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US Army Corps
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Waterways Experiment
Station

John H. Overton Upstream Lock Guard Wall Prototype Experiments

by Frank M. Neilson

Prepared for U.S. Army Engineer District, Vicksburg

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Waterways Experiment Station
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Vicksburg, MS 39180-6199

Final report

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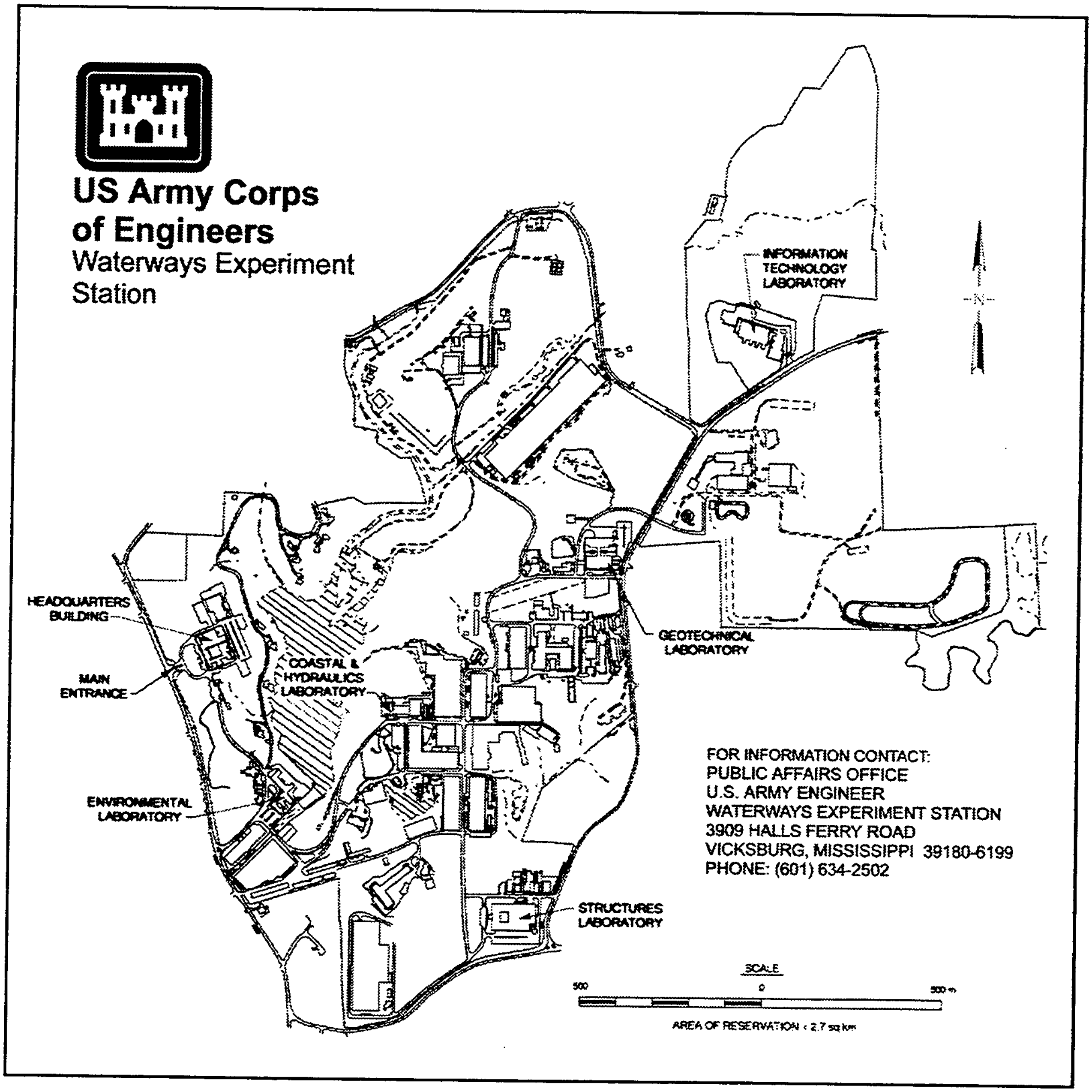
Prepared for U.S. Army Engineer District, Vicksburg
Vicksburg, MS 39180-5191



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Contents

Preface

This prototype study was conducted by personnel of the Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, during January-July 1991. The project was sponsored by the U.S. Army Engineer District, Vicksburg.

The field work was performed by personnel of the Hydraulic Analysis Branch, Hydraulic Structures Division (HSD), Hydraulics Laboratory. The project was monitored by Mr. Rick Robertson of the Vicksburg District. This report was prepared by Dr. Frank M. Neilson, Hydraulic Analysis Branch.

The study was performed under the direction of Messrs. Frank A. Herrmann, Jr., Director of the Hydraulics Laboratory; R. A. Sager, Assistant Director; and Glenn Pickering, Chief, HSD. Technical review was provided by Dr. B. J. Brown, Chief of the Hydraulic Analysis Branch.

This report is being published by the WES Coastal and Hydraulics Laboratory (CHL). The CHL was formed in October 1996 with the merger of the WES Coastal Engineering Research Center and Hydraulics Laboratory. Dr. James R. Houston is the Director of the CHL, and Mr. Charles C. Calhoun, Jr., is the Assistant Director.

Director of WES during preparation of this report was Dr. Robert W. Whalin. Commander was COL Robin R. Cababa, EN.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
cubic feet	0.02831685	cubic meters

1 Introduction

Background

The John H. Overton Lock and Dam (previously named Red River Lock and Dam 2) is located on the Red River near Alexandria, Louisiana, as shown in Figure 1.

The upstream approach, including the guard and guide walls, is shown in Figure 2. The port numbering scheme and the terminology used herein are also given in Figure 2. Two port configurations are studied. For the *initial layout*, all ports are open as shown in Figure 3(a). For the *final layout*, ports 10, 11, and 12 are partially blocked as shown in Figure 3(b).

For the initial layout, navigation tows, entering as well as leaving the lock chamber, tend to be forced into the guard wall. For certain flow conditions, the force in the prototype became so excessively large that navigation was deemed unacceptably difficult. Subsequently, methods to improve navigation conditions were identified using a 1:50-scale physical hydraulic model[1]. The method chosen for the prototype is the final layout, above, in which flow through three downstream ports is restricted by means of baffles.

Objectives

Experiments with the initial unbaffled layout are to determine prototype flow conditions to help evaluate observations in the small physical model. Experiments with the baffled ports provide information regarding changes in the prototype resulting from the baffles.

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[1]Triplett, Glenn R., "Data Report, Upstream Guard Wall Tests, 1:50-scale Structures Model, John H. Overton Lock and Dam, Red River," Memorandum for Record, CEWES-HS-S (1110-2-1403b), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, 16 November 1990.

Scope

Three series of experiments were conducted. Series I, 29 Jan 1991, and Series II, 24 May 1991, are with the initial unbaffled arrangement. Series III, 12 Dec 1991, are with ports 10, 11, and 12 partially closed (baffled) as shown previously in Figure 3(b).

The following measurements were obtained and are presented in this report.

Series I, II, and III

a. *Water-Surface Differentials Across and Along the Guard Wall.* These measurements, using a weighted tape, are referenced to el. 78.72 NGVD[1] at the top of the guard wall parapet.

b. *Velocity of the Flow Through the Guard Wall Ports*. Current meter readings, x-y velocity components, were obtained using a Marsh-McBirney 511 meter referenced to magnetic North. The apparatus was suspended from a hoist positioned over the spillway side of the guard wall parapet.

c. *Velocity Distribution Across the Navigation Approach Channel*. These measurements were made by contracted hydrographic survey (personnel and equipment) and were taken at three ranges (stations 4+16, 5+78, and 8+49) normal to the wall.

d. *Tow Drift*. Near-surface velocities and drift information, also by contracted survey, were taken in the approach channel.

Series II

e. *Hydrographic Information For the Channel Upstream From the Guard Wall.* Four sounding lines (one survey line and three observational, sounding only, lines) were taken approximately parallel to the guard wall but extended over a berm and over two dikes located in the upstream river channel near the left (descending) river bank farther upstream.

f. *Water-Surface Differentials For the Tainter Gate Bays*. These measurements, using a weighted tape, are referenced to el. 108.26 NGVD at the top of the parapet located above the bays.

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[1]All elevations (el) cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD).

Series III

g. Two observational sounding lines, one upstream and one downstream, extending over the berms and two dikes were taken (similar to *e*, above).

h. An additional traverse line (similar to *c*, above) was taken at station 2+54 by contracted survey personnel.

The guard wall and the velocity measuring arrangements on the parapet of the guard wall are shown in Figures 4(a) and 4(b), respectively. The control structure, including the spillway gates, located adjacent to the lock is shown in Figures 5(a) and 5(b). The construction activity upstream from the guide wall, including the contract survey vessel working a range in the navigation approach 29 Jan 1991, is shown in Figures 6(a) and 6(b). The expanse upstream from the guard wall, which gives an indication of irregularities in the water surface, and the flow entering the gate bays are shown in Figures 7(a) and 7(b), respectively.

2 Field Conditions

The experiments were completed in a compressed time frame because of the relatively rapid fall in project discharge. Equipment assembly started at 0600 hours and was completed at 0900 hours; measurements started at 0900 hours and were completed at 1800 hours. Construction equipment, including a barge and towboat, was located along the left bank upstream of the guide wall during series I and II but not during series III.

Series I

Two upbound tows and one downbound tow, locked during the measurement period, had no apparent difficulty along the wall. Spillway conditions were as follows.

Time 29 Jan 1991	Pool EL		Gate Opening, ft					Total Discharge, cfs
	Upper	Lower	1	2	3	4	5	
0530	64.0	57.1	10	23	23	23	23	85,000
1105	64.0	56.7	10	22	22	22	22	85,000
1400	64.0	56.5	10	21	21	21	21	85,000

Small (estimated as 2 to 3 ft in diameter) but intense vortices occur intermittently in the navigation channel over port number 12.5 and, to a lesser extent, over port 12. Severe surface turbulence existed on the spillway side over ports 12.5 to 10. Smoother flow existed on either side upstream from these ports.

Series II

One downbound tow was locked during this period; this tow was oriented at a steep angle to the guard wall (with the bow at the wall). Lock operations personnel noted that during the previous day, an upbound tow moved excessively (toward the left river bank) following the maneuver used to swing the bow of the tow away from the wall. The upbound tow also experienced navigation difficulty near transverse dikes located upstream from the project. The spillway gates were fully open during this measurement period; hydraulic conditions were as follows.

Time 24 May 1991	Pool EL		Total Discharge, cfs
	Upper	Lower	
0800	65.1	62.6	116,000

The upper pool dropped about 0.5 ft during the following ten hours. One (estimated as 3 to 4 ft in diameter) intense vortex occurred persistently over port number 12.5 and intermittently over port 12. Severe surface turbulence existed on the spillway side over ports 12.5 to 10. Smoother flow existed on either side of the guard wall upstream from port 10.

Series III

One upbound tow, locked during the measurement period, had no apparent difficulty along the wall. Spillway conditions were as follows.

Time 12 Dec 1991	Pool EL		Gate Opening, ft					Total Discharge, cfs
	Upper	Lower	1	2	3	4	5	
0600	64.0	57.1	21	22	22	22	21	115,000
1300	64.0	57.2	21	22	22	22	21	115,000

Small (estimated as 2 to 3 feet in diameter) but intense vortices occurred intermittently in the navigation channel over port number 12.5. The surface turbulence on the spillway side appears less than in series I and II.

3 Results

Water-Surface Measurements

Data are listed in Table 1 and shown in Figure 8 for Series I, Table 2 and Figure 9 for Series II, and Table 3 and Figure 10 for Series III. Elevations, *Zn* and *Zs*, refer to conditions along the navigation side and the spillway side, respectively, of the guard wall. The elevation difference, *DZn*, refers to the difference between the upper pool and the navigation-side elevations (*DZn* = Upper Pool El. - *Zn*). The elevation difference, *DZw*, refers to the differential across the wall (*DZw* = *Zn*-*Zs*).

Discharge Through The Guard Wall Ports

Velocity measurement locations and the data reduction procedures are given in Figure 11. The objective is to obtain a reasonable estimate of port by port discharge based on an average of measured velocity magnitude and direction. Data are listed in Tables 4, 5 and 6 for Series I, II, and III, respectively. Each listed velocity value is an estimated average value of a fluctuating dial reading taken near the port centerline. Readings nearer the piers were erratic, particularly in compass direction, indicating high local turbulence levels associated with flow separation at the piers.

The compass and one replacement were damaged, during Series II, by recurring impacts within ports 12.5 - 9. Compass readings for this series are limited to ports 9, 10, and 11 and are unreliable. The origin and cause of the impacts are not known.

The velocity data for series I and II are shown in Figure 12. The average directions shown in Figure 12a are averages of velocity measurements, Tables 4 and 5, for each port. The average directions shown in Figure 12b, primarily based on Series I data, are used in further data reduction for both series of experiments.

The average direction values correspond to reaches along the wall in accordance with the approach channel velocity traverses. For example, the average value for ports 1 - 5 is 19-degrees and is used for the reach between the upstream traverse range, station 8+49, and the intermediate range, station 5+78. Similarly, the 26-degree angle is used for ports 6 - 8, the 40-degree angle for ports 9 - 12, and the 85-degree angle is used for the small terminal port designated 12.5.

Discharge calculations, based on the approximation shown previously in Figure 11, are also listed previously in Tables 4, 5 and 6 for Series I, II, and III, respectively. Port-by-port discharges, as a percentage of the sum of the total measured port discharge, are shown in Figure 13 for both series I and II. Similarly, the accumulative discharges for these series are shown in Figure 14.

Discharge In The Approach Channel

An example of approach channel velocity measurements (station 8+49, 29 Jan 1991) is shown in Figure 15. Measurements are at 0.2D, 0.6D, and 0.8D where D is the local depth as determined by concurrent fathometer readings. The data for the three ranges (stations 8+49, 5+78, and 4+16) are listed in Tables 7 and 8 for Series I and II, respectively.

The distributions of depth-averaged velocity across the approach for the three ranges are shown in Figures 16 and 17 for Series I and II, respectively.

The total approach flow is obtained by integration of the product of depth-averaged velocity and incremental area over the extent of the range. These calculations are also shown in Tables 7 and 8. A comparison of the measured incoming approach flow (accumulative discharge at station 8+49), the overall river flow, and the total port discharge is listed below.

River cfs	Approach Measurements		Port Measurements	
	cfs	% of Spillway	cfs	% of Spillway
85,000	15,770	19	12,745	15
116,000	20,171	17	17,640	15

The arrangement of guard wall ports relative to the stationing of the ranges across the approach channel allows additional comparisons of the discharge measurements. Discharge obtained along range 8+49 is comparable to the total port discharge. The difference between the discharges for range 8+49 and 5+78 is the discharge for ports 1-5. The difference between the discharges for range 8+49 and 4+16 is the discharge for ports 1-8. These comparisons are shown previously in Figure 14.

Near-Surface Flow Conditions

Current speed at 6 ft below the water surface and the corresponding drift tendency of the survey vessel *Cele* were obtained during the survey of the approach channel.

The drift ranges are parallel to the guard wall and extend upstream from an origination point near the miter gate pintles. One range follows the lock centerline and the other is about 4 ft off the landside lock wall.

The near-surface and surface observations are summarized in Figures 18 and 19 for Series I and II, respectively. The transverse range data that show the boundary between positive flow (that is, in the same direction as the Red River) and negative or reverse flow are included in these figures.

Mass Balance

Because of the relatively small change in total river discharge and stage during either series of experiments, each series is treated as a steady flow condition.

Contours that define the balance of flow between segments of the normal ranges and the guard wall ports are shown in Figures 17 and 18 for Series I and II, respectively. Each contour contains the flow (25%, 50%, 75%, and 100% of the total flow passing range 8+49) through a segment extending from the wall to a location, X, along the range. The calculation originates with the upstream range, station 8+49. The X-value for the next downstream range is such that the downstream flow plus the flow through the included ports equals the upstream flow.

The observations of the limits between normal and reverse flows, Figures 18 and 19, and the contours shown in Figures 20 and 21 are consistent.

Soundings Upstream From The Project

Four sounding lines were obtained upstream from the guard wall during Series II, 24 May 1991. The primary interest items are the clearance, the extent of sedimentation, and high surface currents associated with a berm, station 10+00 - station 16+00, and two dikes, stations 20+00 and 23+00, extending from the left bank into the Red River navigation channel. The bottom elevations, relative to a water surface at El. 64.9, are shown in Figure 22.

Line	Description of Survey Procedure
L1	Standard survey line: the range follows the landside face of the guard wall and distance measurements are by means of wire line.
L2	The range line follows, and extends from, L1: no distance measurements are made. Chart positioning is relative to the apparent locations of the berm, from L1, and the crests of the two dikes, as designed.
L3	The range line is estimated as being 20-100 ft riverward of L2 and nonlinear: no distance measurements are made.
L4	The range line is estimated as being 100-150 ft riverward of the left bank: no distance measurements are made. Lines L2 and L3 are obtained with the survey vessel moving continuously upstream; line L4 is with the vessel moving downstream.

