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of Engineers**  
Waterways Experiment  
Station

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# Seismic Reflection Survey at Locks and Dams 20, 22, and 24, Upper Mississippi River

by *Keith J. Sjostrom, Rodney L. Leist*

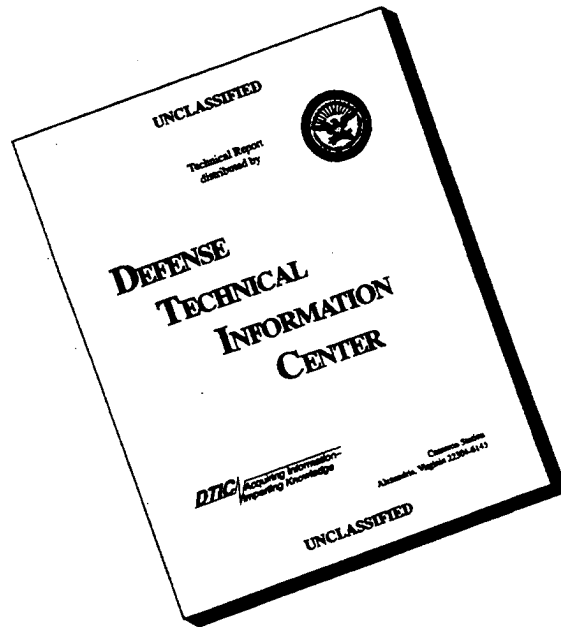
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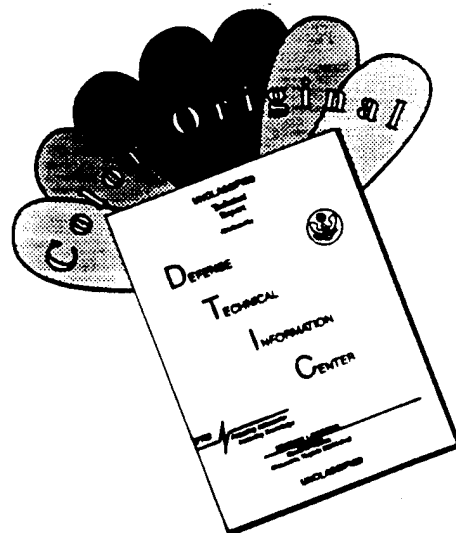
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by Keith J. Sjostrom, Rodney L. Leist

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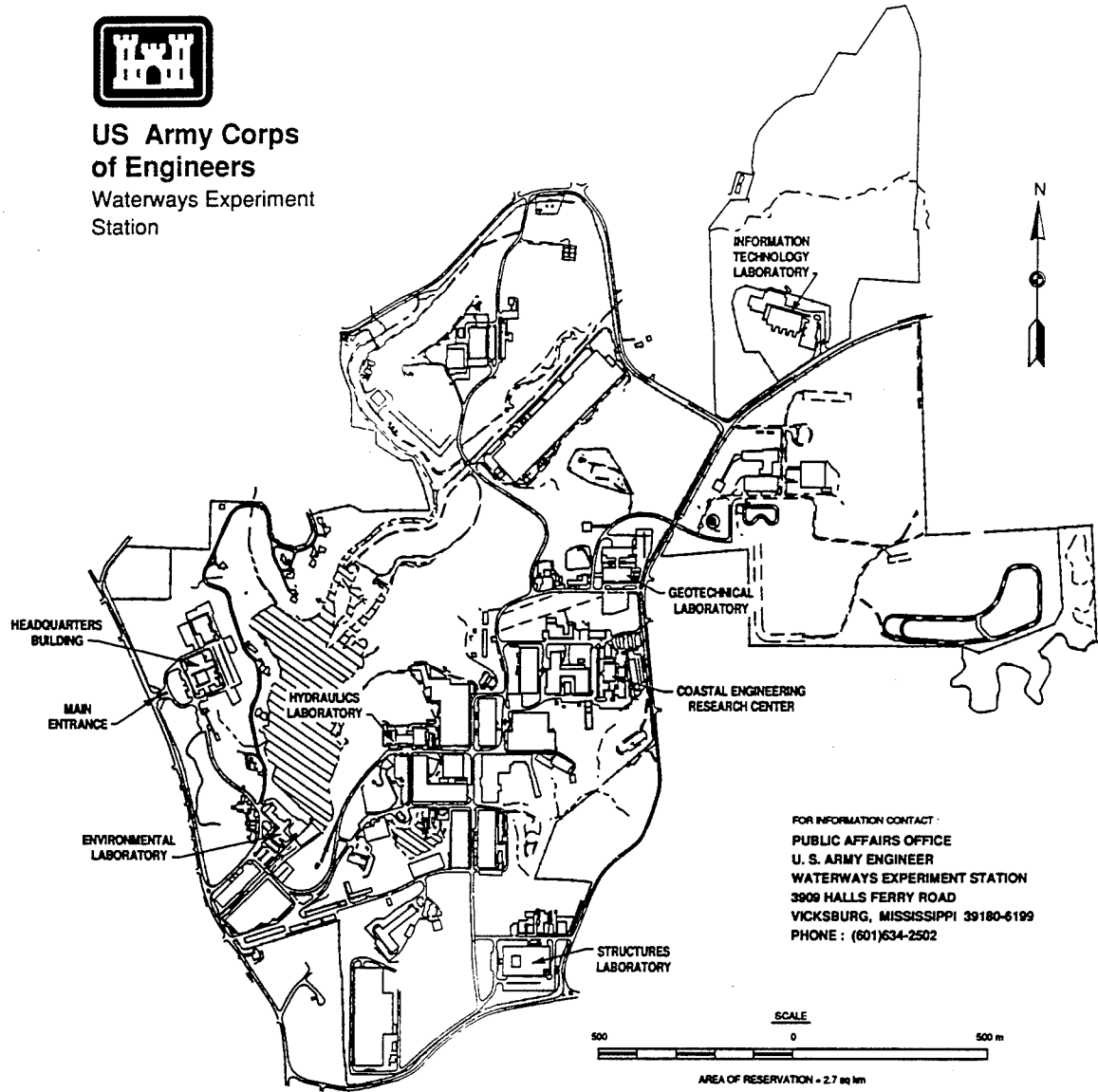
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# Preface

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A seismic reflection investigation was conducted at Locks and Dams 20, 22, and 24 along the upper Mississippi River by personnel of the Geotechnical Laboratory (GL), U.S. Army Engineer Waterways Experiment Station (WES) during the period 19-26 July 1994. The investigation was performed under sponsorship of the U.S. Army Engineer District, Rock Island (CENCR). The CENCR Project Coordinator was Mr. Randall Kinney.

The overall test program was conducted under the general supervision of Drs. W. F. Marcuson III, Director, GL, and A. G. Franklin, Chief, Earthquake Engineering and Geosciences Division (EEGD). Mr. Keith J. Sjostrom was the principal investigator. This report was prepared by Messrs. Sjostrom and Rodney L. Leist under the supervision of Mr. J. R. Curro, Jr., Chief, Engineering Geophysics Branch, GL. Data acquisition and instrumentation support was provided by Mr. Thomas S. Harmon, Jr., EEGD, GL. Data analysis assistance during this study was provided by Ms. Claire R. Livingston, Computer Services Corporation. Data presentation and graphics support was provided by Ms. Janie M. Vaughan, Hydraulic Structures Division, Hydraulics Laboratory, and Mr. Grady A. Holley, Jr., Applied Research Associates, Inc.

Acknowledgement is made to Messrs. Randall Kinney and Bill Monson, Engineering Division, CENCR, and Mr. Mike Navin, Engineering Division, U.S. Army Engineer District, St. Louis (CELMS), for their assistance during this field study. Captains Dave O'Connell, CELMS, and Ken Brenner, CENCR, are especially appreciated for piloting the WES survey vessel 'Waterways Explorer' during the geophysical survey. Appreciation is also expressed to the lockmasters and personnel at Locks and Dams 20, 22, and 24 for their support, guidance, and assistance.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

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# Conversion Factors, Non-SI to SI Units of Measurement

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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            |
| miles (U.S. Statute) | 1,609.347 | meters            |
| feet per second      | 0.3048    | meters per second |

# 1 Introduction

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## Background

At the request of the U.S. Army Engineer District, Rock Island (CENCR), the U.S. Army Engineer Waterways Experiment Station (WES) conducted a waterborne seismic reflection survey at Locks and Dams 20, 22, and 24 along the Upper Mississippi River (see Figure 1). Locks and Dams 20, 22, and 24 are located at river mile (RM) 343.2 at Canton, MO, RM 301.2 near Saver-ton, MO, and RM 273.4 at Clarksville, MO, respectively. The locks and dams along the middle and upper Mississippi River are under consideration to be upgraded or replaced in order to provide better navigation along the waterway. Therefore, information concerning the rock surface elevation and sediment thicknesses at each site are necessary in studying and designing the project criteria for this effort.

## Purpose and Scope

The objective of the geophysical investigation is to determine the depth to and elevation of the underlying rock units upstream and downstream of each lock and dam structure. The results are intended to supplement previously obtained soil borings by providing continuous profile line coverage of the rock surface throughout each project area and aid in placement of additional borings. The interpreted seismic data will also provide better descriptions of variations in subbottom conditions. Two high resolution subbottom profiling systems were used to meet the primary objectives of the investigation.

## Overview of Site Geology

Locks and Dams 20, 22, and 24 are located in a transitional area between the Ozark Uplift and Illinois Basin structural provinces. The near-surface bedrock at these sites is comprised of sedimentary strata of Pennsylvanian and Mississippian age; primarily the Mississippian St. Louis Formation. This formation, as described by the U.S. Army Engineer District, St. Louis (1981),

consists of "... a gray, hard, sublithographic to coarse crystalline, thin to bedded limestone with occasional thin beds of gray shale." Borehole information collected at each site also indicates occurrences of shales and sandstones at the bedrock surface. The elevation of the bedrock surface is highly variable especially near bluffs along the river margins. Regionally, the bedrock strata dip toward the east with a 0.4 degree slope (U.S. Army Engineer District, St. Louis, 1981).

The bedrock structure is overlain by unconsolidated sediments ranging in thickness from 0 to 100 ft. These sediments consist of both glacial and alluvial deposits with materials ranging from clay to boulders. The sediment structure may be identified by at least five specific units which are generally characterized as follows. The deepest sediment regime is an alluvial glacio-fluvial unit containing sand and gravel outwash and glacial lacustrine deposits. Glacial deposits of Illinoian Age overlie the older sediments and consist of a calcareous silt and clay matrix containing sands, gravels, and cobbles. This unit is overlain by Illinoian ice contact deposits of dense sand and gravel. The youngest glacial unit is the Wisconsinian outwash deposits consisting of poorly graded calcareous sands and gravels with cobbles. All, some, or none of these units may be present at the lock and dam sites. Typical river bottom material consists of reworked glacial and alluvial deposits of poorly graded sands and gravels with a few cobbles. Fine-grained material is found at the bottom surface in areas of slack water. More detailed descriptions of the unconsolidated sediment structure are published in U.S. Army Engineer District, St. Louis (1981) and U.S Army Engineer District, Rock Island (1986).

## 2 Technical Approach

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### Seismic Reflection Method

Acoustic subbottom reflection data are produced when a source of acoustic energy is deployed just below the water surface and fired. In a homogeneous medium, the acoustic waves extend uniformly in all directions from the source in which the advancing wavefronts are spherical surfaces centered at the source and perpendicular to the direction of propagation. At large distances from the source, the wave fronts may be represented by rays as shown in Figure 2. When the acoustic energy arrives at a boundary between two materials of differing properties and elastic velocities, part of the energy will be reflected back towards the surface and part transmitted downward into the second medium (see Figure 2). Portions of the transmitted energy will also undergo absorption or attenuation in the material while the wavefront propagates through to the next stratigraphic boundary.

The amplitudes of the incident, reflected, and transmitted wave energies vary with respect to the density and velocity of the materials through which the wave energy is propagating. The ratio between the amplitudes of incident and reflected wave energy is called the reflection coefficient ( $R$ ) and is defined as:

$$R = \sqrt{\frac{A_R}{A_I}}$$

where  $A_R$  and  $A_I$  are the amplitudes of the reflected and incident wave energy, respectively. Reflected wave energies are detected using hydrophones or piezoelectric transducers which convert changes in water pressure due to the acoustic wavefronts into electrical impulses. The electrical signals are amplified, filtered, and recorded using a shallow seismic, digital data acquisition system. The acoustic sources used for this study are a 3.5 kilo-Hertz (kHz) device, referred to as a 'pinger' system because of the audible sound it makes during operation, and a 0.5 to 2.0 kHz system referred to as a 'boomer' system. In general, higher operating frequencies permit greater resolution of the

near-surface geologic structure but shallower depths of energy penetration depending on the characteristics of the sediment material.

The measured amplitudes of the reflected acoustic waves will vary depending on the angle of incidence, but for normal incidence, the reflection coefficient is also expressed by the equation

$$R = \frac{(Z_{i+1} - Z_i)}{(Z_{i+1} + Z_i)}$$

where  $Z$  is the acoustic impedance value of the layer and ' $i$ ' and ' $i+1$ ' identify adjacent stratigraphic layers (see Figure 2). The acoustic impedance of a sediment is defined as the product of the material density ( $\rho_i$ ) and transmission velocity ( $V_i$ ) and represents the influence of the material's characteristics on reflected and transmitted wave energy. Specifically,

$$Z_i = \rho_i V_i$$

where ' $i$ ' identifies the appropriate layer. Therefore, when there is a distinct contrast between layers, high amplitude reflections will be generated at the interface. For example, if silty material overlies rock, it is likely that  $Z_{\text{rock}}$  is much greater than  $Z_{\text{silt}}$ . Hence, the reflection coefficient  $R$  is large and the amplitude of the reflection is higher which means the interface between the silt and rock is easily detectable. However, at a boundary between two materials in which the transmission velocities and densities vary in such a manner that  $Z_i$  and  $Z_{i+1}$  have similar values, as may exist between layers of sand and gravel over rock, the reflection coefficient is small and the ability to detect the interface diminishes. For a more in depth discussion, refer to Telford (1976).

The depths to the interpreted sediment and rock interfaces are determined by measuring the traveltimes of the transmitted and reflected signals on the amplitude records while taking into account the source/receiver separation and acoustic velocities of the overlying sediment units. The results are adjusted to elevation above mean sea level (MSL) by taking into account daily river level fluctuations above and below the dams. The elevation information is also correlated with the survey vessel positioning data.

## Survey Plan and Methodology

Maps showing the location of the seismic reflection survey lines above and below Locks and Dams 20, 22, and 24 are presented in Figures 3, 4, and 5, respectively. Survey lines were performed in areas extending 2,000 ft upstream and 3,000 ft downstream of each lock and dam structure. Lines performed parallel to the channel centerline are nominally spaced 100 ft apart whereas perpendicular lines (cross lines) are spaced approximately 200 or

400 ft apart. The length of each parallel survey line extends a distance of 2,000 ft upstream and 3,000 ft downstream of each dam. Cross lines varied in length depending on the river width. In certain areas, survey line length was also dependent on water depth, water turbulence and flow through the dam, and river traffic. All parallel lines were performed in an upstream direction (against the river current) and the cross lines were conducted from west to east.

The seismic reflection data was produced using two subbottom profiling systems. The first device, a high-resolution 'pinger' system, was mounted on the hull of the survey vessel. The 'pinger' was operated at a tuned frequency of 3.5 kHz and total power of 5.0 kilowatts. The transducers of the source and receiver were separated six feet and each set of transducers were positioned approximately three feet below the water surface. Reflection signatures were digitally recorded in trace lengths of 700 samples with one sample acquired every 24 microseconds. The effective depth of subsurface exploration for this device was nominally 20 to 30 ft below the river bottom surface depending on the characteristics of the bottom and subbottom sediments. The second acoustic system is a high definition 'boomer' system and hydrophone which were towed approximately 70 ft behind the survey vessel during the investigation. The 'boomer' provided an output frequency range of 0.5 to 2.0 kHz. A total trace length of 700 samples was used during data acquisition with samples collected every 52 microseconds. An approximate depth of exploration of 50 to 70 ft below the bottom surface was provided using the 'boomer' system.

Positioning information for each survey line was provided using differential GPS and recorded concurrently during seismic data acquisition. Precision bathymetric data are also simultaneously collected during each survey. River bottom elevations, derived from the water depth information, are referenced to Mean Sea Level (MSL) for each lock and dam facility using daily pool level information and the source/receiver transducer geometry. Pool and tailwater levels at the time of the survey for each lock and dam facility are listed in Table 1.

# 3 Data Analysis and Results

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## Data Analysis and Presentation

Data acquired and results determined during the seismic reflection investigation at Locks and Dams 20, 22, and 24 are presented in several profiles, plots, and tables. Continuous subbottom profiles of the acoustic reflection amplitudes along each survey line illustrate detected sediment and rock interfaces. Copies of the amplitude cross-sections were sent to the CENCR project engineer in September 1994. The positioning coordinates, water depths, and river bottom elevations are tabulated with respect to every third seismic data file in Appendices A through F for both the 'pinger' and 'boomer' subbottom profiling systems. The depths to detected rock interfaces are determined directly from the amplitude cross-sections by measuring the two-way traveltime of the seismic reflection signals and multiplying by 4,900 ft/sec; the propagation velocity of the acoustic pulse in the water and overlying sediments. The interpreted rock elevations and positioning coordinates are used to produce two-dimensional contour maps of the rock surface. The contour plots are overlain on schematic representations of each lock and dam site to aid interpretation of the results. Contour maps of the river bottom elevation at the time of the survey are also provided.

