	23.97	28.04	24.29	34.61	34.55	28.05	40.43	54.31
01/31/83	93.90	43.62	24.29	29.18	25.68	38.33	36.27	28.79	39.40	54.31
02/14/83	90.78	43.58	23.72	22.33	23.96	27.18	25.36	24.30	39.18	54.31
03/01/83	91.74	43.61	24.15	27.57	24.73	36.30	34.68	26.64	40.36	54.31
03/14/83	93.54	43.61	24.15	28.57	25.74	37.25	35.98	27.97	40.78	54.31
03/28/83	92.67	43.61	24.28	29.09	25.79	38.28	36.51	26.44	40.78	54.31
04/11/83	88.17	43.48	23.20	21.16	23.08	23.78	22.83	21.87	40.78	54.31
04/25/83	91.05	43.48	23.92	26.64	24.08	35.77	27.10	26.71	40.78	54.31
05/09/83	91.30	43.48	23.12	28.50	25.54	38.49	20.60	29.18	40.78	54.31
05/23/83	87.63	43.48	21.34	15.99	10.02	13.86	16.65	14.09	36.10	54.31
06/06/83	91.03	43.48	22.76	26.25	24.80	36.12	33.05	30.05	40.76	54.31
06/20/83	91.68	43.50	23.11	27.83	26.90	39.06	36.84	34.79	40.74	54.31
07/05/83	93.09	43.49	23.66	29.73	28.70	40.08	38.13	36.92	40.79	54.31
07/18/83	93.93	43.50	23.89	30.19	29.79	40.75	38.69	38.05	40.79	54.31
08/01/83	94.52	43.50	23.94	30.61	30.37	41.10	39.08	38.82	40.76	54.31
08/15/83	94.92	43.51	23.97	30.83	31.09	41.14	39.45	39.52	40.77	54.31
08/26/83	95.21	43.50	24.09	31.14	31.65	41.28	39.83	40.12	40.78	54.31
09/12/83	95.36	43.51	24.09	31.49	32.25	41.53	40.24	40.73	40.78	54.31
09/30/83	95.68	43.49	24.11	32.03	33.18	42.32	40.75	41.49	40.78	54.28

5. DISCUSSION

Although the data are too limited to warrant final conclusions, certain preliminary observations seem valid at this time. Stations 4 and 6 have many similarities, for example, comparable watershed areas and flow magnitudes. In addition, these two stations usually have lower flows per watershed area and stream length and higher levels of fluctuation in flow than the other stations. They were also the only stations that had no flow recorded at sometime during the study. Although factors such as different soils, vegetation, or slope could be responsible for the anomalous behavior of these two stations, further study is needed to isolate the causative variables. One possibility may be that the channels are aligned with geologic strike and may, thus, be more susceptible to losses to underlying solution openings.

Stations 5 and 7 also have many similarities. They have flows and total drainage areas that are similar in size and smaller than those of the other stations. Both stations exhibit high flows per drainage area and stream length; this was especially apparent in the dry period of the year when these values were greater than those of all other stations. Fluctuations in flows were much lower at stations 5 and 7 than at the other stations. The data indicate that these two sections are fed by sources of dependable groundwater.

More data collections and analyses will be necessary before further characterization of the watersheds will be possible. The permanent stream flow recording equipment installed in September 1983 should produce higher quality data that are needed to verify the initial characterization of West Chestnut Ridge hydrology. The results of these studies are presented by Huff and Frederick (1984).

Based on the results presented here, it has been concluded that sites 2, 5, and 6 could be dropped from the set of locations where continuous flow measurements are taken. Site 2 appears to add little information to results from sites 1 and 3. Site 5 is similar to site 3 and thus can be dropped. Site 6 is also similar to site 4, so site 4 was selected for additional monitoring because of its proximity to site 3, which facilitates site construction and collection of continuous data. Site 7 will be retained because of the different character of flow at that location.

Once an annual cycle of continuous data has been completed, a decision should be made concerning sites to be maintained on a long-term basis. Because of the earlier finding that site 1 has the highest water yield of all the sites, it was selected as a permanent monitoring site, and a permanent flume has been installed at that location.

REFERENCES

Ackerman, W. C. 1949. Possible Floods on White Oak Creek - Oak Ridge Project. ORNL-CF-49-7-205. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Edgar, D. E. 1978. An Analysis of Infrequent Hydrologic Events with Regard to Existing Streamflow Monitoring Capabilities in White Oak Creek Watershed. ORNL/TM-6542. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Huff, D. D., Elmore, J. L., and Farmer, D. C. 1984. Hydrologic Study and Evaluation of Ish Creek Watershed (West Chestnut Ridge Proposed Disposal Site). ORNL/TM-8960. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Huff, D. D., and Frederick, B. J. 1984. Hydrologic Investigations in the Vicinity of the Proposed Central Waste Disposal Facility, Oak Ridge National Laboratory, Tennessee. ORNL/TM-9354. Oak Ridge National Laboratory.

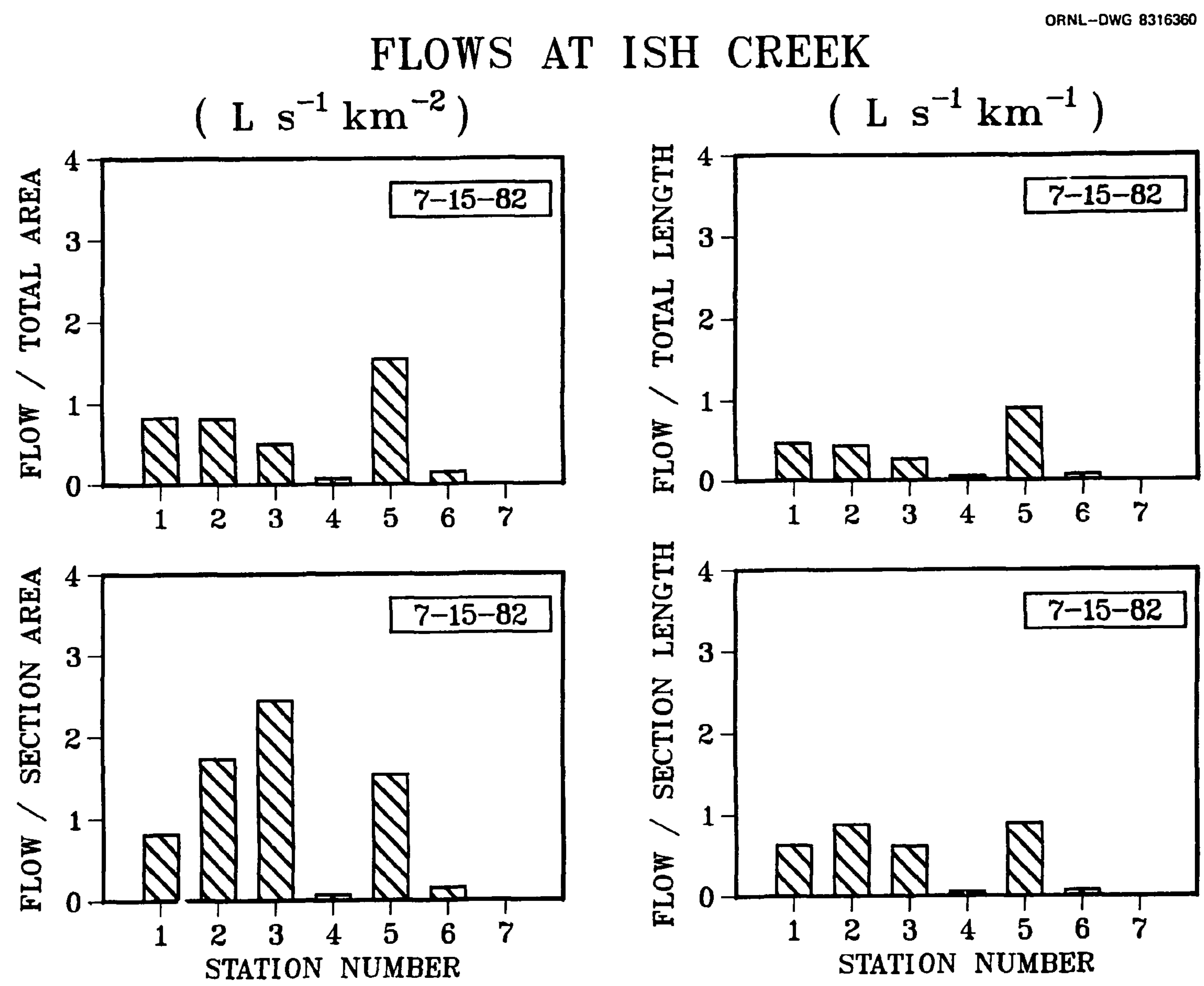
McMaster, W. M. 1967. Hydrologic Data for the Oak Ridge Area. Tennessee Geological Survey Water-Supply Paper 1839-N, Government Printing Office, Washington, D.C.

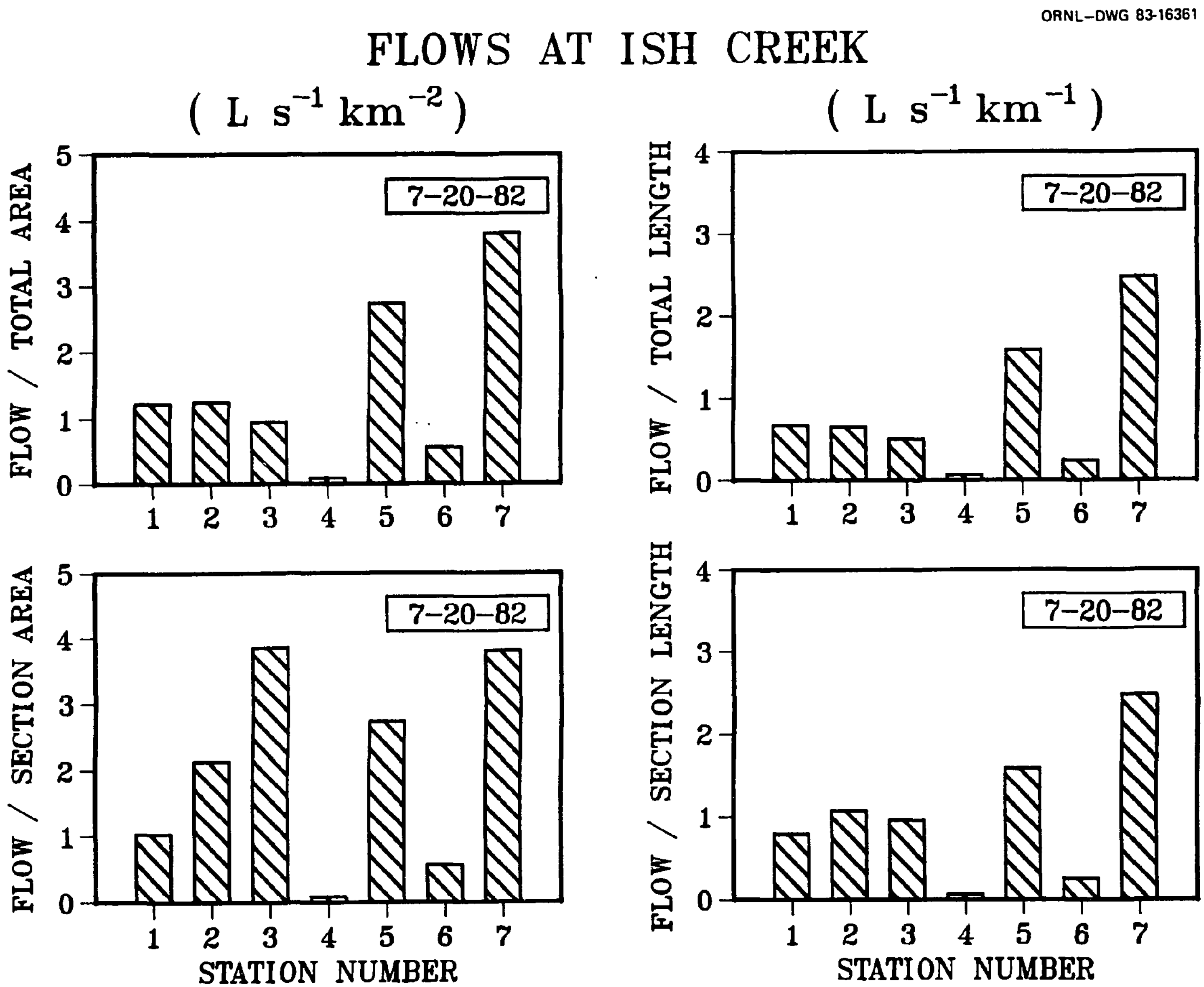
Sheppard, J. D. 1974. Storm Runoff in the Vicinity of Oak Ridge, Tennessee. ORNL/TM-4662. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

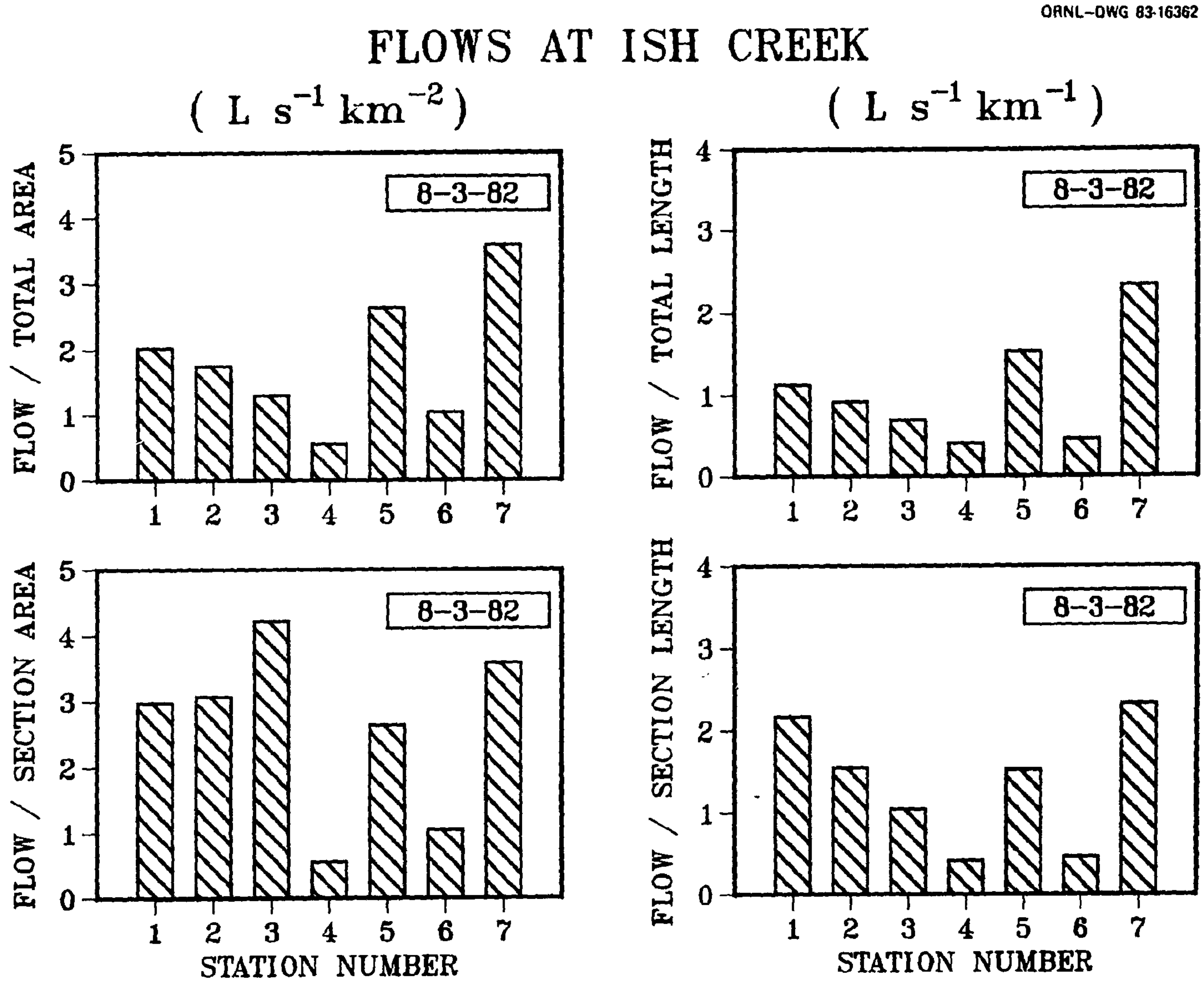
Vennard, J. K. 1962. Elementary Fluid Mechanics, 4th ed., John Wiley and Son, Inc., New York.