High surface currents apparently occur immediately downstream of each of the two dikes as suggested by the profiles of the dikes shown in Figure 22, lines L3 and L4, as well as by on-site visual observations. Severe turbulence is suggested by interference on the sounding record, commonly associated with air entraining flow, as well as by on-site visual observations.

Water-Surface Elevations in the Gate Bays

These elevation measurement locations are immediately below the upstream edge of the tainter gate (control structure) parapet and are obtained by means of a weighted tape relative to the top of the parapet wall. These data are for Series II, 24 May 1991.

Location	Elevation
Top of Control Structure Parapet	108.3
Water Surface: Center Line of Bay 1	63.3
Water Surface: Center Line of Bay 2	63.1
Water Surface: Center Line of Bay 3	63.1
Water Surface: Center Line of Bay 4	63.1
Water Surface: Center Line of Bay 5	63.3
Water Surface: Right Side of Bay 5 Abutment	65.6

4 Discussion and Conclusions

The data needed for model study verification are included in the tables and figures as discussed in the previous paragraphs. The following conclusions are drawn from data related to a) tow drift along the guard wall, b) tows being immobilized after being forced against the guard wall, c) navigation for upstream bound tows, and d) navigation for downbound tows.

a. Tow drift. The upstream drift of tows from the lock chamber results from a water surface that slopes downwards from the lock chamber into the approach area. The slope continues over the total length of wall, Figures 8-10, and is most severe between station 1+75 and about station 4+00. A tow will drift in an upstream direction until drag due to increasing near-surface velocities, Figures 18 and 19, and mechanical friction between the barges and the wall cause the motion to cease.

b. Tow binding along the guard wall. The slope of the water surface over the approach area is indicated by the flow lines shown in Figures 20 and 21. The highest water-surface elevations are within the low velocity region landward of the 100% flow line. The lowest elevations are within the high-velocity region near the guard wall. The gravity force resulting from this slope, and the drag force resulting from velocity, have components that are directed toward the wall. For a 600-ft long tow, these forces are expected to be greatest when the tow is positioned between stations 1+75 and 7+75 based on the flow lines shown in Figures 20 and 21. The position for greatest normal force is independent of direction of tow movement. However, the velocity and slope parallel to the wall, which affect the power needed to offset friction between the tow and the wall, will affect the location at which binding occurs.

c. Upbound tows. The upbound tow, to avoid binding along the guard wall, probably should be oriented with the bow off the wall and aligned with the approach flow. The operation needs to be carried out without having the stern impact on the miter gate. For lower flows with modest forces, Figure 20 for example, the operation is probably not an unusual exit condition. For higher flows with severe forces, Figure 21 for example, the operation is more unusual in that an inadequate operation apparently results in binding whereas an excessive operation forces the tow into the left (descending) bank. More precise suggestions for operation require field assessments so that towboat power and steering mechanisms can be considered.

d. Downbound tows. The downbound tow, also to avoid binding, probably should enter the approach a significant distance offset from the guard wall. The bow will begin to move into the wall near station 6+00. The stern would be moved nearer the wall, by towboat operations, as the bow approaches the miter gate recess. The necessary initial offset is larger for high flows (100 ft may be appropriate for 116,000 cfs, Figure 18) than low flows (50 ft may be appropriate for 85,000 cfs, Figure 20). More precise suggestions for operation require field assessments so that towboat power and steering mechanisms can be considered.

5 Recommendations

General

The basis for the following comments is that a good navigation approach requires a uniform distribution of velocities across the approach upstream of the guard wall and a gradual decrease in velocity from the upstream end of the wall to the final port (12.5). The large reverse flow eddy along the left bank is also not favorable to navigation. The following changes would be helpful to navigation conditions at John H. Overton Lock.

a. Any modification to the upstream ports, such as wing walls extending into the approach channel, that leads to an increased discharge through the upstream guard wall ports starting at port 1. The purpose is to decrease approach velocity more uniformly and to gradually raise the water surface along the wall.

b. Any modification to the downstream ports, such as baffles, that concurrently reduces downstream port flows and enhances upstream port flows. Baffles located downstream of ports 10, 11, and 12 have been evaluated in the model and found to be highly effective and probably provide both upstream enhancement and downstream reduction. Baffles located within these ports are helpful in that downstream port flows are reduced. However, since no mechanism to decrease the velocity in the approach channel is provided, these within port baffles require the overall approach-channel flow pattern to change; i.e., the reverse flow region will probably be enlarged and shift farther upstream. The change in flow pattern between Series I and Series II (Figures 20 and 21, respectively) occurs concurrently with a change in distribution of port flow as shown in Figure 13.

Future Concerns

The physical model study[1] addresses each of the above types of modifications. The appropriate response for this project requires economic considerations and other project concerns, such as sedimentation, that are not included in this study. However, because of the limited flow passage area, the short and deep spillway crest, and other restrictive site-specific factors, flow conditions that result from any modification to existing conditions should be diligently tracked in the field.

[1]Triplett, op. cit.

Table 1
Water-Surface Measurements (29 Jan 1991)

Port	Pt.	n-Rdg ft	s-Rdg ft	Zn ft-NGVD	Zs ft-NGVD	DZn ft	DZw ft	Station ft
U. Staff Gage				64.10				
12.5	2	14.58	15.25	64.14	63.47	-0.04	0.67	185.5
12	1	14.74	15.17	63.98	63.55	0.12	0.43	211.0
	2	14.68	15.08	64.04	63.64	0.06	0.40	229.0
	3	14.65	15.07	64.07	63.65	0.03	0.42	247.0
11	1	14.63	14.83	64.09	63.89	0.01	0.20	265.0
	2	14.65	14.94	64.07	63.78	0.03	0.29	283.0
	3	14.67	15.10	64.05	63.62	0.05	0.43	301.0
10	1	14.63	14.90	64.09	63.82	0.01	0.27	317.0
	2	14.66	14.92	64.06	63.80	0.04	0.26	337.0
	3	14.63	14.99	64.09	63.73	0.01	0.36	355.0
9	1	14.71	14.90	64.01	63.82	0.09	0.19	373.0
	2	14.71	14.93	64.01	63.79	0.09	0.22	391.0
	3	14.79	15.00	63.93	63.72	0.17	0.21	409.0
8	1	14.73	14.83	63.99	63.89	0.11	0.10	427.0
	2	14.67	14.86	64.05	63.86	0.05	0.19	445.0
	3	14.75	14.90	63.97	63.82	0.13	0.15	463.0
7	1	14.74	14.83	63.98	63.89	0.12	0.09	481.0
	2	14.75	14.85	63.97	63.87	0.13	0.10	499.0
	3	14.75	14.88	63.97	63.84	0.13	0.13	517.0
6	1	14.91	14.88	63.81	63.84	0.29	-0.03	535.0
	2	14.83	14.92	63.89	63.80	0.21	0.09	553.0
	3	14.78	14.96	63.94	63.76	0.16	0.18	571.0
5	1	14.82	14.83	63.90	63.89	0.20	0.01	589.0
	2	14.83	14.91	63.89	63.81	0.21	0.08	607.0
	3	14.88	14.92	63.84	63.80	0.26	0.04	625.0
4	1	14.83	14.83	63.89	63.89	0.21	0.00	643.0
	2	14.82	14.84	63.90	63.88	0.20	0.02	661.0
	3	14.85	14.90	63.87	63.82	0.23	0.05	679.0
3	1	14.81	14.98	63.91	63.74	0.19	0.17	697.0
	2	14.75	14.91	63.97	63.81	0.13	0.16	715.0
	3	14.88	14.90	63.84	63.82	0.26	0.02	733.0

(Continued)

Table 1 (Concluded)

Port	Pt.	n-Rdg ft	s-Rdg ft	Zn ft-NGVD	Zs ft-NGVD	DZn ft	DZw ft	Station ft
2	1	14.92	14.90	63.80	63.82	0.30	-0.02	751.0
	2	14.92	14.90	63.80	63.82	0.30	-0.02	769.0
	3	14.85	14.84	63.87	63.88	0.23	-0.01	787.0
1	1	14.88	15.00	63.84	63.72	0.26	0.12	805.0
	2	14.96	14.98	63.76	63.74	0.34	0.02	823.0
	3	15.00	14.92	63.72	63.80	0.38	-0.08	841.0

Table 2
Water-Surface Measurements (24 May 1991)

Port	Pt.	n-Rdg ft	s-Rdg ft	Zn ft-NGVD	Zs ft-NGVD	DZn ft	DZw ft	Station ft
U. Staff Gage				64.90				
12.5	2	13.83	15.13	64.89	63.59	0.01	1.30	185.5
12	1	13.92	14.67	64.80	64.05	0.10	0.75	211.0
	2	14.00	14.92	64.72	63.80	0.18	0.92	229.0
	3	13.96	14.88	64.76	63.84	0.14	0.92	247.0
11	1	13.94	14.60	64.78	64.12	0.12	0.66	265.0
	2	13.98	14.88	64.74	63.84	0.16	0.90	283.0
	3	13.94	14.88	64.78	63.84	0.12	0.94	301.0
10	1	13.96	14.52	64.76	64.20	0.14	0.56	317.0
	2	13.98	14.60	64.74	64.12	0.16	0.62	337.0
	3	13.92	14.75	64.80	63.97	0.10	0.83	355.0
9	1	13.90	14.29	64.82	64.43	0.08	0.39	373.0
	2	13.94	14.50	64.78	64.22	0.12	0.56	391.0
	3	14.06	14.52	64.66	64.20	0.24	0.46	409.0
8	1	14.10	14.48	64.62	64.24	0.28	0.38	427.0
	2	14.04	14.58	64.68	64.14	0.22	0.54	445.0
	3	14.08	14.56	64.64	64.16	0.26	0.48	463.0
7	1	14.02	14.33	64.70	64.39	0.20	0.31	481.0
	2	14.02	14.33	64.70	64.39	0.20	0.31	499.0
	3	14.02	14.38	64.70	64.34	0.20	0.36	517.0
6	1	14.08	14.21	64.64	64.51	0.26	0.13	535.0
	2	14.08	14.23	64.64	64.49	0.26	0.15	553.0
	3	14.08	14.38	64.64	64.34	0.26	0.30	571.0
5	1	14.08	14.29	64.64	64.43	0.26	0.21	589.0
	2	14.08	14.29	64.64	64.43	0.26	0.21	607.0
	3	14.08	14,35	64.64	64.37	0.26	0.27	625.0
4	1	14.04	14.25	64.68	64.47	0.22	0.21	643.0
	2	14.04	14.27	64.68	64.45	0.22	0.23	661.0
	3	14.08	14.25	64.64	64.47	0.26	0.17	679.0
3	1	14.04	14.17	64.68	64.55	0.22	0.13	697.0
	2	14.04	14.19	64.68	64.53	0.22	0.15	715.0
	3	14.06	14.25	64.66	64.47	0.24	0.19	733.0

(Continued)

Table 2 (Concluded)								
Port	Pt.	n-Rdg ft	s-Rdg ft	Zn ft-NGVD	Zs ft-NGVD	DZn ft	DZw ft	Station ft
2	1	14.04	14.19	64.68	64.53	0.22	0.15	751.0
	2	14.06	14.13	64.66	64.59	0.24	0.07	769.0
	3	14.10	14.17	64.62	64.55	0.28	0.07	787.0
1	1	14.04	14.13	64.68	64.59	0.22	0.09	805.0
	2	14.10	14.21	64.62	64.51	0.28	0.11	823.0
	3	14.21	14.25	64.51	64.47	0.39	0.04	841.0

Table 3
Water-Surface Measurements (12 Dec 1991)

Port	Pt.	n-Rdg ft	s-Rdg ft	Zn ft-NGVD	Zs ft-NGVD	DZn ft	DZw ft	Station ft
U. Staff Gage				64.00				
12.5	2	14.65	15.60	64.07	63.12	-0.07	0.96	185.50
12	2	14.73	15.45	63.99	63.27	0.01	0.72	229.00
11	2	14.73	15.44	64.99	63.28	0.01	0.71	283.00
10	2	14.72	15.27	64.00	63.45	-0.00	0.55	337.00
9	2	14.78	15.22	63.94	63.50	0.06	0.44	391.00
8	2	14.72	15.15	64.00	63.57	-0.00	0.43	445.00
7	2	14.75	15.05	63.97	63.67	0.03	0.30	499.00
6	2	14.75	15.05	63.97	63.67	0.03	0.30	553.00
5	2	14.75	14.94	63.97	63.78	0.03	0.19	607.00
4	2	14.74	14.90	63.98	63.82	0.02	0.16	661.00
3	2	14.74	14.80	63.98	63.92	0.02	0.06	715.00
2	2	14.76	14.86	63.96	63.86	0.04	0.10	769.00
1	2	14.79	14.81	63.93	63.91	0.07	0.02	823.00

Table 4
Port Velocity Measurements (29 Jan 1991), John H. Overton Lock, Red River, Prototype Experiments, Upstream Guard Wall and Adjacent Approach Channel

PT	X-Rdg	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	$\underline{V}$, fps [ϕ, deg]	q cfs	q %	Sum q %
Port #12.5											
B2	0.00	-5.60	360	5.60	0	360	85	5.60 [85]	1,523	12	12
Port #12											
B2	2.00	-4.60	330	5.02	-23	307	32				
B3	2.40	-4.80	360	5.37	-27	333	58	5.20 [45]	2,008	16	28
Port #11											
B2	1.00	-6.60	320	6.68	-9	311	36	6.68 [36]	2,142	17	46
Port #10											
B2	-1.40	-6.30	300	6.45	13	313	38	6.45 [38]	2,169	17	63
Port #9											
A2	-2.20	-3.70	290	4.30	31	321	46				
B2	-1.00	-2.80	285	2.97	20	305	30				
C2	-1.10	-2.80	295	3.01	21	316	41	3.43 [39]	1,178	9	72
Port #8											
A2	-1.40	-1.00	250	1.72	54	304	29				
B2	-0.50	-3.10	280	3.14	9	289	14				
C2	-0.60	-3.50	295	3.55	10	305	30	2.80 [24]	623	5	77
Port #7											
A2	-2.00	-1.60	270	2.56	51	321	46				
B2	-1.10	-2.80	280	3.01	21	301	26				
C2	-0.50	-2.80	290	2.84	10	300	25	2.80 [32]	811	7	84
Port #6											
C1	-0.80	-3.10	280	3.20	14	294	19				
A2	-1.30	-2.70	280	3.00	26	306	31				
B2	-0.50	-2.60	270	2.65	11	281	6				
C2	-0.50	-1.60	290	1.68	17	307	32	2.63 [22]	538	4	88

(Continued)

Table 4 (Concluded)

PT	X-Rdg	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	$\underline{V}$, fps [ϕ, deg]	q cfs	q %	Sum q %
Port #5											
A2	-1.30	-2.60	260	2.91	27	287	12				
B2	-0.60	-2.50	270	2.57	13	283	8	2.74 [10]	260	2	90
Port #4											
B2	-0.50	-2.10	290	2.16	13	303	28				
C2	0.00	-2.10	285	2.10	0	285	10	2.13 [19]	379	3	93
Port #3											
B2	-0.50	-1.60	270	1.68	17	287	12				
C2	0.00	-0.60	305	0.60	0	305	30	1.14 [21]	223	2	95
Port #2											
C2	-0.30	-1.30	290	1.33	13	303	28	1.33 [28]	342	3	98
Port #1											
B1	0.30	-1.20	300	1.24	-14	286	11				
C1	0.00	-3.10	295	3.10	0	295	20				
A2	0.20	-0.60	300	0.63	-18	282	7				
C2	0.30	-2.00	320	2.02	-9	311	36	1.75 [16]	263	2	100
											Total Q = 12,458 cfs

Table 5
Port Velocity Measurements (24 May 1991), John H. Overton Lock, Red River, Prototype Experiments, Upstream Guard Wall and Adjacent Approach Channel

PT	X-Rdg	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	V,fps [ϕ,deg]	q cfs	q %	Sum q %
Port #12.5											
A2	0.00	-10.80		10.80							
C2	0.00	-5.00		5.00				7.90 [85][1]	2,148	12	12
Port#12											
C2	-2.00	-6.00		6.32				6.32 [40][1]	2,220	12	24
Port #11											
B2	1.00	-6.00	20	6.08	-9	371	96				
C2	1.00	-7.50	330	7.57	-8	322	47	6.82 [72][1]	3,544	20	44
Port #10											
C3	0.00	-6.50	300	6.50	0	300	25	6.50 [25][1]	1,500	8	52
Port #9											
A2	-0.30	-2.40	310	2.42	7	317	42				
B2	-1.00	-4.00		4.12							
C2	-2.50	-6.50		6.96							
A3	-2.00	-5.50		5.85							
B3	-1.60	-4.60		4.87							
C3	-1.60	-4.50		4.78				4.83 [42][1]	1,766	10	62
Port #8											
A1	-2.00	-3.00		3.61							
B1	-1.00	-4.50		4.61							
C1	-1.50	-5.50		5.70							
A2	-0.80	-5.80		5.85							
B2	-1.30	-5.50		5.65							
C2	-1.60	-5.50		5.73							
A3	-0.60	-4.20		4.24							

(Sheet 1 of 3)

[1] These values are smoothed angles from 29 Jan 1991 experiments. The initial compass and the replacement were damaged while experimenting with ports 12.5 - 9, 24 May 1991.