### Limitations in interpretation

Despite the simplistic overview of the basic seismic reflection principles discussed earlier, the analysis and interpretation of seismic reflection data requires great skill. Besides the subjectivity involved in selecting reflection horizons from the amplitude records, other factors such as outside acoustic noise, complex sediment geometries, and organically-rich sediments may also complicate interpretation. Two important factors as related to this study are: (1) frequent lithologic changes in the near-surface sediments in which numerous reflection horizons exist and (2) surface and subsurface irregularities and steeply dipping rock interfaces which cause the reflected signals to scatter away from the receiver such that reflected events may have anomalously low amplitudes or be completely masked. However, throughout most of the survey, favorable conditions existed such that distinct reflections can be identified

and information regarding the depth to and elevation of sediment and rock interfaces can be derived.

The depth to rock interpretations are measured from data collected with a remote sensing technique and should not be considered absolute measurements. As with any geophysical technique, there are limitations involved with the seismic reflection technique. Some of these limitations are outlined below as described by McGee et al.(1995).

*Signal-to-noise ratio.* The ability of this technique to accurately detect subbottom layers is a function of the data quality. Data having a low signal-to-noise ratio will produce poor quality results or no results at all. The data quality at each lock and dam site was generally good. However, there were areas of poor signal-to-noise data caused by water turbulence near the dam and boat motor noise during vessel maneuvering and turning. A portion of a seismic reflection record, collected downstream of Lock and Dam 24, is presented in Figure 6 and illustrates the poor data quality caused by water turbulence downstream of the dams.

*Layer detection and resolution.* Unique sediment and rock interfaces can be detected only when a difference in impedance exists between materials. Gradual changes in material type, e.g. fractured rock overlying competent rock, may not result in an impedance differential large enough to produce a distinct reflection.

Vertical resolution of sediment units and depth of exploration are primarily dependent on the frequency of the acoustic wave. As stated earlier, higher operating frequencies allow better resolution of the subbottom layers but shallower depths of energy penetration depending on the characteristics of the bottom and subbottom material. In sediments having high attenuation rates such as sands or gravels, higher frequencies are dissipated at a greater rate than low frequency signals and, therefore, layer recognition is further degraded. Data enhancement algorithms, such as full wave rectification, are typically used improve the signal-to-noise ratio and interface detection.

*Multiple reflections.* Multiple reflections are one of the primary causes of data quality degradation in shallow marine seismic measurements. The most common multiples detected are due to the acoustic wave being reflected back and forth between the air-water and water-sediment interfaces. As illustrated in Figure 10, the multiple reflection is a copy of the bottom surface reflector but located at a depth twice that of the water depth. Multiple reflections typically mask the reflections from other subbottom interfaces or, depending on water depth and the reflection coefficient at the water/bottom surface interface, completely saturate the record such that no interfaces may be detected. The direct

wave between the acoustic source of the 'boomer' system and receiver hydrophone array is also indicated at the top of Figure 10.

*Depth Determination.* Determining a depth to an interface requires measurement of the traveltimes of the transmitted and reflected wave while taking into account the acoustic velocities within the overlying materials. For this study, all interface depths are based on an average acoustic velocity of 4,900 ft/sec for the entire water and sediment column. The accuracy of these results is also somewhat restricted because of the specific pulse lengths of the acoustic signals. The 'pinger' and 'boomer' devices have well-defined acoustic pulse lengths and are able to resolve an interface to within approximately  $\pm 2.5$  and  $\pm 5.0$  ft, respectively. The acoustic pulse wavelets are graphically illustrated in Figures 9 and 11 for the 'boomer' and 'pinger' sources, respectively. For the depth to rock measurements, an error bound of  $\pm 2.0$  ft should be allowed. The error bounds of the measured bottom depths are less than  $\pm 0.5$  ft because the acoustic device used operates at a much greater frequency, namely 200 kHz.

*Data presentation.* The measured bottom surface and interpreted rock surface elevations are presented in 2-D contour plots. The plots are generated using a geostatistical method called kriging which is an unbiased estimator that has minimal estimation errors. The technique spatially averages the data over a specified radius and, therefore, may smooth some of the elevation values.

## Existing Borehole Information

Prior to and during the construction phases of each lock and dam facility in the early to mid-1930's, exploratory borings were completed to determine the depth to the bedrock interface. The approximate locations of a representative number of borings at each site are illustrated in Figures 8, 14, and 20 for Locks and Dams 20, 22, and 24, respectively. At each facility, borings are concentrated near the lock and along the dam structure. No measured rock depth information is available away from the structures to assist in ground truth correlation. A summary of rock elevation information determined from the borings shown are outlined in Tables 2, 3, and 4 for Locks and Dams 20, 22, and 24, respectively.

## Results of Seismic Reflection Survey

### Lock and Dam 20

Lock and Dam 20 is located at RM 343.2 on the Upper Mississippi River at Canton, MO. A total of 42 seismic reflection survey lines were performed at the lock and dam site (see Figure 3). Twenty-two (22) surveys are situated upstream of the lock and dam with 15 lines performed parallel to the river channel. Downstream of the lock and dam, 20 seismic survey lines were performed with 13 lines conducted parallel to the river channel. Data quality was good except just below the dam where turbulent water created noise in the seismic records. Plan maps illustrating the river bottom and interpreted rock elevations are presented in Figures 7 and 8, respectively.

The elevation of the river bottom upstream of the dam varies from 441 ft MSL near the lock structure to 467 ft MSL. The water depth values are greatest along the dam structure with the deepest point located near the gates closest to the lock facility. Two channels having bottom elevations less than 457.5 ft MSL trend along the western and eastern edges of the site as shown in Figure 7. These areas of deeper water are likely caused by the flow patterns and erosional/depositional characteristics of the river due to the structure and the operational history of the facility. The central portion of the survey area upstream of the dam has bottom elevation values greater than 460 ft MSL. The river bottom elevations computed downstream of the dam range from 431 ft MSL near the dam to 460 ft MSL along the river margins. The bottom elevation is typically less than 455 ft MSL along the centerline of the river as shown in Figure 7 with elevation values increasing towards each riverbank. The deepest water is along the gates nearest to the lock facility. Bottom elevation values at the upstream and downstream approaches to the lock are greater than 457.5 ft MSL. The water level elevation upstream and downstream of the dam at the time of the survey was 479.0 and 476.4 ft MSL, respectively.

Interpreted rock elevation values at the approaches to the lock are greater than 455 ft MSL as illustrated in the contour plot in Figure 8. North and south of the lock, the bedrock elevation remains fairly constant with values ranging from 455 to 460 ft MSL along the western edge of the study area. Comparing the acoustically derived rock elevation information to values measured from existing borings, the results indicate good correlation both upstream and downstream of the lock. The boring locations are shown in Figure 8 with the measured elevations summarized in Table 2. Within a few hundred feet east of the lock, the depth to rock increases rapidly until the bedrock surface is no longer detected in any of the existing borings. Seismic data collected with the 'boomer' system along survey line No. 54, performed perpendicular to the river channel, is shown in Figure 9 and illustrates the rapidly increasing depth to the rock surface. The lock is at the left hand side of the figure where the bedrock is detected at the bottom surface. The interpreted rock interface is poorly defined because of the steeply dipping

reflection horizon and acoustic noise caused by turbulent water below the dam. From a location near the center of the river channel and to the eastern riverbank, there are no reflection interfaces detected upstream or downstream of the dam which are indicative of rock. Therefore, the bedrock elevation is likely lower than 420 ft MSL across the central and eastern part of the river. Near the eastern river edge, another interface is detected as shown in Figure 9. This interface dips steeply towards the west and correlates with a compacted sand, gravel, and loose rock zone indicated in borings 19 and 20 along the eastern side of the dam. This interface is also detected along survey line No. 44 performed parallel with the river channel upstream of the dam as illustrated in Figure 10.

The near-surface alluvial sediments consist primarily of silts, sands, gravels, and rock fragments. Bedding planes, zones of gravels and cobbles, former channel bottoms, and other sediment facies are detected within the study area. The seismic data illustrated in Figures 11 and 12 was collected with the 'pinger' along survey lines No. 12 (downstream of the dam) and No. 29 (upstream of the dam), respectively, and illustrate some of the interfaces and reflection horizons in the near-surface sediments. The first interface detected below the river bottom surface along survey line No. 12 (see Figure 11) may represent the river bottom surface prior to the 1993 flood.

### **Lock and Dam 22**

Lock and Dam 22 is located near the town of Saverton, MO at RM 301.2 along the Upper Mississippi River. Forty-three (43) seismic reflection surveys were conducted at Lock and Dam 22 as shown in Figure 4. Twenty-one (21) seismic lines were performed downstream of the lock and dam with 15 lines performed parallel to the river channel. Upstream of the lock and dam, 22 surveys were conducted with 17 lines traversing parallel to the river channel. No surveys were conducted along the northeastern side of the river because of shallow water. Data quality was good along all lines except in those areas just below the dam where turbulent water produced noise in the seismic records. Plan maps illustrating the river bottom and interpreted rock elevations are presented in Figures 13 and 14, respectively.

River bottom elevations upstream of the dam vary from 427 ft MSL at the dam to approximately 448 ft MSL at the upstream edge of the study area. Water depth values are greatest along the dam structure with the deepest point located near the abutment between the dam and concrete dike. The river bottom geometry is similar to that found above Lock and Dam 20 where two channel features trend diagonally away from the dam towards the northeastern and northwestern river banks and have bottom elevation values lower than 440 ft MSL. The central portion of the survey area has bottom elevation values higher than 440 ft MSL as illustrated in Figure 13. River bottom elevations measured downstream of the lock and dam facility range from approximately 427 ft MSL near the dam to 440 ft MSL near the river margins

(see Figure 13). Bottom elevations are typically lower than 435 ft MSL along the center-line of the river. The deepest water downstream of the dam is also detected near the abutment between the dam and concrete dike. The water level elevation upstream and downstream of the dam at the time of the survey was 459.5 and 455.0 ft MSL, respectively.

The contour map illustrating the interpreted rock surface elevation at Lock and Dam 22 is presented in Figure 14. The elevation values of the interpreted rock surface are greatest near the lock facility and gradually slope to lower values towards the northeast. Rock elevation values at the lock are higher than 435 ft MSL. Away from the lock facility, the rock elevation is lower than 415 ft MSL upstream of the dam and below 425 ft MSL downstream. The northeastward sloping rock interface is indicated on the seismic record shown in Figure 15. The data was collected with the 'boomer' along survey line No. 67 upstream of the lock and dam. The bedrock surface upstream of the dam is shown in Figures 16 and 17 where seismic data was collected with both the 'pinger' and 'boomer', respectively. This data was collected parallel to the river channel along a portion of survey line No. 33. The amount of sediment overlying the bedrock upstream of the dam varies from 5 to 30 ft and consists primarily of silts and sands. Bedding planes, zones of gravels and cobbles, and other sediment facies are also detected in the near-surface material. Downstream of the dam, sediment thickness varies from 0 to 10 ft. The varying thickness of the overlying sediment is best illustrated by the sub-bottom data collected along survey line No. 10 shown in Figure 18. The rock surface emerges from beneath a mound of sandy sediment and is situated close to the current river bottom surface as indicated at the right side of the figure. The detected mound of sediment may be a depositional feature formed following the 1993 flood and overlies the pre-flood river bottom surface.

At the lock facility and along the dam, rock elevation information from the existing borings correlate well with the interpreted elevation values. The approximate locations of the borings are presented on the interpreted rock elevation contour map shown in Figure 14 with the measured rock elevation values listed in Table 3. Referring to Table 3 and the contour map in Figure 14, interpreted rock elevation values along the dam agree to within a foot of the measured rock elevation values. Closer to the lock structure, the difference between the interpreted values and measured elevations varies from 1 to 3 ft. As an example, measured rock elevation values at borings 16, 19, and 9 are 429.5, 435.6, and 436.2 ft MSL, respectively. The respective rock elevations interpreted from the seismic data at these locations are approximately 433.0, 434.0, and 434.5 ft MSL.

### **Lock and Dam 24**

Lock and Dam 24 is located at RM 273.4 at Clarksville, MO. A total of 49 seismic reflection surveys were performed at the project area as indicated in Figure 5. Twenty-two (22) seismic lines were performed upstream of the dam with 16 lines performed parallel to the river channel. No surveys were

conducted along the northeastern side of the river because of shallow water. Downstream of the lock and dam, seismic data was collected along 27 surveys with 19 lines conducted parallel to the river channel. In the upstream pool, data quality was good along all survey lines. Between the dam and a point approximately 500 ft downstream of the dam, data quality was fair to poor because acoustic noise generated by water turbulence (refer back to Figure 6) and excessive boat engine noise contaminated the data records. Further downstream of the dam, data quality was fair to good. Plan maps illustrating the river bottom and interpreted rock elevations are presented in Figures 19 and 20, respectively.

River bottom elevation values upstream of the dam vary from 412 ft MSL at the dam to higher than 430 ft MSL along the southwest river bank (see Figure 19). The water level elevation upstream of the dam at the time of the survey was 447.5 ft MSL. Water depth values are greatest along the dam structure with depths exceeding 30 ft at locations nearest the lock facility. River bottom elevation values along the main portion of the river channel gradually increase upstream of the dam and reach an average elevation of 425 ft MSL at the upstream limit of the study area. River bottom elevation values measured downstream of the lock and dam facility range from approximately 390 ft MSL near the dam to higher than 425 ft MSL near the river margins (see Figure 19). Water depths are approximately 40 ft along the base of the dam with the greatest depths detected downstream of the gates farthest from the lock facility. Downstream of the dam, bottom elevation values are typically lower than 417.5 ft MSL along the channel centerline. The water level elevation downstream of the dam at the time of the survey was 441.0 ft MSL.

The elevation of the interpreted rock surface at Lock and Dam 24 is represented by the contour lines shown in Figure 20. The rock elevation values are greatest near the lock facility and dramatically decrease to lower elevations within a few hundred feet northeast of the lock. Further along the dam, the elevation values level off and gradually slope downward towards the northeast. Rock elevations at the upstream entrance to the lock are approximately 425 ft MSL whereas near the downstream entrance, rock elevation values are higher than 405 ft MSL. Delineation of the rock surface was hindered by poor data quality, limited energy penetration, and poor resolution of the steeply dipping rock interface near the lock. Seismic data collected along survey line No. 4 (see the right side of Figure 21) downstream of the lock illustrates the difficulty in detecting the rock interface. In addition, competent river bottom sediments such as gravels or rock fragments, as sampled in many nearby cores, may also diminish the resolution of the underlying rock surface as demonstrated in Figure 22.

Away from the lock facility and upstream of the dam, the rock surface has a more gradual slope and is better defined. Interpreted rock elevation values range from approximately 385 ft MSL near the lock to lower than 375 ft MSL towards the north-northeast side of the study area (see Figure 20). The

northeastward sloping rock interface is indicated on the seismic records shown in Figures 23 and 24 for 'boomer' data collected along survey lines No. 35 and No. 75, respectively. Downstream of the dam, rock surface elevation values range from 380 to 385 ft MSL over most of the study area as shown in Figure 20. Interpreted rock elevation values begin to increase rapidly near the southwestern river margin. Portions of the 'boomer' seismic record collected along survey lines No. 3 and No. 4 are presented in Figures 25 and 21, respectively, and illustrate the interpreted rock interfaces for both the limestone and overlying shale units.

The measured rock elevation values from borings drilled along the gates of the dam correlate well with the interpreted elevations from the seismic data. The approximate locations of representative borings are presented on the interpreted rock elevation contour map shown in Figure 20. Measured rock elevation values are listed in Table 4. As a comparison between measured and interpreted rock elevations, the measured rock elevation values from borings 78 and 84 are 382.0 and 381.0 ft MSL, respectively. Referring to Figure 20, the interpreted elevations from the seismic data are approximately 384.5 and 380.0 for the same locations. Although the correlation between the measured and interpreted rock elevation values along the dam are good, the correlation between the elevation results in and around the lock are much poorer. The difference between interpreted values and measured elevations varies from 1 to 10 ft. As an example, the measured rock surface elevations at borings 15, 66, and 53 are 384.8, 384.0, and 401.2 ft MSL, respectively. The respective rock elevation values interpreted from the seismic data at these locations (see Figure 20) are approximately 392.0, 387.0, and 402.0 ft MSL. The differences between these values may be attributed to poor data quality and poor resolution of the rock surface as per the limitations discussed earlier in the text. Also, for example, the slope of the rock surface near boring 15 makes the location of the boring critical for comparison.

The interpreted thickness of sediment overlying the bedrock surface upstream of the dam varies from 30 to 50 ft whereas approximately 15 to 40 ft of alluvial material overlies the rock surface below the dam. The thickness of this material generally increases towards the channel margins. The unconsolidated sediments consist of silts, sands, gravels, and rock fragments with bedding planes, lenses, and other sediment facies detected in the near-surface material. Seismic data collected with the 'pinger' along survey lines No. 3 (downstream of the dam) and No. 30 (upstream of the dam), see Figures 26 and 27, respectively, illustrate the numerous interfaces and reflection horizons in the near-surface sediments. Some of the interfaces may represent the river bottom prior to the 1993 flood.

## 4 Survey Summary

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A high-resolution, seismic reflection survey was performed at Locks and Dams 20, 22, and 24 along the Upper Mississippi River to determine the rock surface elevation at each facility. Analysis of the seismic data yielded interpreted rock surface elevation values upstream and downstream of each lock and dam. Rock surface elevations, presented in two-dimensional contour plots, are compared to borehole information to provide better analysis of the rock surface. Bathymetry data collected during the seismic survey is also presented in contour plots in order to investigate the geometry of the river bottom at the time of the survey. The contour maps are displayed on schematic diagrams of each project area.

At Lock and Dam 20, the bedrock surface is only detected near the lock facility. The elevation values north and south of the approaches to the lock are greater than 455 ft MSL which correlates well with measured values from existing core locations. A few hundred feet east of the lock, the depth to rock increases rapidly towards the east until it is no longer detected by the seismic methods or existing borings. The elevation of the bedrock surface is lower than 420 ft MSL across the remainder of the site. Along the eastern side of the river, east of E 124,000 grid line, a dipping horizon comprised of compacted sand and gravel is detected. Bedding planes and smaller zones of sand and gravel are also detected throughout the near-surface sediments.