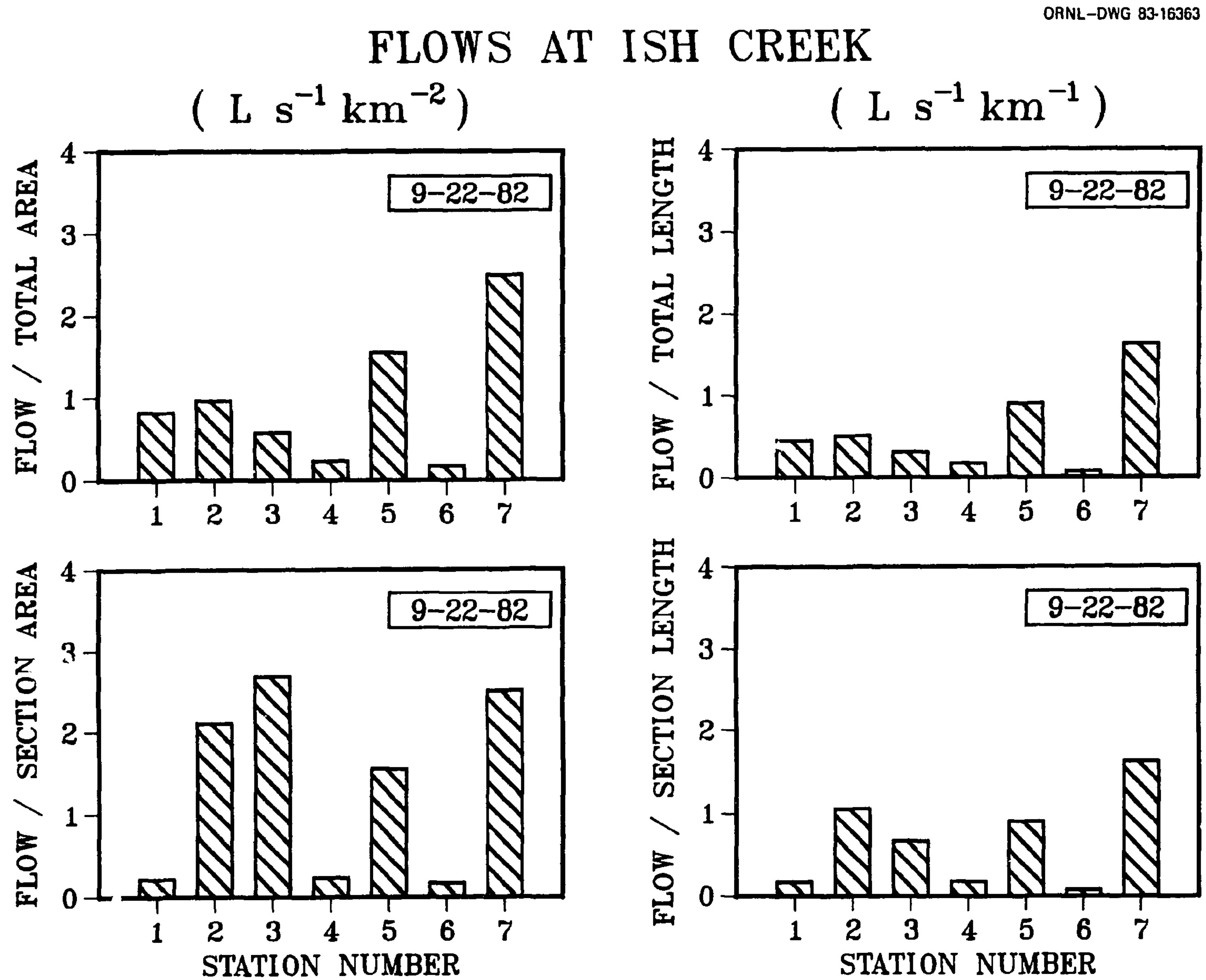
APPENDIX A

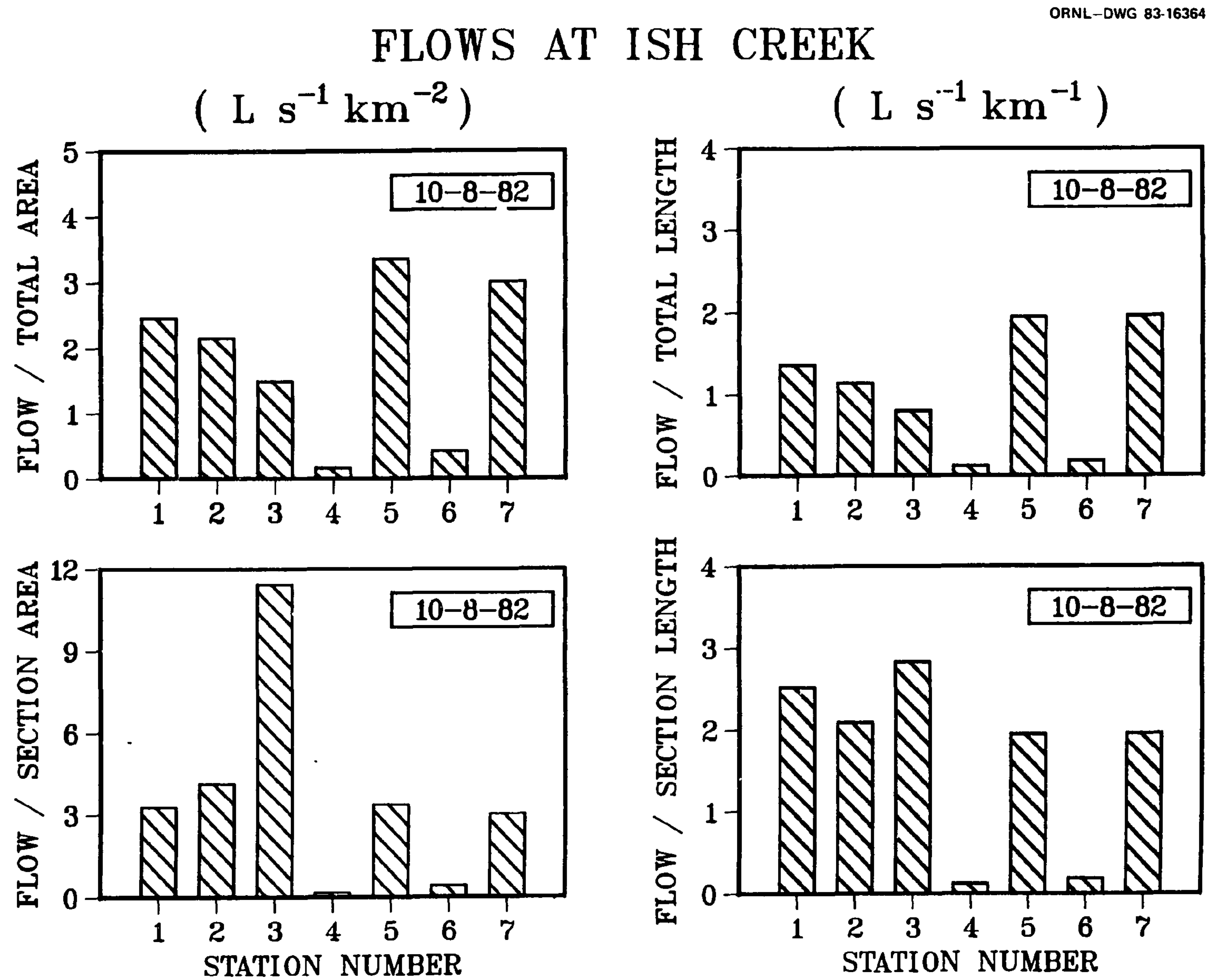
FLOW PATTERNS AT ISH CREEK MONITORING SITES BY DATE SHOWN

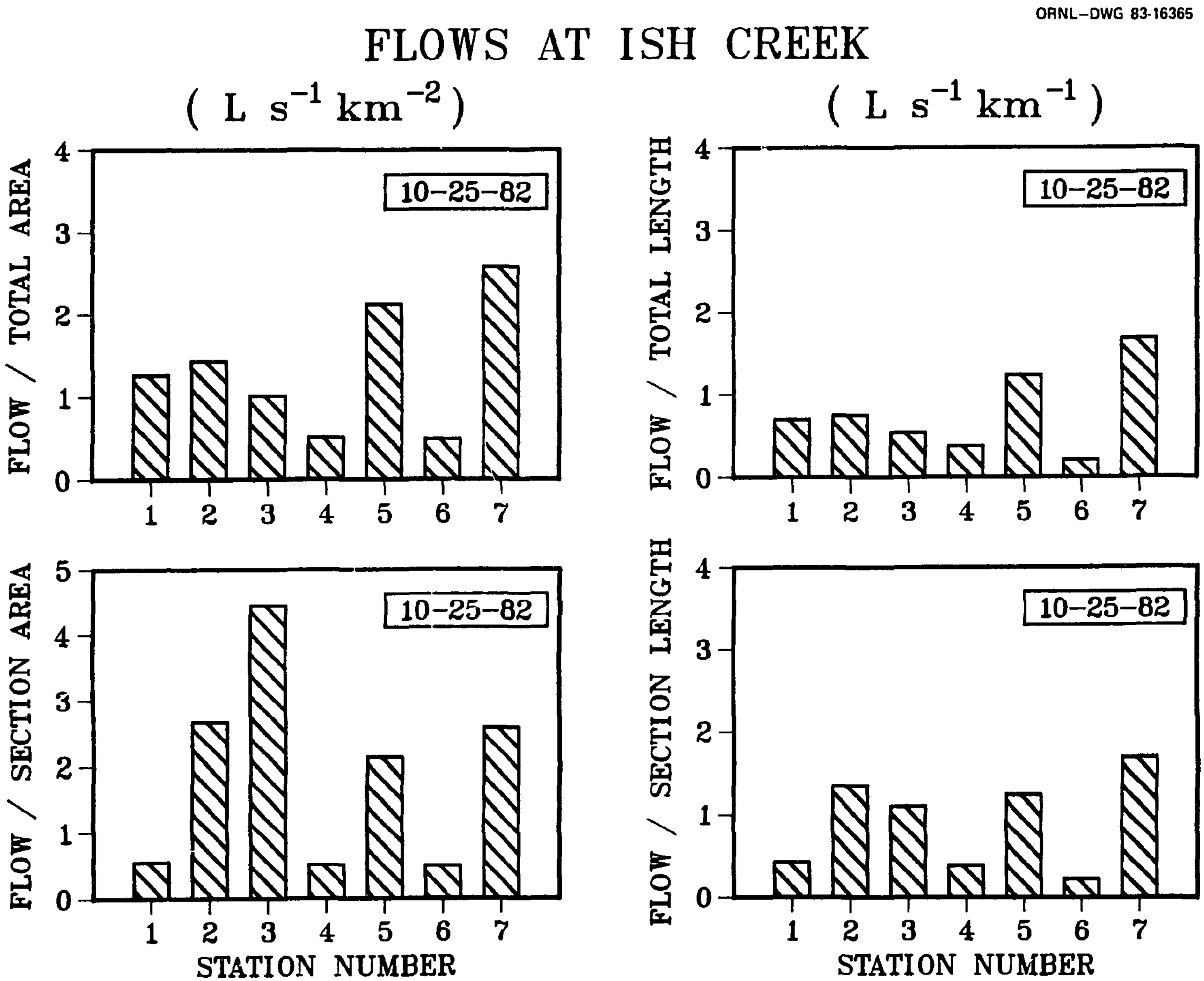

ORNL-DWG 8316360
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
7-15-82
STATION NUMBER
0
1
2
3
4
5
6
7

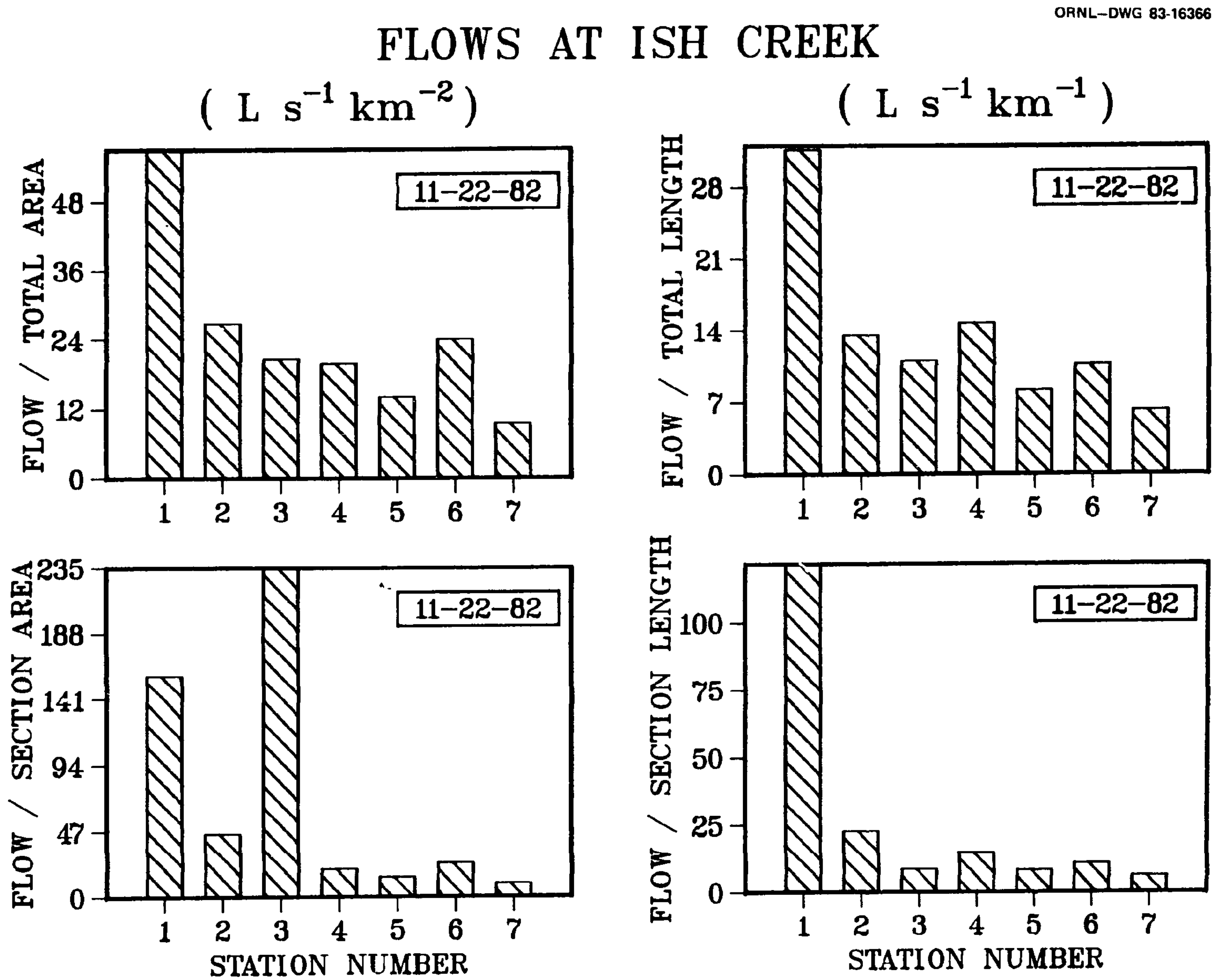

ORNL-DWG 83-16361
FLOWS AT ISH CREEK
(L s^-1 km^-2)
(L s^-1 km^-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
7-20-82
7-20-82
7-20-82
7-20-82
0 1 2 3 4 5
0 1 2 3 4
1 2 3 4 5 6 7
STATION NUMBER
STATION NUMBER


ORNL-DWG 83-16362
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
8-3-82
STATION NUMBER

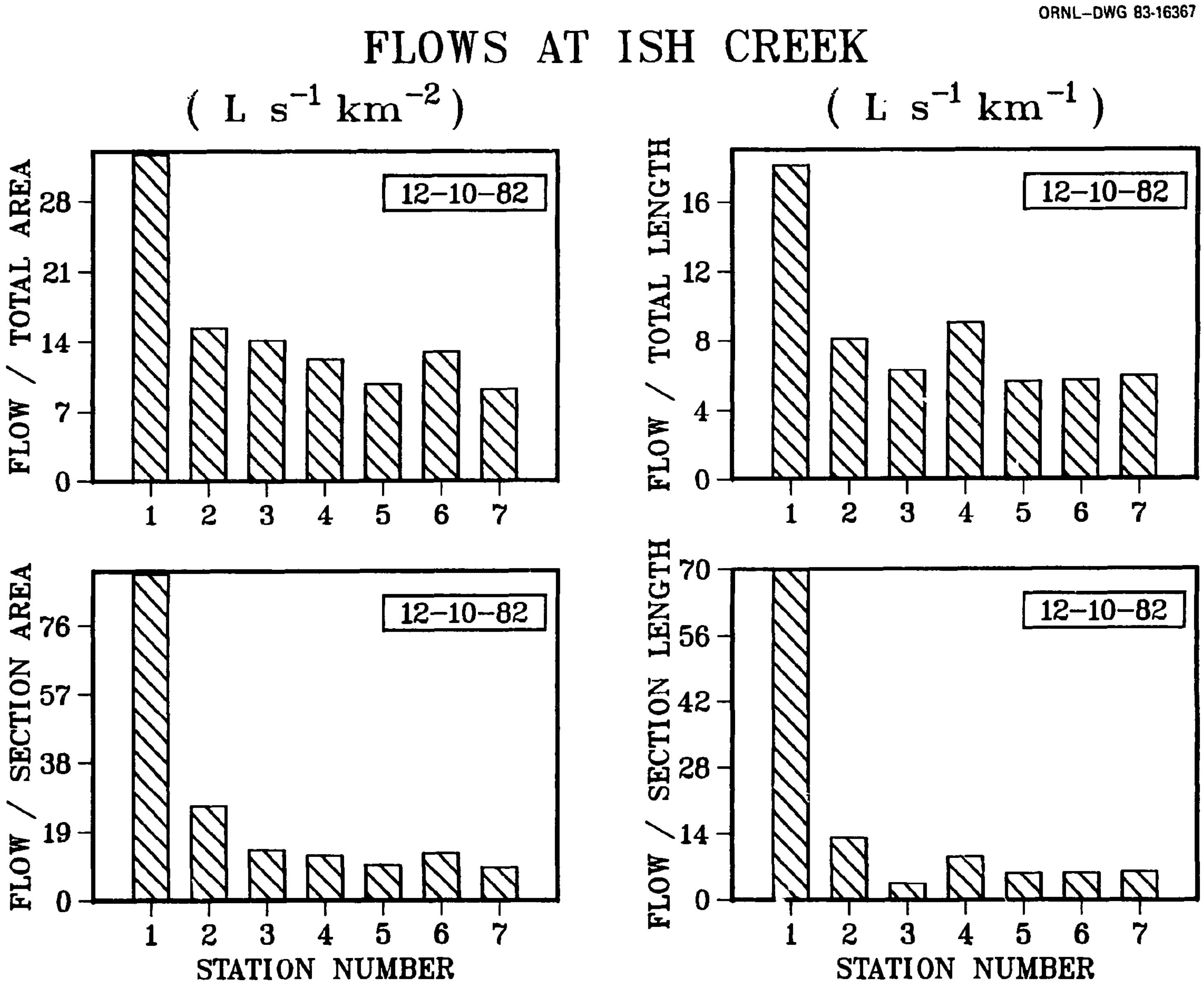

ORNL-DWG 83-16363
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
9-22-82
0
1
2
3
4
1 2 3 4 5 6 7
STATION NUMBER