Table 5 (Continued)

PT	X-Rdg	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	V,fps [ϕ,deg]	q cfs	q %	Sum q %
B3	-1.30	-4.60		4.78							
C3	-1.30	-4.20		4.40				4.95 {26}[1]	1,185	7	68
Port #7											
C1	0.80	-3.00		3.10							
A2	-1.30	-4.30		4.49							
B2	-0.80	-5.20		5.26							
C2	-1.30	-4.30		4.49							
A3	0.00	-4.40		4.40							
B3	-0.30	-5.20		5.21							
C3	-0.40	-4.70		4.72				4.53 [26][1]	1,083	6	74
Port #6											
A1	0.40	-4.30		4.32							
B1	0.30	-4.80		4.81							
C1	0.60	-5.40		5.43							
A2	0.30	-4.60		4.61							
B2	-0.40	-4.80		4.82							
C2	-0.40	-5.00		5.02				4.83 [26][1]	1,157	6	81
Port #5											
B1	0.80	-4.50		4.57							
C1	-0.40	-5.60		5.61							
A2	0.00	-3.80		3.80							
B2	-0.40	-4.00		4.02							
C2	0.20	-4.70		4.70				4.54 [19][1]	807	4	85
Port #4											
A1	0.30	-4.00		4.01							
B1	-0.40	-4.10		4.12							
C1	-0.50	-4.00		4.03				4.05 [19][1]	721	4	89

(Sheet 2 of 3)

Table 5 (Concluded)

PT	X-Rdg	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	V,fps [ϕ,deg]	q cfs	q %	Sum q %
Port #3											
A1	0.60	-3.20		3.26							
B1	0.60	-4.30		4.34							
C1	0.50	-4.60		4.63				4.07 {19}[1]	724	4	93
Port #2											
A1	0.00	-2.20		2.20							
B1	0.00	-3.50		3.50							
C1	-0.80	-3.20		3.30				3.00 [19][1]	533	3	96
Port #1											
A1	1.40	-3.50		3.77							
B1	0.70	-3.30		3.37							
C1	0.00	-4.60		4.60				3.91 [19][1]	696	4	100

Total Q = 18,084 cfs

Table 6
Port Velocity Measurements (12 Dec 1991), John H. Overton Lock, Red River, Prototype Experiments, Upstream Guard Wall and Adjacent Approach Channel

PT	X-Rdg	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	$V_r$fps [ϕ,deg]	q cfs	q %	Sum q %
Port #12.5											
A2	0.00	-7.80	340	7.80	0	340	65				
A3	0.00	-9.20	350	9.20	0	350	75				
B3	0.00	-7.20	350	7.20	0	350	75				
C3	0.00	-8.20	300	8.20	0	300	25	8.10 [60]	1,915	6	6
Port #12											
A1	0.00	-3.50	330	3.50	0	330	55				
B1	0.00	-5.20	330	5.20	0	330	55				
C1	0.00	-6.00	325	6.00	0	325	50				
A2	0.00	-4.50	290	4.50	0	290	15				
B2	0.00	-7.50	360	7.50	0	360	85				
C2	0.00	-9.00	360	9.00	0	360	85				
A3	0.00	-5.80	310	5.80	0	310	35				
B3	0.00	-7.20	340	7.20	0	340	65				
C3	0.00	-7.50	360	7.50	0	360	85	6.24 [59]	2,919	10	16
Port #11											
A1	0.00	-6.00	340	6.00	0	340	65				
A2	0.00	-4.80	345	4.80	0	345	70				
B2	0.00	-7.20	330	7.20	0	330	55				
C2	0.00	-7.00	340	7.00	0	340	65				
A3	0.00	-7.80	305	7.80	0	305	30				
B3	0.00	-8.00	300	8.00	0	300	25				
C3	0.00	-9.20	310	9.20	0	310	35	7.14 [49]	2,956	10	26
Port #10											
A1	0.00	-3.00	300	3.00	0	300	25				
A2	0.00	-4.00	350	4.00	0	350	75				
A3	0.00	-7.50	350	7.50	0	350	75				
B3	0.00	-8.00	350	8.00	0	350	75				

Table 6 (Continued)

PT	X-Rd g	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	$V_r$fps [ϕ,deg]	q cfs	q %	Sum q %
C3	0.00	-7.50	360	7.50	0	360	85	6.54 [76]	3,473	12	38
Port #9											
A1	0.00	-7.00	355	7.00	0	355	80				
B1	0.00	-7.00	300	7.00	0	300	25				
A3	-2.00	-7.00	340	7.28	16	356	81	6.82 [71]	3,531	12	49
Port #8											
A1	0.00	-6.20	350	6.20	0	350	75				
B1	0.00	-8.00	330	8.00	0	330	55				
C1	0.00	-2.00	350	2.00	0	350	75				
A2	0.00	-6.80	330	6.80	0	330	55				
B2	0.00	-7.30	340	7.30	0	340	65				
C2	0.50	-6.20	340	6.22	-5	335	60				
B3	0.00	-6.00	360	6.00	0	360	85	6.19 71	3,201	11	60
Port #7											
A1	0.00	-4.40	350	4.40	0	350	75				
B1	0.00	-7.20	330	7.20	0	330	55				
C1	0.00	-6.80	330	6.80	0	330	55				
A2	0.00	-6.50	325	6.50	0	325	50				
B2	0.00	-6.20	325	6.20	0	325	50				
C2	0.00	-5.80	330	5.80	0	330	55				
A3	0.00	-2.00	360	2.00	0	360	85				
B3	0.00	-6.20	360	6.20	0	360	85				
C3	1.00	-5.50	345	5.59	-10	335	60	5.63 [63]	2,747	9	69
Port #6											
A1	0.00	-4.20	335	4.20	0	335	60				
B1	0.00	-5.80	335	5.80	0	335	60				
C1	0.00	-5.80	335	5.80	0	335	60				
A2	0.20	-5.60	335	5.60	-2	333	58				
B2	0.00	-5.60	325	5.60	0	325	50				
C2	0.00	-5.60	335	5.60	0	335	60				

(Sheet 2 of 4)

Table 6 (Continued)											
PT	X-Rdg	Y-Rdg	Fish deg.	v fps	ϕ_1 deg.	ϕ_2 deg.	ϕ_3 deg.	$V_r$fps [ϕ,deg]	q cfs	q %	Sum q %
A3	0.00	-1.60	350	1.60	0	350	75				
B3	0.00	-2.50	340	2.50	0	340	65				
C3	0.00	-5.00	350	5.00	0	350	75	4.63 [63]	2,245	7	77
Port #5											
A1	-0.40	-3.50	335	3.52	7	342	67				
B1	0.00	-4.70	320	4.70	0	320	45				
C1	0.00	-4.40	315	4.40	0	315	40				
A2	0.00	-4.80	325	4.80	0	325	50				
B2	0.00	-5.20	315	5.20	0	315	40				
C2	0.00	-4.80	325	4.80	0	325	50				
A3	0.10	-0.50	355	0.51	-11	344	69	3.56 [38]	1,195	4	81
Port #4											
A1	0.00	-3.30	325	3.30	0	325	50				
B1	0.00	-5.20	330	5.20	0	330	55				
C1	0.00	-4.70	315	4.70	0	315	40				
B2	0.00	-4.80	335	4.80	0	335	60	4.50 [51]	1,916	6	87
Port #3											
A1	-0.10	-4.20	345	4.20	1	346	71				
B1	0.00	-3.70	315	3.70	0	315	40				
C1	0.10	-3.60	320	3.60	-2	318	43				
B2	0.00	-3.00	330	3.0	0	330	55	3.63 [52]	1,569	5	92
Port #2											
A1	-0.20	-3.70	325	3.71	3	328	52				
B1	-0.10	-2.30	310	2.30	2	312	37				
C1	0.00	-3.50	315	3.50	0	315	40				
B2	-0.20	-1.50	355	1.51	8	363	88	2.76 [55]	1,225	4	96
Port #1											
A1	-0.80	-1.40	320	1.61	30	350	75				
B1	0.20	-3.20	335	3.21	-4	331	56				

(Sheet 3 of 4)

Table 6 (Concluded)											
PT	**X-Rdg**	**Y-Rdg**	**Fish deg.**	**v fps**	**ϕ_1 deg.**	**ϕ_2 deg.**	**ϕ_3 deg.**	**$V_s$fps [ϕ,deg]**	**q cfs**	**q %**	**Sum q %**
C1	0.20	-2.50	345	2.51	-5	340	65	2.04 [77]	1,084	4	100
											Total Q = 29,976 cfs

Table 7
Survey Ranges; Velocity and Depth (12 Dec 1991), John H. Overton Lock, Red River, Prototype Experiments, Upstream Guard Wall and Adjacent Approach Channel

Range	X ft	v, fps, for 3 depths			V fps	Depth ft	q cfs	Sum q cfs	Hv ft
		0.2D	0.6D	0.8D					
8+49	12.5	3.83	3.21	3.13	3.39	29.7	1,259	1,121	0.18
	25.0	3.98	3.65	3.13	3.59	27.6	2,475	3,596	0.20
	50.0	3.89	3.28	2.74	3.30	26.8	2,213	5,809	0.17
	75.0	3.73	3.21	2.74	3.23	26.0	2,097	7,906	0.16
	100.0	3.56	3.48	2.92	3.32	27.3	2,266	10,172	0.17
	125.0	4.37	3.06	2.44	3.29	29.9	2,459	12,632	0.17
	150.0	4.37	3.83	2.99	3.73	27.6	2,574	15,205	0.22
	175.0	4.37	3.83	3.13	3.78	21.7	2,049	17,254	0.22
	200.0	3.56	3.28	2.55	3.13	15.6	1,221	18,475	0.15
	225.0	2.86	2.10	2.10	2.35	12.4	730	19,204	0.09
	250.0	2.10	2.20	2.15	2.15	6.0	323	19,527	0.07
5+78	12.5	3.83	4.16	3.98	3.99	29.9	1,491	1,054	0.25
	25.0	3.73	3.48	3.13	3.45	30.0	2,585	3,639	0.18
	50.0	3.56	2.92	2.44	2.97	29.7	2,208	5,847	0.14
	75.0	4.07	3.26	2.44	3.26	29.2	2,377	8,224	0.16
	100.0	4.37	3.65	2.05	3.36	29.6	2,484	10,708	0.17
	125.0	4.07	3.48	2.50	3.35	29.7	2,487	13,195	0.17
	150.0	2.74	1.96	1.65	2.12	28.8	1,524	14,719	0.07
	175.0	2.99	2.68	1.84	2.50	22.7	1,421	16,140	0.10
	200.0	0.84	0.72	0.93	0.83	14.8	307	16,447	0.01
	225.0	-0.75	-0.76	-0.80	-0.77	9.8	-189	16,258	0.01
	250.0	-0.46	-0.76	-0.82	-0.68	8.1	-138	16,121	0.01
4+16	12.5	3.28	4.37	4.37	4.01	30.1	1,508	1,095	0.25
	25.0	4.07	3.73	3.06	3.62	30.2	2,733	3,828	0.20
	50.0	3.73	2.74	1.84	2.77	30.0	2,078	5,906	0.12
	75.0	4.27	2.99	1.96	3.07	29.5	2,267	8,172	0.15
	100.0	3.65	2.74	2.20	2.86	29.5	2,112	10,284	0.13
	125.0	2.99	2.10	1.62	2.24	29.2	1,633	11,917	0.08
	150.0	1.88	2.20	1.06	1.71	28.8	1,234	13,150	0.05
	175.0	-1.11	-0.75	-0.29	-0.72	20.4	-366	12,785	0.01

(Continued)

Table 7 (Concluded)

Range	X ft	v, fps, for 3 depths 0.2D	 0.6D	 0.8D	V fps	Depth ft	q cfs	Sum q cfs	Hv ft
4+16 (Cont)	200.0	-0.84	-0.67	-1.11	-0.87	12.0	-262	12,523	0.01
	225.0	-1.41	-1.35	-2.05	-1.60	11.0	-441	12,082	0.04
2+54	12.5	3.73	3.56	3.06	3.45	30.0	2,588	2,588	0.18
	25.0	2.68	1.88	2.44	2.33	29.9	1,744	4,332	0.08
	50.0	2.99	1.44	1.38	1.94	29.0	1,404	5,736	0.06
	75.0	0.46	1.11	1.80	1.12	29.1	817	6,553	0.02

Table 8
Survey Ranges; Velocity and Depth (24 May 1991), John H. Overton Lock, Red River, Prototype Experiments, Upstream Guard Wall and Adjacent Approach Channel

Range	X ft	v, fps, for 3 depths			V fps	Depth ft	q cfs	Sum q cfs	Hv ft
		0.2D	0.6D	0.8D					
8+49	12.5	4.79	4.37	3.73	4.30	28.5	1,531	1,531	0.29
	25.0	4.57	3.65	3.48	3.90	29.0	2,828	4,359	0.24
	50.0	4.47	3.89	2.86	3.74	28.4	2,655	7,014	0.22
	75.0	4.68	4.07	3.48	4.08	28.3	2,884	9,898	0.26
	100.0	4.57	4.16	3.13	3.95	28.0	2,767	12,665	0.24
	125.0	4.79	4.26	2.99	4.01	29.0	2,910	15,575	0.25
	150.0	4.37	3.73	3.73	3.94	28.5	2,810	18,385	0.24
	175.0	2.99	3.41	2.74	3.05	22.5	1,714	20,099	0.14
	200.0	1.41	1.01	1.58	1.33	16.8	560	20,659	0.03
	225.0	-0.53	-0.97	-0.80	-0.77	13.6	-261	20,398	0.01
	250.0	-1.26	-1.01	-0.76	-1.01	9.0	-227	20,171	0.02
5+78	12.5	4.16	3.98	3.56	3.90	29.0	1,414	1,414	0.24
	25.0	4.91	4.16	3.56	4.21	29.1	3,063	4,477	0.28
	50.0	4.16	3.56	3.06	3.59	29.0	2,605	7,082	0.20
	75.0	4.57	3.98	2.99	3.85	29.0	2,789	9,871	0.23
	100.0	4.57	2.99	2.61	3.39	29.3	2,483	12,354	0.18
	125.0	3.56	3.98	3.48	3.67	29.0	2,663	15,017	0.21
	150.0	1.08	1.35	2.92	1.78	27.7	1,235	16,252	0.05
	175.0	0.72	1.44	1.01	1.06	22.0	581	16,833	0.02
	200.0	-0.63	-0.62	-0.77	-0.67	15.3	-258	16,576	0.01
	225.0	-0.65	-1.20	-0.75	-0.87	9.0	-195	16,381	0.01
	250.0	-0.83	-0.54	-0.50	-0.62	6.0	-94	16,287	0.01
4+16	12.5	4.07	3.98	3.41	3.82	29.6	1,413	1,413	0.23
	25.0	4.79	4.16	2.99	3.98	29.2	2,905	4,318	0.25
	50.0	3.56	3.21	4.57	3.78	29.5	2,788	7,106	0.22
	75.0	2.86	3.73	3.19	3.26	28.7	2,339	9,445	0.17
	100.0	3.48	3.56	3.48	3.51	28.6	2,507	11,952	0.19
	125.0	2.24	2.69	2.20	2.38	29.0	1,723	13,676	0.09
	150.0	1.16	2.20	1.58	1.65	28.3	1,165	14,841	0.04