At Lock and Dam 22, the elevation values of the interpreted rock surface are higher near the lock facility and gradually slope towards the northeast. Rock elevation values at the lock are greater than 435 ft MSL. Away from the lock, rock elevation values are less than 415 ft MSL upstream of the dam and lower than 422 ft MSL downstream. Along the dam, the interpreted rock elevation values agree to within a foot of measured values from existing boring information. Closer to the lock structure, the difference between the interpreted values and measured elevations varies from 1 to 3 ft. The amount of sediment overlying the bedrock upstream of the dam varies from 5 to 30 ft and consists primarily of silts and sands. Bedding planes, zones of gravels and cobbles, and other sediment facies are also detected in the near-surface material. Downstream of the dam, sediment thickness varies from 0 to 10 ft near channel centerline with greater thicknesses detected along the channel margins.

At Lock and Dam 24, the elevation values of the interpreted rock surface are higher near the lock facility and dramatically decrease to lower elevations within a few hundred feet northeast of the lock. Along the dam structure, the interpreted rock surface elevation gradually slopes downward towards the northeast. Upstream of the dam, the rock surface has a gradual slope with interpreted elevation values ranging from approximately 385 ft MSL near the lock to less than 375 ft MSL towards the north-northeast side of the study area. Downstream of the dam, the rock surface elevation ranges from 380 to 385 ft MSL over most of the study area. Measured rock elevations from cores along the gates of the dam correlate well with interpreted values from seismic data with differences of 1 to 3 ft. Rock elevation values increase rapidly near the lock and along the southwestern river margin. Rock elevations at the upstream entrance to the lock are approximately 425 ft MSL whereas near the downstream entrance, elevation values are higher than 405 ft MSL. However, delineation of the rock surface was hindered by poor data quality and limited resolution of the steeply dipping rock interface. The correlation between the measured and interpreted elevation results in and around the lock is fair. However, comparisons near the lock are dependent on the position of the existing borings over the steeply sloping rock surface. The difference between interpreted values and measured elevations varies from 1 to 10 ft. The interpreted thickness of sediment overlying the bedrock surface upstream of the dam varies from 30 to 50 ft whereas approximately 15 to 40 ft of alluvial material overlies the rock surface below the dam. Little to no sediment overlies the rock surface near the lock.

The near-surface alluvial sediments at each site are comprised primarily of silts, sands, gravels, cobbles, and rock fragments. Bedding planes, zones of gravels and cobbles, former channel bottoms, sand bars, and other sediment facies are commonly detected in the near-surface material within each study area. In certain areas, as pointed out in the text, interfaces near the bottom surface may represent the river bottom surface prior to the 1993 flood.

Analysis of the seismic information provides continuous profiles of the rock surface and illustrates variations in the bottom and subbottom sediments. Elevation values computed from the seismic records depict the extent and depth of the river bottom, rock surface, and other reflection horizons. Rock elevations at each facility will provide data to support the planning phases for replacement or modernization of the locks and dams.

## References

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- McGee, R. G., Ballard, R. F. Jr., and Caulfield, D. D. (1995). "A technique to assess the characteristics of bottom and subbottom marine sediments." Technical Report DRP-95-3. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
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- U.S. Army Engineer District, Rock Island. (1986). "Mississippi river lock and dam No. 20 major rehabilitation; design memorandum No. 1, general design memorandum and environmental assessment." Rock Island, Illinois.
- U.S. Army Engineer District, St. Louis. (1981). "Lock and dam No. 26 replacement - liquifaction analysis." St. Louis, Missouri.

|                 | <b>Pool Elevation<br/>(ft, MSL)</b> | <b>Tailwater Elevation<br/>(ft, MSL)</b> |
|-----------------|-------------------------------------|--|
| Lock and Dam 20 | 479.0                               | 476.4                                    |
| Lock and Dam 22 | 459.5                               | 455.0                                    |
| Lock and Dam 24 | 447.5                               | 441.0                                    |

**Table 2**  
**Summary of Borehole Information Lock and Dam 20, Upper**  
**Mississippi River**

| Core            | Easting <sup>1</sup> | Northing <sup>1</sup> | River Bottom Elevation, ft | Rock Elevation, ft |
|-----------------|----------------------|-----------------------|----------------------------|--------------------|
| 6               | 123265               | 1269141               | 470.4                      | 437.5              |
| 7               | 123286               | 1269142               | 465.0                      | 429.3              |
| 8               | 123309               | 1269144               | 459.3                      | 426.0              |
| 9               | 123255               | 1269033               | 471.5                      | 440.5              |
| 10              | 123286               | 1269034               | 465.7                      | 434.1              |
| 11              | 123315               | 1269038               | 457.5                      | 425.2              |
| 15 <sup>2</sup> | 123633               | 1269110               | 456.0                      | ---                |
| 16 <sup>2</sup> | 124045               | 1269118               | 466.8                      | ---                |
| 17 <sup>2</sup> | 124352               | 1269145               | 466.5                      | ---                |
| 18 <sup>2</sup> | 124684               | 1269163               | 460.7                      | ---                |
| 19 <sup>2</sup> | 125091               | 1269178               | 470.5                      | ---                |
| 20 <sup>2</sup> | 125391               | 1269195               | 481.5                      | ---                |
| 17              | 122903               | 1269939               | 459.3                      | 457.3              |
| 18              | 122830               | 1270049               | 464.0                      | 456.4              |
| 19              | 122815               | 1270148               | 464.3                      | 459.2              |
| 20              | 123157               | 1268055               | 461.6                      | 461.6              |
| 21              | 123044               | 1268355               | 464.9                      | 464.9              |
| 32              | 123083               | 1268949               | 459.3                      | 459.3              |
| 37              | 123018               | 1269558               | 458.0                      | 458.0              |
| 38              | 122986               | 1269855               | 458.2                      | 458.2              |
| 39              | 122958               | 1270154               | 458.3                      | 455.8              |
| 40              | 122929               | 1270448               | 458.8                      | 458.8              |
| 41              | 123193               | 1268336               | 458.9                      | 458.9              |
| 42              | 123183               | 1268540               | 458.0                      | 458.0              |
| 43              | 123230               | 1268671               | 455.3                      | 455.3              |
| 45              | 123203               | 1268975               | 453.7                      | 453.7              |
| 48              | 123192               | 1269243               | 454.5                      | 454.5              |
| 52              | 123195               | 1269461               | 454.3                      | 445.1              |
| 55              | 123176               | 1269648               | 453.7                      | 437.0              |
| 56              | 123120               | 1269868               | 455.3                      | 444.3              |

<sup>1</sup> Approximate coordinates.

<sup>2</sup> Cores located along dam structure.

**Table 3**  
**Summary of Borehole Information Lock and Dam 22, Upper**  
**Mississippi River**

| Core | Easting <sup>1</sup> | Northing <sup>1</sup> | River Bottom Elevation, ft | Rock Elevation, ft  |
|------|----------------------|-----------------------|----------------------------|---------------------|
| 1    | 194450               | 1083838               | 440.7                      | 433.6               |
| 9    | 195912               | 1081984               | 437.0                      | 436.2               |
| 10   | 194929               | 1083454               | 432.4                      | 431.0               |
| 12   | 195273               | 1082977               | 437.9                      | 437.6               |
| 14   | 195627               | 1082498               | 437.8                      | 437.0               |
| 15   | 194855               | 1083761               | 429.6                      | 427.0               |
| 16   | 195036               | 1083530               | 430.3                      | 429.5               |
| 17   | 195221               | 1083296               | 434.0                      | 434.0               |
| 18   | 195404               | 1083070               | 434.6                      | 434.6               |
| 19   | 195587               | 1082836               | 435.6                      | 435.6               |
| 20   | 195768               | 1082598               | 433.8                      | 433.4               |
| 21   | 195951               | 1082368               | 433.3                      | 432.2               |
| 24   | 195516               | 1083162               | 433.5                      | 433.0               |
| 27   | 195587               | 1083365               | 437.6                      | 430.2               |
| 30   | 195804               | 1083379               | 441.2                      | 428.5               |
| 33   | 195881               | 1083578               | 440.0                      | 425.8               |
| 36   | 196102               | 1083591               | ---                        | approximately 423.0 |
| 47   | 195389               | 1083310               | 433.2                      | 432.4               |
| 48   | 195704               | 1083539               | 442.0                      | 427.4               |
| 50   | 196119               | 1083803               | 444.4                      | 421.1               |
| 52   | 196278               | 1083918               | 446.7                      | 420.2               |
| 54   | 196442               | 1084040               | 447.8                      | 418.7               |
| 56   | 196596               | 1084156               | 447.9                      | 417.4               |
| 57   | 196837               | 1084318               | 447.7                      | 414.7               |
| 58   | 197070               | 1084493               | 447.6                      | 412.5               |
| 59   | 197309               | 1084673               | 443.0                      | 405.2               |
| 60   | 197555               | 1084848               | 440.9                      | 407.8               |
| 61   | 197797               | 1085025               | 467.6                      | 408.1               |

<sup>1</sup> Approximate coordinates.

**Table 4**  
**Summary of Borehole Information Lock and Dam 24, Upper**  
**Mississippi River**

| Core | Easting <sup>1</sup> | Northing <sup>1</sup> | River Bottom Elevation, ft | Rock Elevation, ft |
|------|----------------------|-----------------------|----------------------------|--------------------|
| 1    | 384274               | 1290186               | 427.3                      | 420.6              |
| 2    | 384535               | 1289976               | 431.2                      | 424.0              |
| 3    | 384707               | 1289825               | 434.0                      | 427.4              |
| 9    | 384813               | 1289927               | 408.1                      | 397.1              |
| 13   | 384753               | 1290187               | 414.0                      | 383.4              |
| 14   | 384917               | 1290032               | 416.4                      | 383.2              |
| 15   | 385178               | 1289836               | 415.8                      | 384.8              |
| 16   | 385372               | 1289645               | 416.2                      | 386.8              |
| 36   | 385027               | 1289715               | 422.5                      | 422.5              |
| 37   | 385249               | 1289517               | 423.9                      | 421.3              |
| 40   | 385322               | 1289592               | 432.4                      | 412.1              |
| 43   | 385438               | 1289537               | 417.0                      | 390.2              |
| 50   | 386043               | 1288633               | 427.2                      | 415.8              |
| 52   | 385858               | 1288895               | 424.7                      | 410.8              |
| 53   | 386096               | 1288690               | 422.6                      | 401.2              |
| 56   | 385571               | 1289203               | 423.4                      | 420.7              |
| 57   | 385772               | 1289031               | 423.2                      | 406.7              |
| 58   | 386042               | 1288820               | 422.7                      | 392.2              |
| 59   | 384388               | 1290291               | 420.1                      | 392.0              |
| 60   | 384643               | 1290080               | 419.9                      | 396.5              |
| 61   | 385536               | 1289320               | 420.3                      | 405.8              |
| 62   | 385948               | 1288993               | 421.6                      | 394.1              |
| 65   | 385633               | 1289421               | 417.6                      | 386.1              |
| 66   | 385821               | 1289271               | 419.1                      | 384.0              |
| 67   | 386042               | 1289092               | 419.4                      | 384.1              |
| 68   | 385725               | 1289171               | 421.5                      | 398.6              |
| 76   | 385393               | 1289832               | ---                        | 384.0              |
| 78   | 385538               | 1290016               | ---                        | 382.0              |
| 80   | 385684               | 1290200               | ---                        | 381.0              |
| 82   | 385825               | 1290383               | ---                        | 381.0              |
| 84   | 385970               | 1290566               | ---                        | 381.0              |
| 86   | 386116               | 1290750               | ---                        | 375.0              |

<sup>1</sup> Approximate coordinates.