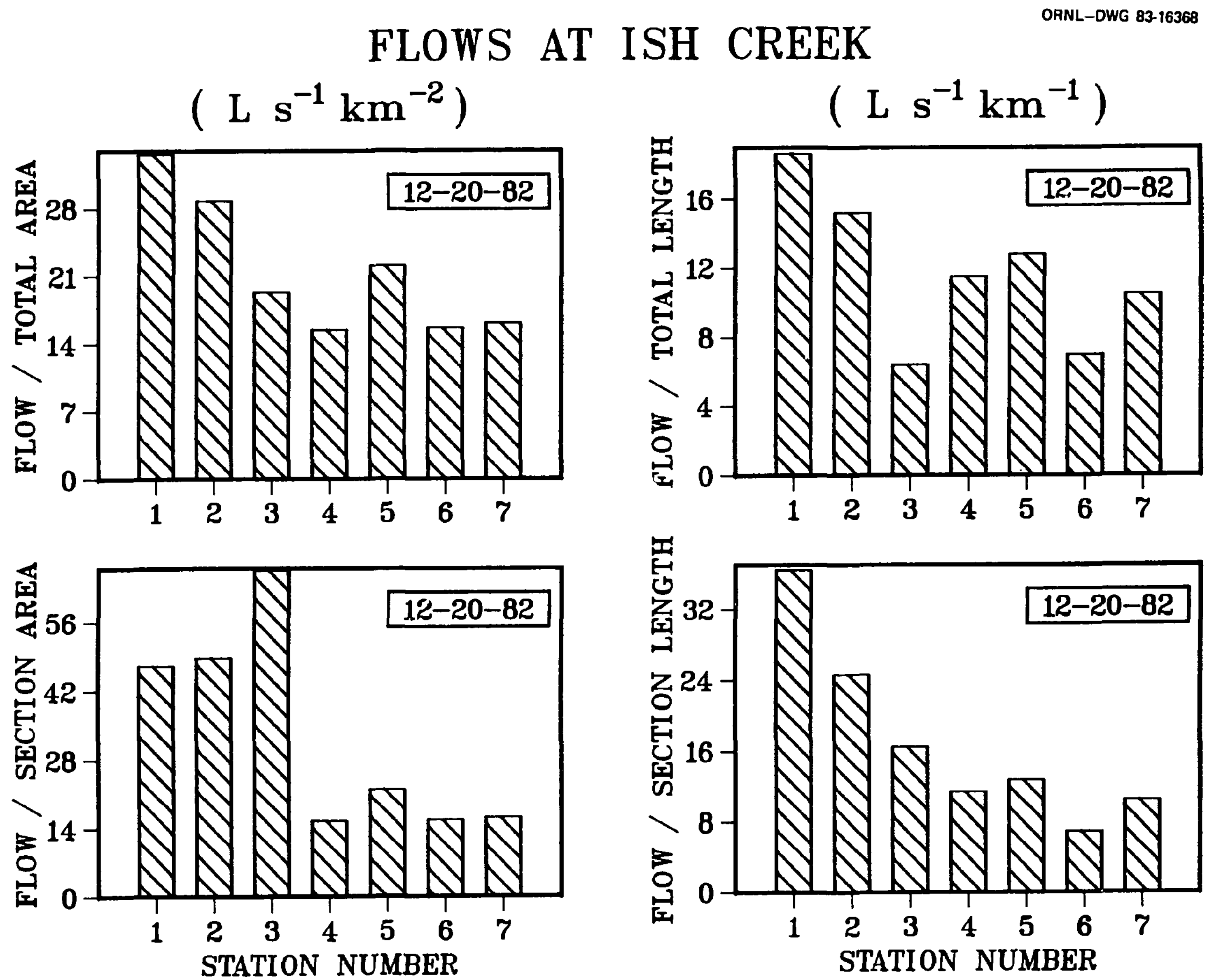

ORNL–DWG 83-16364
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
10-8-82
STATION NUMBER

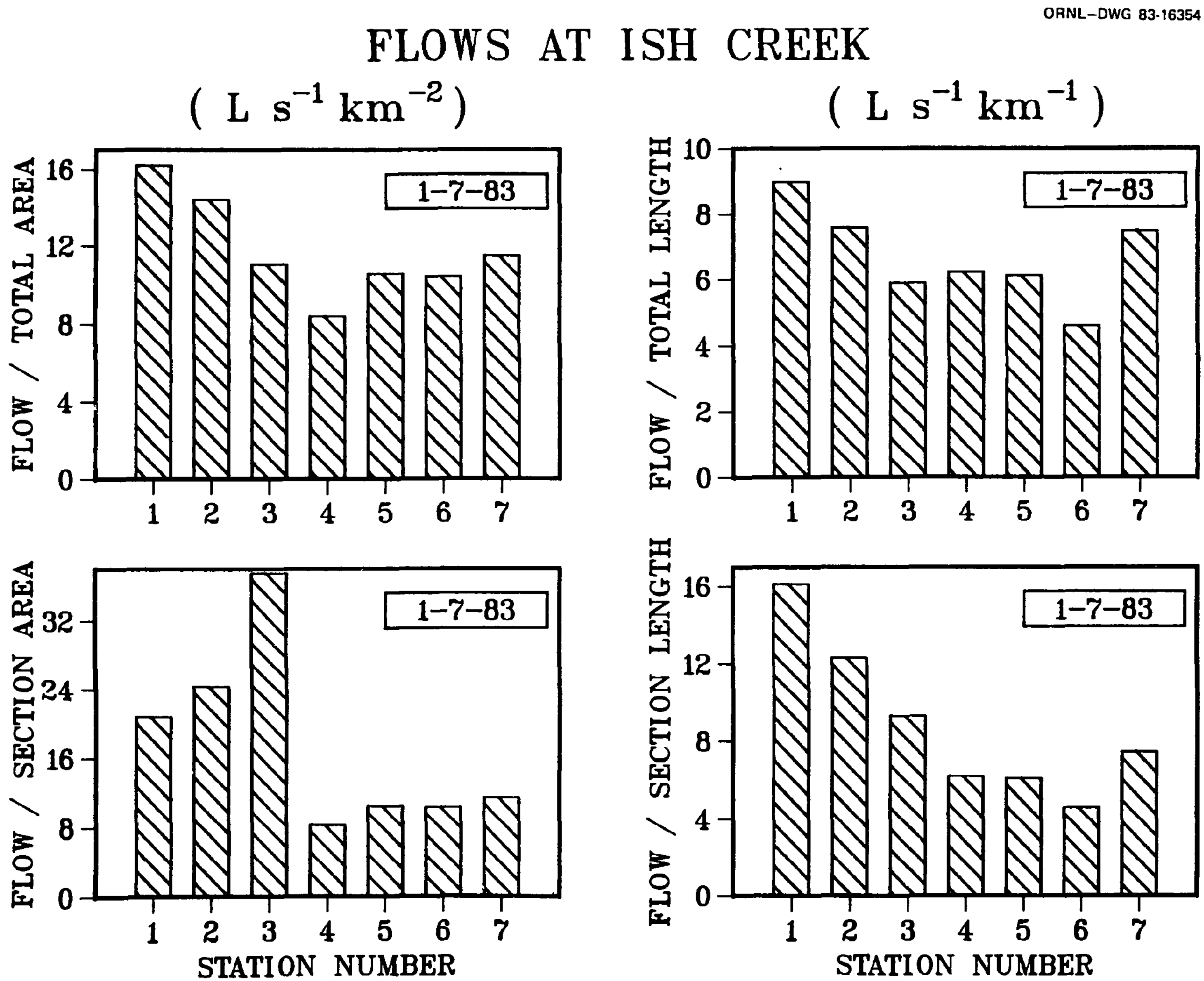

ORNL–DWG 83-16365
FLOWS AT ISH CREEK
(L s⁻¹ km⁻²)
(L s⁻¹ km⁻¹)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
10–25–82
10–25–82
10–25–82
10–25–82
STATION NUMBER
STATION NUMBER

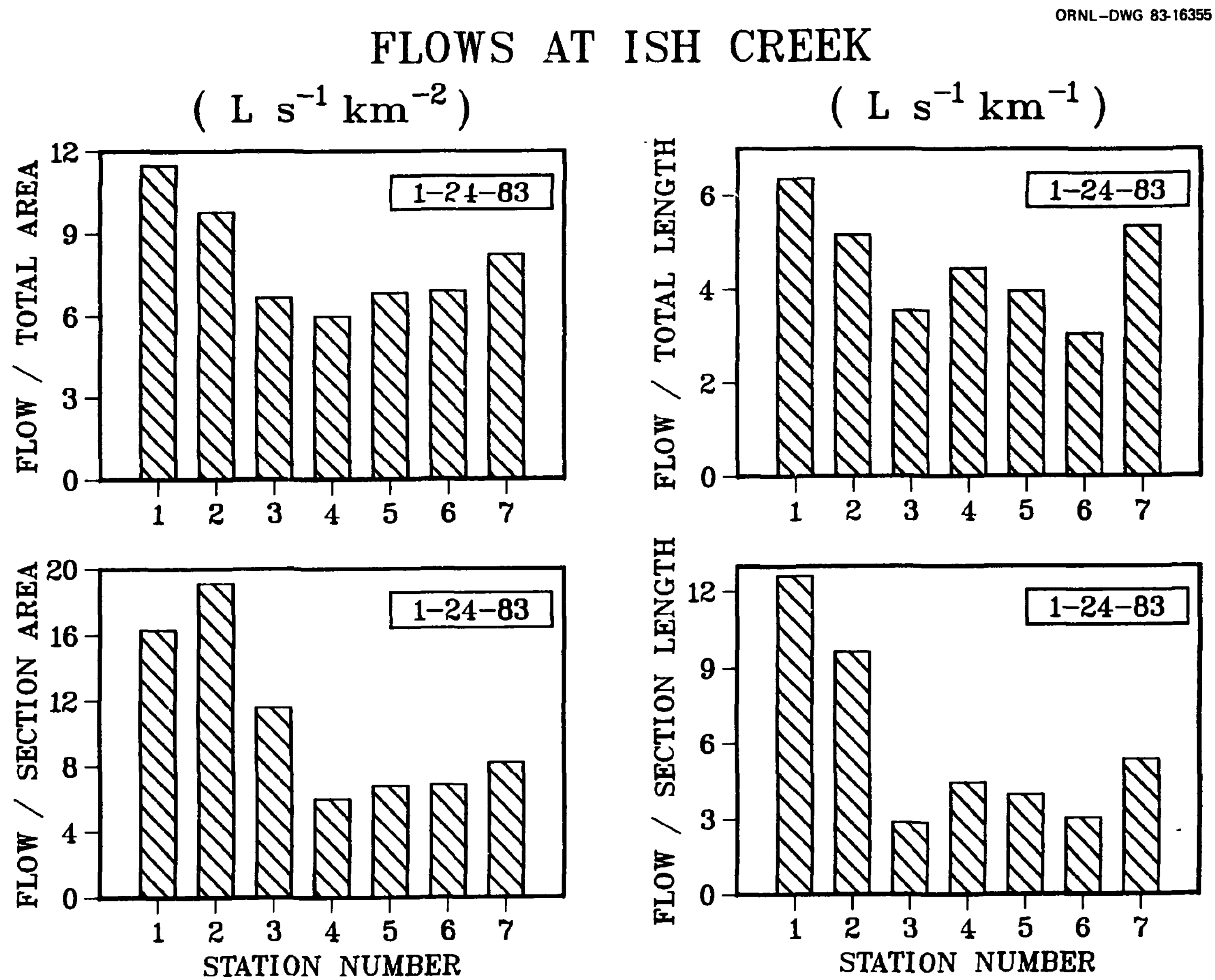


ORNL–DWG 83-16366
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
0
12
24
36
48
0
7
14
21
28
0
47
94
141
188
235
0
25
50
75
100
11–22–82
1 2 3 4 5 6 7
STATION NUMBER

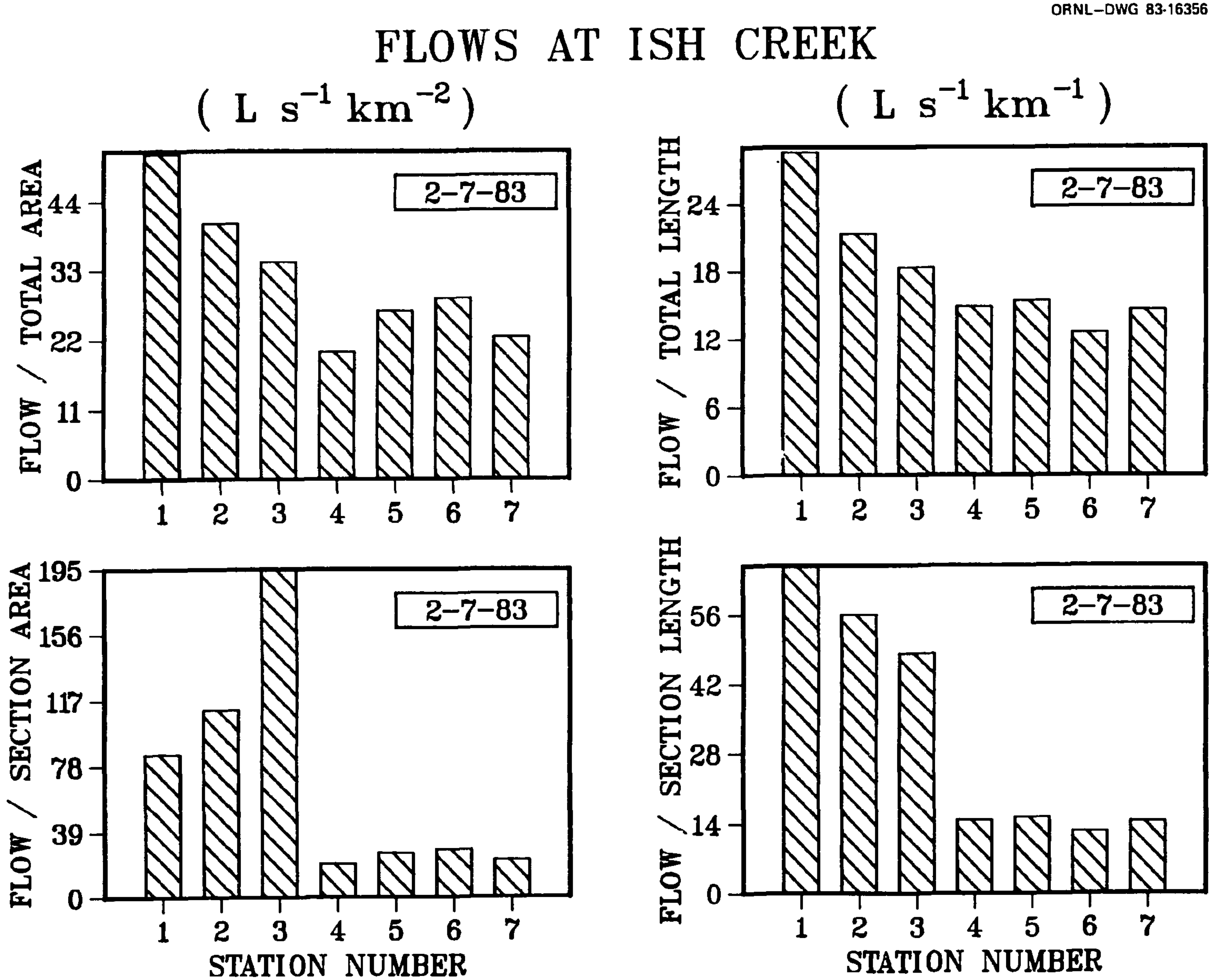

ORNL–DWG 83-16367
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLOW / TOTAL AREA
0
7
14
21
28
12–10–82
FLOW / TOTAL LENGTH
0
4
8
12
16
12–10–82
FLOW / SECTION AREA
0
19
38
57
76
12–10–82
FLOW / SECTION LENGTH
0
14
28
42
56
70
12–10–82
1
2
3
4
5
6
7
STATION NUMBER
STATION NUMBER