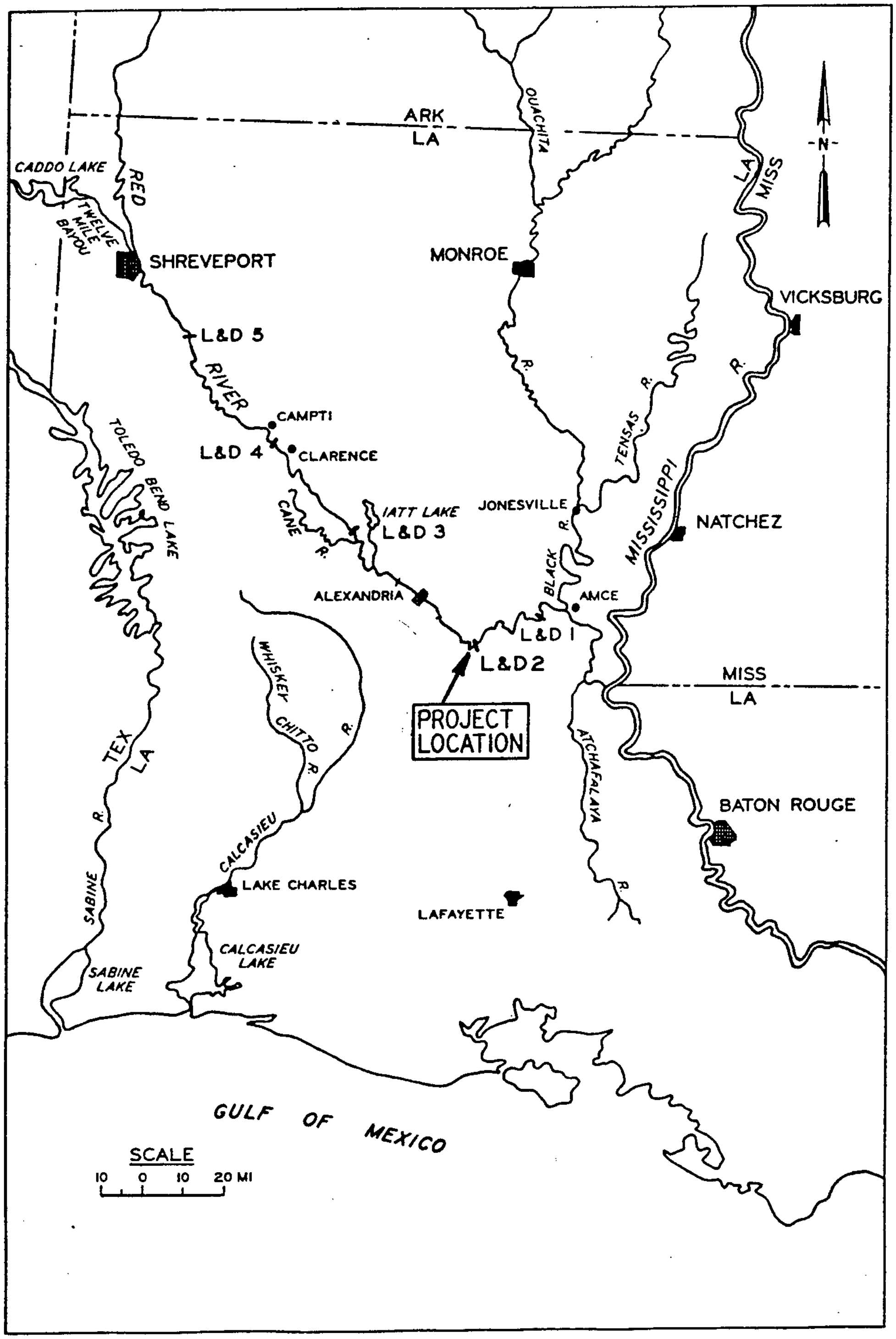


Figure 1. Location map

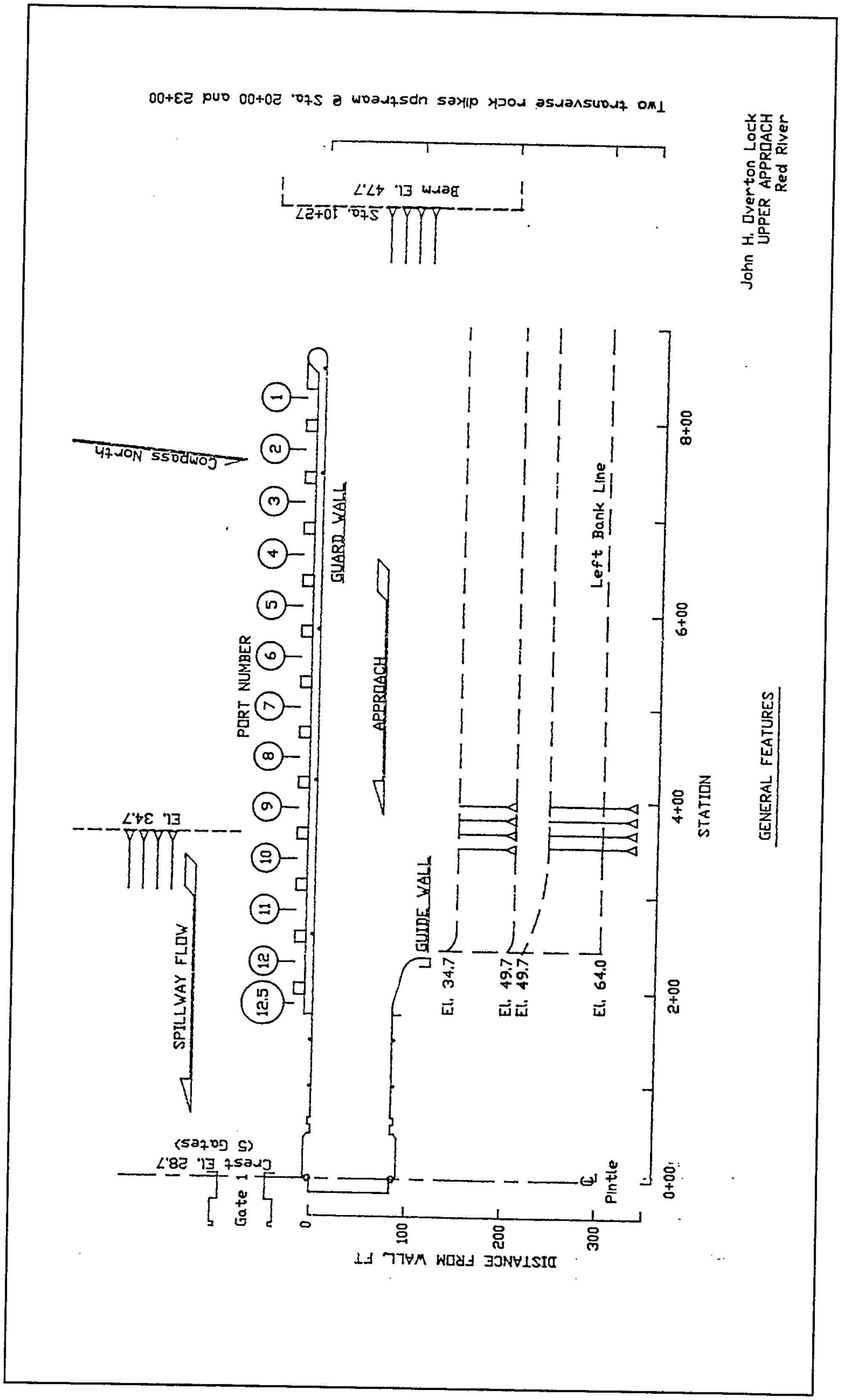
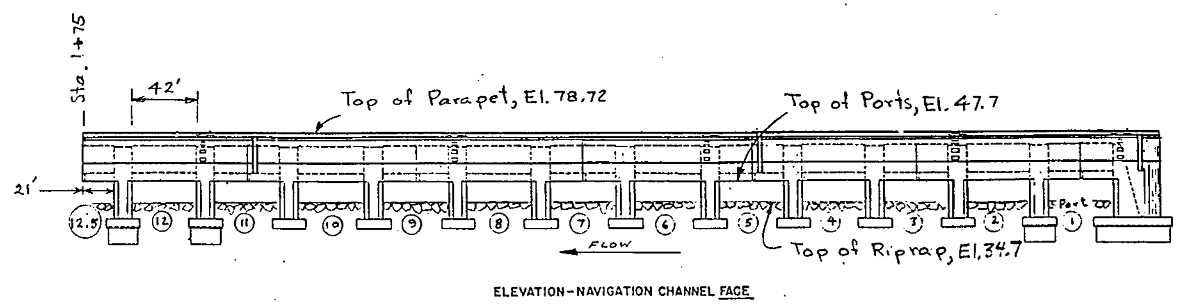
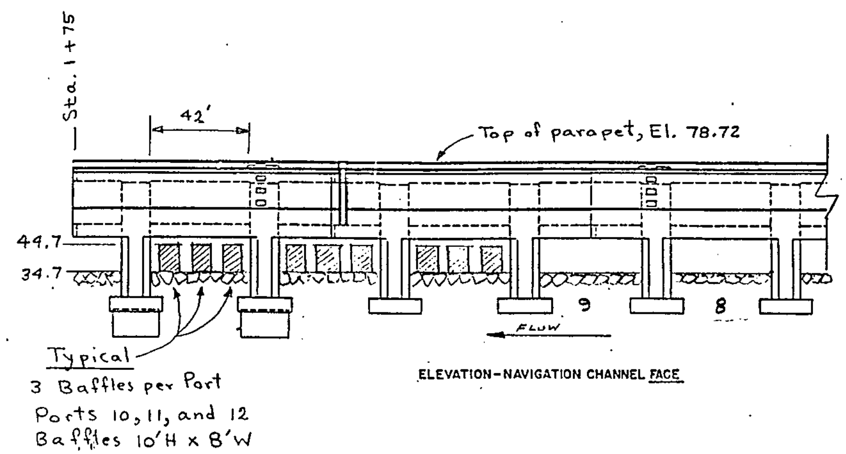


Figure 2. Layout and terminology

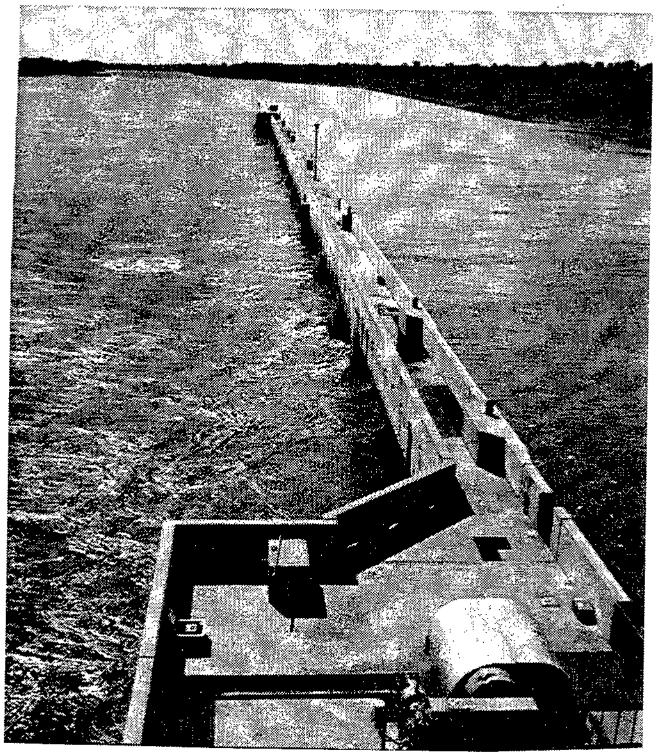


a. Initial layout, ports are not baffled

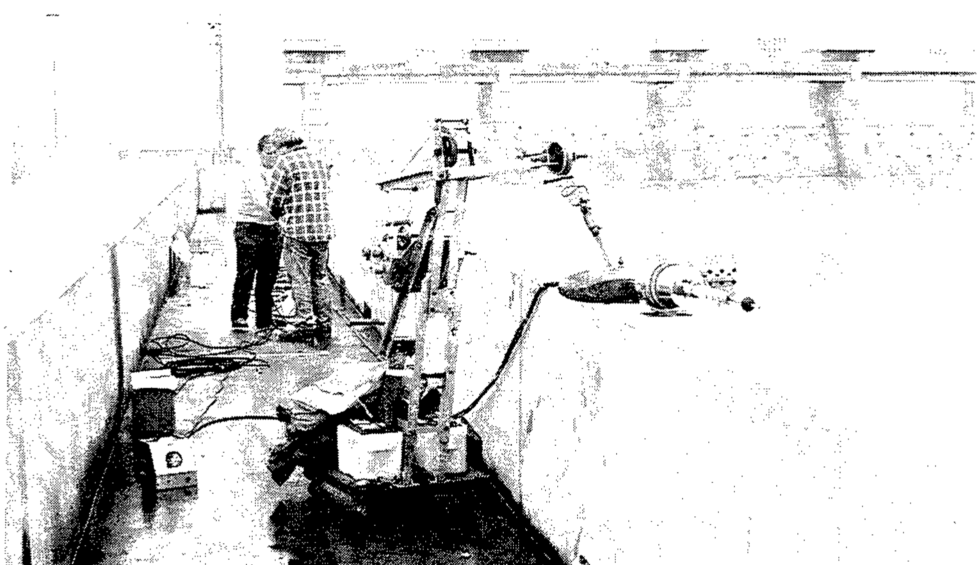


b. Final layout, Ports 10, 11, and 12 are baffled

Figure 3. Ports and baffles

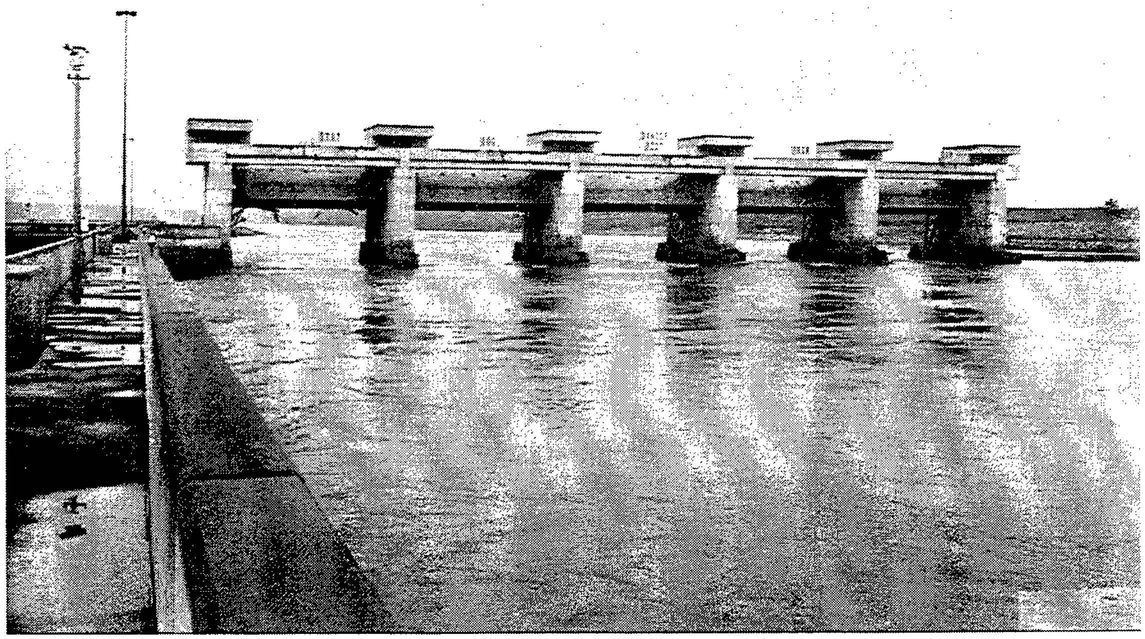


a. Guard wall, 24 May 1991. View looking upstream; the turbulence along the spillway side is most severe for ports 10-12.5