Figure 1. Location of Locks and Dams 20, 22, and 24, Upper Mississippi River

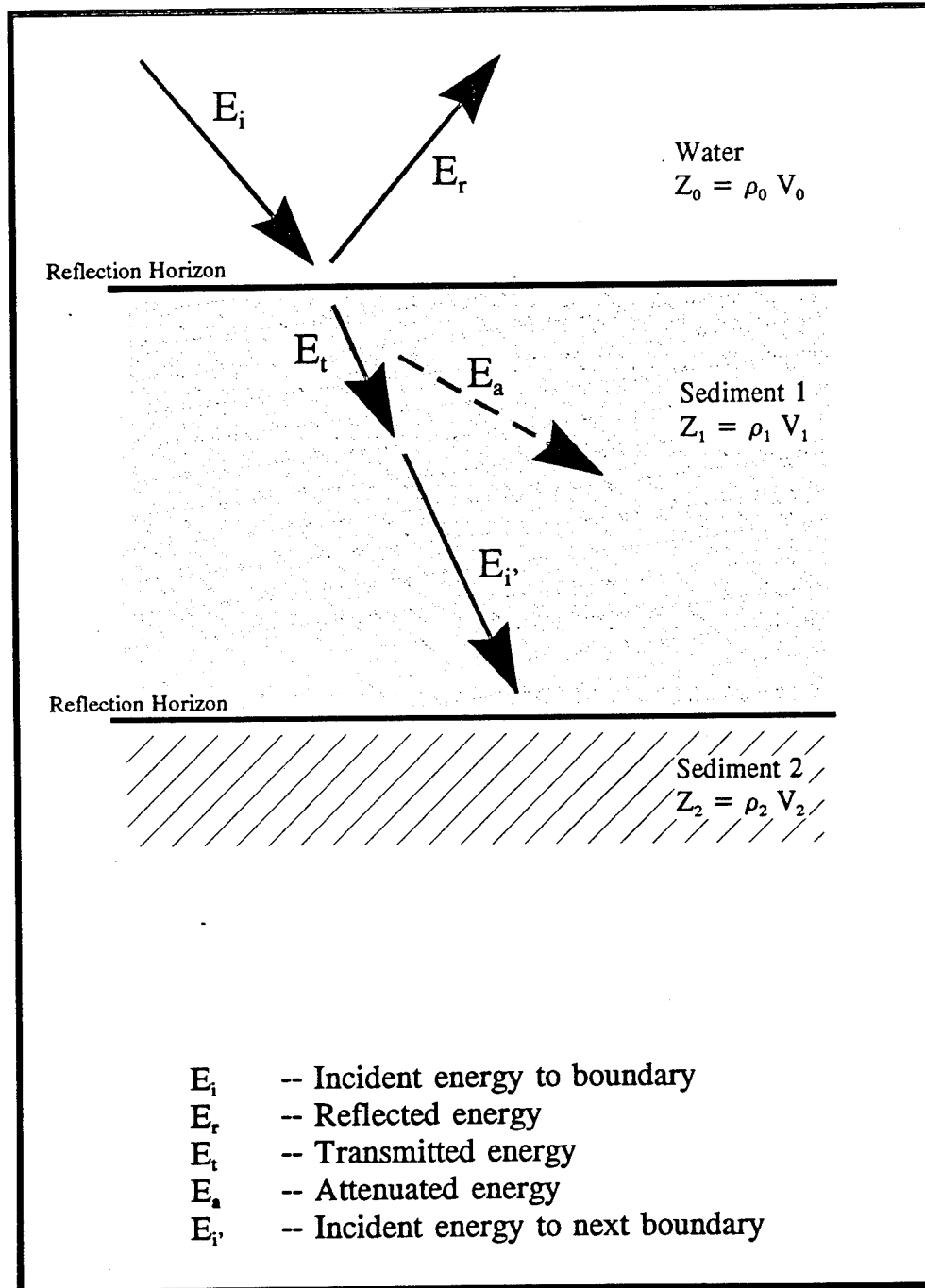


Figure 2. Energy path schematic

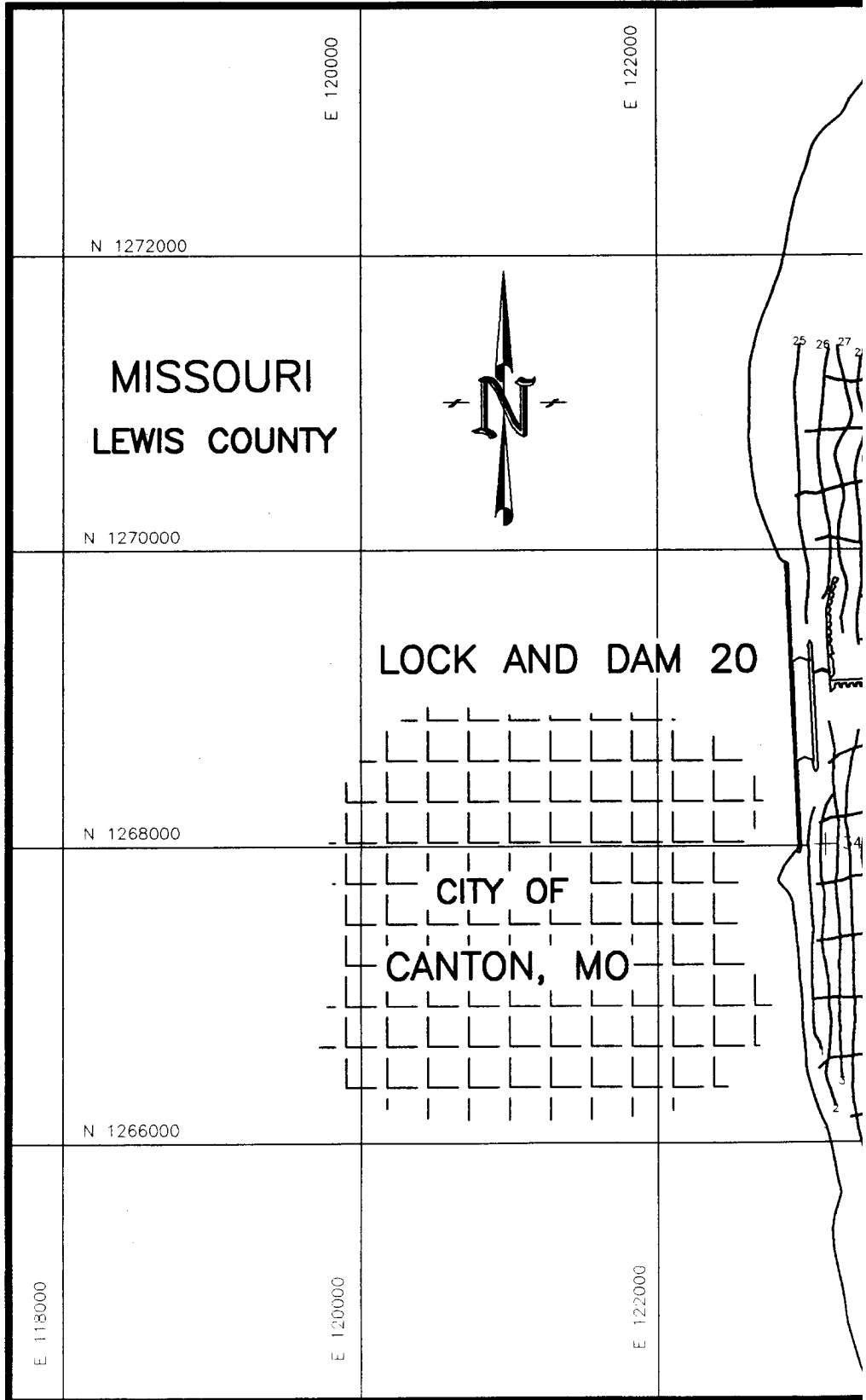
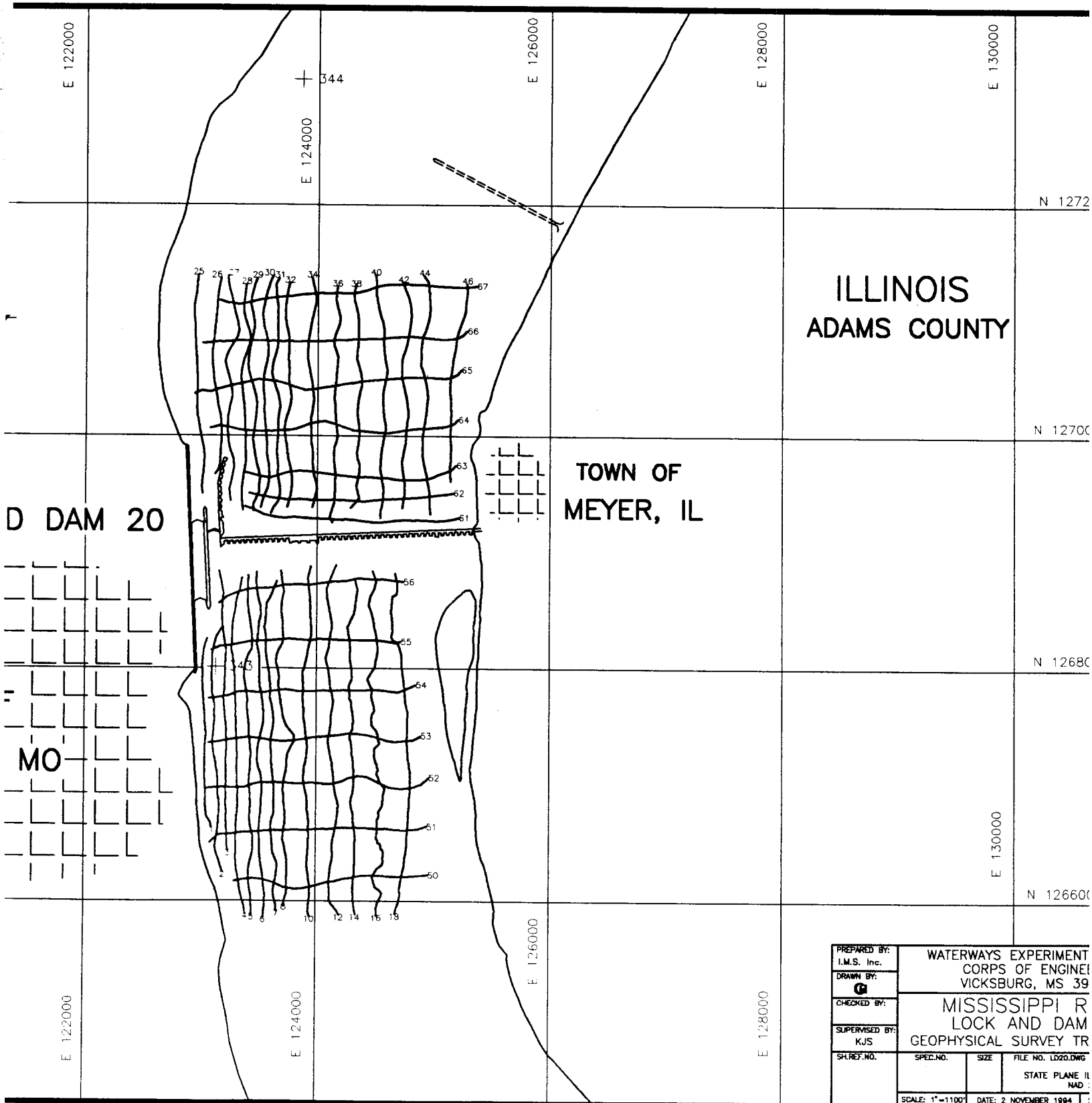


Figure 3. Seismic reflection survey lines, Lock and Dam 20



ILLINOIS  
ADAMS COUNTY

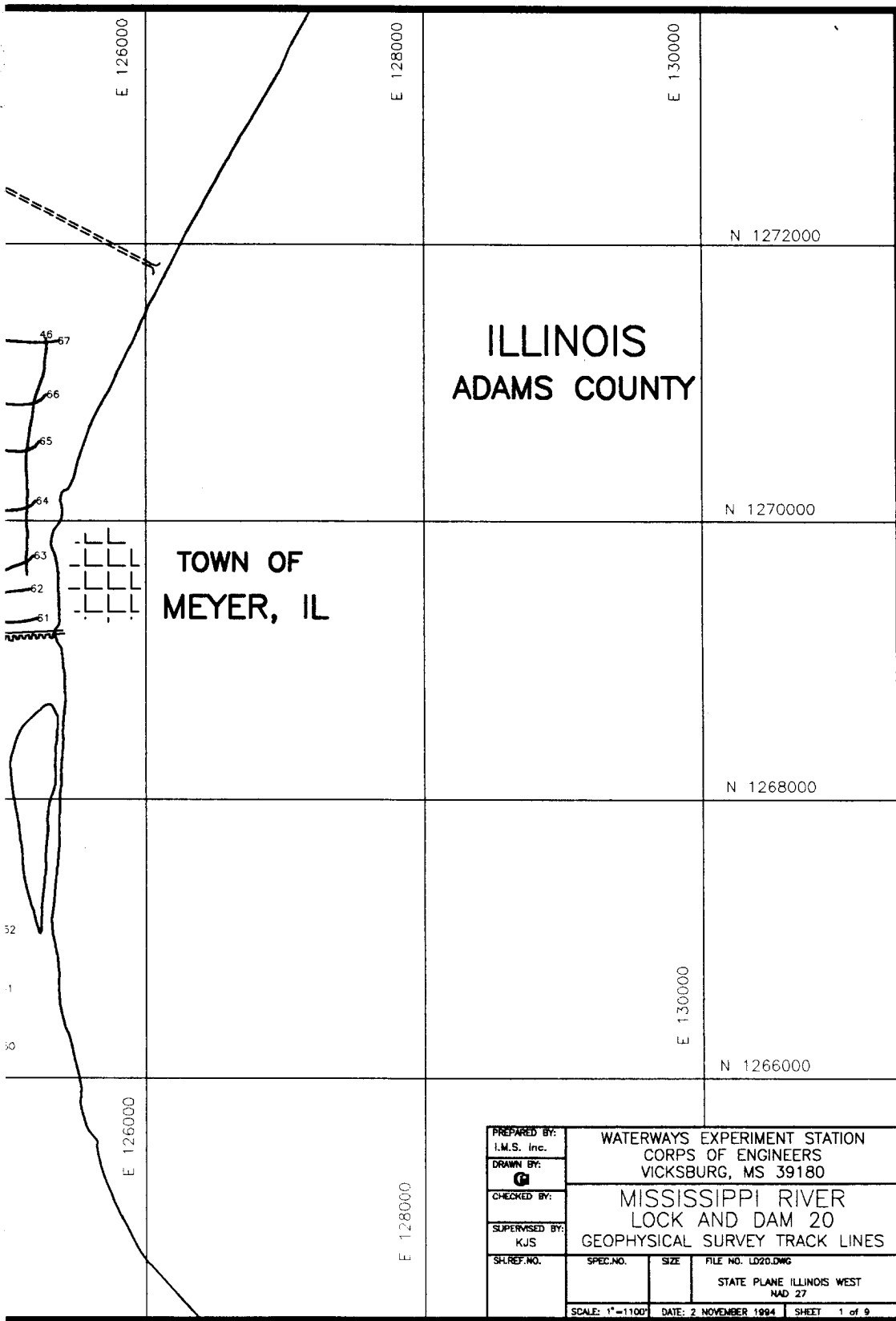
TOWN OF  
MEYER, IL

DAM 20

MO

|                             |  |                       |                       |
|-----------------------------|--|-----------------------|-----------------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENT<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39 |                       |                       |
| DRAWN BY:<br>G              | MISSISSIPPI R<br>LOCK AND DAM                                  |                       |                       |
| CHECKED BY:                 | GEOPHYSICAL SURVEY TR  |                       |                       |
| SUPERVISED BY:<br>KJS       | SPEC. NO.  | SIZE                  | FILE NO. LD20.DWG     |
| SH. REF. NO.                |  |                       | STATE PLANE IL<br>NAD |
| SCALE: 1"=1100'             |  | DATE: 2 NOVEMBER 1994 |                       |

Dam 20



ILLINOIS  
ADAMS COUNTY

TOWN OF  
MEYER, IL

|                             |   |                       |                                     |
|-----------------------------|---|-----------------------|-------------------------------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENT STATION<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180 |                       |                                     |
| DRAWN BY:<br>               | MISSISSIPPI RIVER<br>LOCK AND DAM 20<br>GEOPHYSICAL SURVEY TRACK LINES    |                       |                                     |
| CHECKED BY:                 |   |                       |                                     |
| SUPERVISED BY:<br>KJS       |   |                       |                                     |
| SH. REF. NO.                | SPEC. NO.   | SIZE                  | FILE NO. LD20.DWG                   |
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| SCALE: 1"=1100'             |   | DATE: 2 NOVEMBER 1994 | SHEET 1 of 9                        |

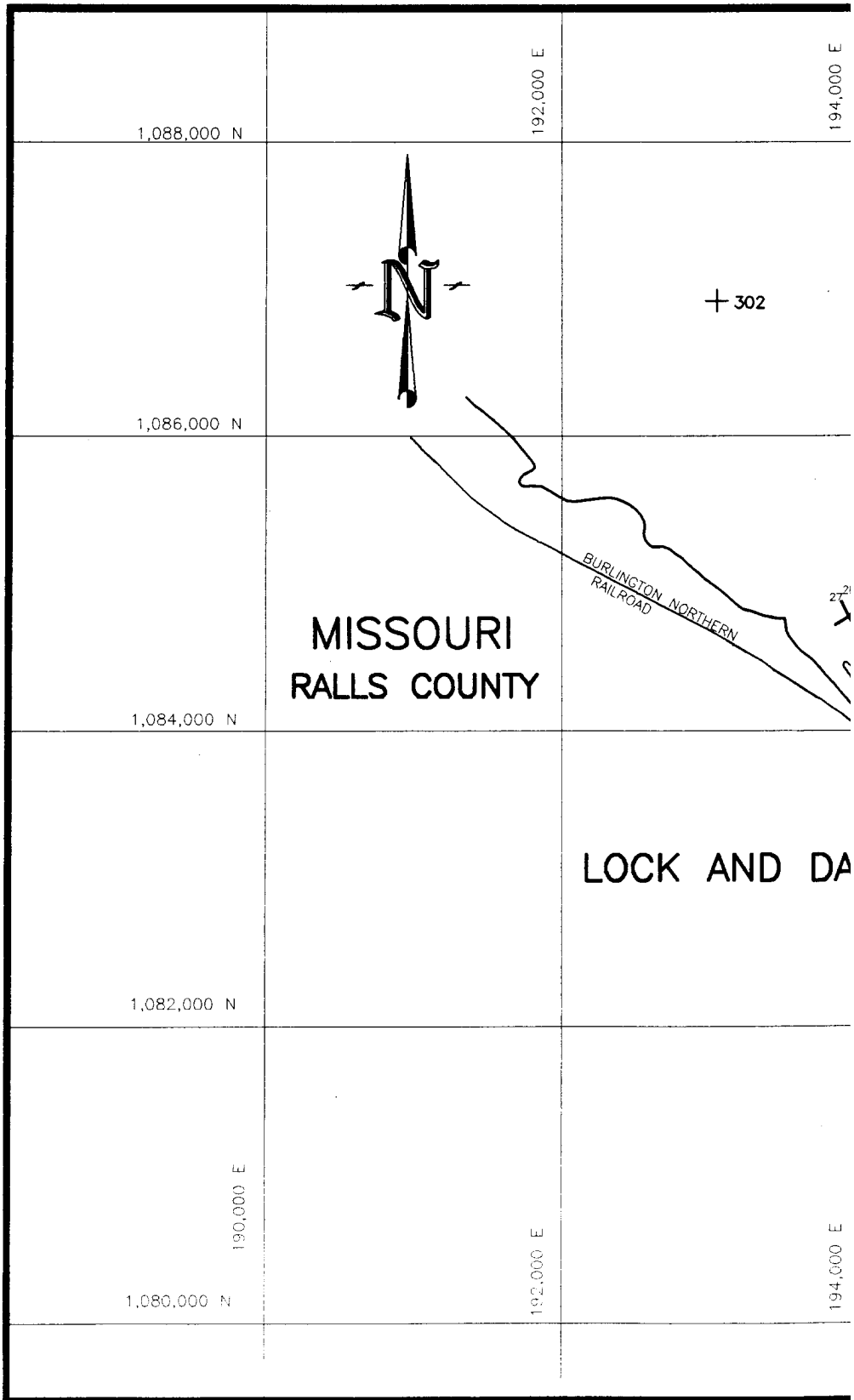
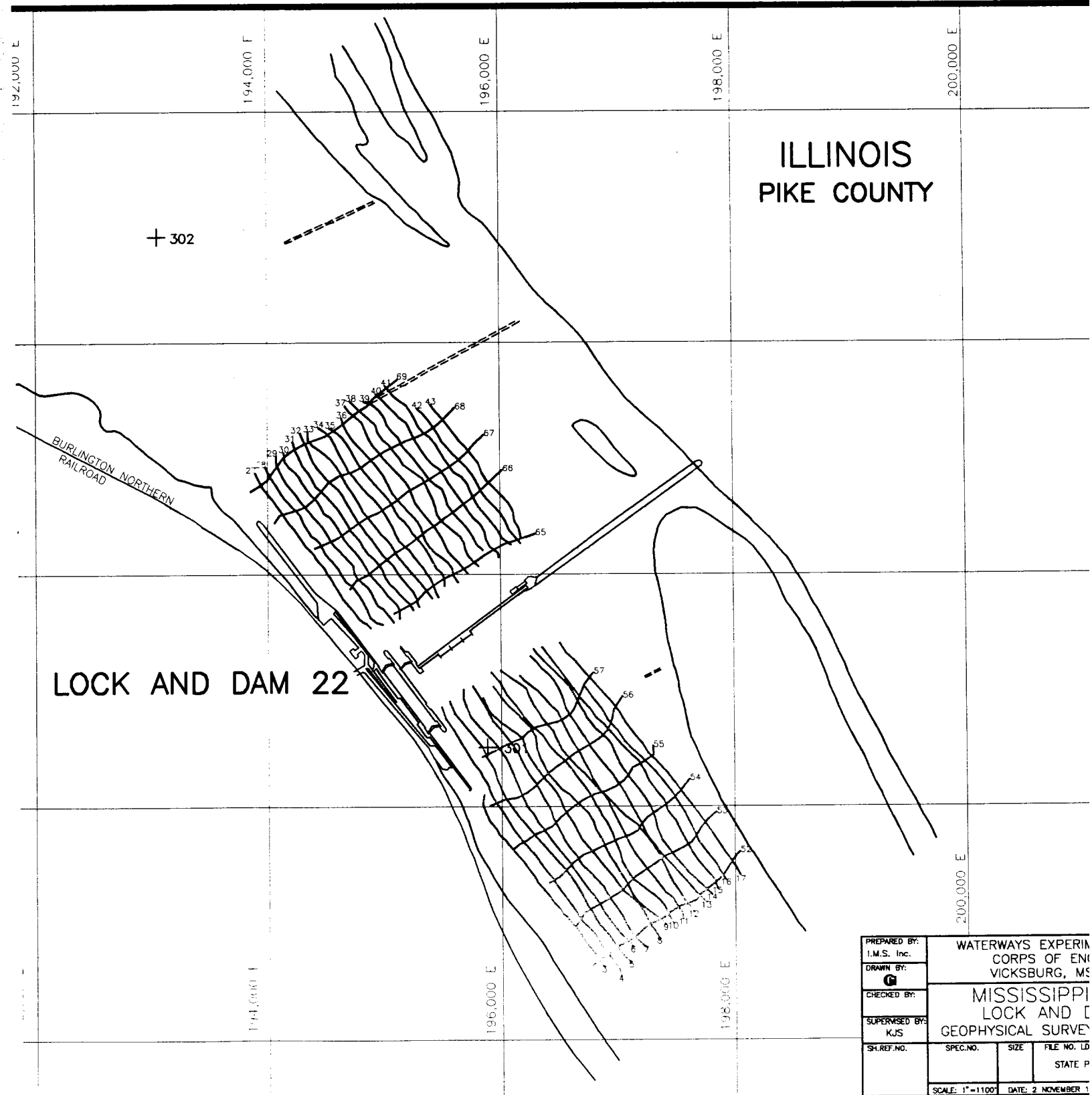