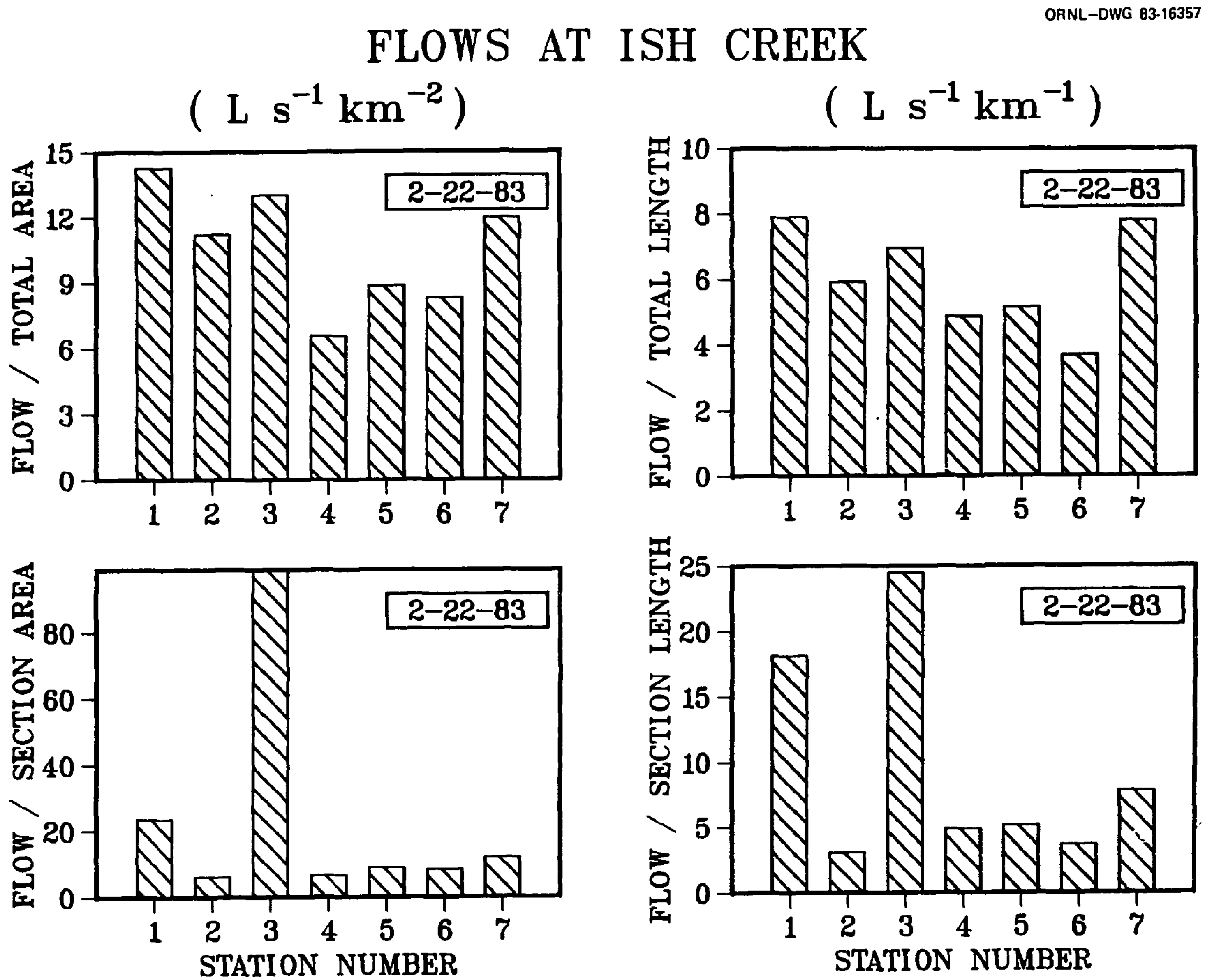

ORNL–DWG 83-16368
FLOWS AT ISH CREEK
(L s−1 km−2)
(L s−1 km−1)
FLOW / TOTAL AREA
0
7
14
21
28
FLOW / TOTAL LENGTH
0
4
8
12
16
FLOW / SECTION AREA
0
14
28
42
56
FLOW / SECTION LENGTH
0
8
16
24
32
12–20–82
1 2 3 4 5 6 7
STATION NUMBER

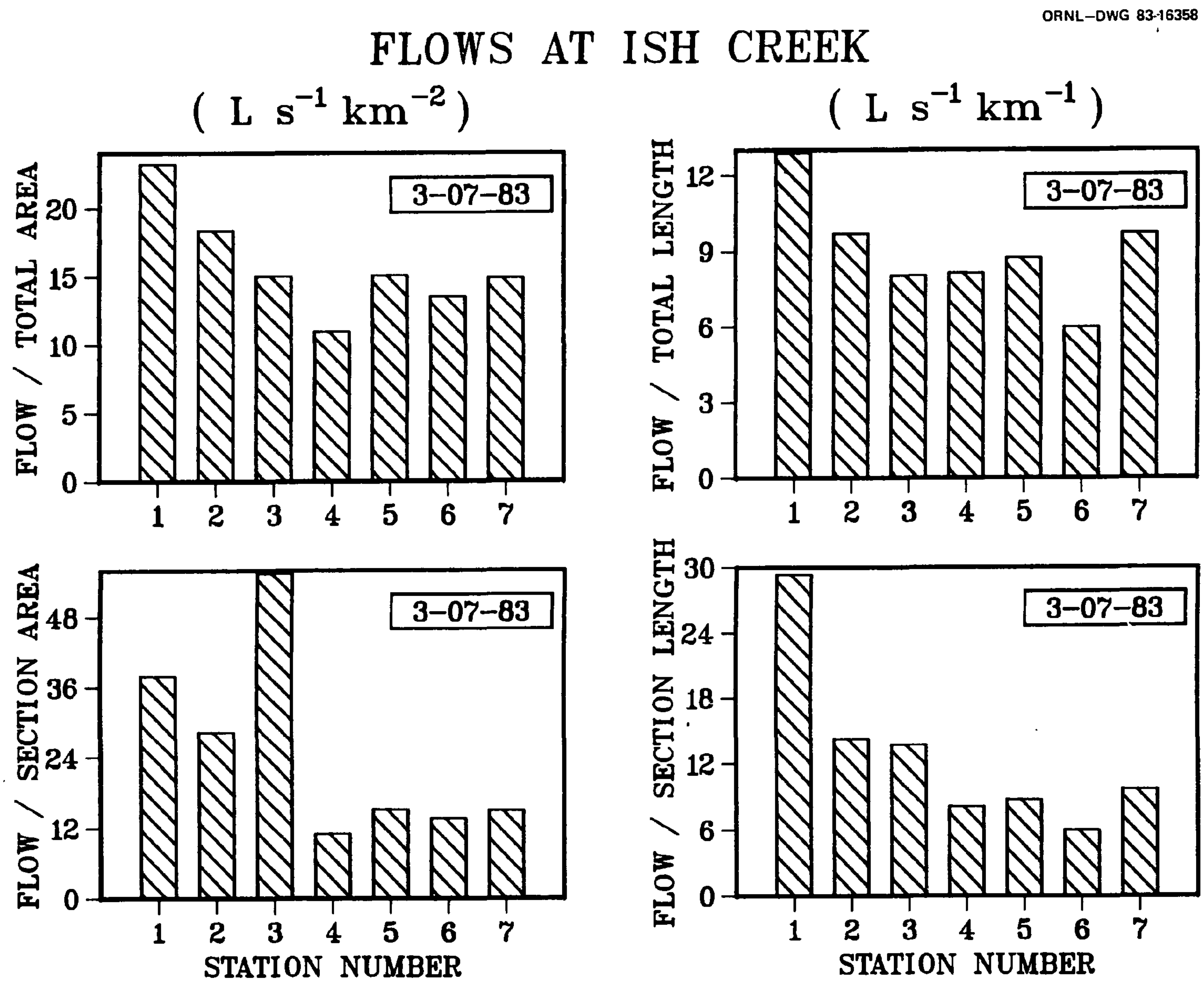

ORNL-DWG 83-16354
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
1-7-83
1-7-83
1-7-83
1-7-83
0
4
8
12
16
0
2
4
6
8
10
0
8
16
24
32
0
4
8
12
16
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
STATION NUMBER
STATION NUMBER

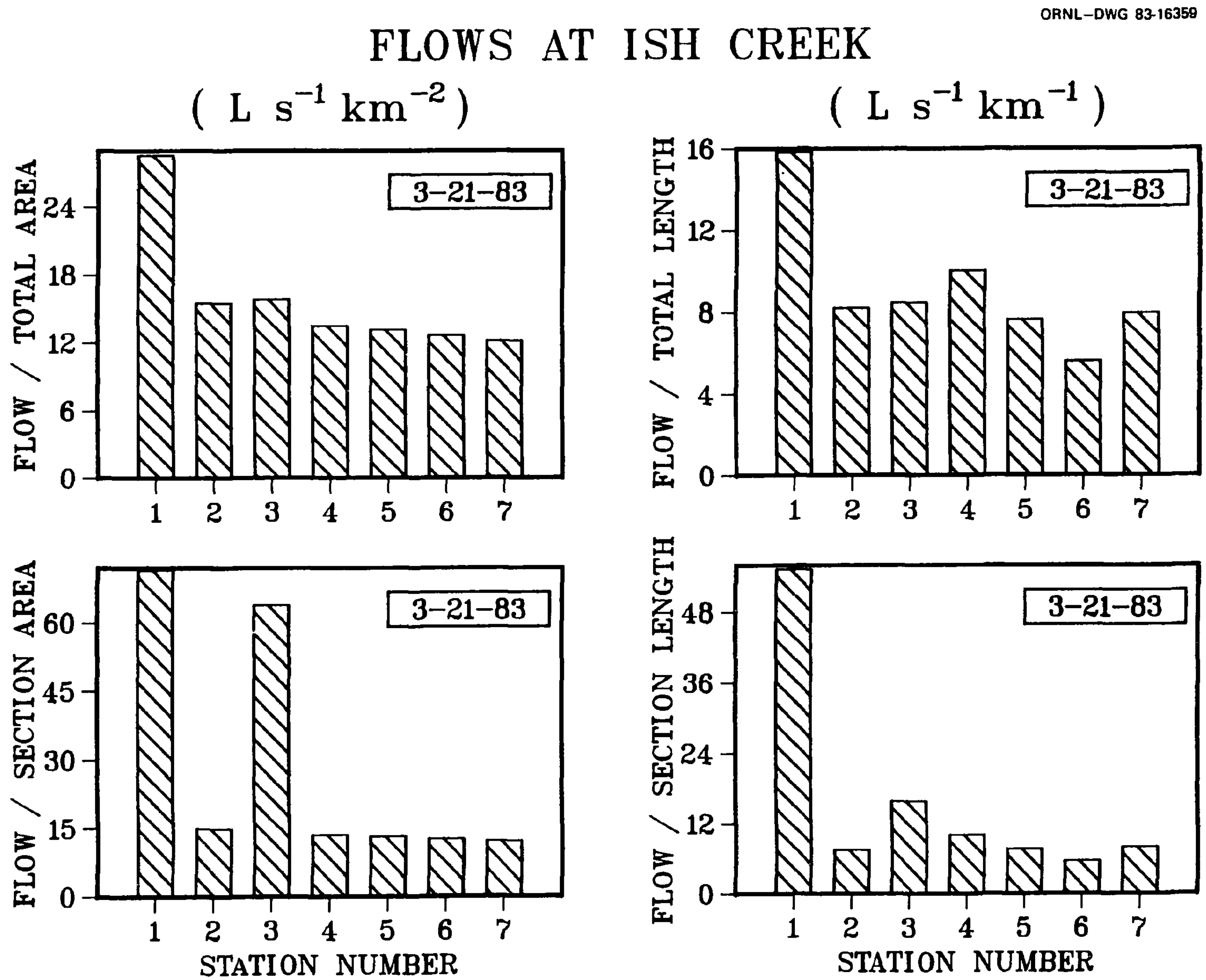

ORNL-DWG 83-16355
FLOWS AT ISH CREEK
(L s^-1 km^-2)
(L s^-1 km^-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
1-24-83
STATION NUMBER