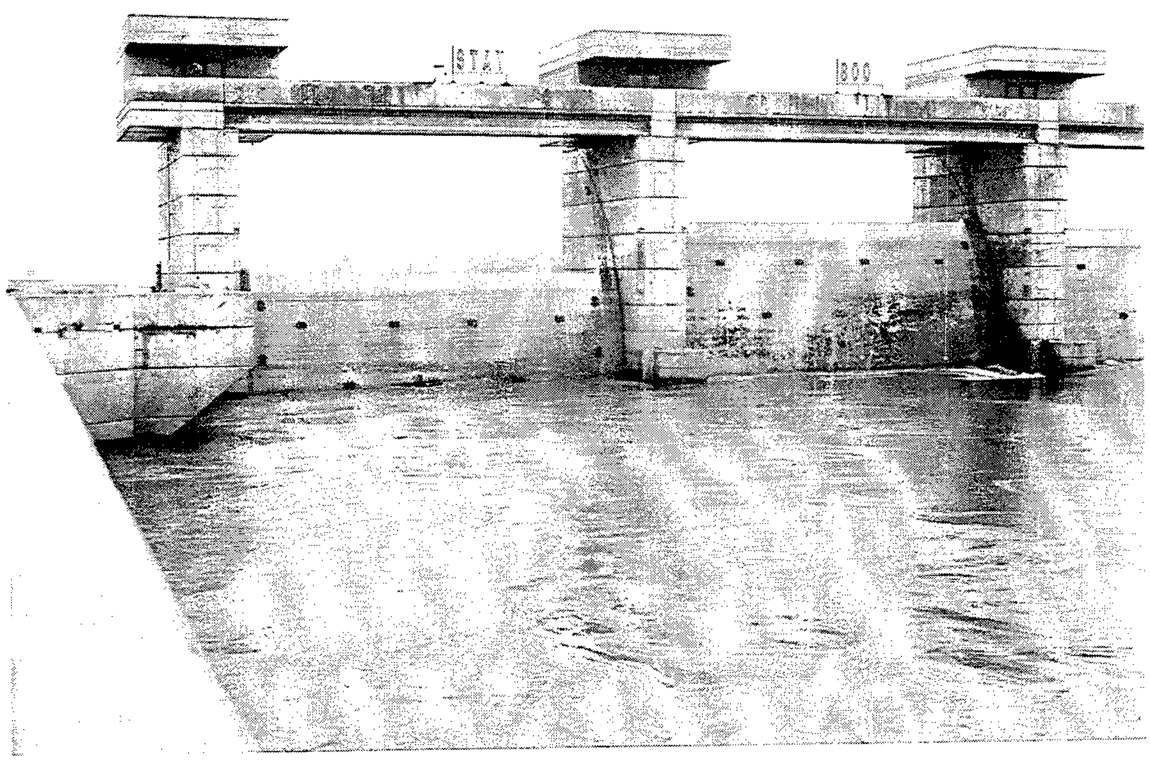


b. Velocity meter, compass, and fish on the guard wall parapet, 29 Jan 1991

Figure 4. Upstream guard wall at John H. Overton Lock

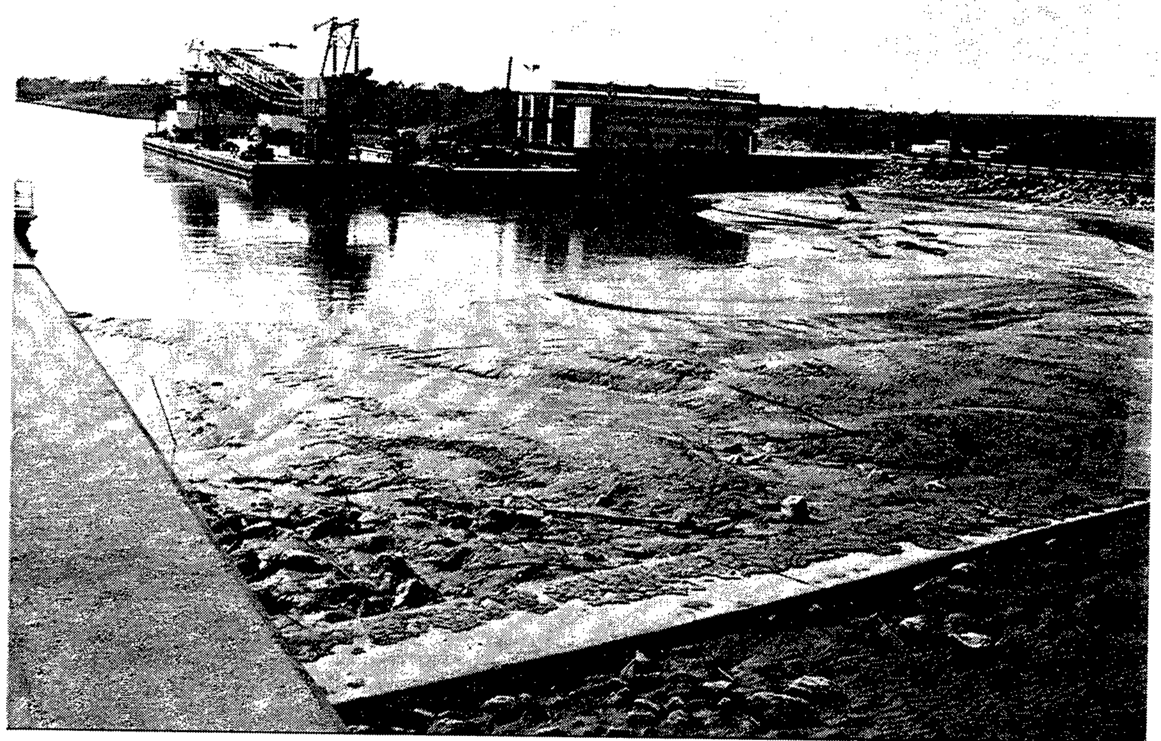


a. Spillway (Gates 1-5 full open), 24 May 1991

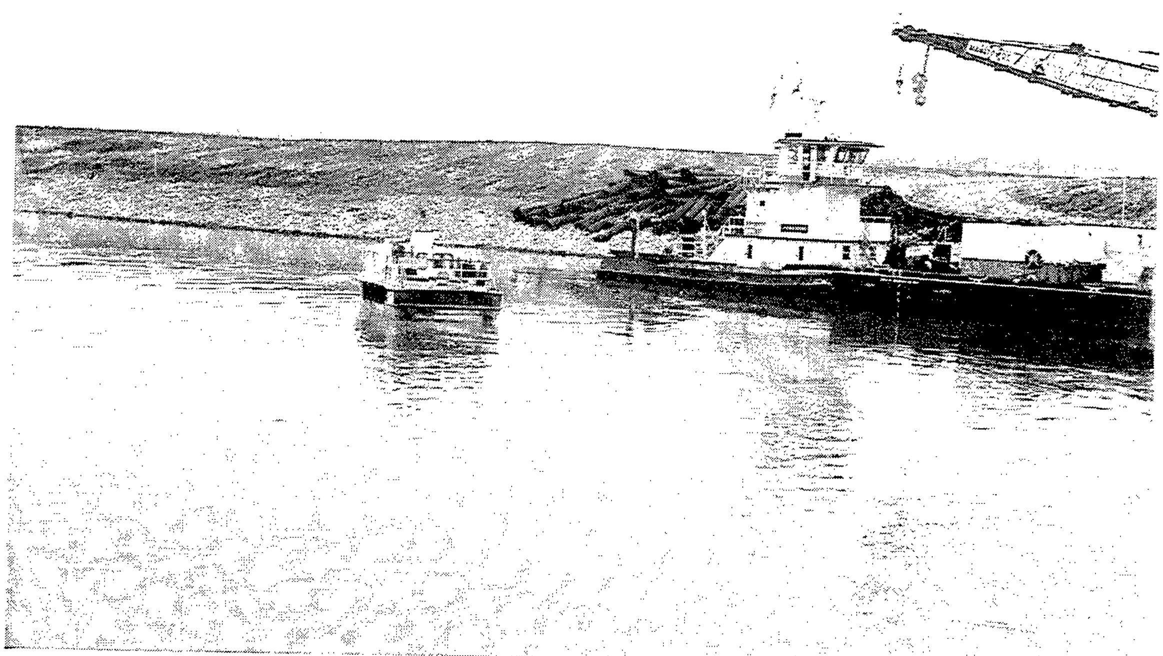


b. Spillway (Gate 1 open 10 ft; Gates 2-5 open 22 ft), 29 Jan 1991

Figure 5. Spillway flow conditions



a. 24 May 1991



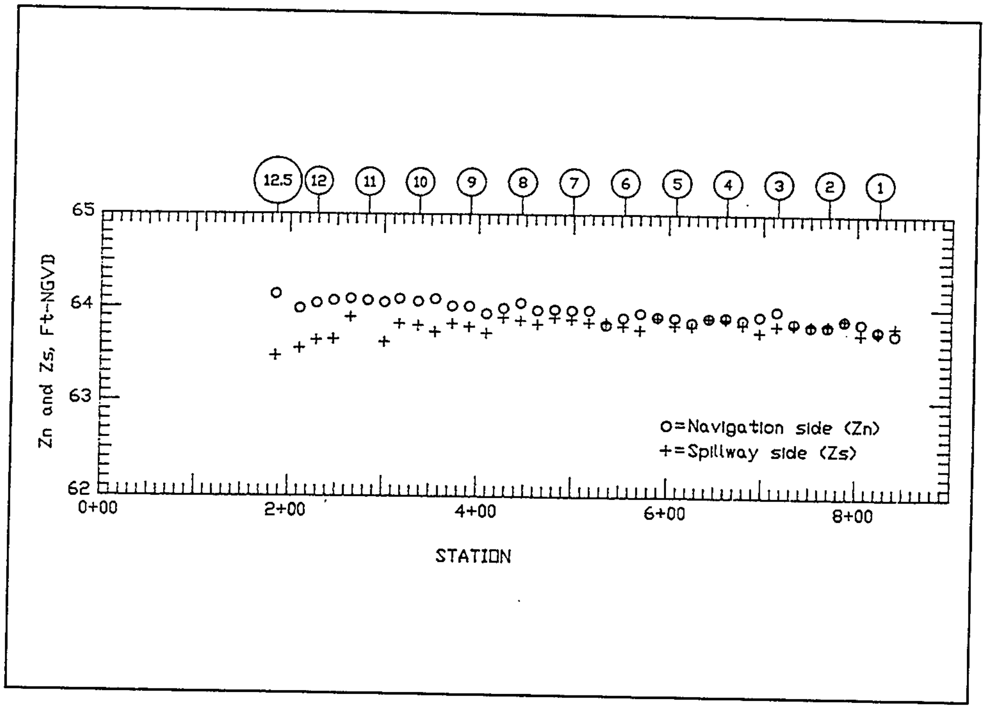
b. 29 Jan 1991 (survey vessel *Cele* on Range 4+16)

Figure 6. Construction activity

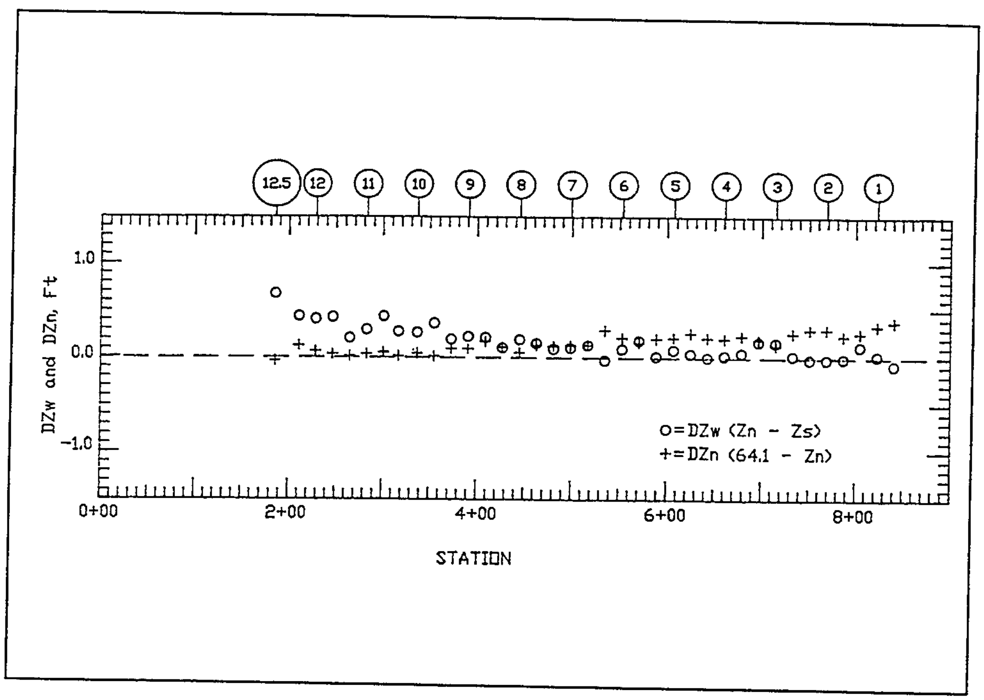
a. Approach channel upstream from the guard wall

b. Flow at the gate bays

Figure 7. Special topics, 24 May 1991

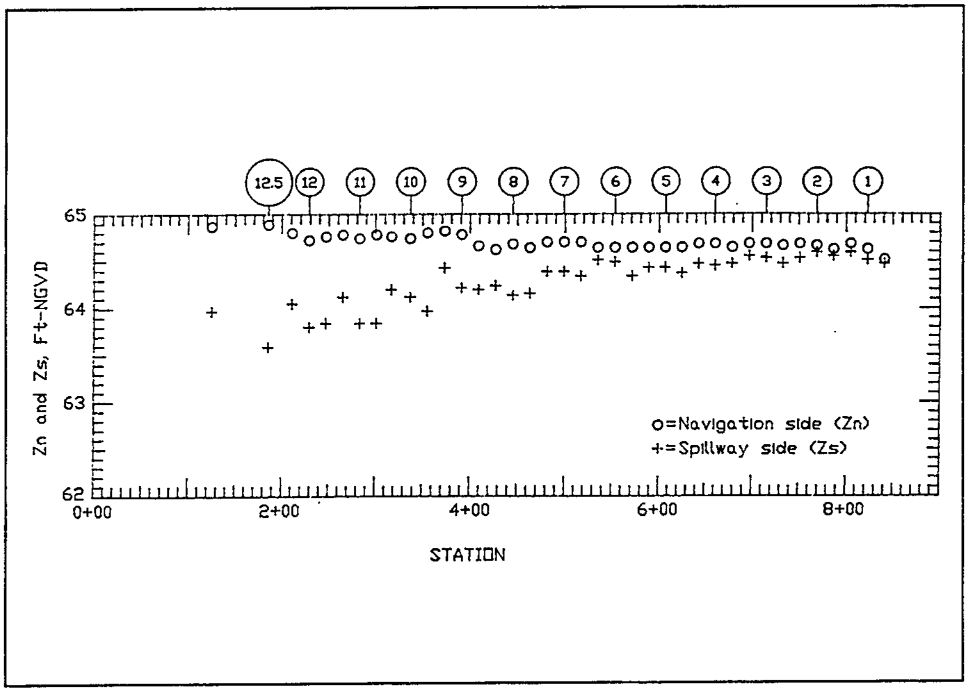


a. Elevations

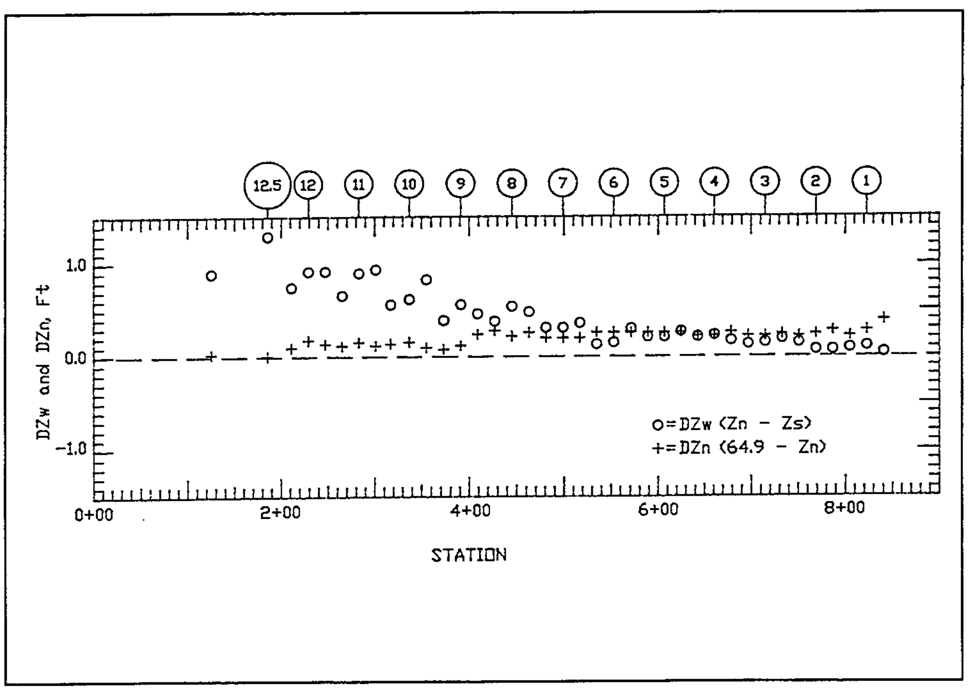


b. Differentials

Figure 8. Water-surface measurements (29 Jan 1991), Upper pool el. = 64.0 ft NGVD, River flow = 85,000 cfs