Figure 4. Seismic reflection survey lines, Lock and Dam 22



LOCK AND DAM 22

ILLINOIS  
PIKE COUNTY

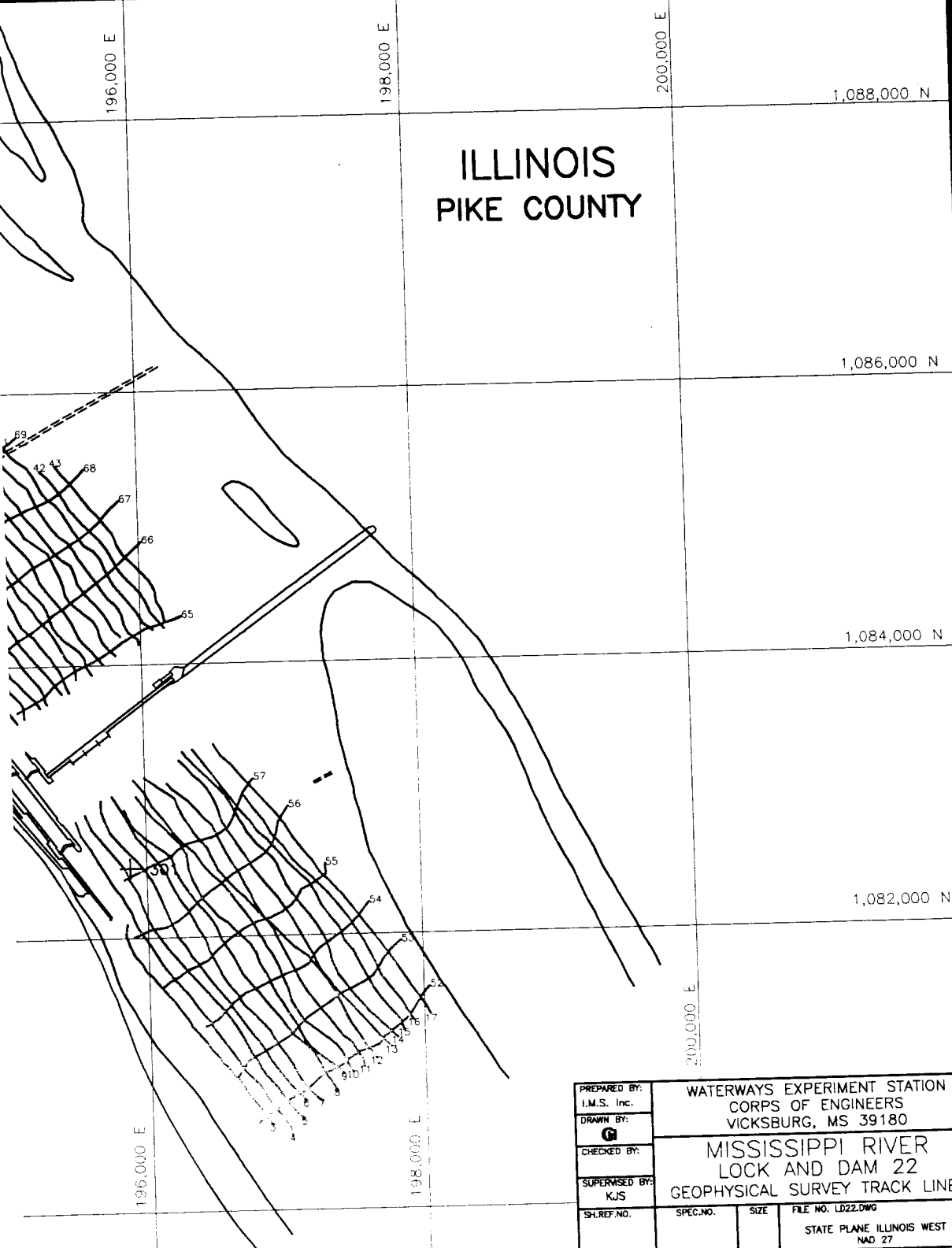
BURLINGTON NORTHERN  
RAILROAD

+ 302

|                             |  |                       |             |
|-----------------------------|--|-----------------------|-------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENTAL<br>CORPS OF ENGINEERS<br>VICKSBURG, MISSISSIPPI |                       |             |
| DRAWN BY:<br>G              | MISSISSIPPI<br>LOCK AND DAM<br>GEOLOGICAL SURVEY                       |                       |             |
| CHECKED BY:                 | STATE PROJECT  |                       |             |
| SUPERVISED BY:<br>KJS       | SPEC. NO.  | SIZE                  | FILE NO. LD |
| SH. REF. NO.                |  |                       |             |
| SCALE: 1" = 1100'           |  | DATE: 2 NOVEMBER 1961 |             |

Lock and Dam 22

# ILLINOIS PIKE COUNTY



|                             |   |                       |                   |
|-----------------------------|---|-----------------------|-------------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENT STATION<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180 |                       |                   |
| DRAWN BY:<br>G              | MISSISSIPPI RIVER<br>LOCK AND DAM 22<br>GEOPHYSICAL SURVEY TRACK LINES    |                       |                   |
| CHECKED BY:                 |   |                       |                   |
| SUPERSEDED BY:<br>KJS       | SPEC. NO.   | SIZE                  | FILE NO. LD22.DWG |
| SH. REF. NO.                | STATE PLANE ILLINOIS WEST<br>NAD 27                                       |                       |                   |
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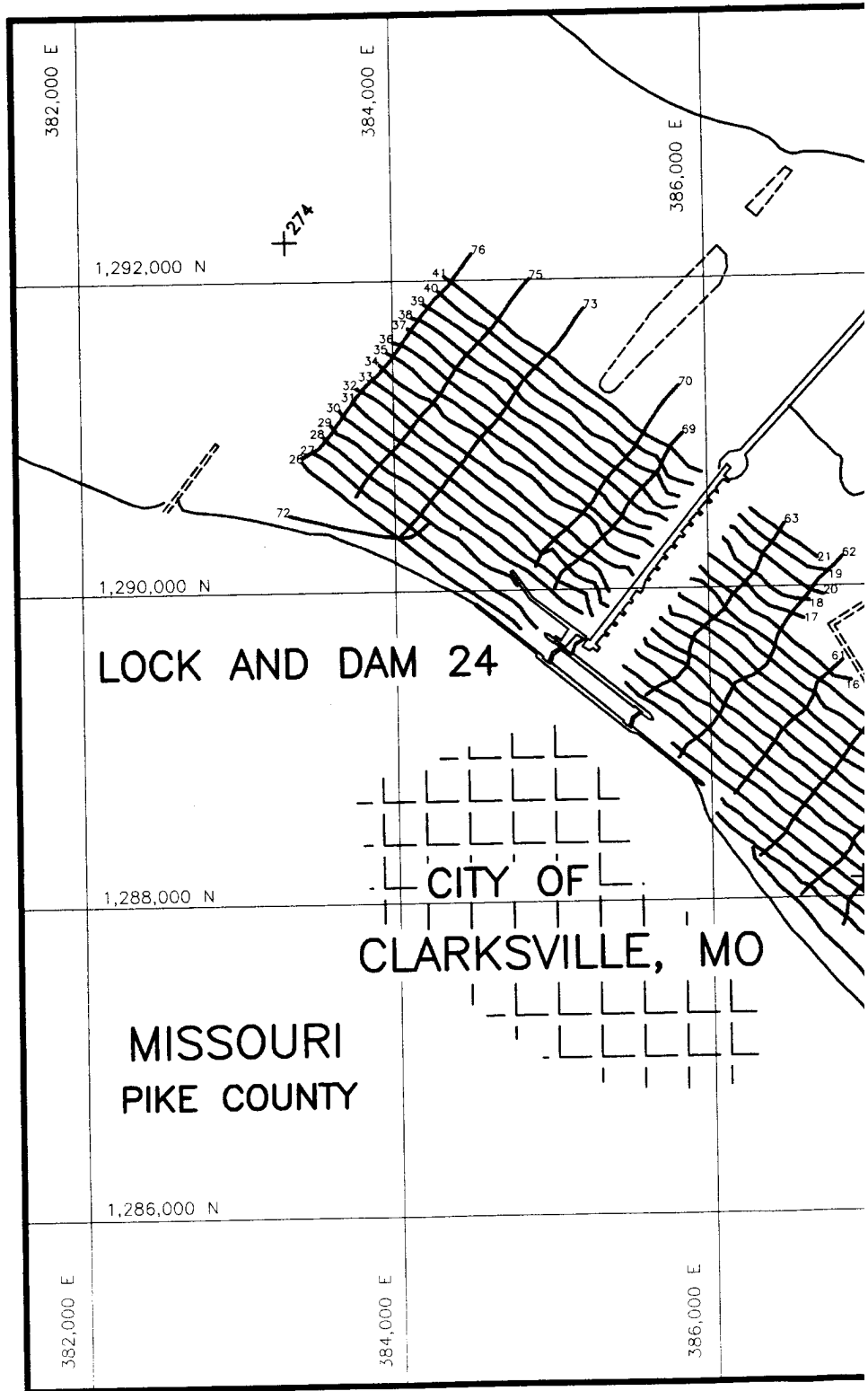
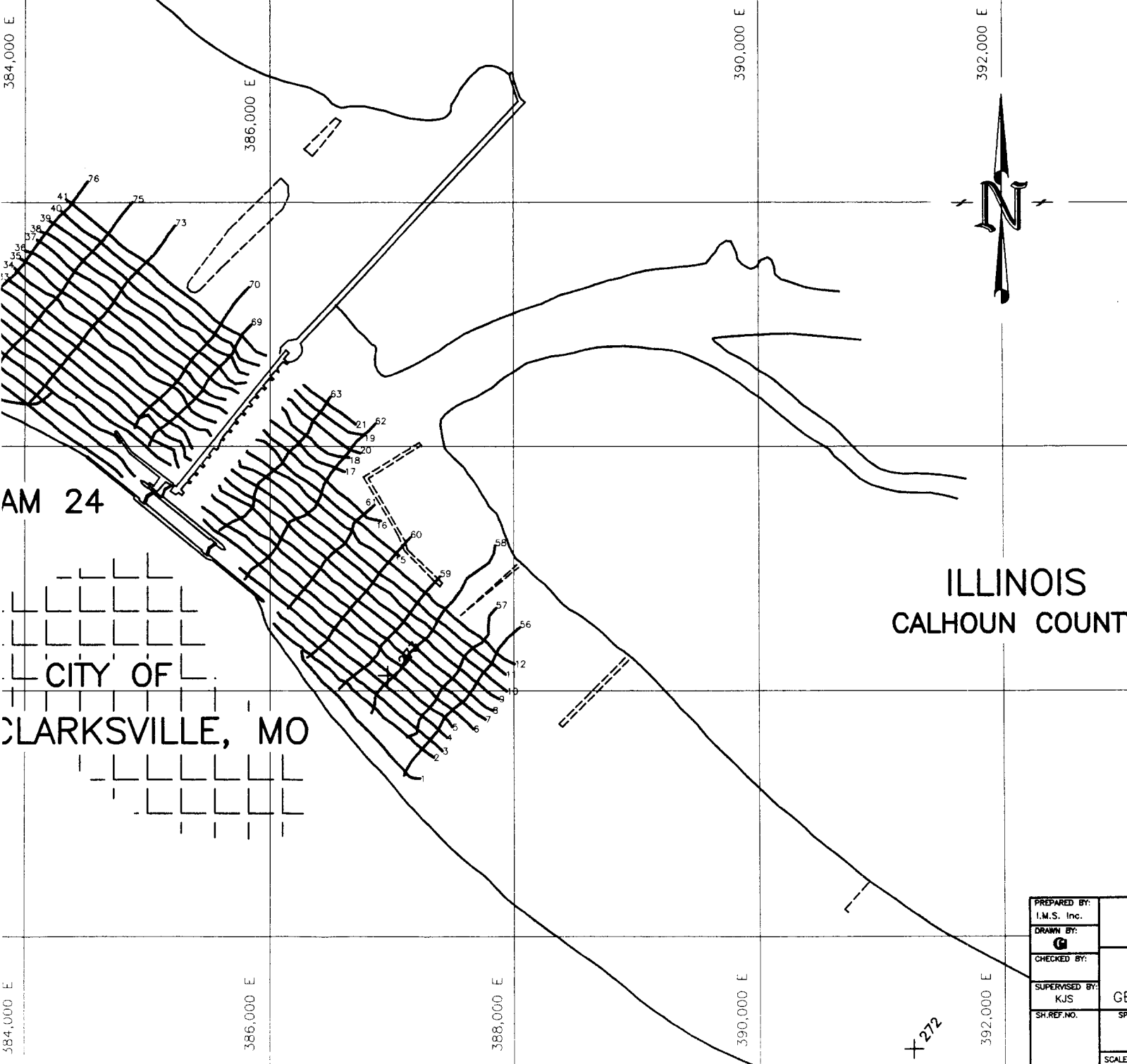


Figure 5. Seismic reflection survey lines, Lock and Dam 24



AM 24

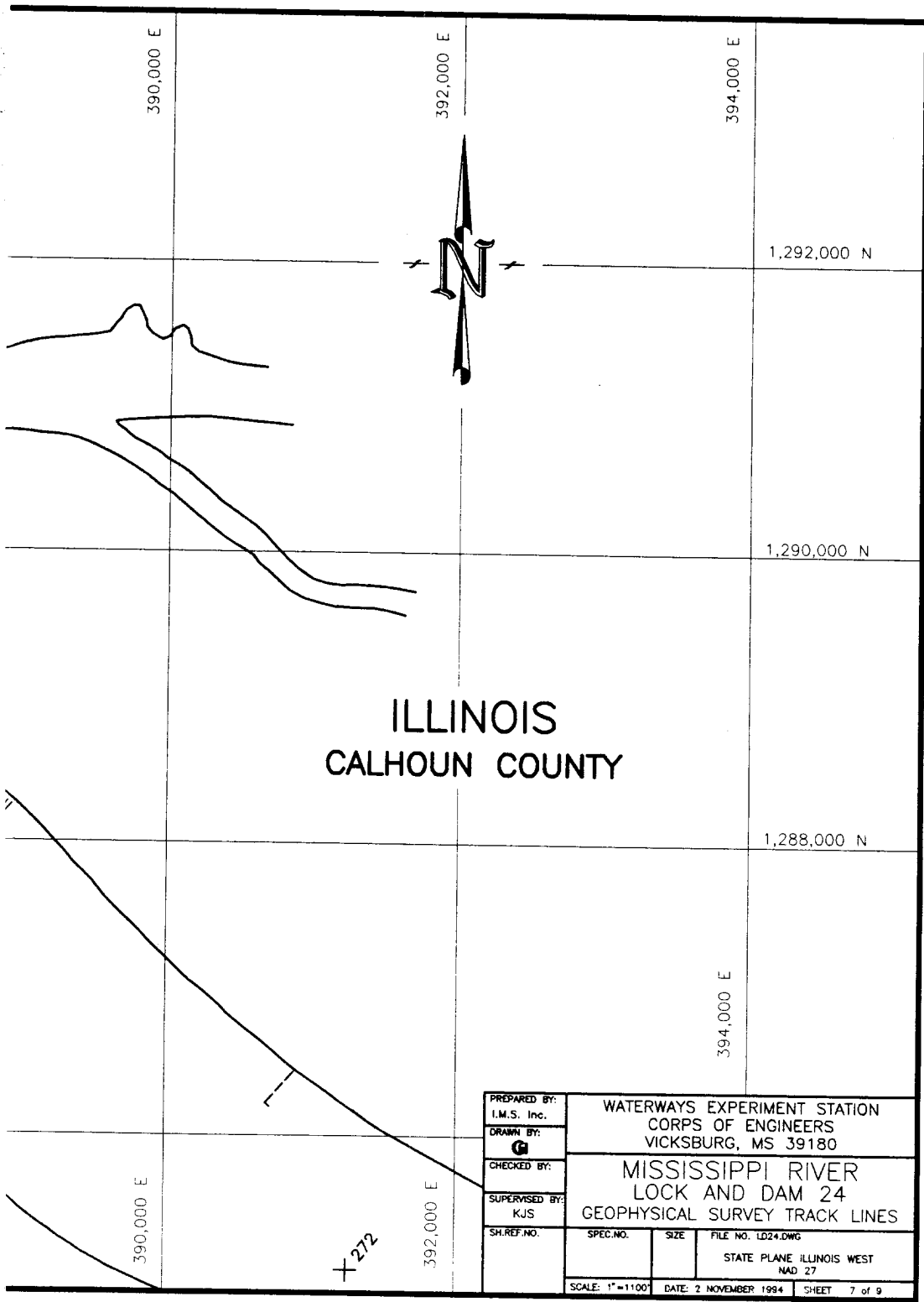
CITY OF  
CLARKSVILLE, MO

ILLINOIS  
CALHOUN COUNTY



|                             |      |
|-----------------------------|------|
| PREPARED BY:<br>I.M.S. Inc. |      |
| DRAWN BY:<br>G              |      |
| CHECKED BY:                 |      |
| SUPERVISED BY:<br>KJS       | GE   |
| SH. REF. NO.                | SPEC |
| SCALE:                      |      |