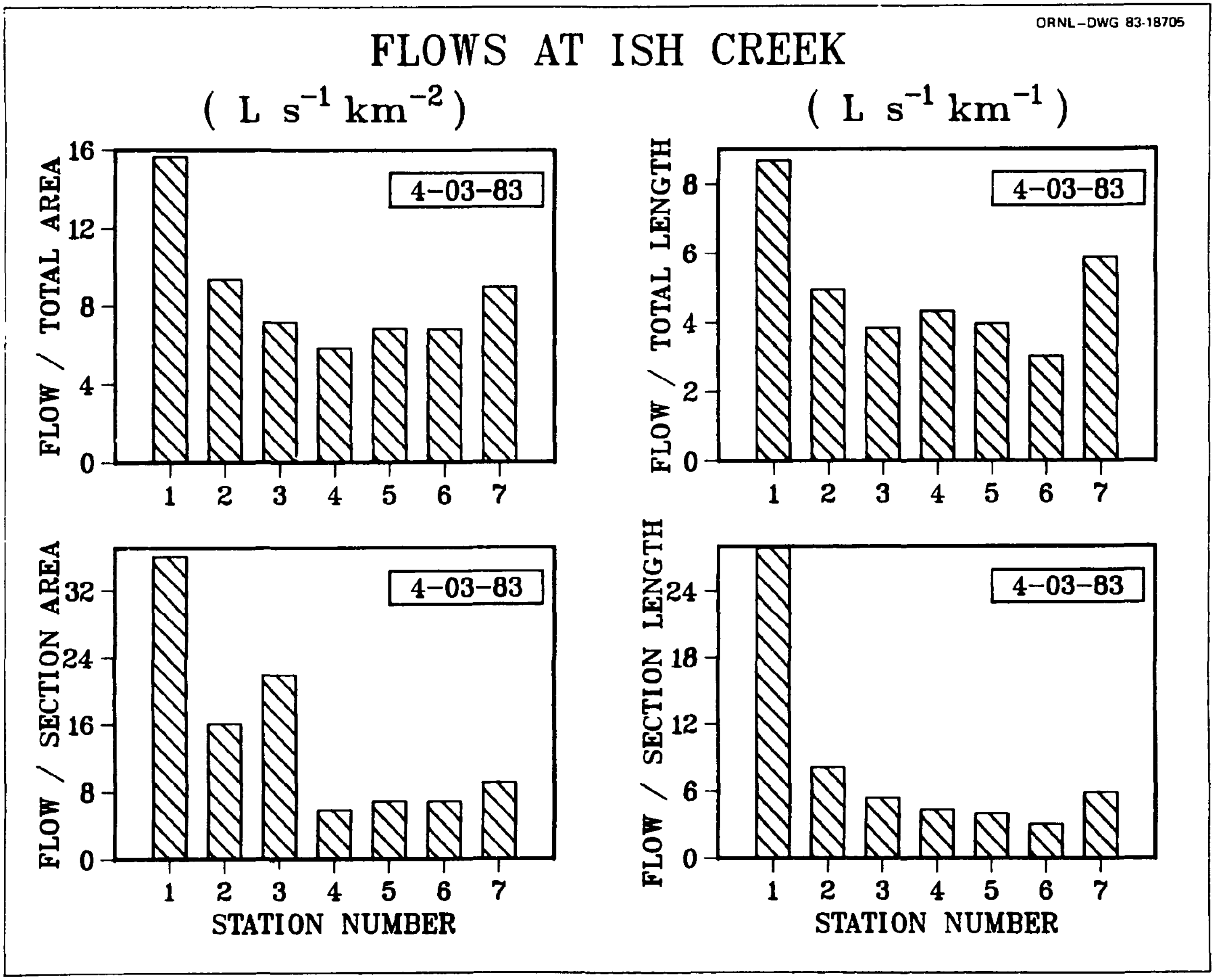
ORNL–DWG 83-16356

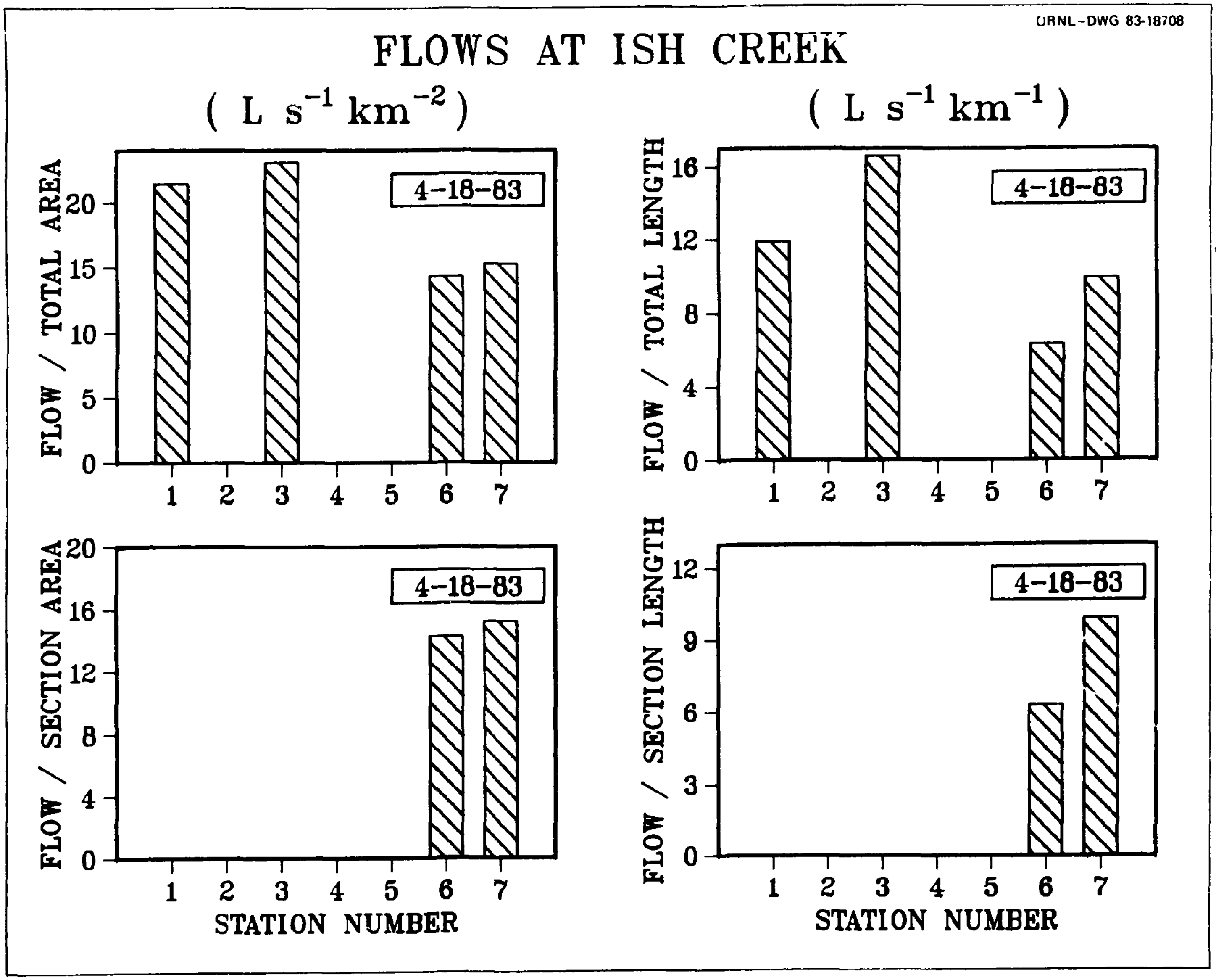


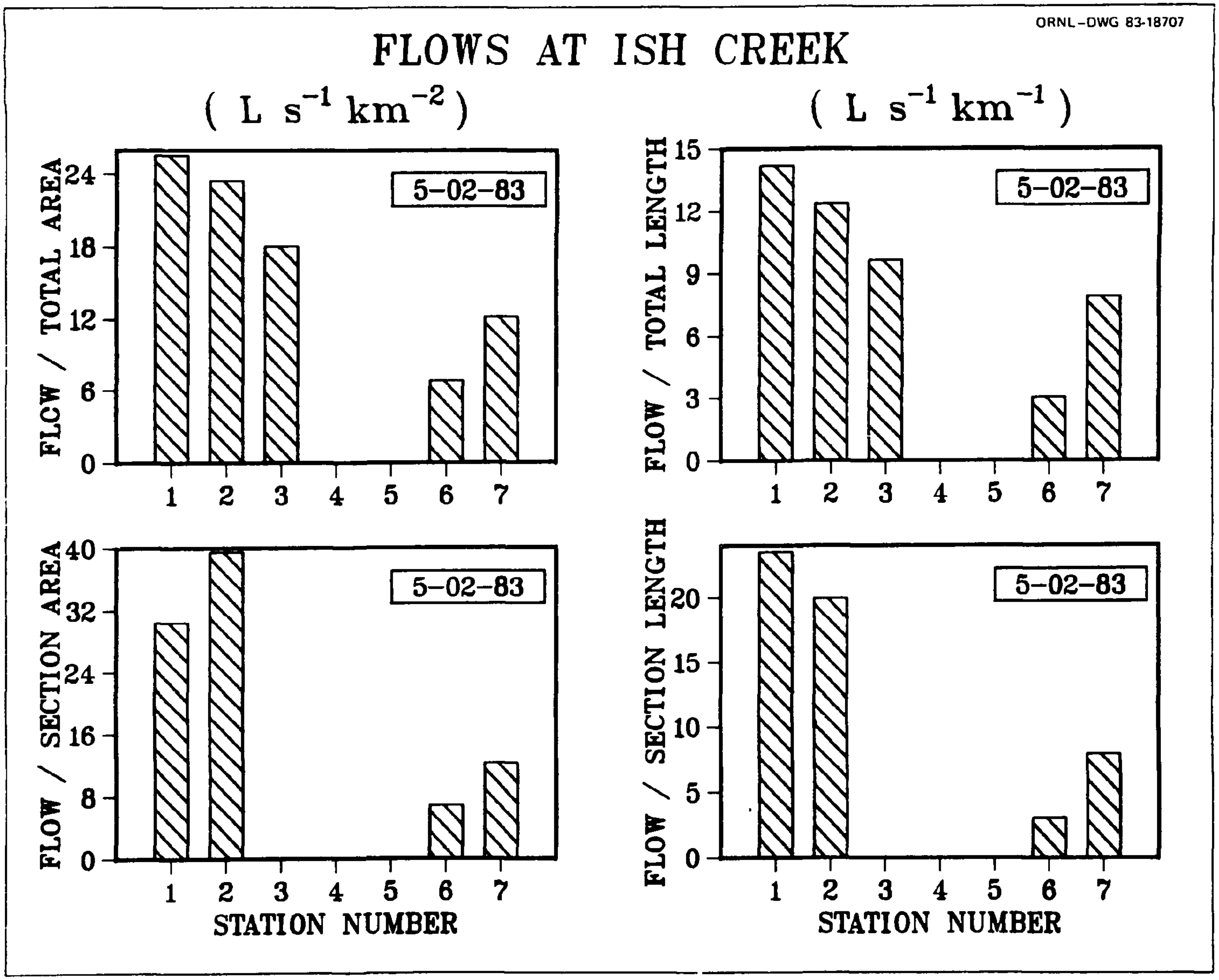

ORNL–DWG 83-16357
FLOWS AT ISH CREEK
(L s⁻¹ km⁻²)
(L s⁻¹ km⁻¹)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
2–22–83
2–22–83
2–22–83
2–22–83
STATION NUMBER
STATION NUMBER
0
3
6
9
12
15
0
2
4
6
8
10
0
20
40
60
80
0
5
10
15
20
25
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7

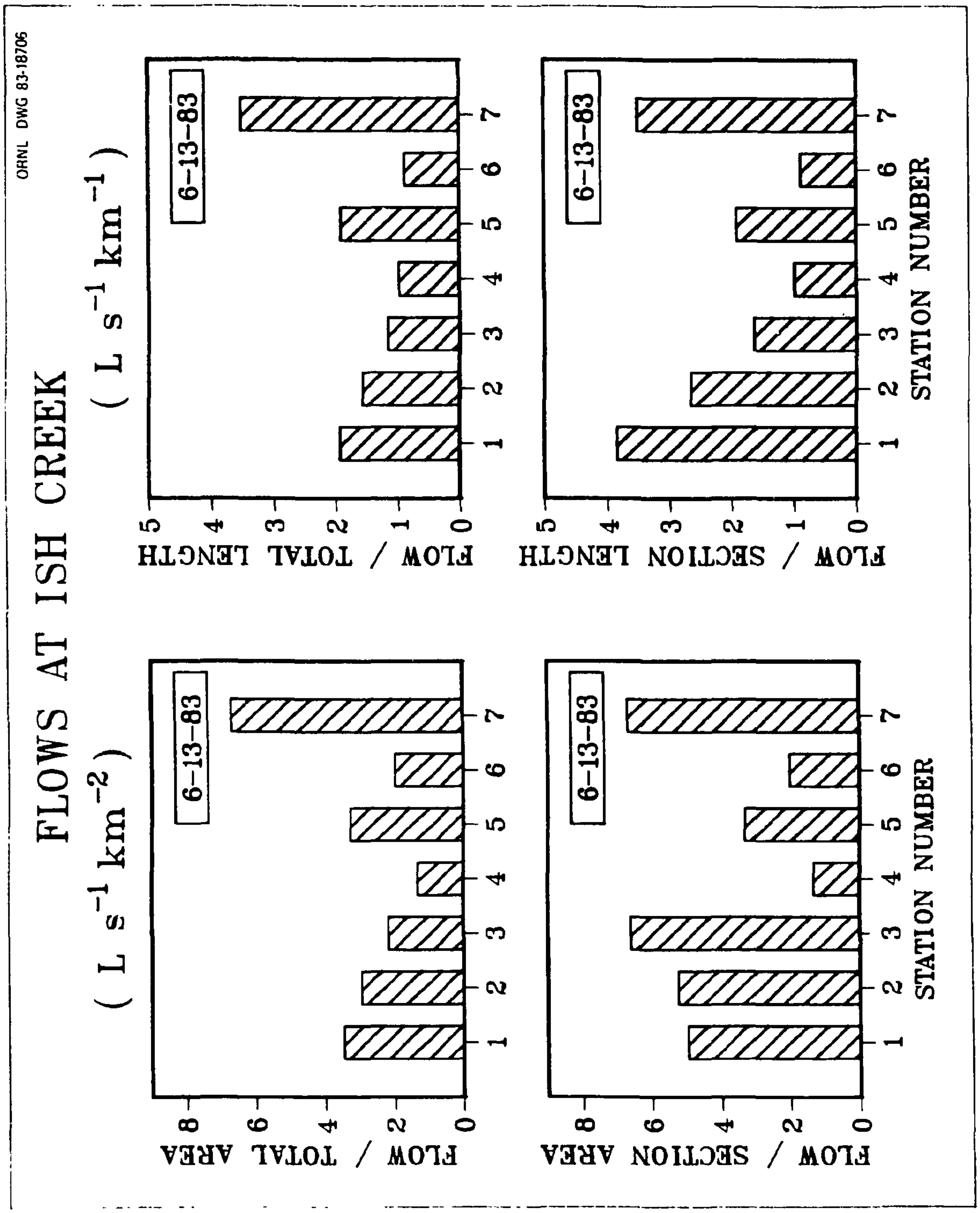

ORNL–DWG 83-16358
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
3–07–83
STATION NUMBER
0
5
10
15
20
3
6
9
12
24
36
48
18
30
1
2
4
7

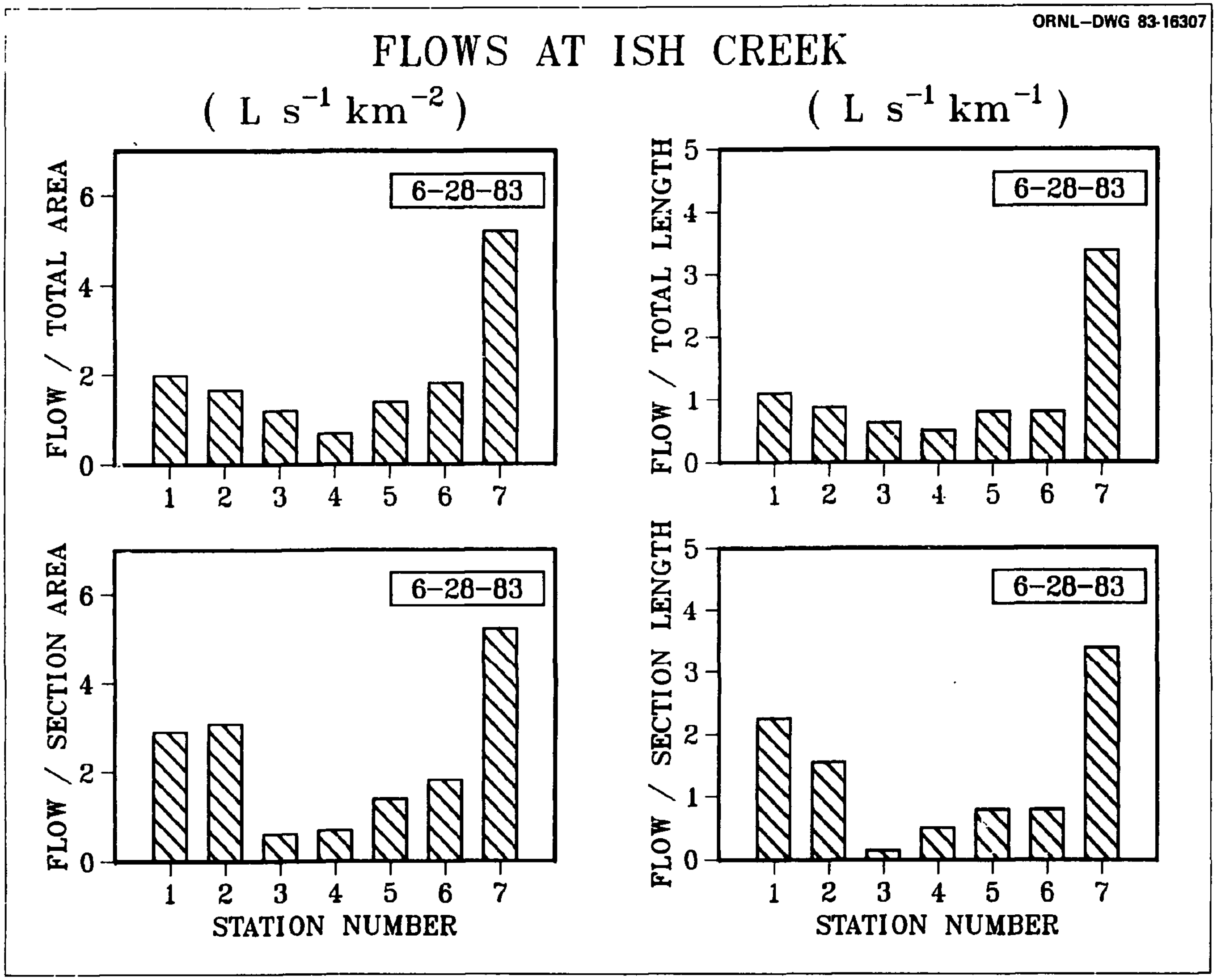

ORNL–DWG 83-16359
FLOWS AT ISH CREEK
(L s⁻¹ km⁻²)
(L s⁻¹ km⁻¹)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
3–21–83
STATION NUMBER
0
6
12
18
24
4
8
16
15
30
45
60
36
48
1
2
3
4
5
6
7

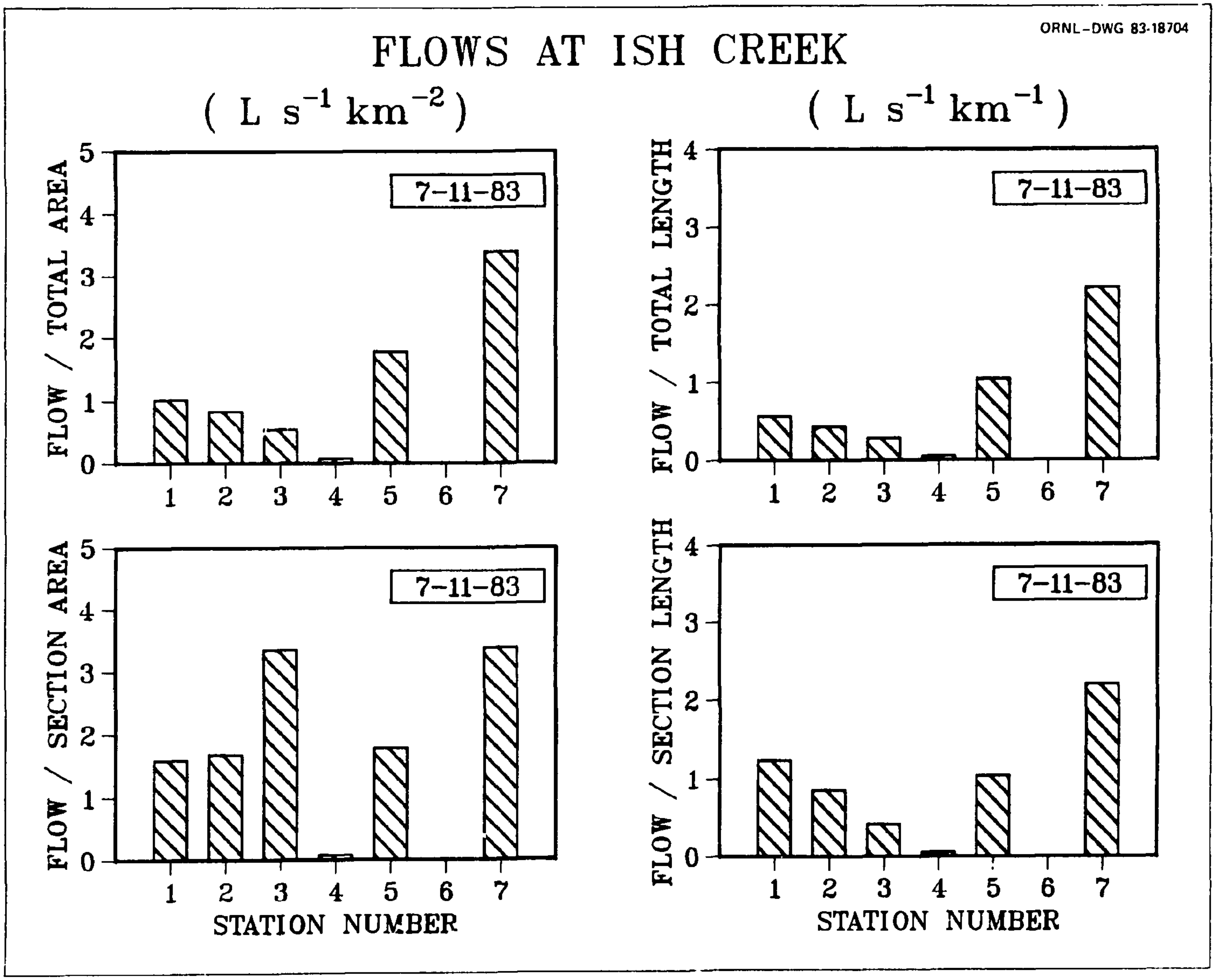

ORNL-DWG 83-18705
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
4-03-83
STATION NUMBER
0
4
8
12
16
2
6
18
24
32
1
3
5
7