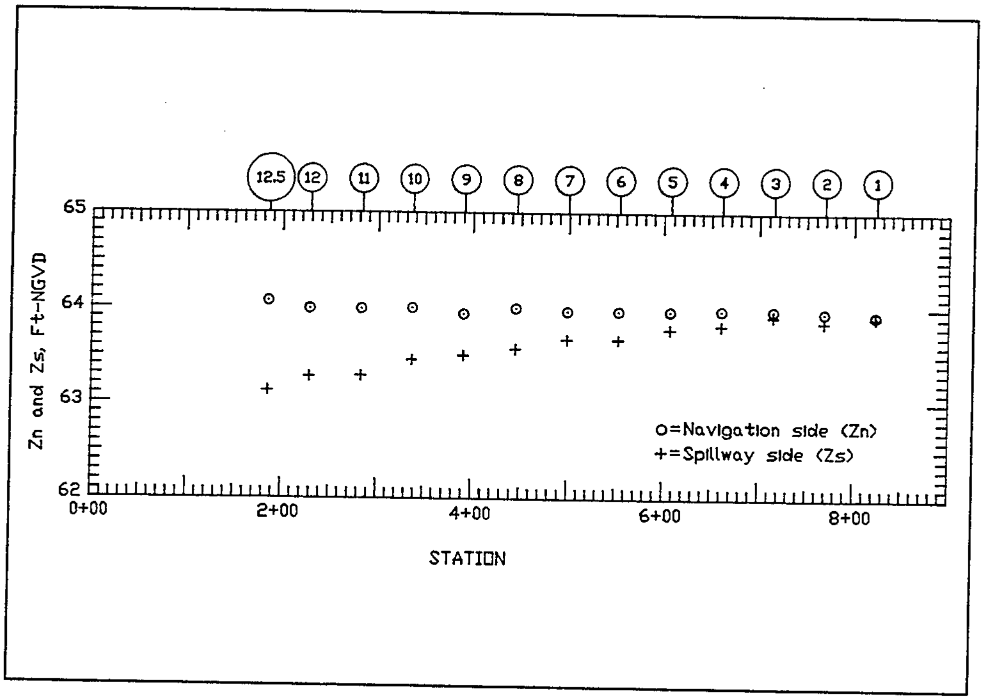


a. Elevations

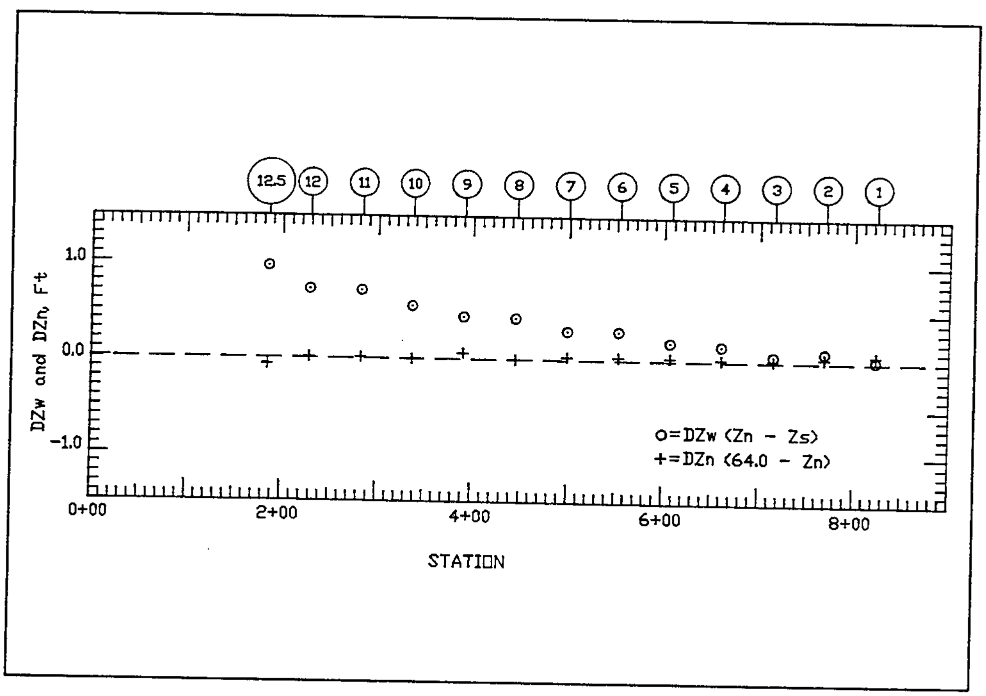


b. Differentials

Figure 9. Water-surface measurements (24 May 1991), Upper pool el. = 65.1 ft NGVD, River flow = 116,000 cfs

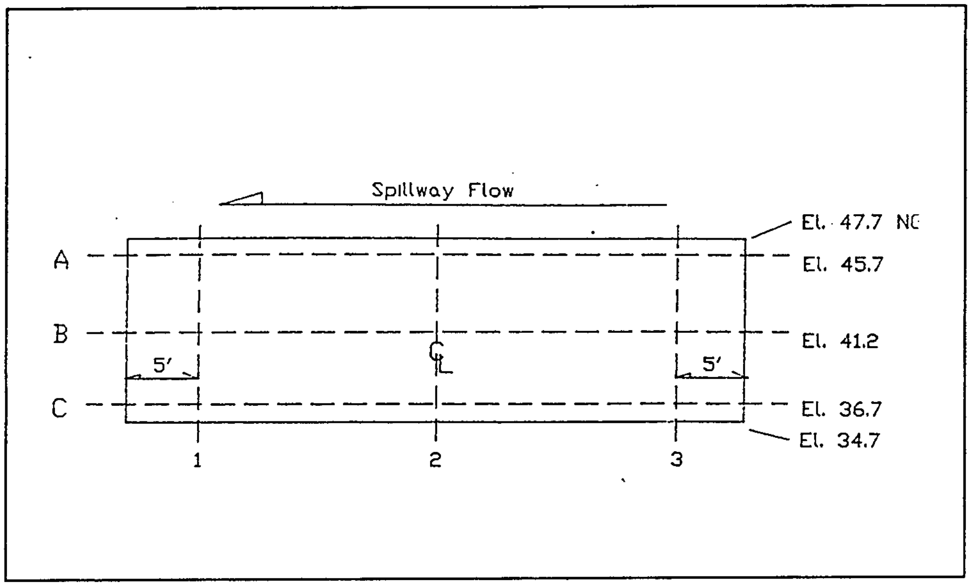


a. Elevations

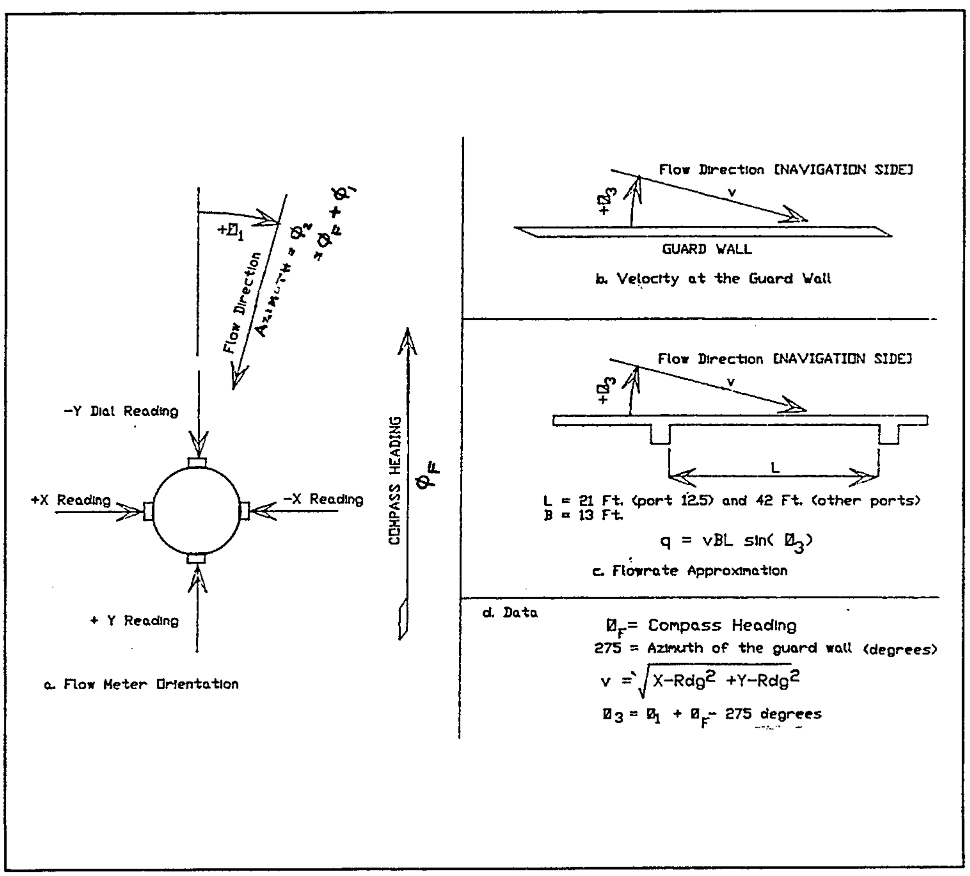


b. Differentials

Figure 10. Water-surface measurements (12 Dec 1991), Upper pool el. = 64.0 ft NGVD, River flow = 115,000 cfs

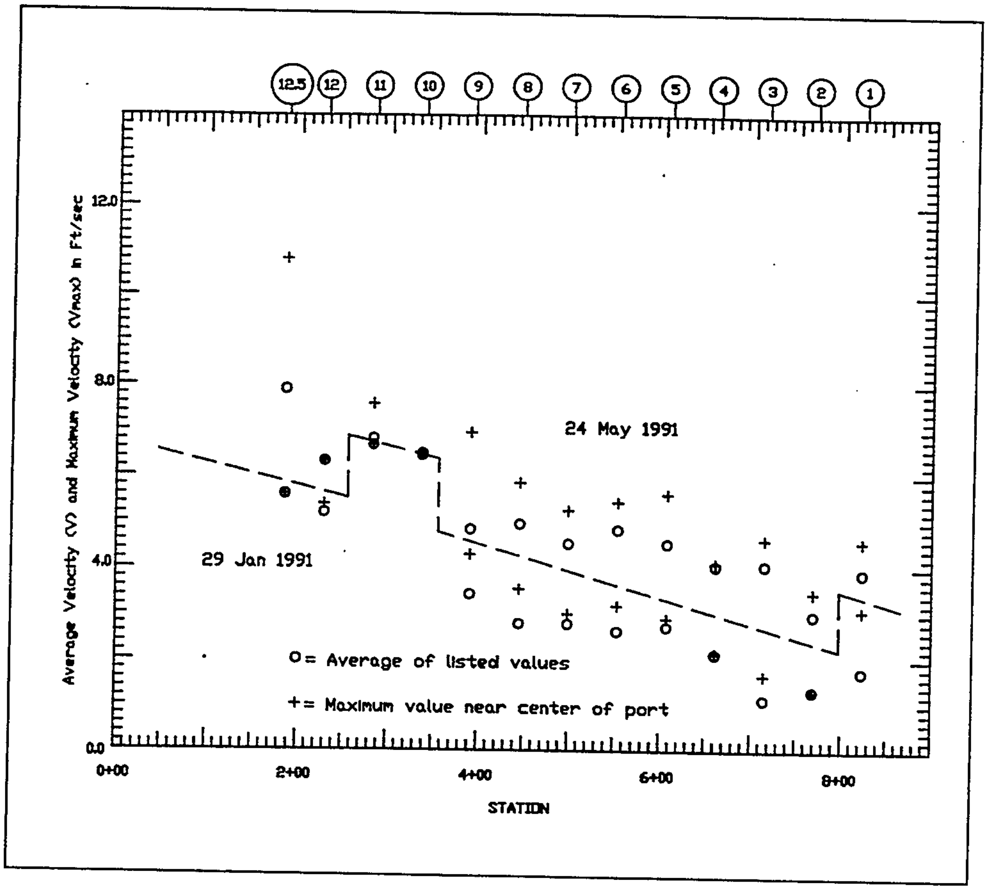


a. Velocity measurement locations (typical) 29 Jan 1991. Points 1 and 3 are moved an extra 5.5 ft towards the center 24 May 1991

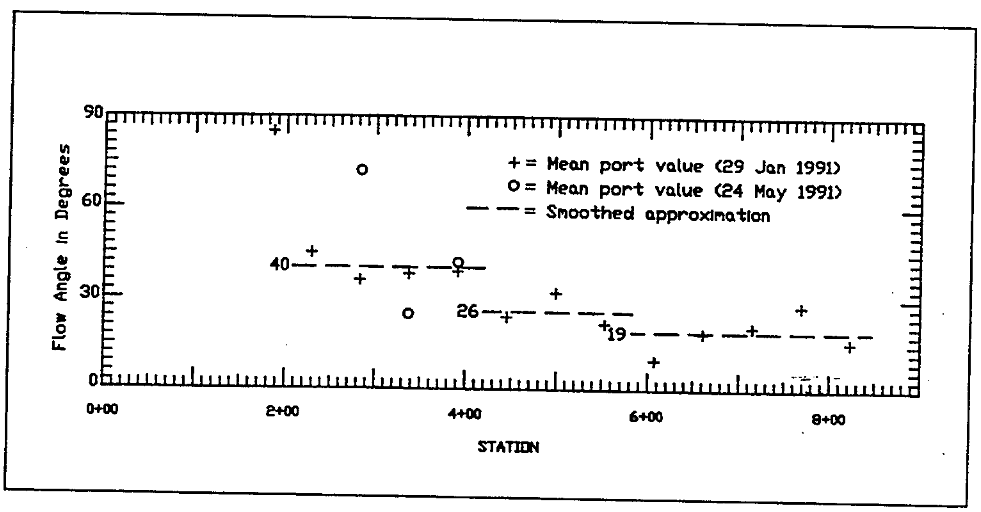


b. Current meter definition sketch

Figure 11. Port velocity measurement locations and definitions



a. Magnitude



b. Direction

Figure 12. Velocity of the flow through the ports. Flow angle is relative to the guard wall