urvey lines, Lock and Dam 24



ILLINOIS  
CALHOUN COUNTY

|                             |   |                       |                                     |
|-----------------------------|---|-----------------------|-------------------------------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENT STATION<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180 |                       |                                     |
| DRAWN BY:<br>G              |   |                       |                                     |
| CHECKED BY:                 | MISSISSIPPI RIVER<br>LOCK AND DAM 24<br>GEOPHYSICAL SURVEY TRACK LINES    |                       |                                     |
| SUPERVISED BY:<br>KJS       |   |                       |                                     |
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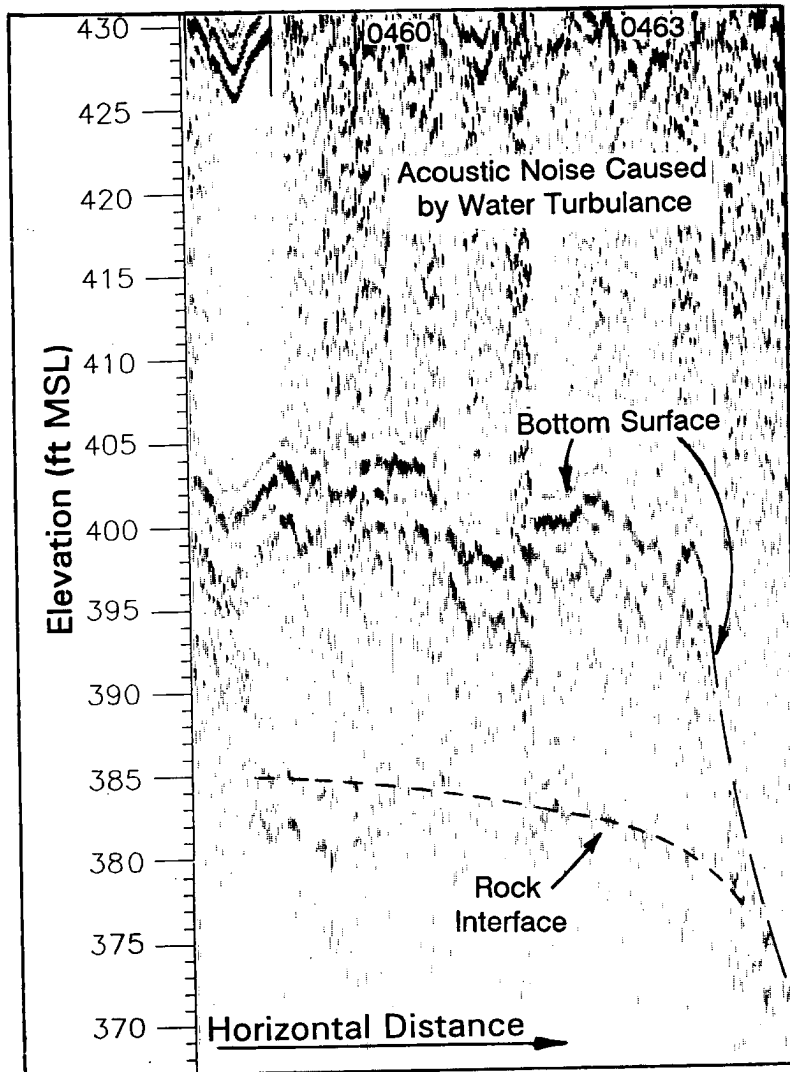


Figure 6. Acoustic noise along 'boomer' survey line #63 caused by water turbulence downstream of Lock and Dam 24

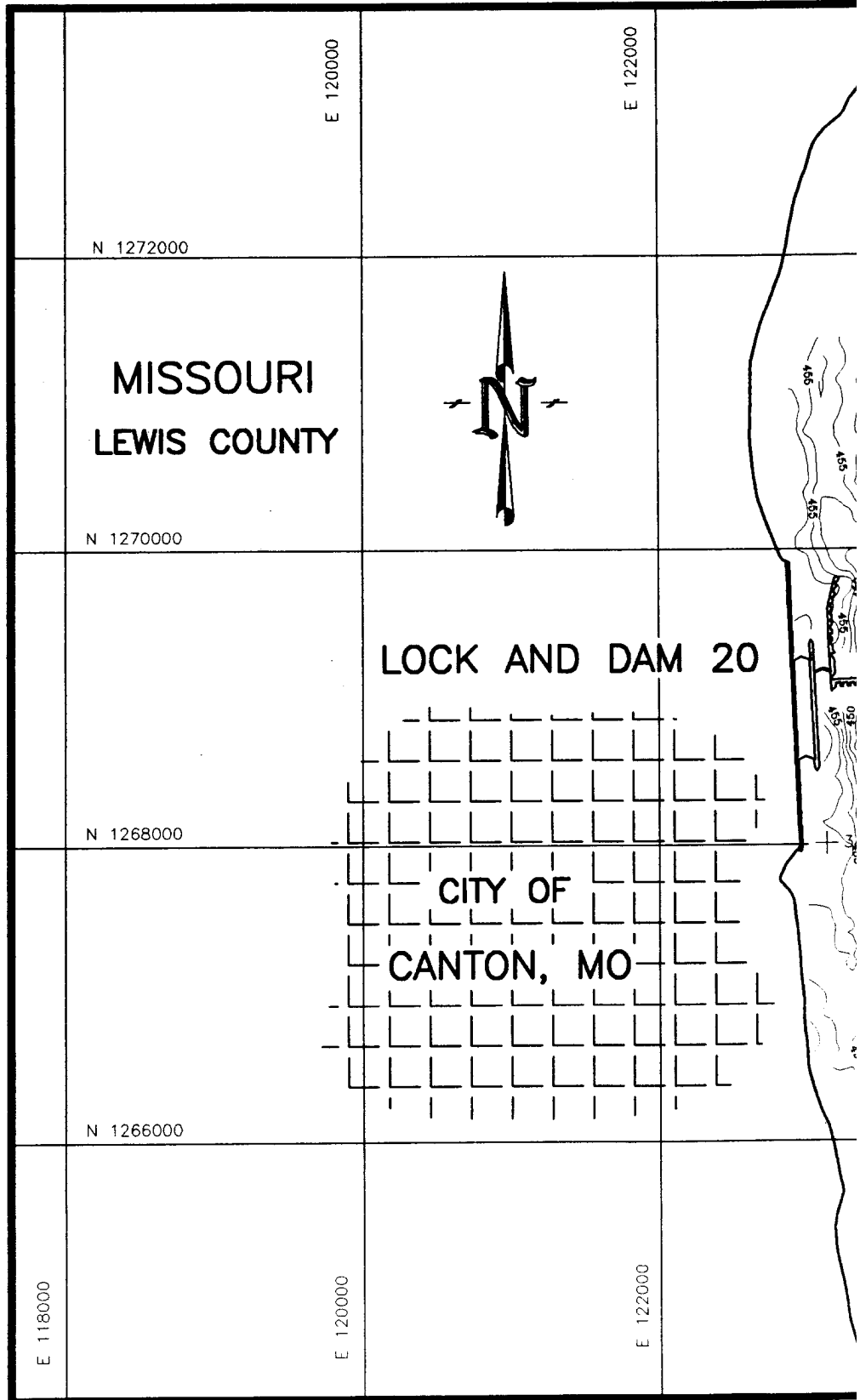


Figure 7. River bottom elevation plot, Lock and Dam 20

E 122000

E 126000

E 128000

E 130000

344  
E 124000



ILLINOIS  
ADAMS COUNTY

CK AND DAM 20

TOWN OF  
MEYER, IL

CITY OF  
STON, MO

NOTE:  
CONTOUR INTERVAL  
@ 2.5 FT

E 122000

E 124000

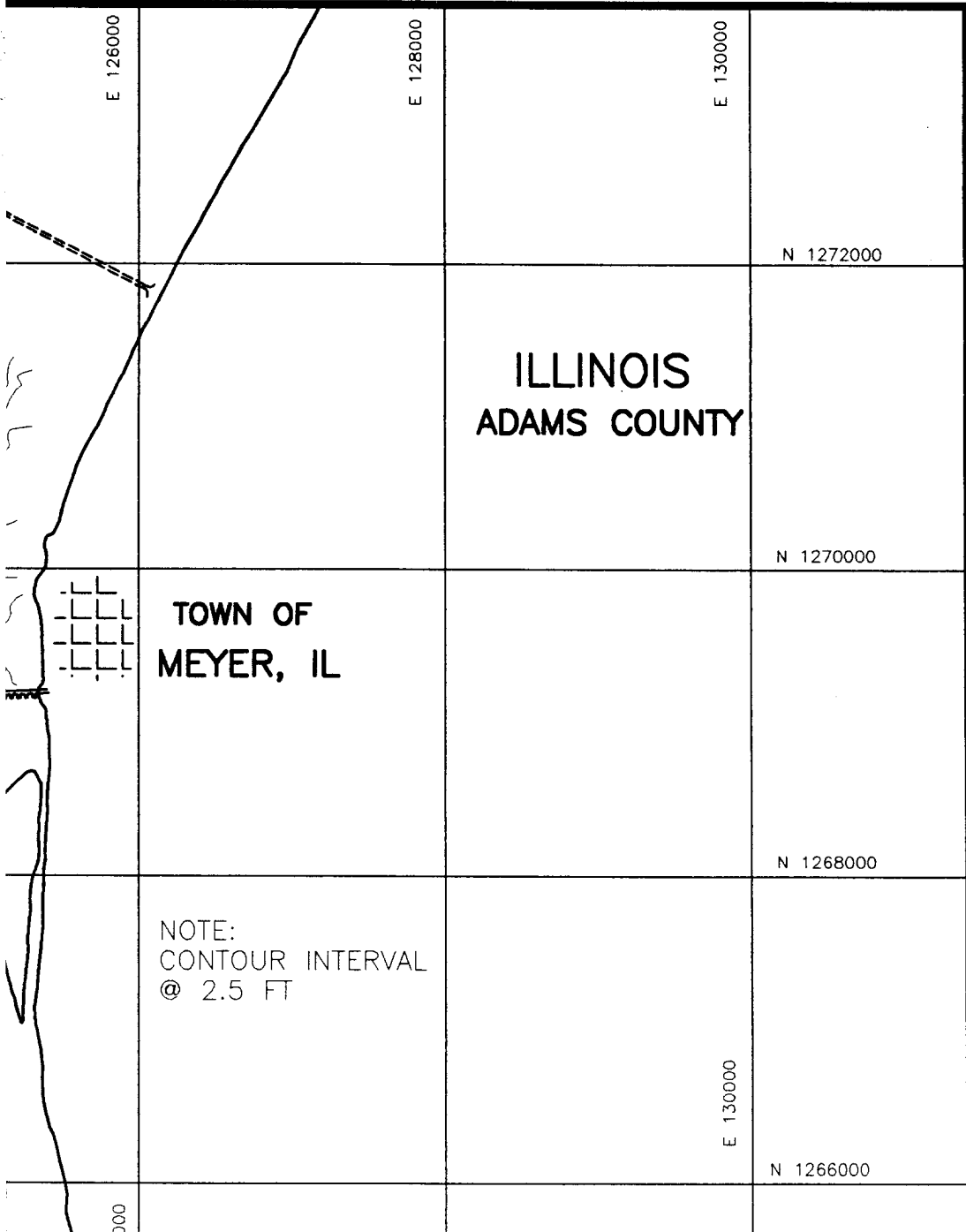
E 126000

E 128000

E 130000

|                             |                                       |       |
|-----------------------------|---------------------------------------|-------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS<br>CORP<br>VICKS            |       |
| DRAWN BY:<br>C              | MISSISSIPPI<br>LOCK<br>RIVER BOTTLING |       |
| CHECKED BY:                 | SPEC. NO.                             | SIZE  |
| SUPERVISED BY:<br>KJS       |                                       |       |
| SH. REF. NO.                |                                       |       |
| SCALE: 1"=1100'             |                                       | DATE: |

Lock and Dam 20



**ILLINOIS  
ADAMS COUNTY**

**TOWN OF  
MEYER, IL**

NOTE:  
CONTOUR INTERVAL  
@ 2.5 FT

|  |   |      |                   |
|--|---|------|-------------------|
| PREPARED BY:<br>I.M.S. Inc.                              | WATERWAYS EXPERIMENT STATION<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180 |      |                   |
| DRAWN BY:<br>  | MISSISSIPPI RIVER<br>LOCK AND DAM 20                                      |      |                   |
| CHECKED BY:  | RIVER BOTTOM ELEVATION, FT MSL  |      |                   |
| SUPERVISED BY:<br>KJS                                    | SPEC. NO.   | SIZE | FILE NO. LD20.DWG |
| SH. REF. NO.   | STATE PLANE ILLINOIS WEST<br>NAD 27                                       |      |                   |
| SCALE: 1"=1100'    DATE: 2 NOVEMBER 1994    SHEET 2 of 9 |   |      |                   |