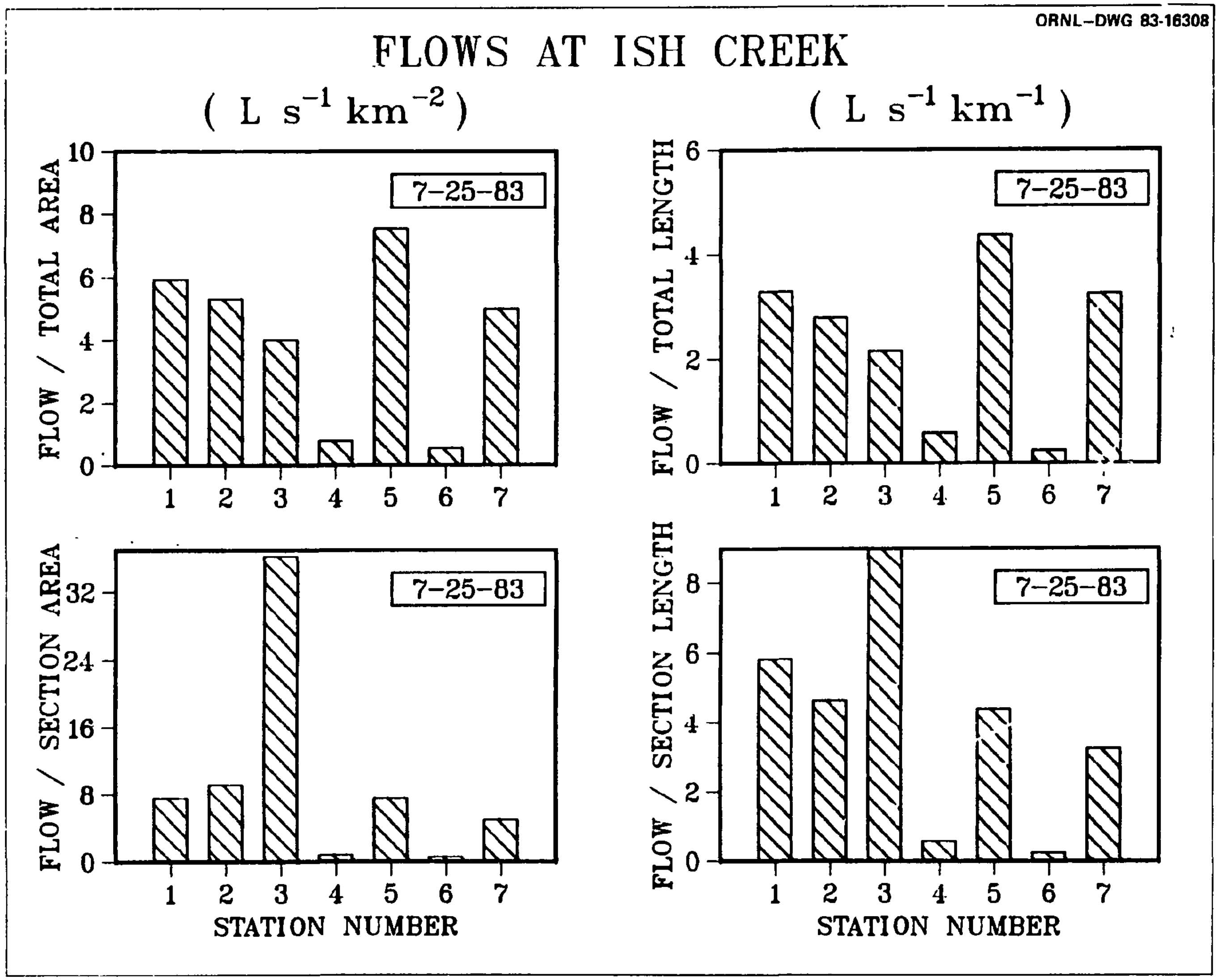

ORNL-DWG 83-18708
FLOWS AT ISH CREEK
(L s^-1 km^-2)
(L s^-1 km^-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
4-18-83
4-18-83
4-18-83
4-18-83
0 5 10 15 20
0 4 8 12 16
0 4 8 12 16 20
0 3 6 9 12
1 2 3 4 5 6 7
STATION NUMBER
STATION NUMBER

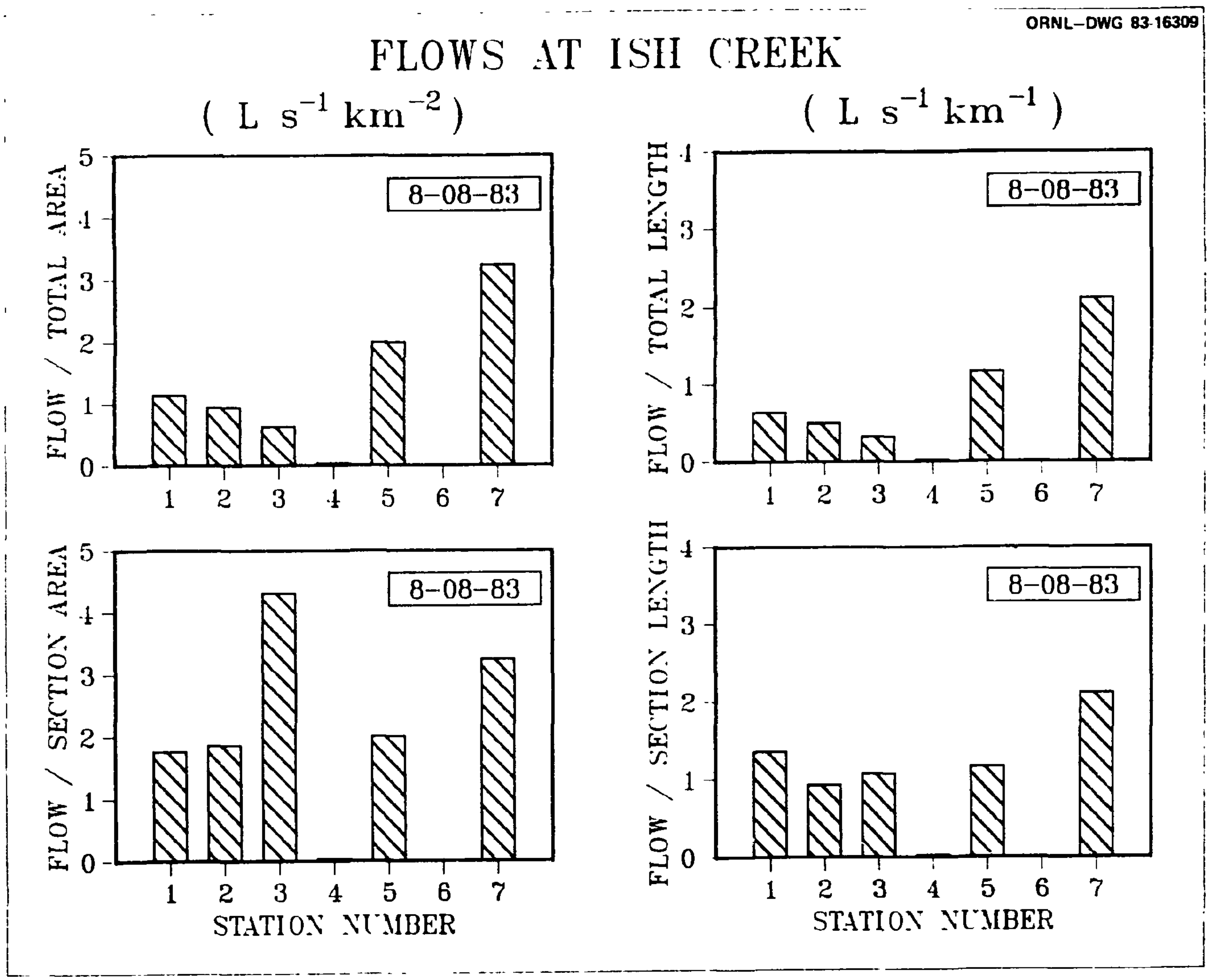

ORNL-DWG 83-18707
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLCW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
5-02-83
5-02-83
5-02-83
5-02-83
0
6
12
18
24
0
3
6
9
12
15
0
8
16
24
32
40
0
5
10
15
20
1 2 3 4 5 6 7
STATION NUMBER
STATION NUMBER

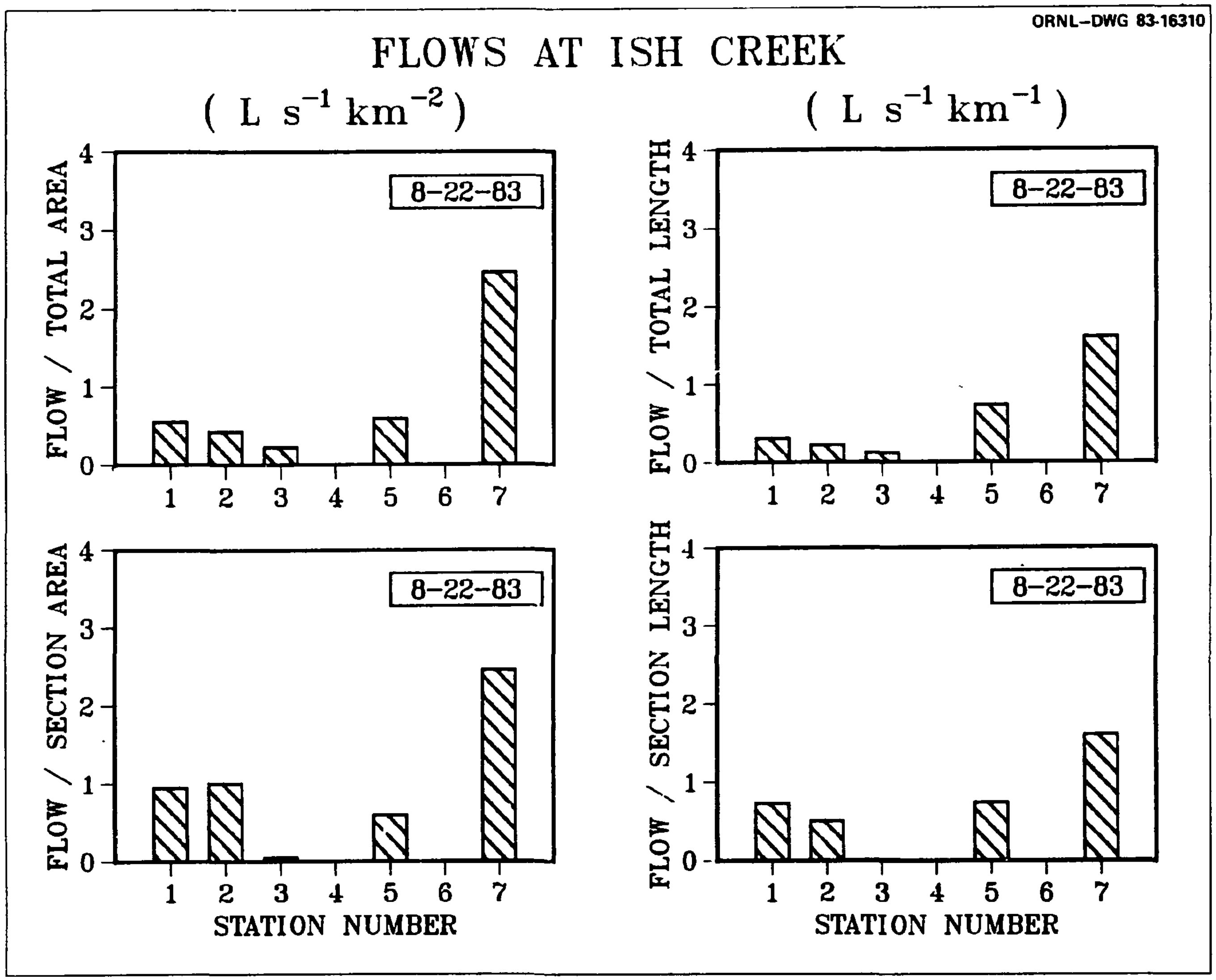

FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
ORNL DWG 83-18706
FLOW / TOTAL AREA
FLOW / SECTION AREA
FLOW / TOTAL LENGTH
FLOW / SECTION LENGTH
STATION NUMBER
6-13-83

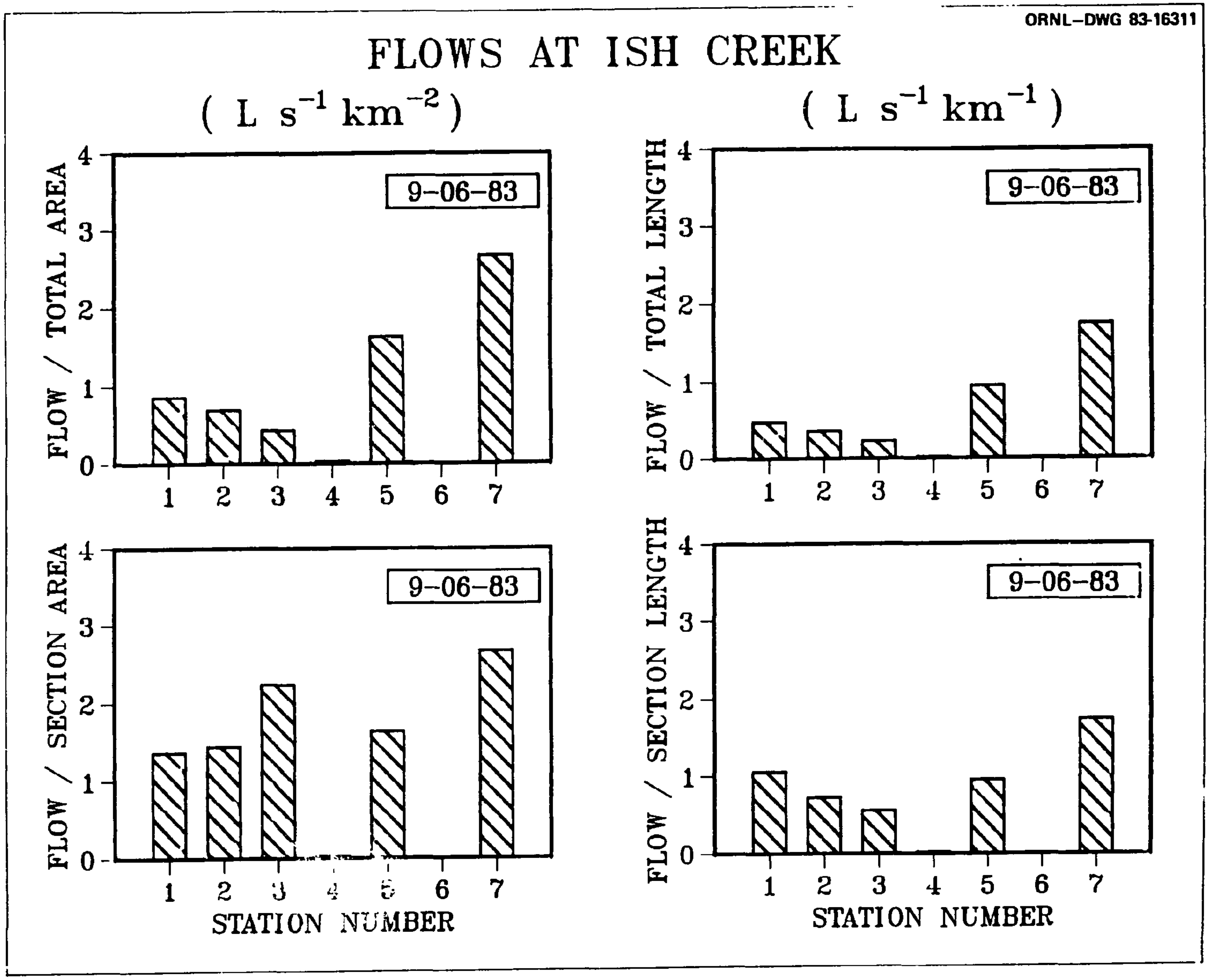

ORNL-DWG 83-16307
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
6-28-83
STATION NUMBER