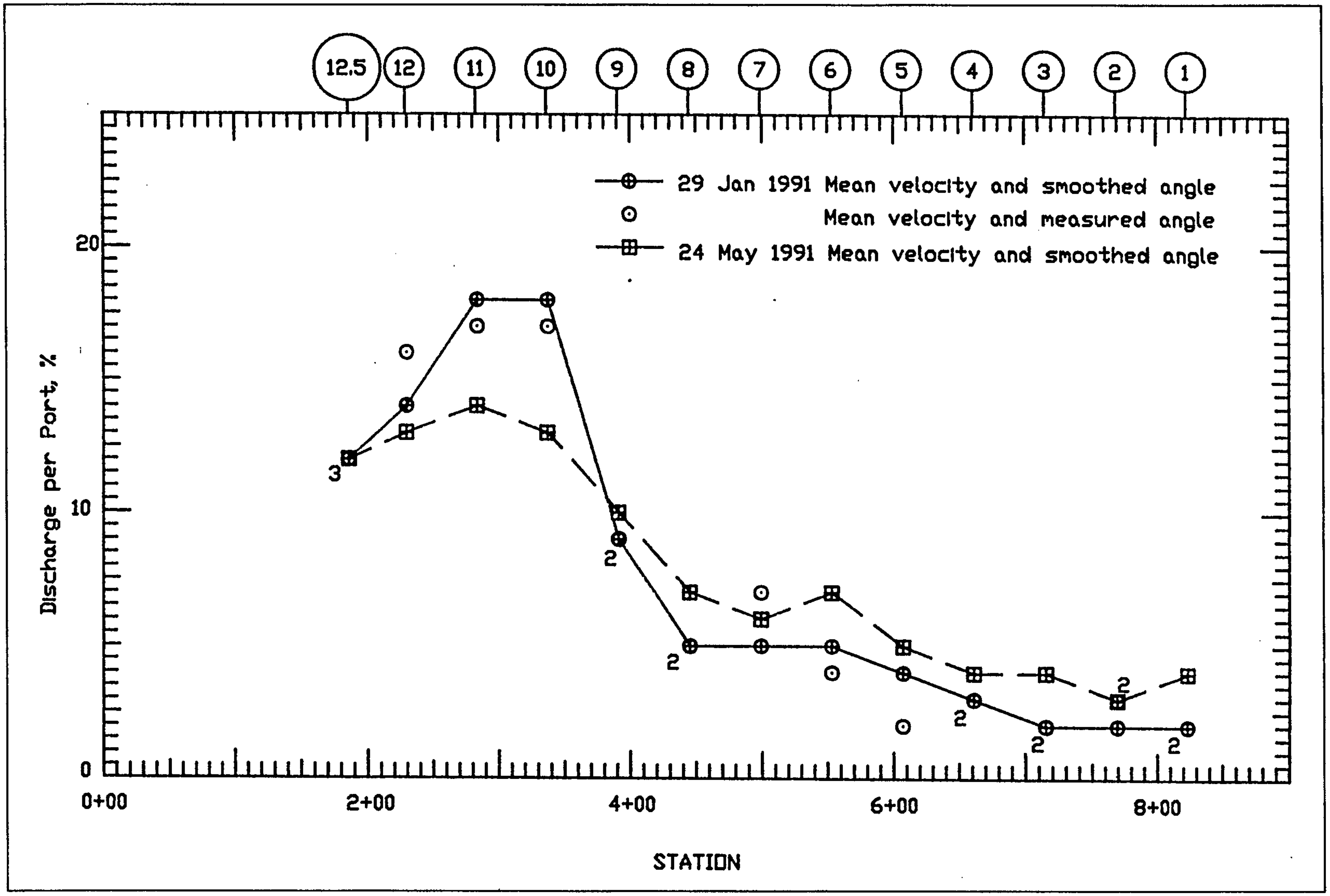


Figure 13. Flow distribution for the guard wall ports

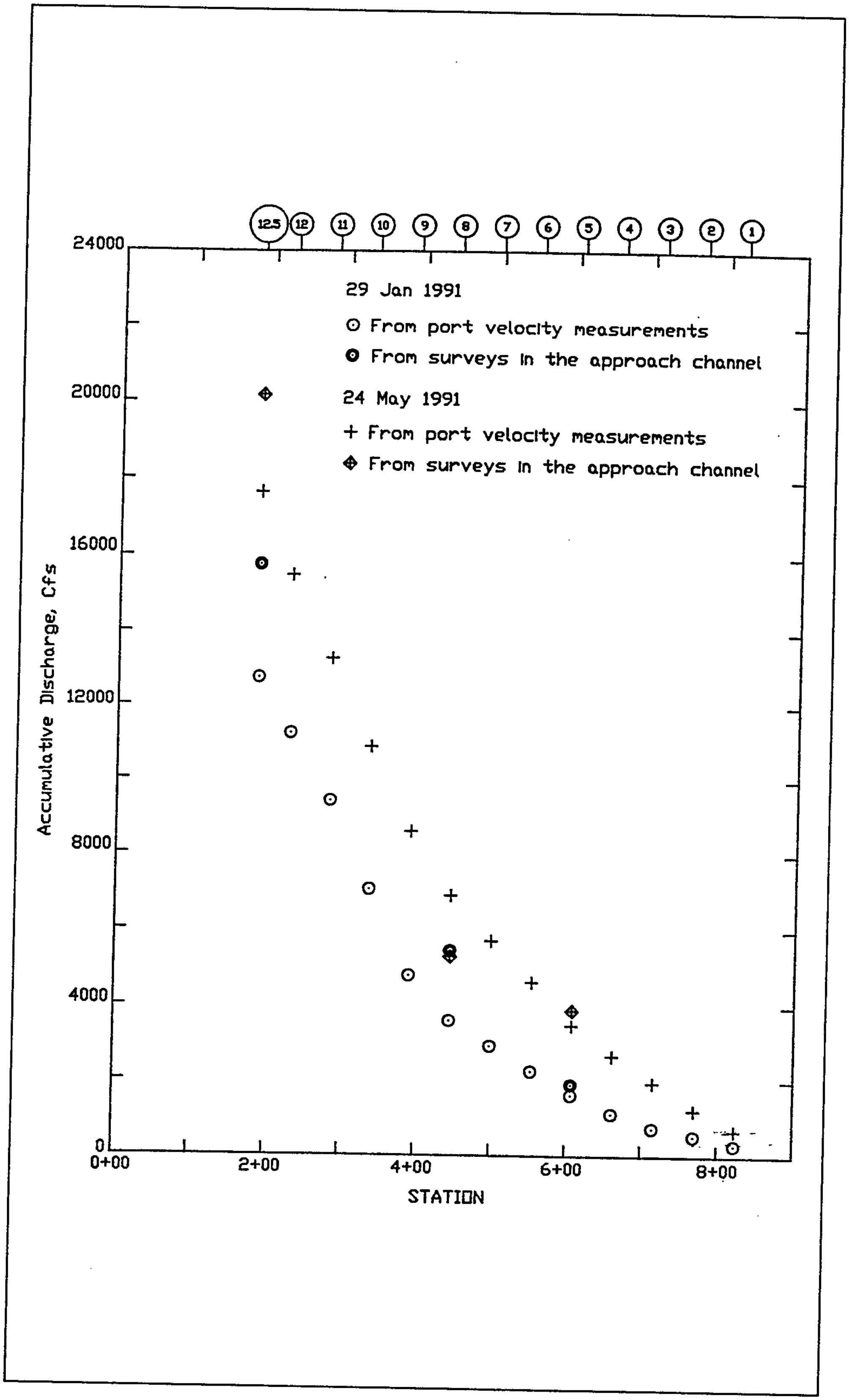
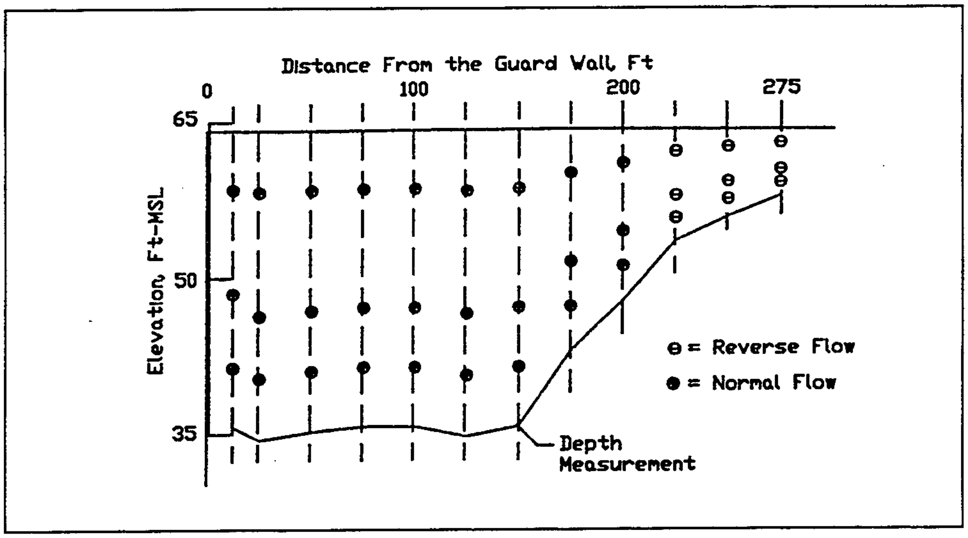
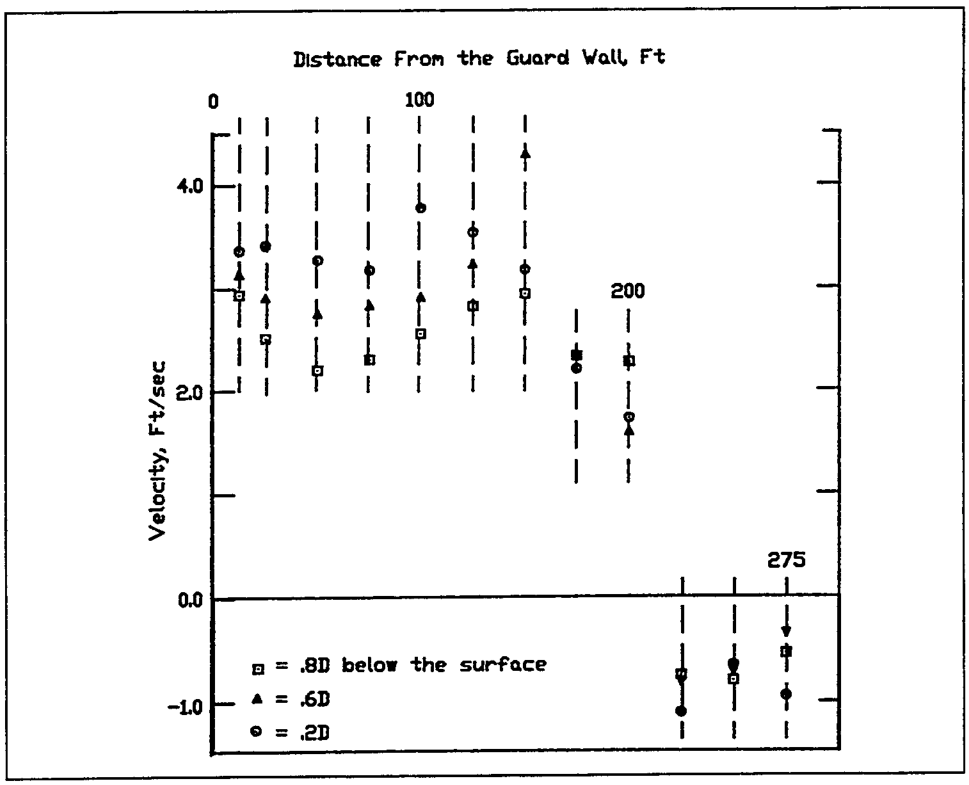


Figure 14. Accumulative discharge through the guard wall ports



a. Measurement locations (sectional view)



b. Velocity distribution

Figure 15. Example of a velocity traverse in the approach channel. The data are from the 29 Jan 1991 experiments and are for the range at Sta. 8+49

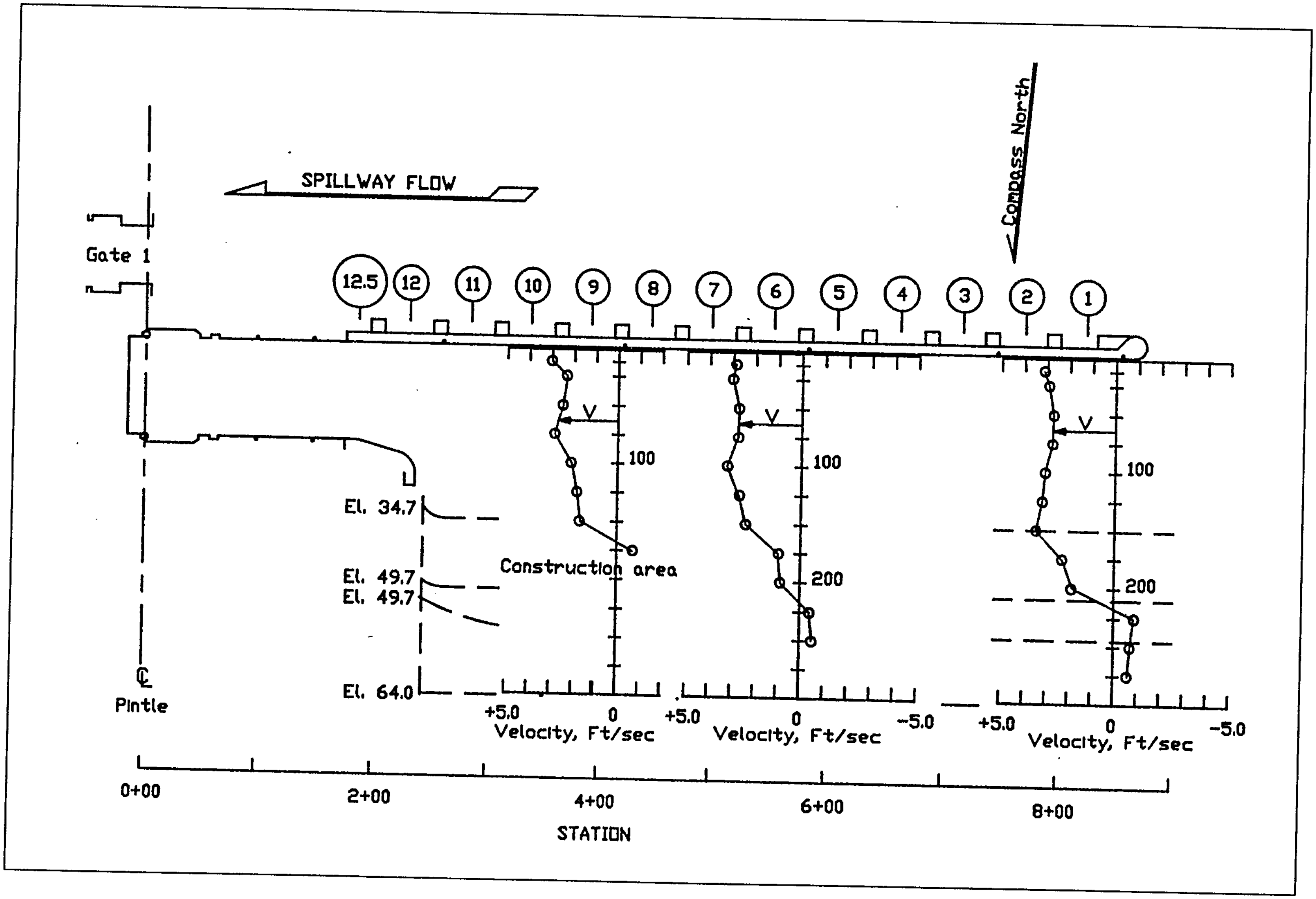


Figure 16. Depth-averaged velocity across the navigation channel. Data are from 29 Jan 1991 experiments (Q = 85,000 cfs)

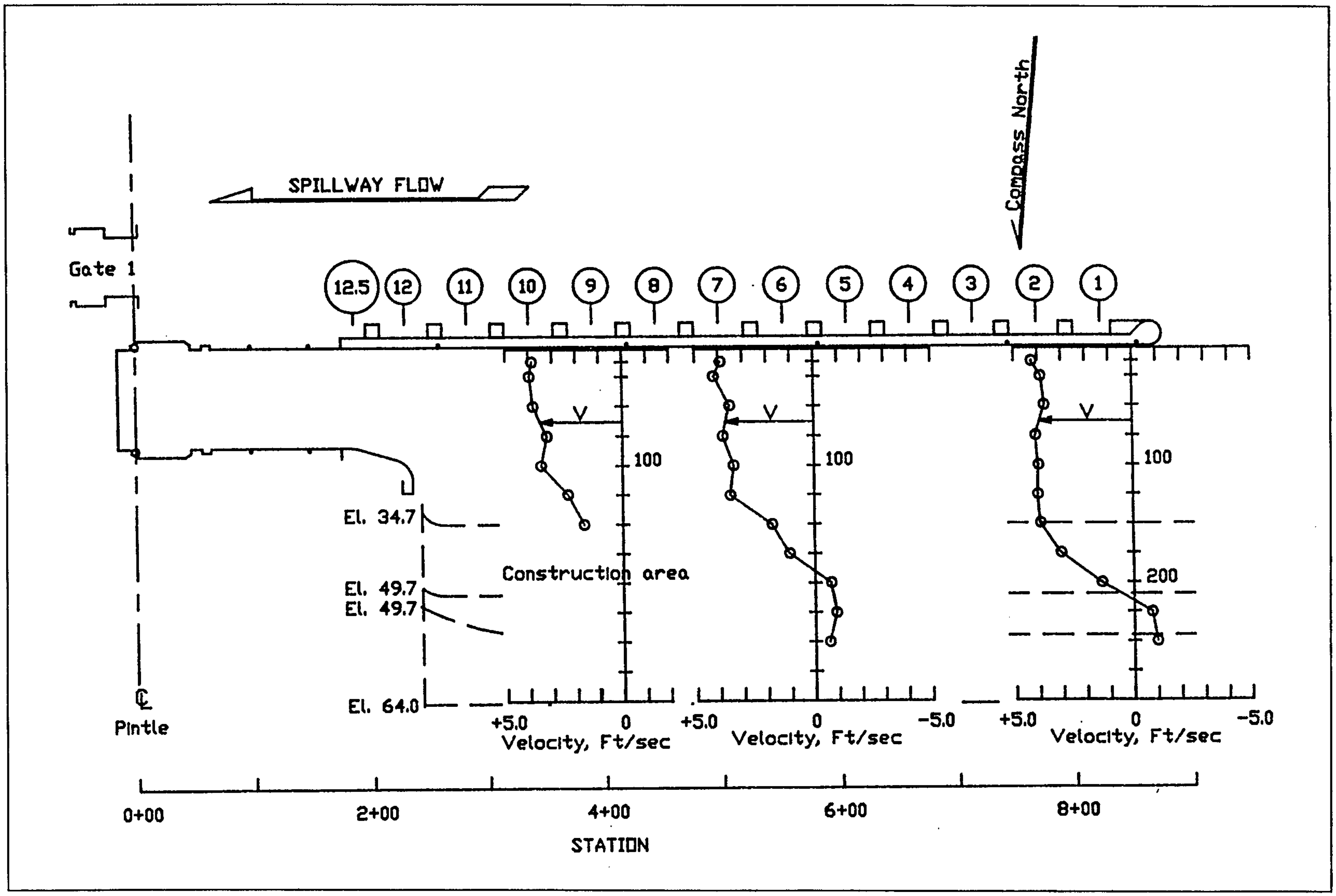


Figure 17. Depth-averaged velocity across the navigation channel. Data are from 24 May 1991 experiments (Q = 116,000 cfs)