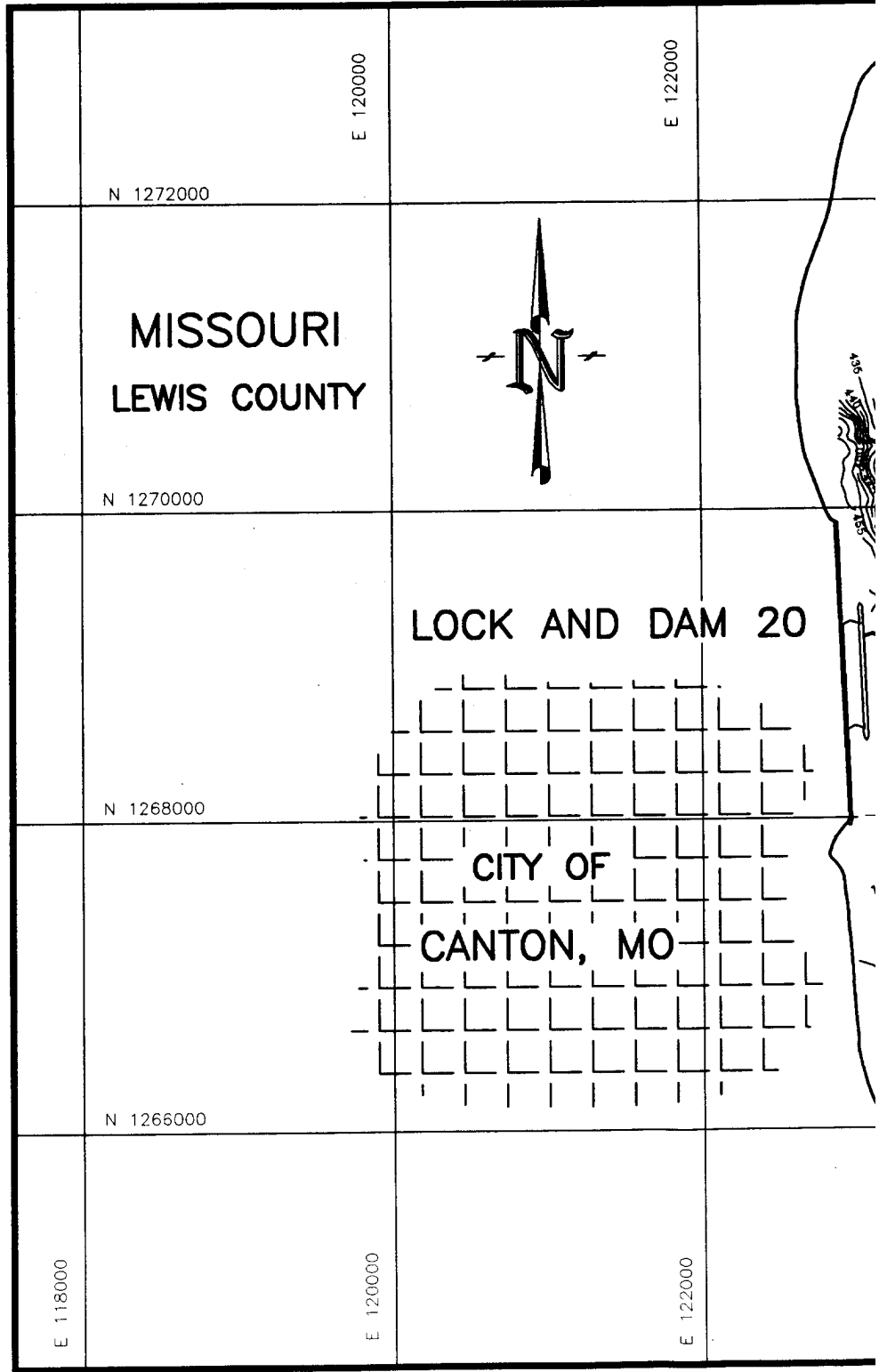
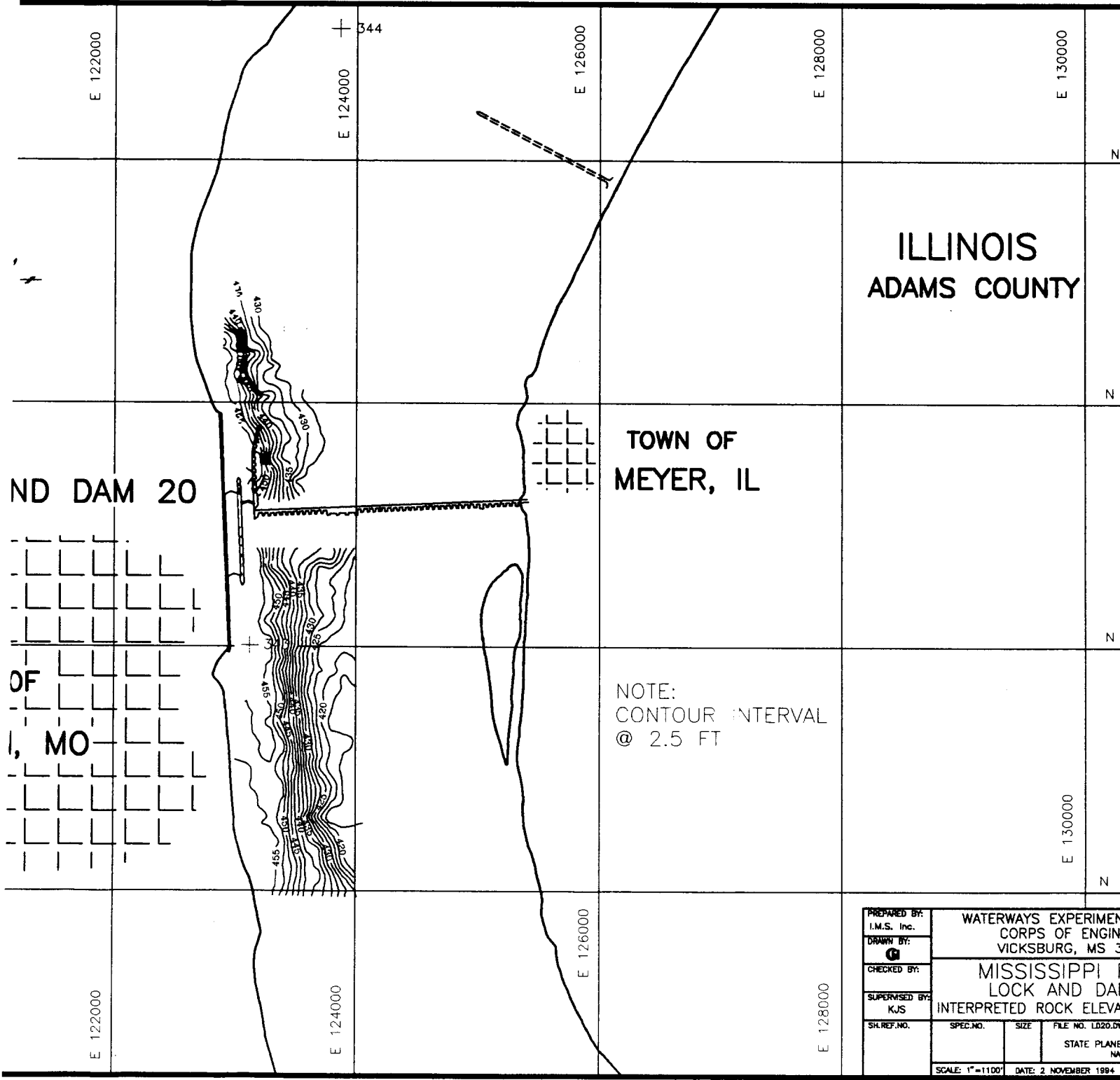
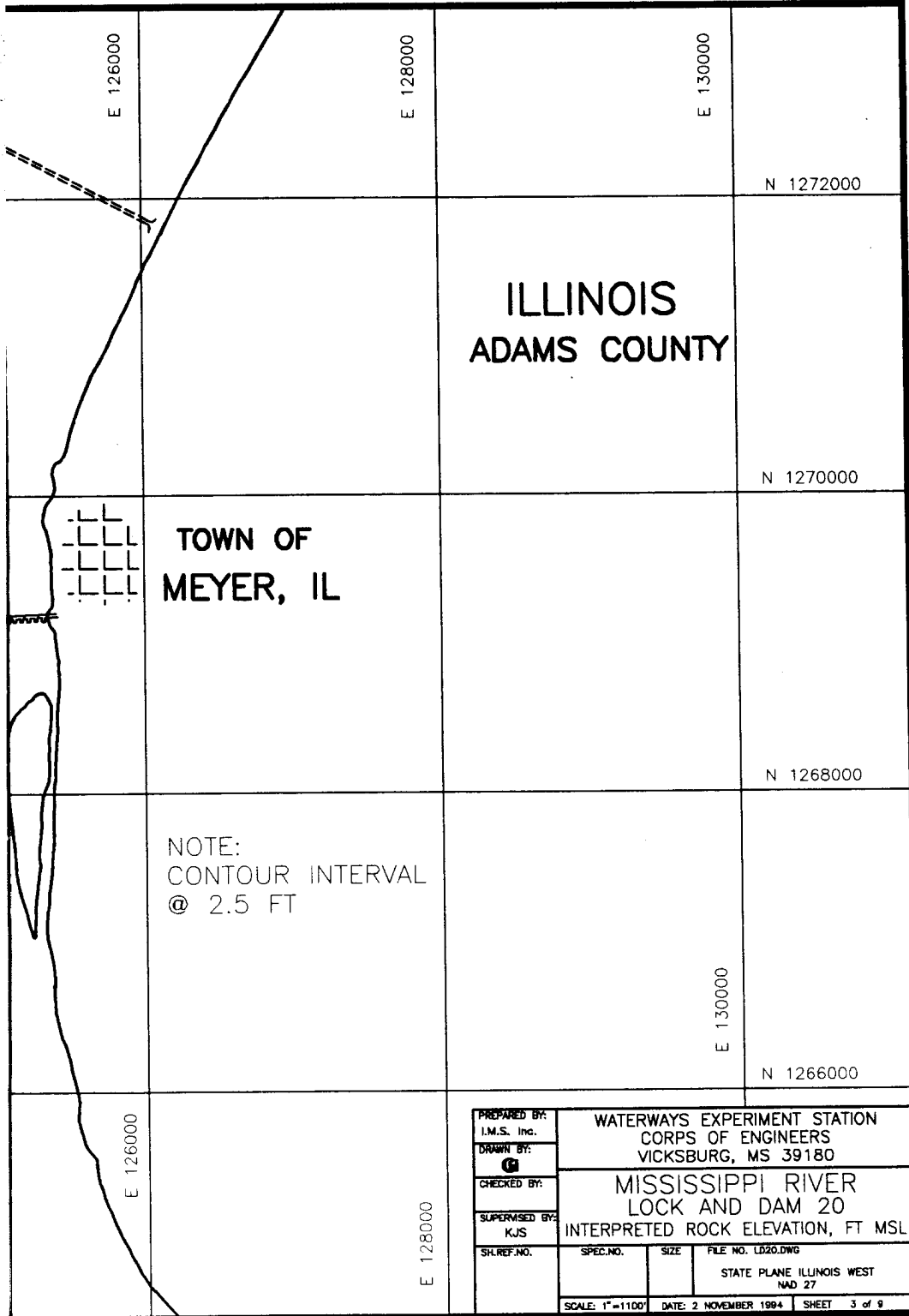


Figure 8. Interpreted rock surface elevation map, Lock and Dam 20. Rep



Map of Lock and Dam 20. Representative CENCR core locations are also illustrated

|                             |  |      |                                       |
|-----------------------------|--|------|---------------------------------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENTAL<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180                  |      |                                       |
| DRAWN BY:<br>G              | MISSISSIPPI FLOOD CONTROL DISTRICT<br>LOCK AND DAM 20<br>INTERPRETED ROCK ELEVATIONS |      |                                       |
| CHECKED BY:<br>KJS          | SPEC. NO.  | SIZE | FILE NO. LD20.DW                      |
| SUPERVISED BY:              |  |      | STATE PLANE<br>NAD                    |
| SH. REF. NO.                |  |      | SCALE: 1"=1100' DATE: 2 NOVEMBER 1984 |



Locations are also illustrated

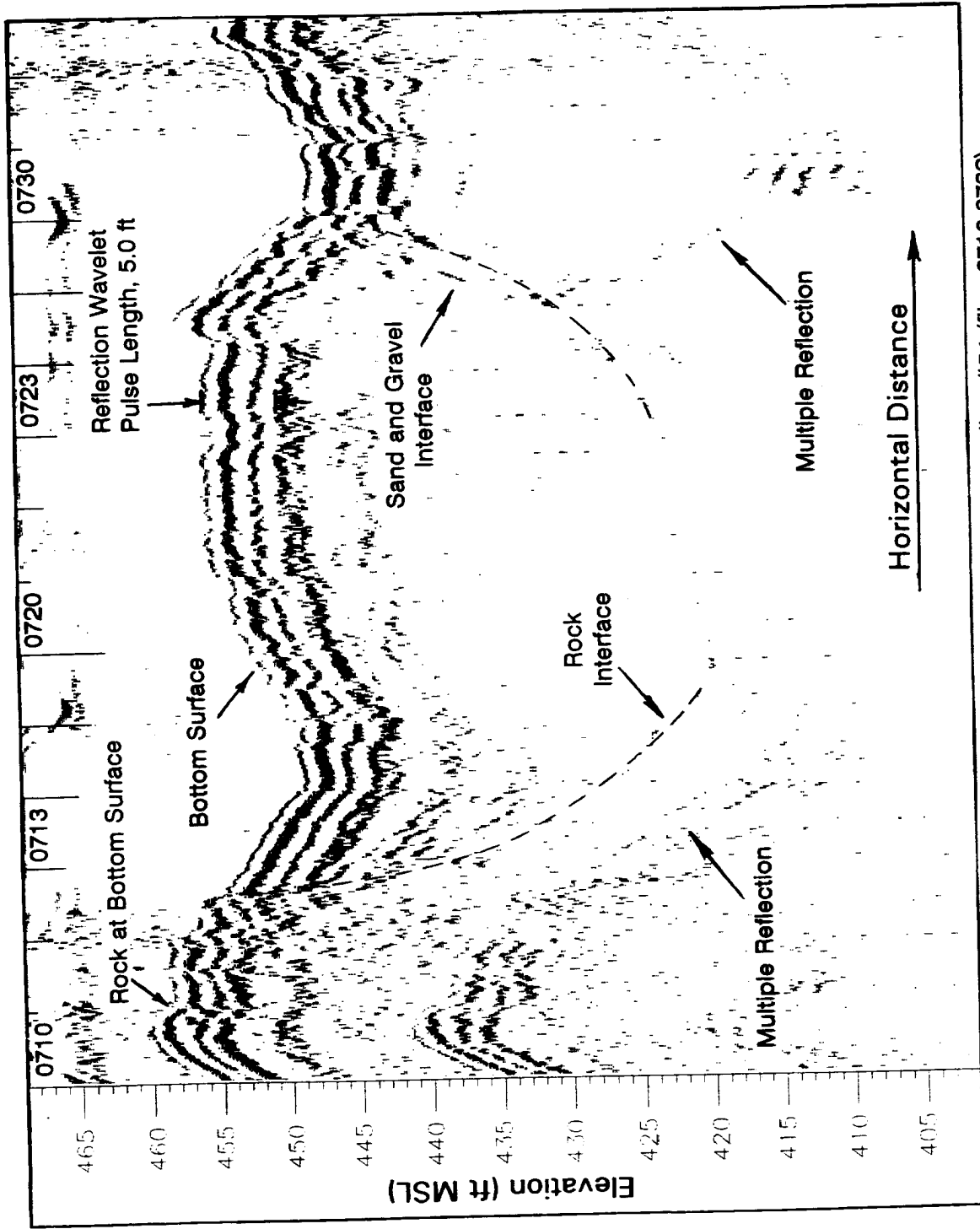


Figure 9. Subbottom seismic reflection record along 'boomer' survey line #54 (files 0710-0732), downstream of Lock and Dam 20

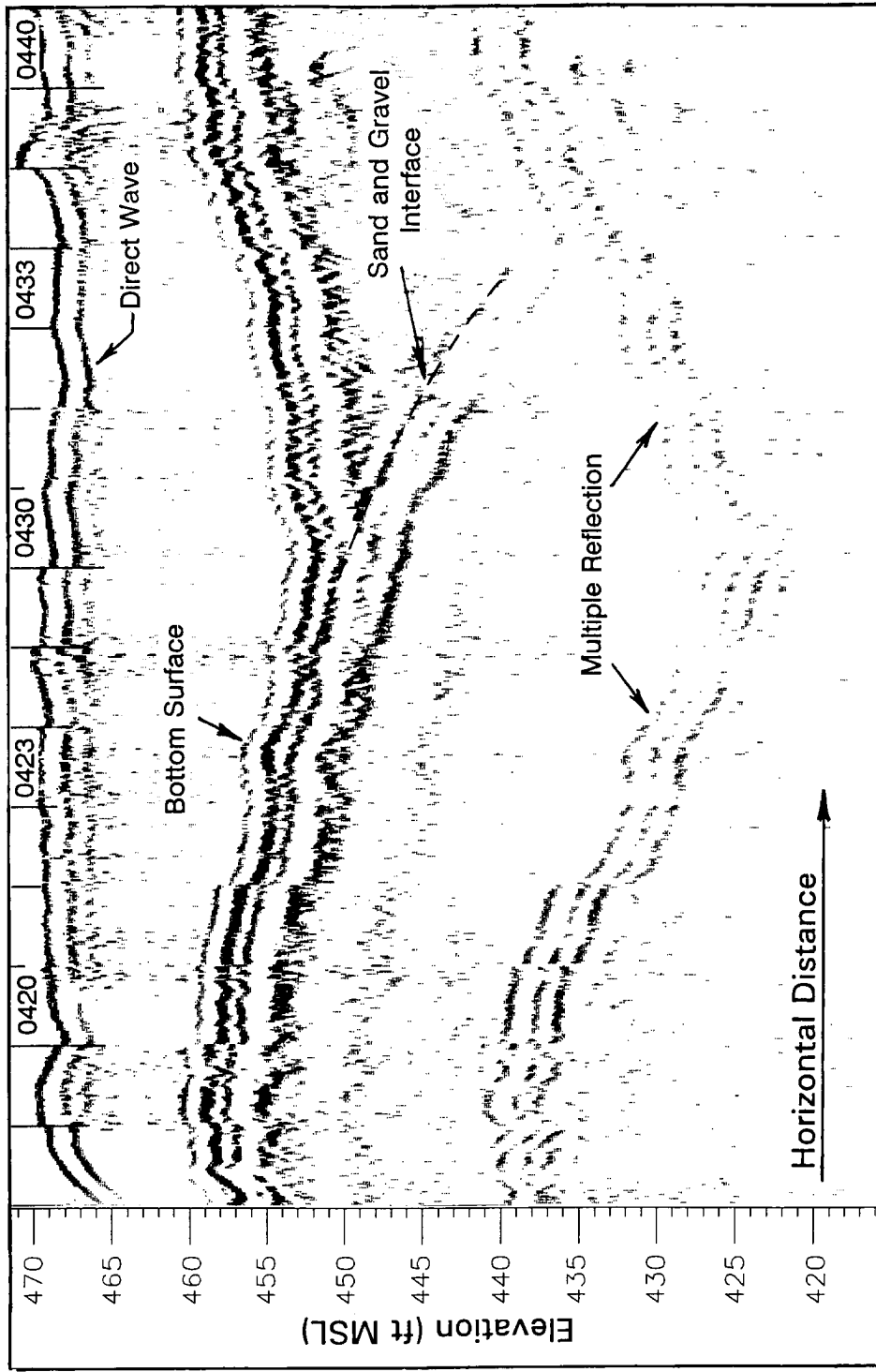


Figure 10. Subbottom seismic reflection record along 'boomer' survey line #44 (files 0414-0440), upstream of Lock and Dam 20

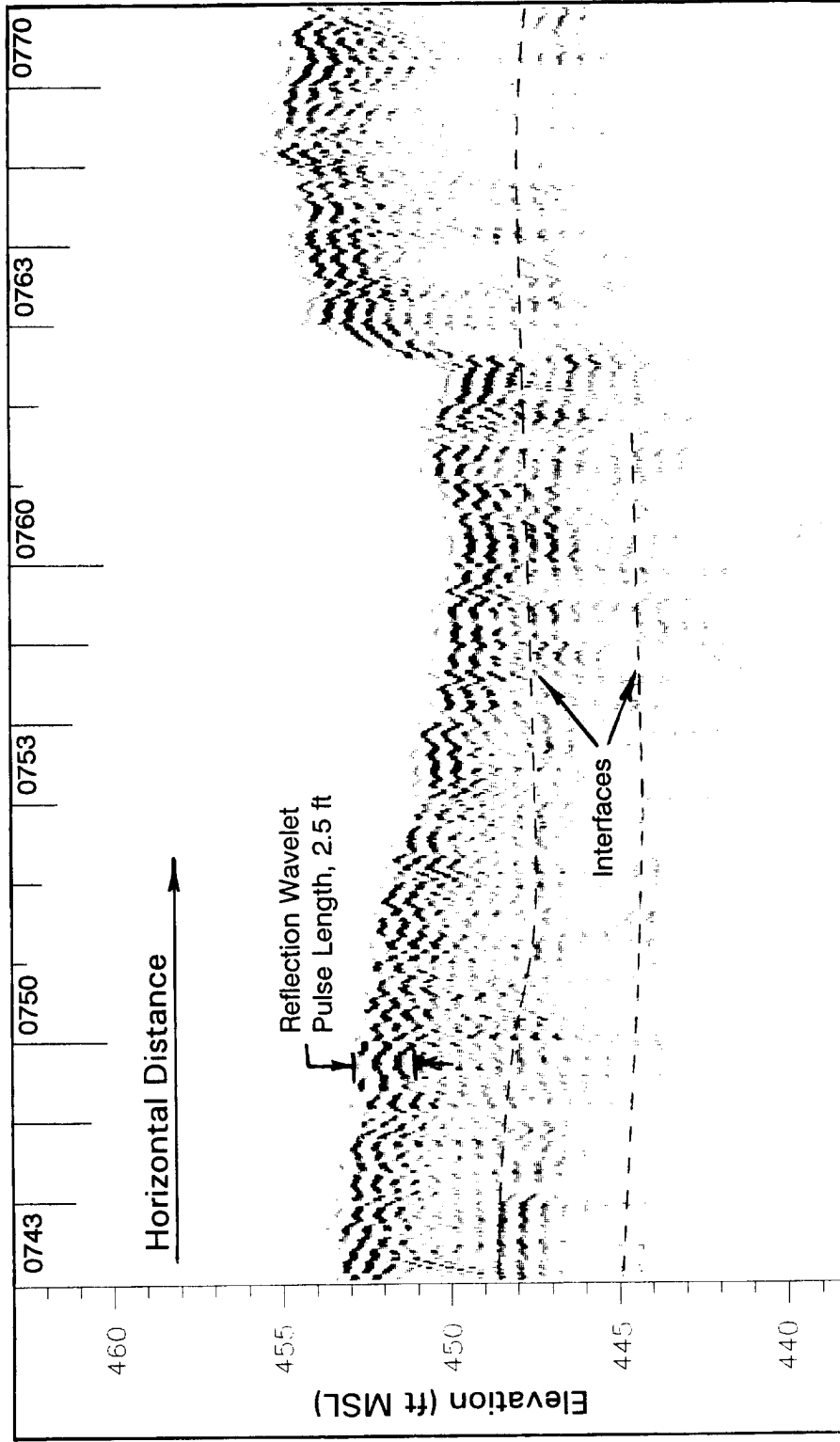


Figure 11. Subbottom seismic reflection record along 'pinger' survey line #12 (files 0743-0770), downstream of Lock and Dam 20