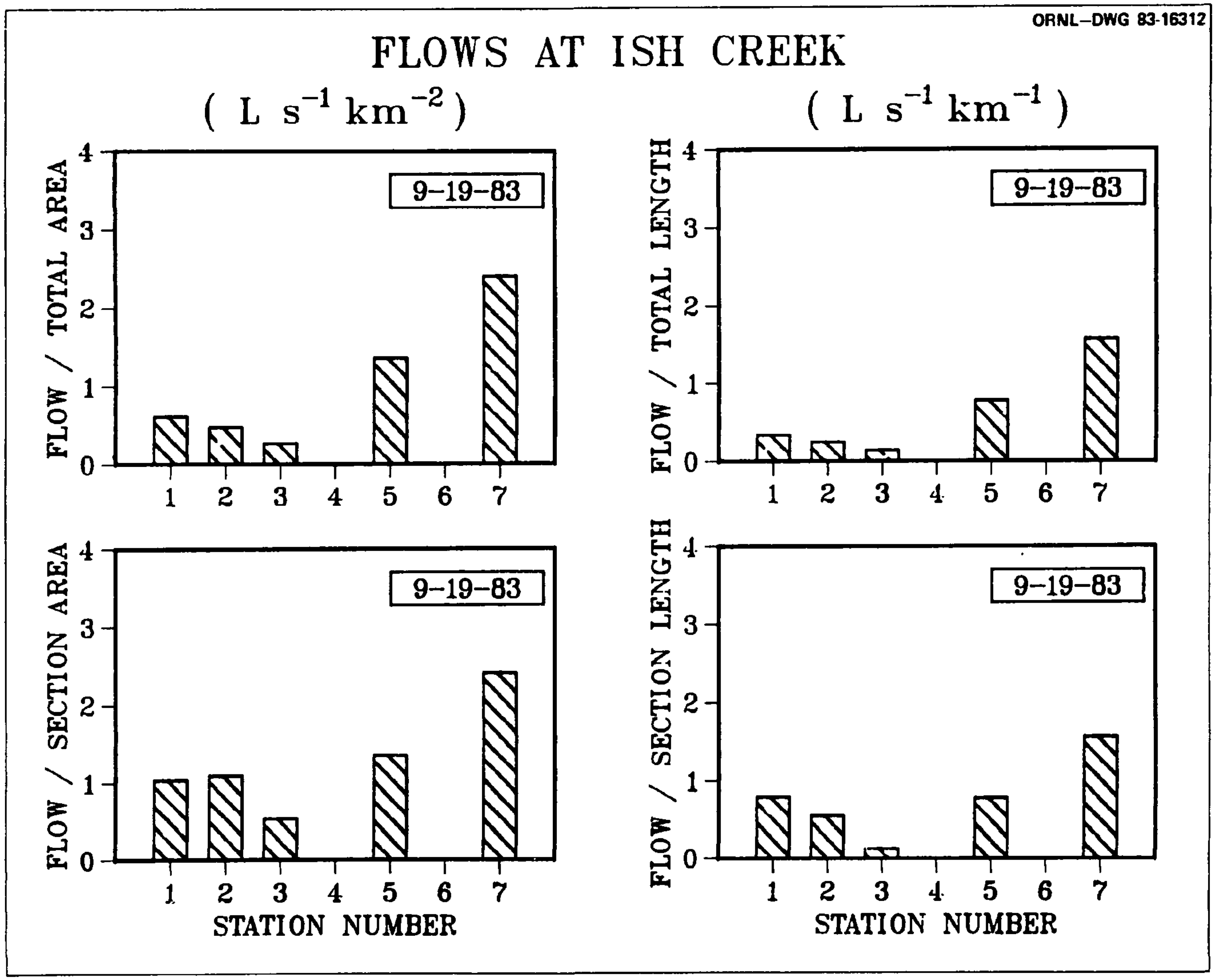

ORNL-DWG 83-18704
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
7-11-83
STATION NUMBER

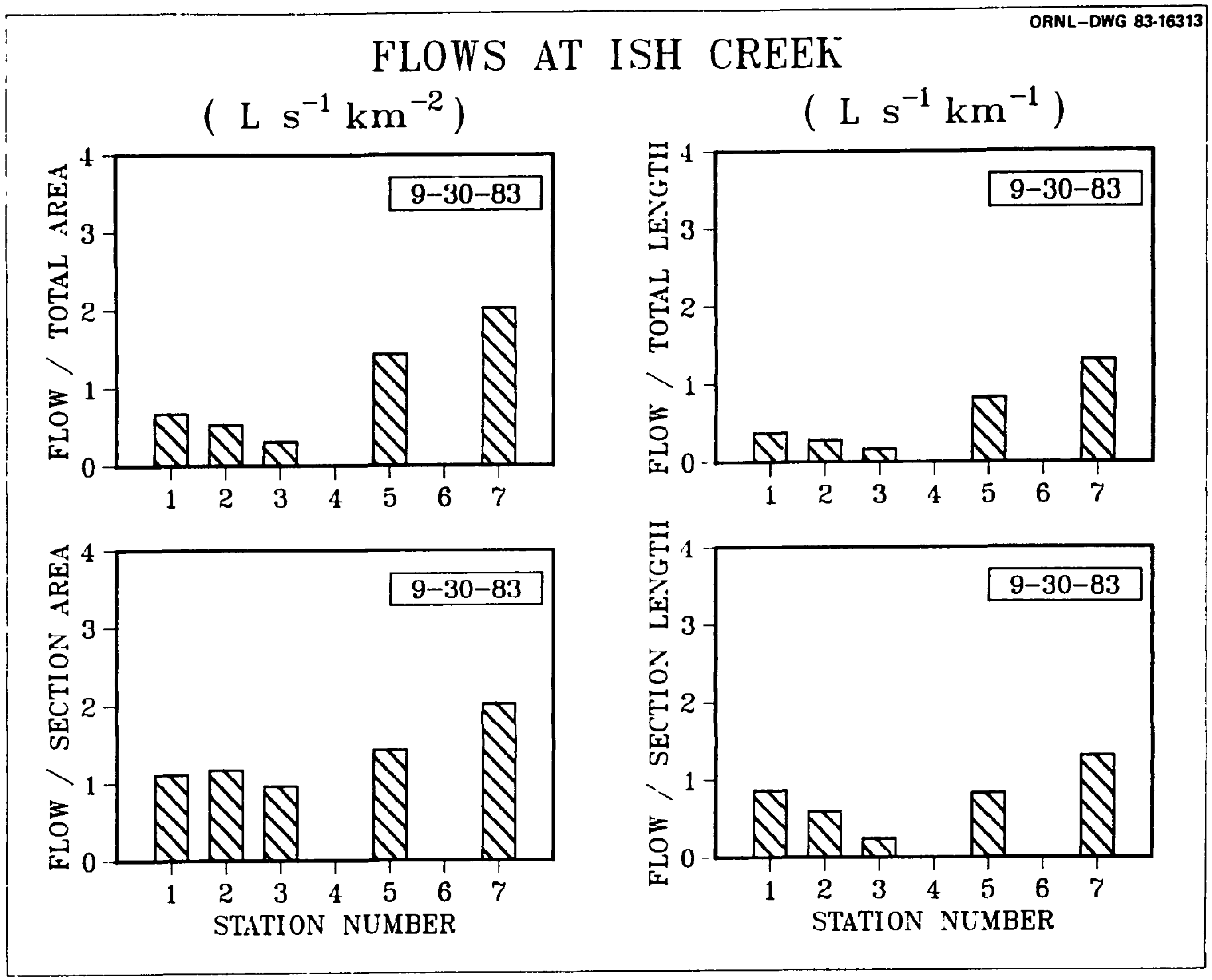

ORNL–DWG 83-16308
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
7-25-83
7-25-83
7-25-83
7-25-83
STATION NUMBER
STATION NUMBER


ORNL-DWG 83-16309
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
8-08-83
STATION NUMBER
0
1
2
3
4
5
6
7


ORNL-DWG 83-16310
FLOWS AT ISH CREEK
(L s-1 km-2)
(L s-1 km-1)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
8-22-83
STATION NUMBER
0
1
2
3
4
5
6
7


ORNL-DWG 83-16311
FLOWS AT ISH CREEK
(L s⁻¹ km⁻²)
(L s⁻¹ km⁻¹)
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
9-06-83
9-06-83
9-06-83
9-06-83
0 1 2 3 4
1 2 3 4 5 6 7
STATION NUMBER
STATION NUMBER


ORNL–DWG 83-16312
FLOWS AT ISH CREEK
(L s^{-1} km^{-2})
(L s^{-1} km^{-1})
FLOW / TOTAL AREA
FLOW / TOTAL LENGTH
FLOW / SECTION AREA
FLOW / SECTION LENGTH
9–19–83
0 1 2 3 4
1 2 3 4 5 6 7
STATION NUMBER


ORNL-DWG 83-16313
FLOWS AT ISH CREEK
(L s⁻¹ km⁻²)
(L s⁻¹ km⁻¹)
FLOW / TOTAL AREA
FLOW / SECTION AREA
FLOW / TOTAL LENGTH
FLOW / SECTION LENGTH
9-30-83
STATION NUMBER

APPENDIX B

LISTING OF COMPUTER FILES OF FLOW DATA

APPENDIX B

LISTING OF COMPUTER FILES OF FLOW DATA

Below is a list of computer files used to generate graphs of flow patterns at Ish Creek monitoring sites by the dates shown. Numbers in the first column are station identifiers, followed by flow per total area (L/s/km^2), flow per total length (L/s/km), flow per section area (L/s/km^2), and flow per section length (L/s/km). -0.000 indicates no data collected.

.7-15-82$				
1	0.827	0.459	0.801	0.619
2	0.810	0.428	1.736	0.876
3	0.499	0.266	2.443	0.606
4	0.068	0.050	0.068	0.050
5	1.543	0.895	1.543	0.895
6	0.149	0.066	0.149	0.066
7	-0.000	-0.000	-0.000	-0.000
7-20-82$				
1	1.223	0.678	1.016	0.786
2	1.246	0.658	2.128	1.074
3	0.951	0.508	3.852	0.955
4	0.088	0.065	0.088	0.065
5	2.736	1.587	2.736	1.587
6	0.564	0.249	0.564	0.249
7	3.804	2.476	3.804	2.476
8-3-82$				
1	2.027	1.124	2.975	2.161
2	1.750	0.923	3.073	1.551
3	1.306	0.698	4.216	1.045
4	0.557	0.413	0.557	0.413
5	2.634	1.527	2.634	1.527
6	1.048	0.463	1.048	0.463
7	3.577	2.329	3.577	2.329
9-22-82$				
1	0.818	0.454	0.216	0.167
2	0.966	0.510	2.100	1.059
3	0.584	0.312	2.682	0.665
4	0.233	0.173	0.233	0.173
5	1.551	0.900	1.551	0.900
6	0.168	0.074	0.168	0.074
7	2.500	1.628	2.500	1.628
10-8-82$				
1	2.462	1.366	3.261	2.521
2	2.163	1.142	4.138	2.088
3	1.500	0.801	11.409	2.828
4	0.169	0.125	0.169	0.125
5	3.358	1.947	3.358	1.947
6	0.426	0.188	0.426	0.188
7	3.010	1.960	3.010	1.960

APPENDIX B (continued)

.10-25-82$				
1	1.264	0.701	0.549	0.424
2	1.429	0.754	2.669	1.347
3	1.013	0.541	4.443	1.101
4	0.511	0.379	0.511	0.379
5	2.130	1.235	2.130	1.235
6	0.491	0.217	0.491	0.217
7	2.582	1.681	2.582	1.681
11-22-82$				
1	56.990	31.610	157.520	121.780
2	26.790	13.540	45.120	22.770
3	20.660	11.040	234.770	8.510
4	19.830	14.700	19.830	14.700
5	13.980	8.110	13.980	8.110
6	24.000	10.610	24.000	10.610
7	9.480	6.170	9.480	6.170
12-10-82$				
1	32.630	18.100	90.150	69.690
2	15.350	8.100	25.980	13.110
3	14.120	6.300	13.750	3.410
4	12.220	9.060	12.220	9.060
5	9.720	5.640	9.720	5.640
6	12.910	5.710	12.910	5.710
7	9.180	5.970	9.180	5.970
12-20-82$				
1	33.610	18.640	47.100	36.410
2	28.790	15.200	48.780	24.620
3	19.390	6.380	66.590	16.510
4	15.480	11.470	15.480	11.470
5	22.050	12.790	22.050	12.790
6	15.680	6.930	15.680	6.930
7	16.130	10.500	16.130	10.500
1-7-83$				
1	16.190	8.980	20.850	16.120
2	14.400	7.600	24.390	12.310
3	11.050	5.900	37.500	9.300
4	8.400	6.230	8.400	6.230
5	10.550	6.120	10.550	6.120
6	10.420	4.610	10.420	4.610
7	11.490	7.480	11.490	7.480
.1-24-83$				
1	11.480	6.370	16.300	12.610
2	9.770	5.160	19.090	9.630
3	6.640	3.550	11.590	2.870
4	5.990	4.440	5.990	4.440
5	6.810	3.950	6.810	3.950
6	6.880	3.040	6.880	3.040
7	8.200	5.340	8.200	5.340

APPENDIX B (continued)

2-7-83$				
1	51.480	28.550	84.960	65.690
2	40.460	21.360	111.100	56.060
3	34.340	18.350	194.660	48.250
4	20.060	14.860	20.060	14.860
5	26.570	15.410	26.570	15.410
6	28.550	12.620	28.550	12.620
7	22.420	14.600	22.420	14.600
2-22-83$				
1	14.250	7.900	23.420	18.110
2	11.220	5.920	6.080	3.070
3	13.010	6.950	98.640	24.450
4	6.560	4.860	6.560	4.860
5	8.860	5.140	8.860	5.140
6	8.300	3.670	8.300	3.670
7	11.960	7.790	11.960	7.790
3-07-83$				
1	23.200	12.870	37.900	29.300
2	18.340	9.680	28.270	14.270
3	15.030	8.030	55.450	13.750
4	10.970	8.130	10.970	8.130
5	15.080	8.740	15.080	8.740
6	13.560	5.990	13.560	5.990
7	14.900	9.700	14.900	9.700
3-21-83$				
1	28.570	15.850	71.560	55.320
2	15.530	8.200	14.860	7.500
3	15.810	8.450	63.750	15.800
4	13.510	10.010	13.510	10.010
5	13.150	7.630	13.150	7.630
6	12.620	5.580	12.620	5.580
7	12.160	7.920	12.160	7.920
.4-03-83$				
1	15.640	8.670	36.000	27.830
2	9.400	4.960	16.040	8.090
3	7.180	3.840	21.820	5.410
4	5.830	4.320	5.830	4.320
5	6.850	3.970	6.850	3.970
6	6.830	3.020	6.830	3.020
7	9.020	5.870	9.020	5.870
4-18-83$				
1	46.416	25.745	63.728	49.269
2	40.142	21.188	67.451	34.037
3	23.080	16.560	-0.000	-0.000
4	-0.000	-0.000	-0.000	-0.000
5	-0.000	-0.000	-0.000	-0.000
6	14.260	6.310	14.260	6.310
7	15.210	9.900	15.210	9.900

APPENDIX B (continued)

5-02-83$				
1	25.570	14.180	30.400	23.500
2	23.450	12.370	39.510	19.940
3	18.070	9.650	-0.000	-0.000
4	-0.000	-0.000	-0.000	-0.000
5	-0.000	-0.000	-0.000	-0.000
6	6.830	3.020	6.830	3.020
7	12.170	7.920	12.170	7.920
6-13-83$				
1	3.490	1.936	4.969	3.842
2	2.968	1.567	5.260	2.654
3	2.200	1.175	6.614	1.639
4	1.325	0.982	1.325	0.982
5	3.295	1.911	3.295	1.911
6	1.998	0.883	1.998	0.883
7	6.706	3.507	6.706	3.507
6-28-83$				
1	1.979	1.098	2.902	2.244
2	1.659	0.876	3.069	1.549
3	1.186	0.634	0.602	0.149
4	0.680	0.504	0.680	0.504
5	1.374	0.797	1.374	0.797
6	1.807	0.799	1.807	0.799
7	5.201	3.386	5.201	3.386
.7-11-83$				
1	1.022	0.567	1.591	1.230
2	0.831	0.439	1.683	0.849
3	0.544	0.291	3.352	0.413
4	0.072	0.053	0.072	0.053
5	1.787	1.037	1.787	1.037
6	0.000	0.000	0.000	0.000
7	3.381	2.201	3.381	2.201
7-25-83$				
1	5.939	3.294	7.547	5.835
2	5.308	2.802	9.175	4.630
3	4.013	2.144	36.227	8.980
4	0.778	0.576	0.778	0.576
5	7.543	4.374	7.543	4.374
6	0.543	0.240	0.543	0.240
7	4.985	3.245	4.985	3.245
8-08-83$				
1	1.141	0.633	1.755	1.357
2	0.934	0.495	1.856	0.936
3	0.624	0.333	4.307	1.068
4	0.029	0.022	0.029	0.022
5	2.000	1.160	2.000	1.160
6	0.000	0.000	0.000	0.000
7	3.237	2.107	3.237	2.107

APPENDIX B (continued)