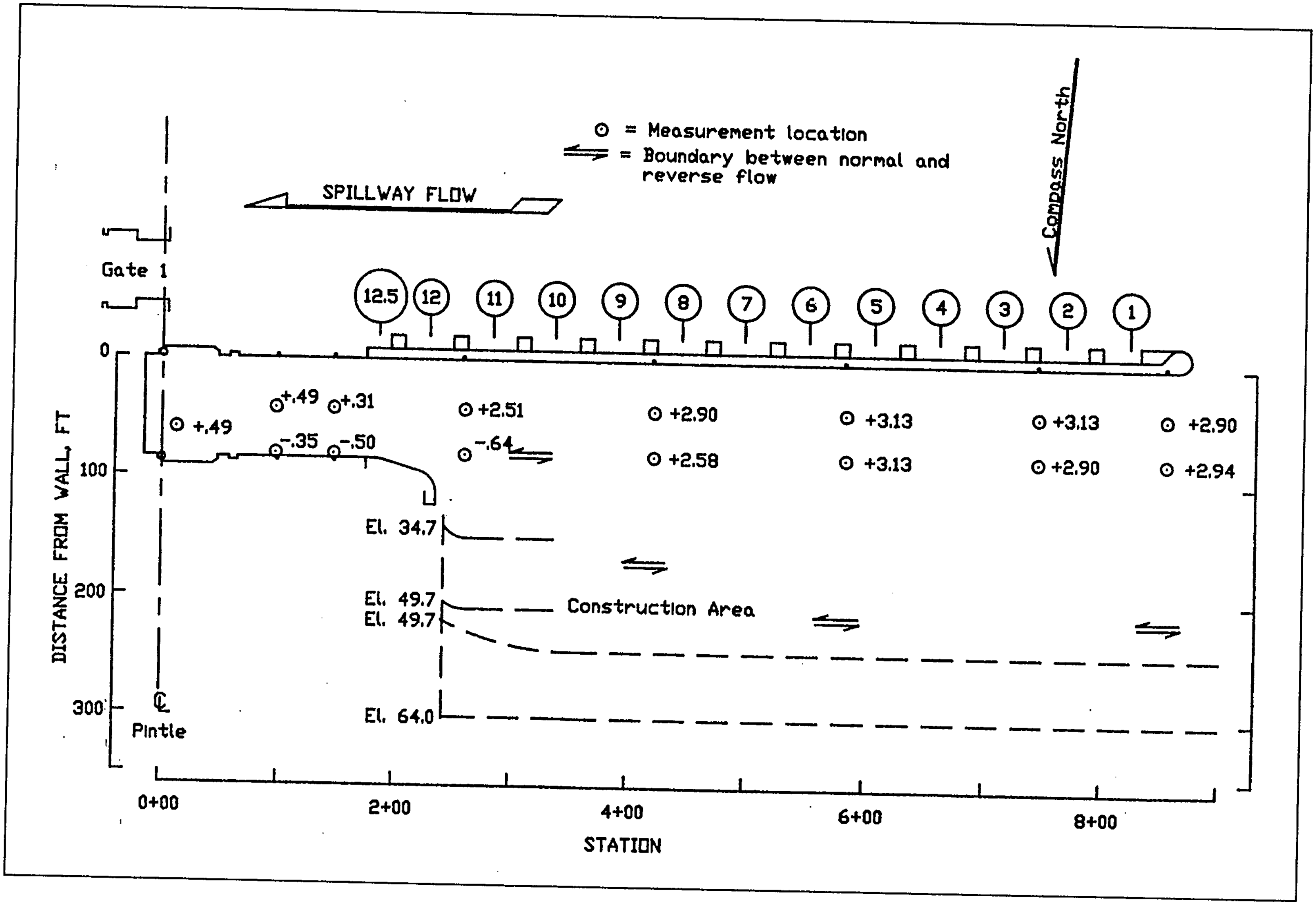


Figure 18. Near-surface velocities and drift (*Cele*) 29 Jan 1991

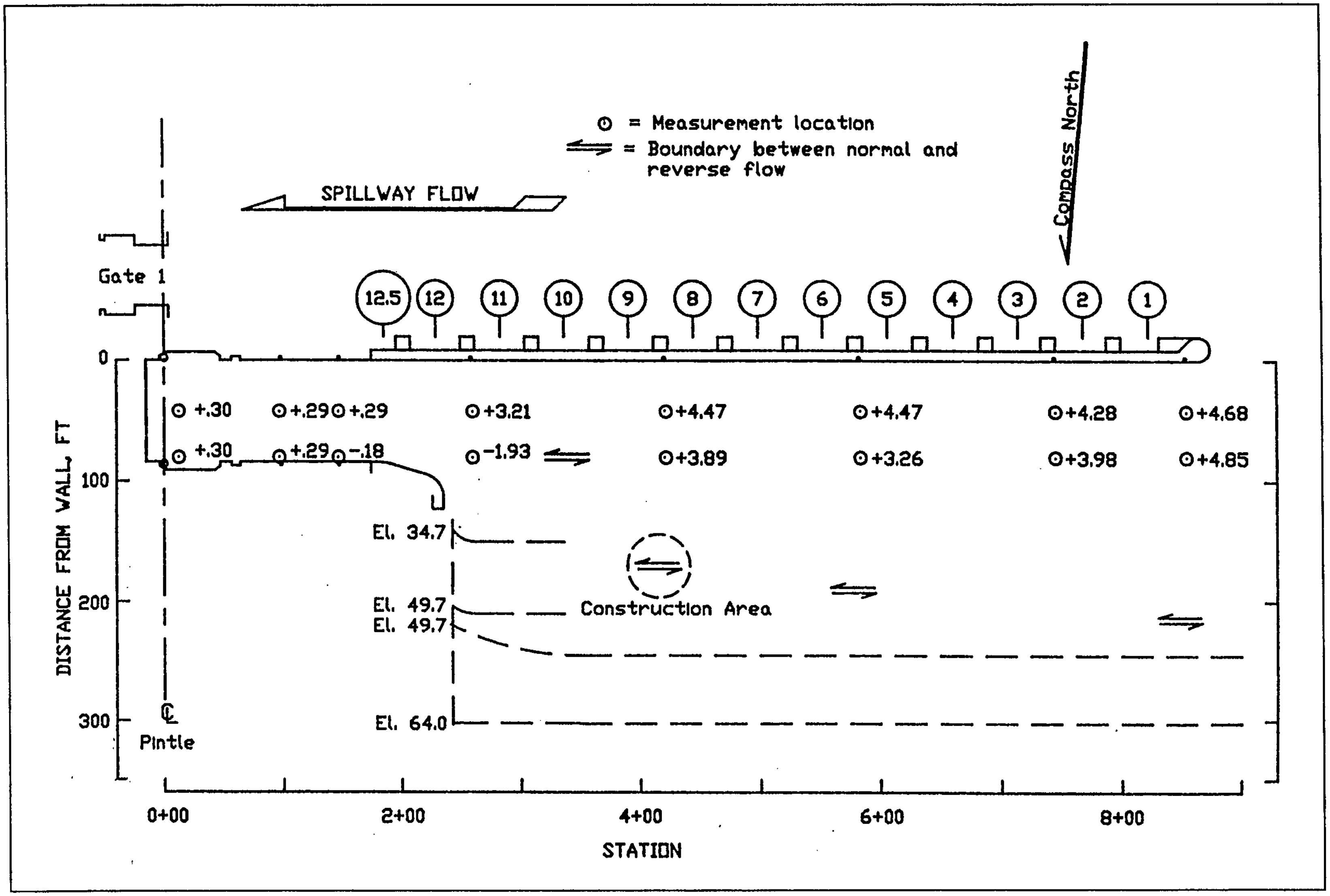


Figure 19. Near-surface velocities and drift (*Cele*) 24 May 1991

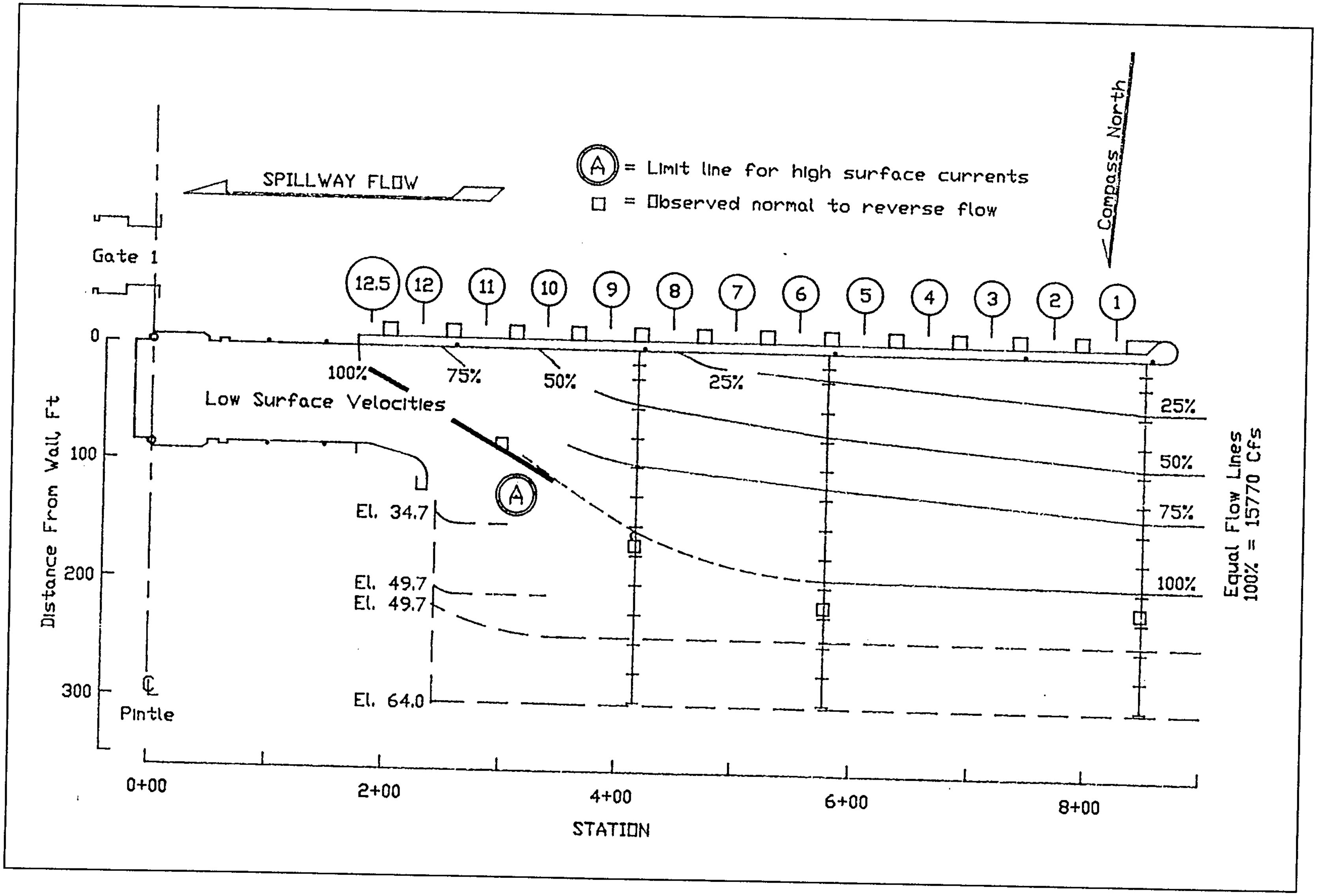


Figure 20. Flow distribution in the approach channel. 29 Jan 1991 experiments (Q = 85,000 cfs)

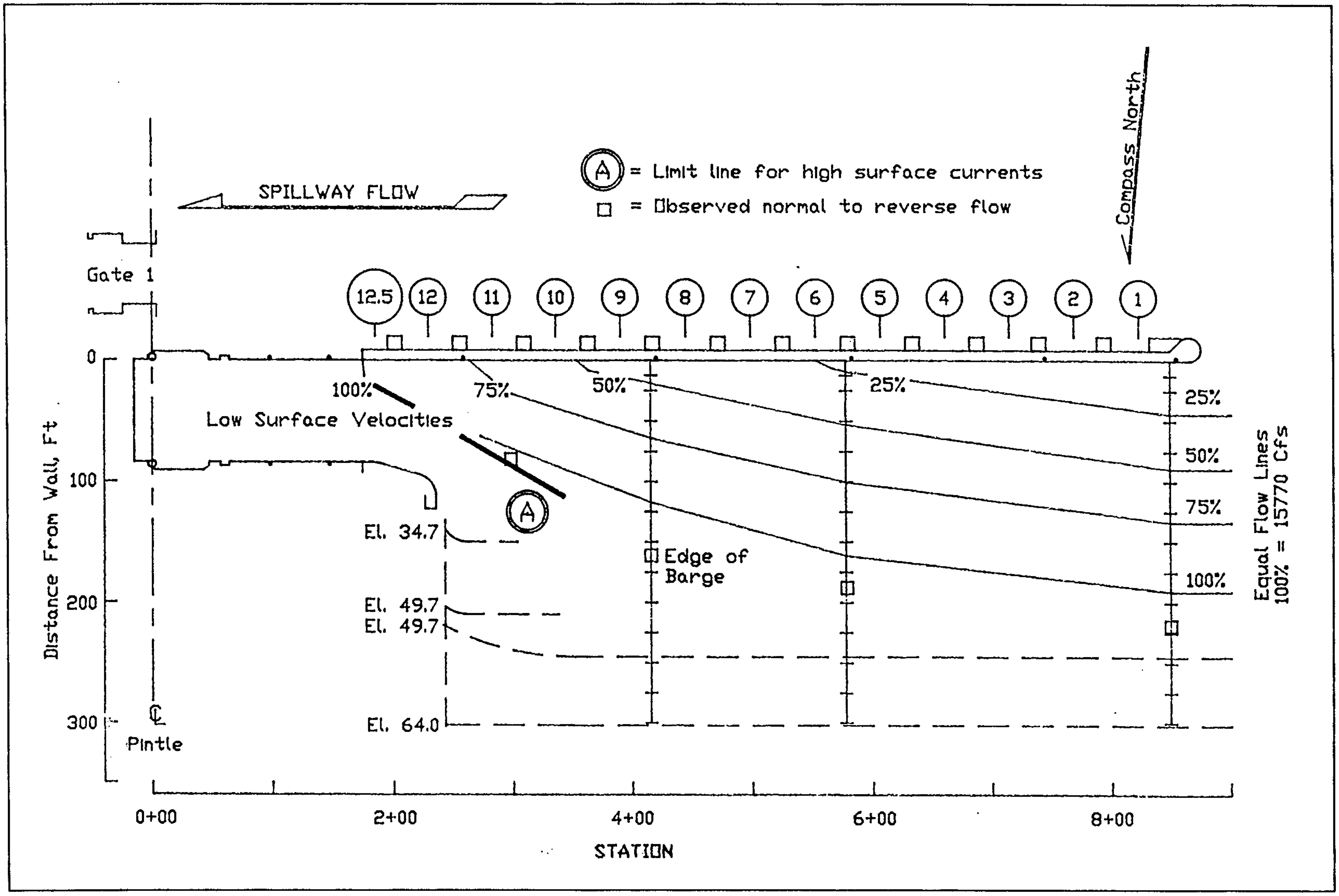


Figure 21. Flow distribution in the approach channel. 24 May 1991 experiments (Q = 116,000 cfs)

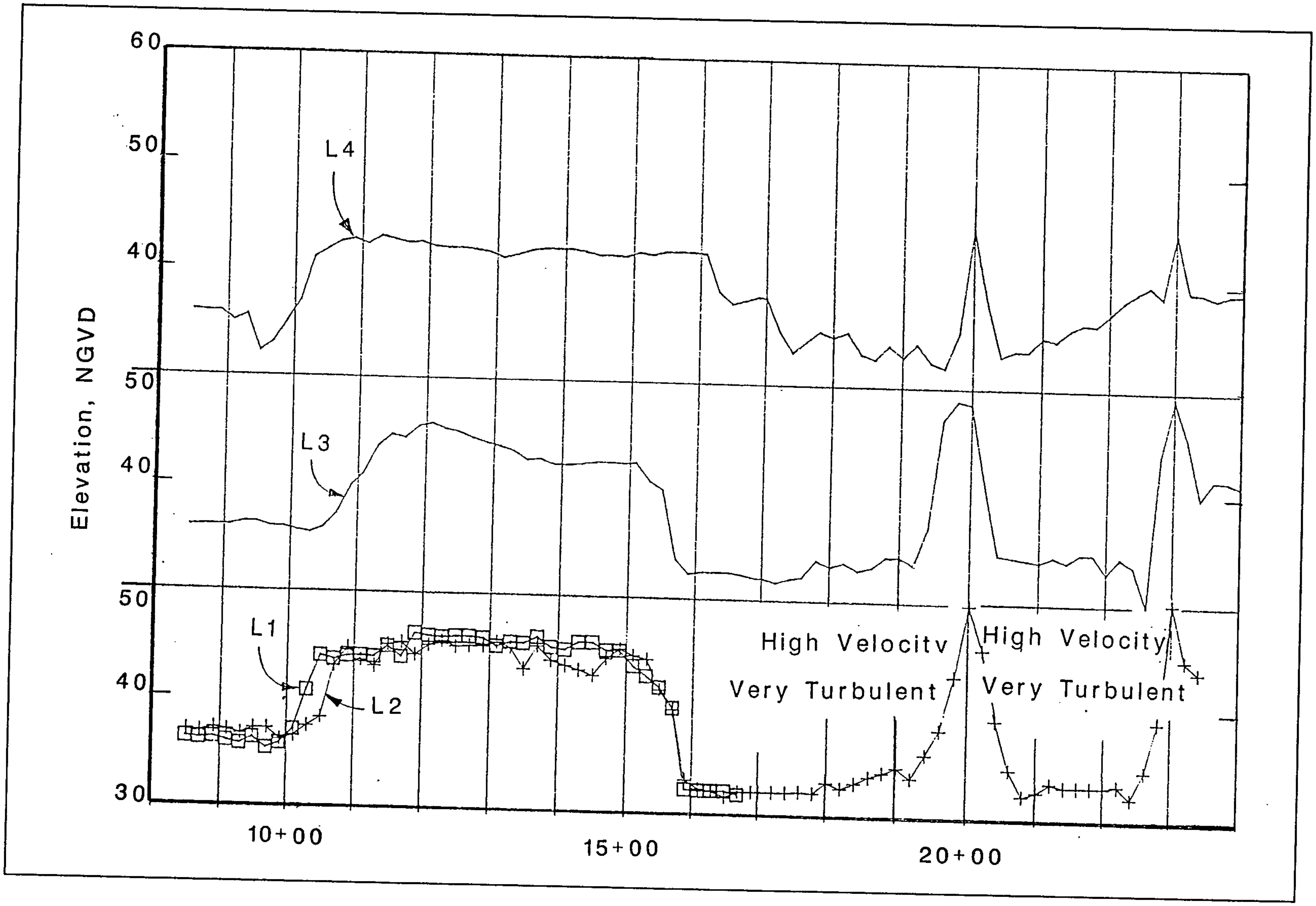


Figure 22. Sounding lines (24 May 1991)

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Frank M. Neilson

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13. ABSTRACT *(Maximum 200 words)*

High forces tend to move and bind large tows against the upstream guard wall at John H. Overton Lock and Dam. Prototype velocities, discharges, and water-surface elevations were obtained to verify and supplement physical model study information. The data are also a basis by which prototype performance, following modifications to the guard wall ports, can be assessed.

14. SUBJECT TERMS

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John H. Overton Lock	Red River
Navigation	

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