8-22-83$				
1	0.547	0.303	0.940	0.727
2	0.420	0.221	0.996	0.503
3	0.225	0.120	0.045	0.011
4	0.000	0.000	0.000	0.000
5	0.592	0.735	0.592	0.735
6	0.000	0.000	0.000	0.000
7	2.459	1.601	2.459	1.601
9-06-83$				
1	0.856	0.475	1.364	1.055
2	0.687	0.363	1.443	0.728
3	0.432	0.231	2.239	0.555
4	0.026	0.019	0.026	0.019
5	1.634	0.947	1.634	0.947
6	0.000	0.000	0.000	0.000
7	2.670	1.738	2.670	1.738
.9-19-83$				
1	0.614	0.341	1.033	0.798
2	0.477	0.252	1.091	0.551
3	0.270	0.144	0.534	0.132
4	-0.000	-0.000	-0.000	-0.000
5	1.354	0.785	1.354	0.785
6	0.000	0.000	0.000	0.000
7	2.402	1.564	2.402	1.564
9-30-83$				
1	0.673	0.373	1.113	0.861
2	0.528	0.279	1.177	0.594
3	0.309	0.165	0.962	0.238
4	0.000	0.000	0.000	0.000
5	1.429	0.829	1.429	0.829
6	0.000	0.000	0.000	0.000
7	2.021	1.315	2.021	1.315

APPENDIX C

PRECIPITATION DATA COLLECTED FROM THE WEST CHESTNUT RIDGE AREA

APPENDIX C

PRECIPITATION DATA COLLECTED FROM THE WEST CHESTNUT RIDGE AREA

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: December 1982

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
12/20/1982	0.00
12/21/1982	0.00
12/22/1982	0.00
12/23/1982	6.05
12/24/1982	0.24
12/25/1982	0.24
12/26/1982	8.19
12/27/1982	0.19
12/28/1982	15.04
12/29/1982	0.00
12/30/1982	0.00
12/31/1982	0.00
MONTHLY TOTAL	29.95

CUSTOM REPORT BY D.D. HUFF
ENVIRONMENTAL SCIENCES DIVISION
OAK RIDGE NATIONAL LABORATORY

THIS SUMMARY PREPARED ON July 1, 1985

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: January 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
1/01/1983	0.00
1/02/1983	9.17
1/03/1983	0.00
1/04/1983	0.00
1/05/1983	0.00
1/06/1983	0.00
1/07/1983	0.00
1/08/1983	0.00
1/09/1983	10.36
1/10/1983	3.02
1/11/1983	1.90
1/12/1983	0.25
1/13/1983	0.00
1/14/1983	0.00
1/15/1983	0.00
1/16/1983	0.00
1/17/1983	0.00
1/18/1983	0.00
1/19/1983	0.00
1/20/1983	0.25
1/21/1983	11.18
1/22/1983	0.00
1/23/1983	0.00
1/24/1983	0.00
1/25/1983	0.00
1/26/1983	0.00
1/27/1983	0.00
1/28/1983	0.00
1/29/1983	4.63
1/30/1983	0.00
1/31/1983	0.00
MONTHLY TOTAL	40.76

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: February 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
2/01/1983	31.95
2/02/1983	14.61
2/03/1983	0.12
2/04/1983	0.00
2/05/1983	0.00
2/06/1983	14.61
2/07/1983	2.41
2/08/1983	0.00
2/09/1983	1.03
2/10/1983	25.72
2/11/1983	3.95
2/12/1983	0.00
2/13/1983	0.00
2/14/1983	0.00
2/15/1983	0.00
2/16/1983	0.00
2/17/1983	0.00
2/18/1983	0.00
2/19/1983	0.00
2/20/1983	0.00
2/21/1983	0.00
2/22/1983	12.07
2/23/1983	0.00
2/24/1983	5.23
2/25/1983	0.00
2/26/1983	0.00
2/27/1983	0.00
2/28/1983	0.00
MONTHLY TOTAL	111.70

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: March 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
3/01/1983	0.00
3/02/1983	0.00
3/03/1983	0.00
3/04/1983	0.00
3/05/1983	13.52
3/06/1983	4.23
3/07/1983	0.00
3/08/1983	0.33
3/09/1983	0.00
3/10/1983	0.00
3/11/1983	0.00
3/12/1983	0.00
3/13/1983	0.00
3/14/1983	0.00
3/15/1983	0.00
3/16/1983	0.00
3/17/1983	0.00
3/18/1983	1.71
3/19/1983	0.00
3/20/1983	22.27
3/21/1983	0.00
3/22/1983	0.00
3/23/1983	0.00
3/24/1983	0.00
3/25/1983	0.00
3/26/1983	3.42
3/27/1983	11.45
3/28/1983	0.00
3/29/1983	0.00
3/30/1983	0.00
3/31/1983	0.91
MONTHLY TOTAL	57.84

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: April 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
4/01/1983	0.00
4/02/1983	8.14
4/03/1983	0.42
4/04/1983	0.38
4/05/1983	92.15
4/06/1983	0.38
4/07/1983	0.00
4/08/1983	3.74
4/09/1983	23.66
4/10/1983	0.50
4/11/1983	0.00
4/12/1983	0.00
4/13/1983	0.00
4/14/1983	0.52
4/15/1983	0.77
4/16/1983	0.00
4/17/1983	0.51
4/18/1983	8.13
4/19/1983	0.00
4/20/1983	0.00
4/21/1983	0.00
4/22/1983	2.76
4/23/1983	19.56
4/24/1983	1.24
4/25/1983	0.00
4/26/1983	0.00
4/27/1983	0.00
4/28/1983	0.00
4/29/1983	0.00
4/30/1983	0.17

MONTHLY TOTAL 163.03

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: May 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
5/01/1983	0.69
5/02/1983	0.00
5/03/1983	10.66
5/04/1983	0.00
5/05/1983	0.00
5/06/1983	0.00
5/07/1983	1.68
5/08/1983	19.51
5/09/1983	0.00
5/10/1983	0.00
5/11/1983	0.00
5/12/1983	0.39
5/13/1983	4.82
5/14/1983	0.00
5/15/1983	10.29
5/16/1983	7.49
5/17/1983	0.00
5/18/1983	0.00
5/19/1983	27.06
5/20/1983	22.74
5/21/1983	18.29
5/22/1983	16.24
5/23/1983	6.62
5/24/1983	0.00
5/25/1983	0.00
5/26/1983	0.00
5/27/1983	0.00
5/28/1983	0.00
5/29/1983	4.13
5/30/1983	0.00
5/31/1983	0.00
MONTHLY TOTAL	150.61

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: June 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
6/01/1983	0.00
6/02/1983	0.00
6/03/1983	0.00
6/04/1983	24.13
6/05/1983	0.00
6/06/1983	0.28
6/07/1983	0.76
6/08/1983	0.00
6/09/1983	0.00
6/10/1983	0.00
6/11/1983	0.00
6/12/1983	0.00
6/13/1983	0.00
6/14/1983	0.00
6/15/1983	0.00
6/16/1983	0.00
6/17/1983	9.16
6/18/1983	5.72
6/19/1983	1.91
6/20/1983	0.00
6/21/1983	0.00
6/22/1983	9.40
6/23/1983	0.00
6/24/1983	0.00
6/25/1983	0.00
6/26/1983	0.00
6/27/1983	4.83
6/28/1983	0.00
6/29/1983	0.00
6/30/1983	0.00
MONTHLY TOTAL	56.19

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: July 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
7/01/1983	0.00
7/02/1983	0.00
7/03/1983	0.00
7/04/1983	3.82
7/05/1983	1.75
7/06/1983	0.00
7/07/1983	0.00
7/08/1983	0.00
7/09/1983	0.00
7/10/1983	0.00
7/11/1983	0.00
7/12/1983	0.00
7/13/1983	0.00
7/14/1983	0.00
7/15/1983	0.00
7/16/1983	3.36
7/17/1983	1.63
7/18/1983	17.27
7/19/1983	18.91
7/20/1983	8.89
7/21/1983	0.00
7/22/1983	0.00
7/23/1983	0.00
7/24/1983	1.40
7/25/1983	11.13
7/26/1983	0.00
7/27/1983	0.00
7/28/1983	0.00
7/29/1983	0.00
7/30/1983	0.00
7/31/1983	0.00
MONTHLY TOTAL	68.16

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: August 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
8/01/1983	2.01
8/02/1983	0.00
8/03/1983	0.00
8/04/1983	0.00
8/05/1983	0.00
8/06/1983	0.00
8/07/1983	0.00
8/08/1983	0.00
8/09/1983	0.00
8/10/1983	0.00
8/11/1983	7.88
8/12/1983	0.00
8/13/1983	0.00
8/14/1983	0.00
8/15/1983	0.00
8/16/1983	0.00
8/17/1983	0.00
8/18/1983	0.00
8/19/1983	0.00
8/20/1983	0.00
8/21/1983	0.00
8/22/1983	0.00
8/23/1983	8.25
8/24/1983	4.57
8/25/1983	0.00
8/26/1983	0.00
8/27/1983	3.15
8/28/1983	0.00
8/29/1983	0.00
8/30/1983	0.00
8/31/1983	0.00

MONTHLY TOTAL 25.86

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: September 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
9/01/1983	0.00
9/02/1983	1.02
9/03/1983	0.91
9/04/1983	9.14
9/05/1983	0.00
9/06/1983	0.00
9/07/1983	0.00
9/08/1983	0.00
9/09/1983	0.00
9/10/1983	0.00
9/11/1983	0.00
9/12/1983	0.00
9/13/1983	3.55
9/14/1983	0.00
9/15/1983	0.00
9/16/1983	0.00
9/17/1983	0.00
9/18/1983	0.00
9/19/1983	0.00
9/20/1983	6.23
9/21/1983	13.93
9/22/1983	0.00
9/23/1983	0.00
9/24/1983	0.00
9/25/1983	0.00
9/26/1983	0.00
9/27/1983	0.00
9/28/1983	0.00
9/29/1983	0.00
9/30/1983	0.00

MONTHLY TOTAL 34.78

77/78

APPENDIX C (continued)

MONTHLY SUMMARY OF HYDROLOGIC CONDITIONS

SITE: ISH
MONTH AND YEAR: October 1983

OBSERVATION DATA

PRECIPITATION (MM)

DATE	RAINGAGE
10/01/1983	0.00
10/02/1983	0.00
10/03/1983	0.00
10/04/1983	0.00
10/05/1983	32.76
10/06/1983	0.00
10/07/1983	0.00
10/08/1983	0.00
10/09/1983	0.00
10/10/1983	0.00
10/11/1983	2.15
10/12/1983	2.18
10/13/1983	41.04
10/14/1983	0.00
10/15/1983	0.00
10/16/1983	0.00
10/17/1983	0.00
10/18/1983	0.00
10/19/1983	(0.00)
10/20/1983	(0.00)
10/21/1983	(3.37)
10/22/1983	(7.26)
10/23/1983	(35.84)
10/24/1983	(0.00)
10/25/1983	0.00
10/26/1983	0.00
10/27/1983	0.00
10/28/1983	0.00
10/29/1983	0.00
10/30/1983	0.00
10/31/1983	0.00

MONTHLY TOTAL (125.74)

**** NOTE: PARENTHETICAL VALUES ARE ESTIMATES. ****

ORNL/TM-9392

INTERNAL DISTRIBUTION

1. T. L. Ashwood
2. S. I. Auerbach
3-12. L. D. Bates
13. W. J. Boegly, Jr.
14. R. B. Clapp
15. N. H. Cutshall
16. E. C. Davis
17. L. R. Dole
18-22. J. L. Elmore
23. L. D. Eyman
24. J. R. Gissel
25. C. S. Haase
26. S. G. Hildebrand
27-31. D. D. Huff
32-36. J. R. Jones
37. R. Jordan
38. R. H. Ketelle
39. S. Y. Lee
40. C. A. Little
41. L. E. McNeese
42. T. E. Myrick
43. T. W. Oakes
44. W. W. Pitt
45. D. E. Reichle
46. T. H. Row
47. E. D. Smith
48. B. P. Spalding
49. S. H. Stow
50-59. L. E. Stratton
60. J. Switek
61. T. Tamura
62. G. T. Yeh
63. Central Research Library
64-78. ESD Library
79-80. Laboratory Records Dept.
81. Laboratory Records, ORNL-RC
82. ORNL Patent Section
83. ORNL Y-12 Technical Library

EXTERNAL DISTRIBUTION

84. M. Barainca, Program Manager, Low-Level Waste Management Program, U.S. Department of Energy, 550 Second Street, Idaho Falls, ID 83401
85. J. J. Blakeslee, Program Manager, Nuclear Waste Processing, Rocky Flats Plant, Rockwell International, P.O. Box 464, Golden, CO 80401
86. J. Thomas Callahan, Associate Director, Ecosystem Studies Program, Room 336, 1800 G Street, NW, National Science Foundation, Washington, DC 20550
87. T. C. Chee, R&D and Byproducts Division, DP-123 (GTN), U.S. Department of Energy, Washington, DC 20545
88. A. T. Clark, Jr., Division of Fuel Material Safety, U.S. Nuclear Regulatory Commission, Washington, DC 20555
89. Peter Colombo, Group Leader, Nuclear Waste Research, Brookhaven National Laboratory, Bldg. 701, Upton, NY 11973
90. E. F. Conti, Office of Nuclear Regulatory Research, Nuclear Regulatory Commission, MS-1130-SS, Washington, DC 20555
91. J. E. Dieckhoner, Acting Director, Operations and Traffic Division, DP-122 (GTN), U.S. Department of Energy, Washington, DC 20545
92. G. J. Foley, Office of Environmental Process and Effects Research, U.S. Environmental Protection Agency, 401 M Street, SW, RD-682, Washington, DC 20460
93. Carl Gertz, Director, Radioactive Waste Technology Division, Idaho Operations Office, U.S. Department of Energy, 550 Second Street, Idaho Falls, ID 83401

94. W. H. Hannum, Director, West Valley Project Office, U.S. Department of Energy, P.O. Box 191, West Valley, NY 14171
95. J. W. Huckabee, Project Manager, Environmental Assessment Department, Electric Power Research Institute, 3412 Hillview Avenue, P.O. Box 10412, Palo Alto, CA 94303
96. E. A. Jennrich, Program Manager, Low-Level Waste Management Program, EG&G Idaho, Inc., P.O. Box 1625, Idaho Falls, ID 83415
97. J. J. Jicha, Director, R&D and Byproducts Division, DP-123 (GTN), U.S. Department of Energy, Washington, DC 20545
98. E. A. Jordan, Low Level Waste Program Manager, Division of Storage and Treatment Projects, NE-25 (GTN), U.S. Department of Energy, Washington, DC 20545
99. George Y. Jordy, Director, Office of Program Analysis, Office of Energy Research, ER-30, G-226, U.S. Department of Energy, Washington, DC 20545
100. J. Howard Kittel, Manager, Office of Waste Management Programs, Argonne National Laboratory, 9700 S. Cass Ave., Bldg. 205, Argonne, IL 60439
101. L. T. Lakey, Waste Isolation, Pacific Northwest Laboratory, Richland, WA 99352
102. Leonard Lane, Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545
103. D. B. Leclaire, Director, Office of Defense Waste and Byproducts Management, DP-12 (GTN), U.S. Department of Energy, Washington, DC 20545
104. Helen McCammon, Director, Ecological Research Division, Office of Health and Environmental Research, Office of Energy Research, MS-E201, ER-75, Room E-233, Department of Energy, Washington, DC 20545
105. Michael McFadden, Waste Management, Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, NM 37115
106. G. L. Meyer, Environmental Protection Agency, 401 M Street SW, MS-ANR459, Washington, DC 20460
107. Edward O'Donnell, Division of Radiation Programs and Earth Sciences, U.S. Nuclear Regulatory Commission, MS 1130 SS, Washington, DC 20555
108. J. W. Patterson, Program Director, Waste Management Program Office, Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352
109. J. Quinlan, National Park Service, P. O. Box 8, Mammoth Cave, KY 42259
110. Irwin Remson, Department of Applied Earth Sciences, Stanford University, Stanford, CA 94305
111. Paul G. Risser, Office of the Chief, Illinois Natural History Survey, Natural Resources Building, 607 E. Peabody Ave., Champaign, IL 61820
112. Jackson Robertson, USGS, 410 National Center, Reston, VA 22092
113. E. M. Romney, University of California, Los Angeles, 900 Veteran Avenue, Los Angeles, CA 90024
114. R. J. Starmer, HLW Technical Development Branch, Office of Nuclear Material Safety and Safeguards, Nuclear Regulatory Commission, Room 427-SS, Washington, DC 20555

115. J. G. Steger, Environmental Sciences Group, Los Alamos Scientific Laboratory, MS-K495, P.O. Box 1663, Los Alamos, NM 87545
116. R. J. Stern, Director, Office of Environmental Compliance, MS PE-25, FORRESTAL, U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585
117. J. A. Stone, Savannah River Laboratory, E. I. DuPont de Nemours and Company, Bldg. 773-A, Room E-112, Aiken, SC 29808
118. Leonard H. Weinstein, Program Director of Environmental Biology, Cornell University, Boyce Thompson Institute for Plant Research, Ithaca, NY 14853
119. Raymond G. Wilhour, Chief, Air Pollution Effects Branch, Corvallis Environmental Research Laboratory, U.S. Environmental Protection Agency, 200 SW 35th Street, Corvallis, OR 97330
120. Frank J. Wobber, Ecological Research Division, Office of Health and Environmental Research, Office of Energy Research, MS-E201, Department of Energy, Washington, DC 20545
121. M. Gordon Wolman, The Johns Hopkins University, Department of Geography and Environmental Engineering, Baltimore, MD 21218
122. Office of Assistant Manager for Energy Research and Development, Oak Ridge Operations, P. O. Box E, U.S. Department of Energy, Oak Ridge, TN 37831

123-149. Technical Information Center, Oak Ridge, TN 37831