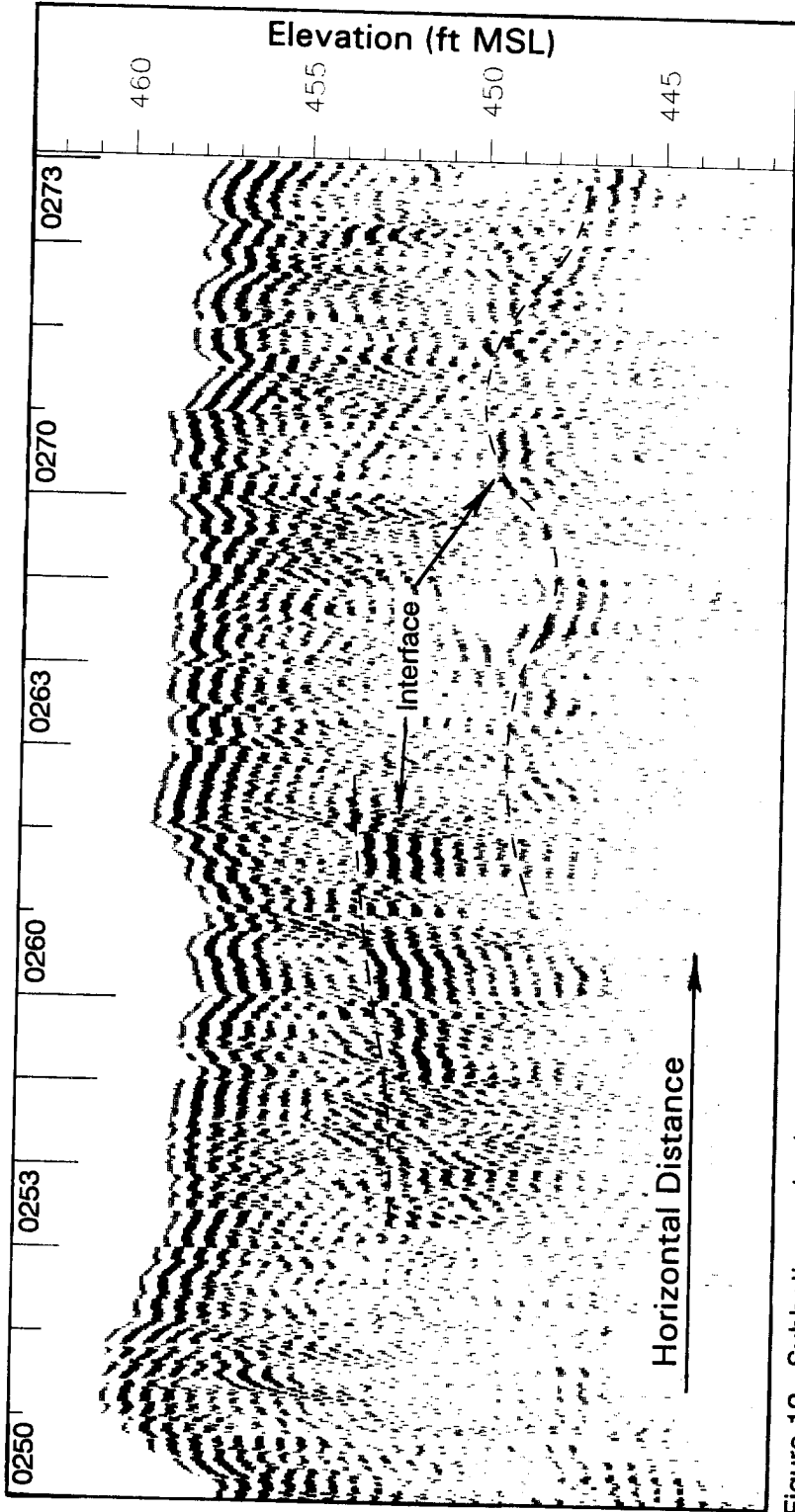


Figure 12. Subbottom seismic reflection record along 'pinger' survey line #29 (files 0250-0273), upstream of Lock and Dam 20

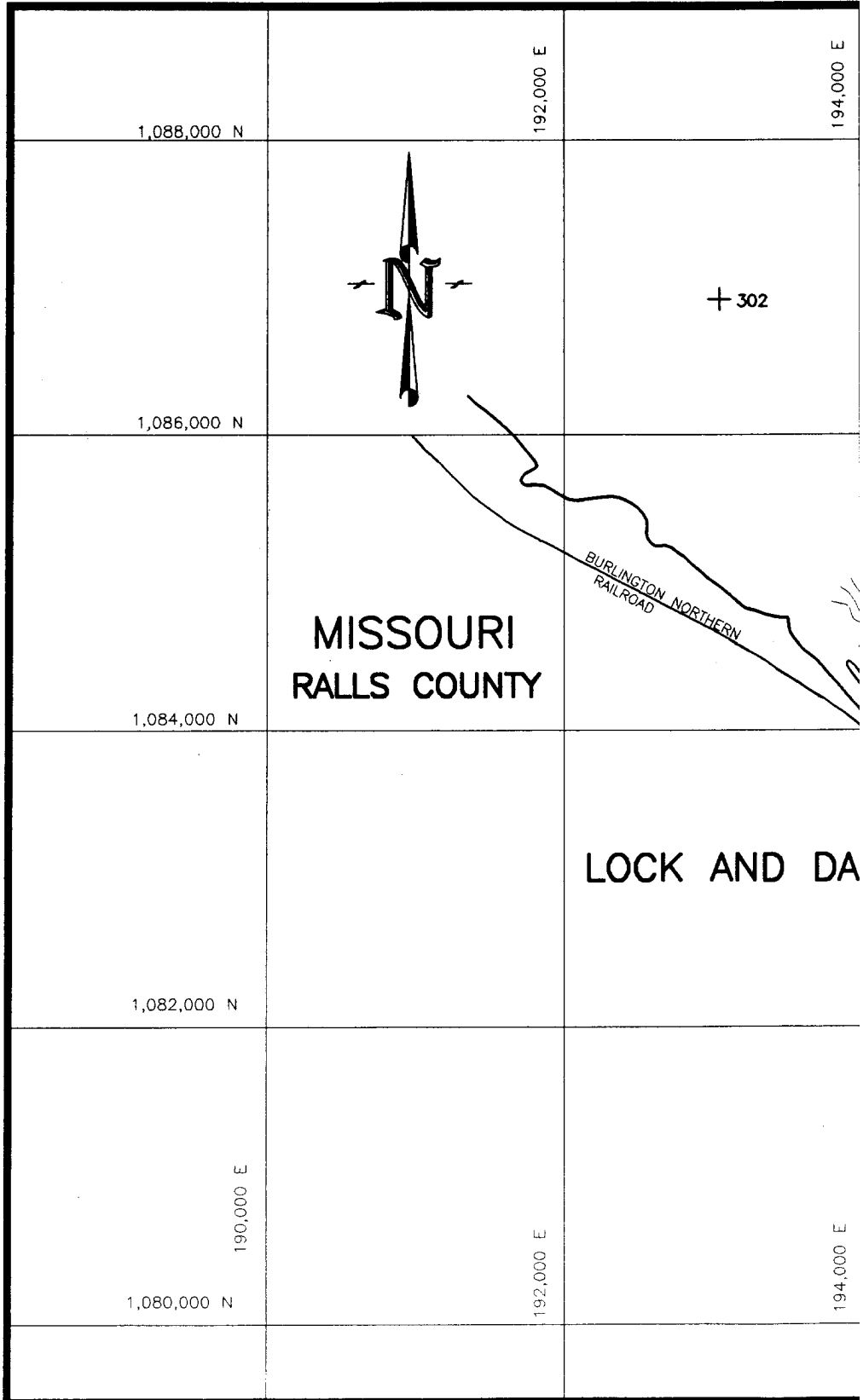
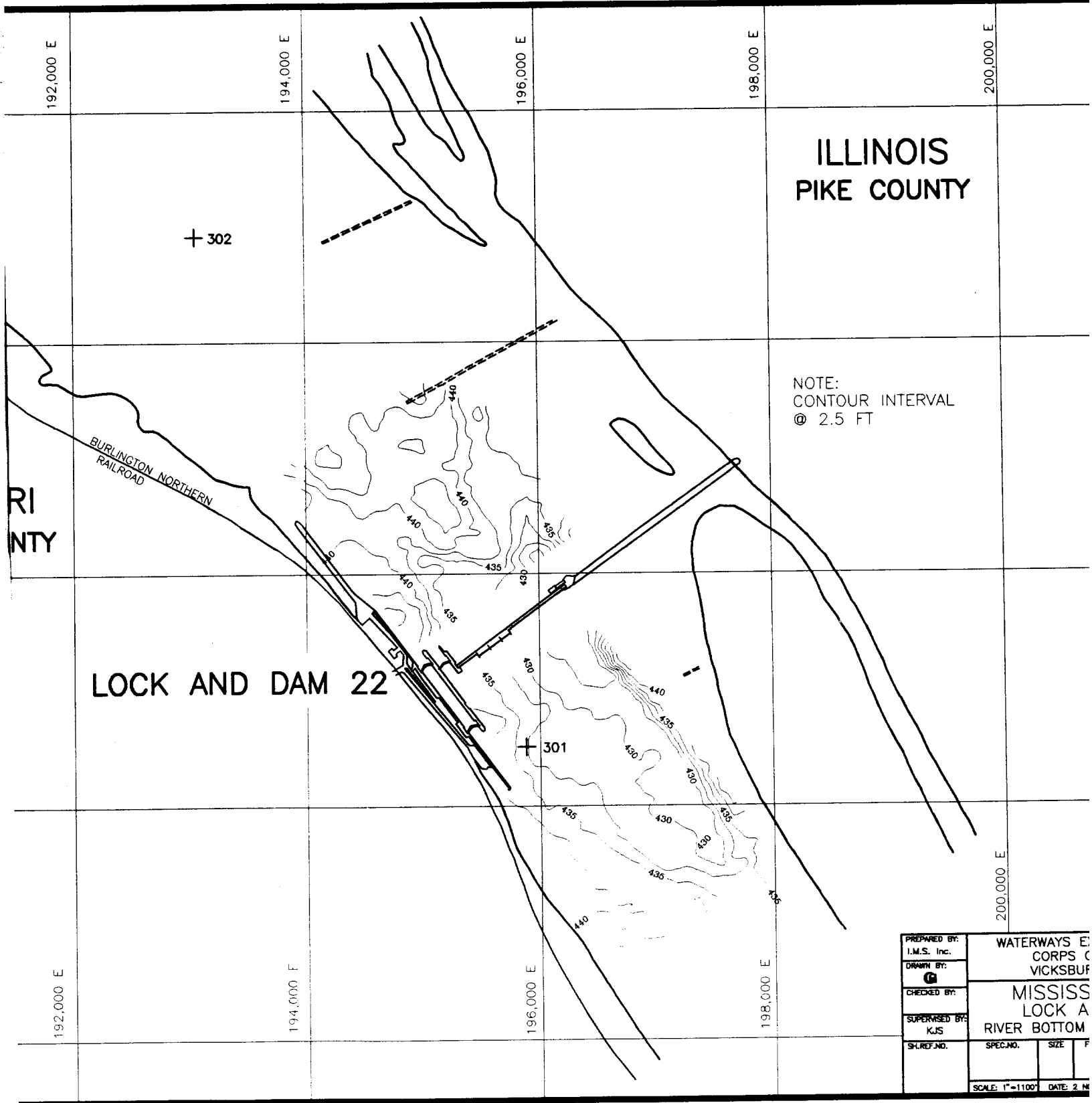


Figure 13. River bottom elevation plot, Lock and Dam 22



ILLINOIS  
PIKE COUNTY

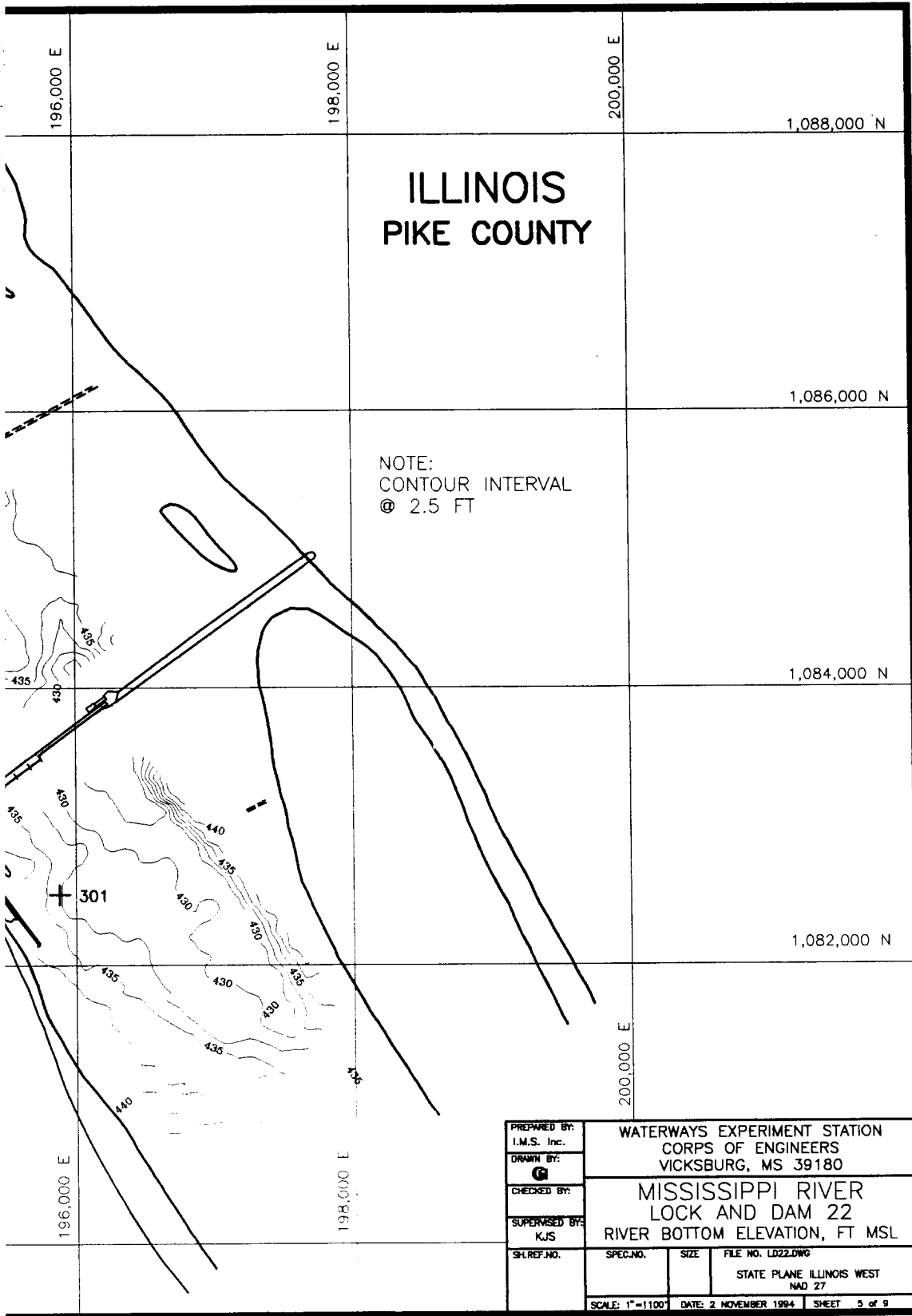
NOTE:  
CONTOUR INTERVAL  
@ 2.5 FT

BURLINGTON NORTHERN  
RAILROAD

LOCK AND DAM 22

|                             |   |                  |   |
|-----------------------------|---|------------------|---|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS ENGINEERING<br>CORPS (C)<br>VICKSBURG |                  |   |
| DRAWN BY:<br>G              | MISSISSIPPI<br>LOCK AND DAM<br>RIVER BOTTOM     |                  |   |
| CHECKED BY:                 | SPEC. NO.                                       | SIZE             | F |
| SUPERVISED BY:<br>KJS       |   |                  |   |
| SH. REF. NO.                |   |                  |   |
| SCALE: 1"=1100'             |   | DATE: 2 MAR 1964 |   |

Lock and Dam 22



# ILLINOIS PIKE COUNTY

NOTE:  
CONTOUR INTERVAL  
@ 2.5 FT

|  |   |      |                   |
|--|---|------|-------------------|
| PREPARED BY:<br>I.M.S. Inc.                              | WATERWAYS EXPERIMENT STATION<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180 |      |                   |
| DRAWN BY:<br>  | MISSISSIPPI RIVER<br>LOCK AND DAM 22                                      |      |                   |
| CHECKED BY:  | RIVER BOTTOM ELEVATION, FT MSL  |      |                   |
| SUPERSEDED BY:<br>KJS                                    | SPEC. NO.   | SIZE | FILE NO. LD22.DWG |
| SH. REF. NO.   | STATE PLANE ILLINOIS WEST<br>NAD 27                                       |      |                   |
| SCALE: 1"=1100'    DATE: 2 NOVEMBER 1994    SHEET 5 of 9 |   |      |                   |

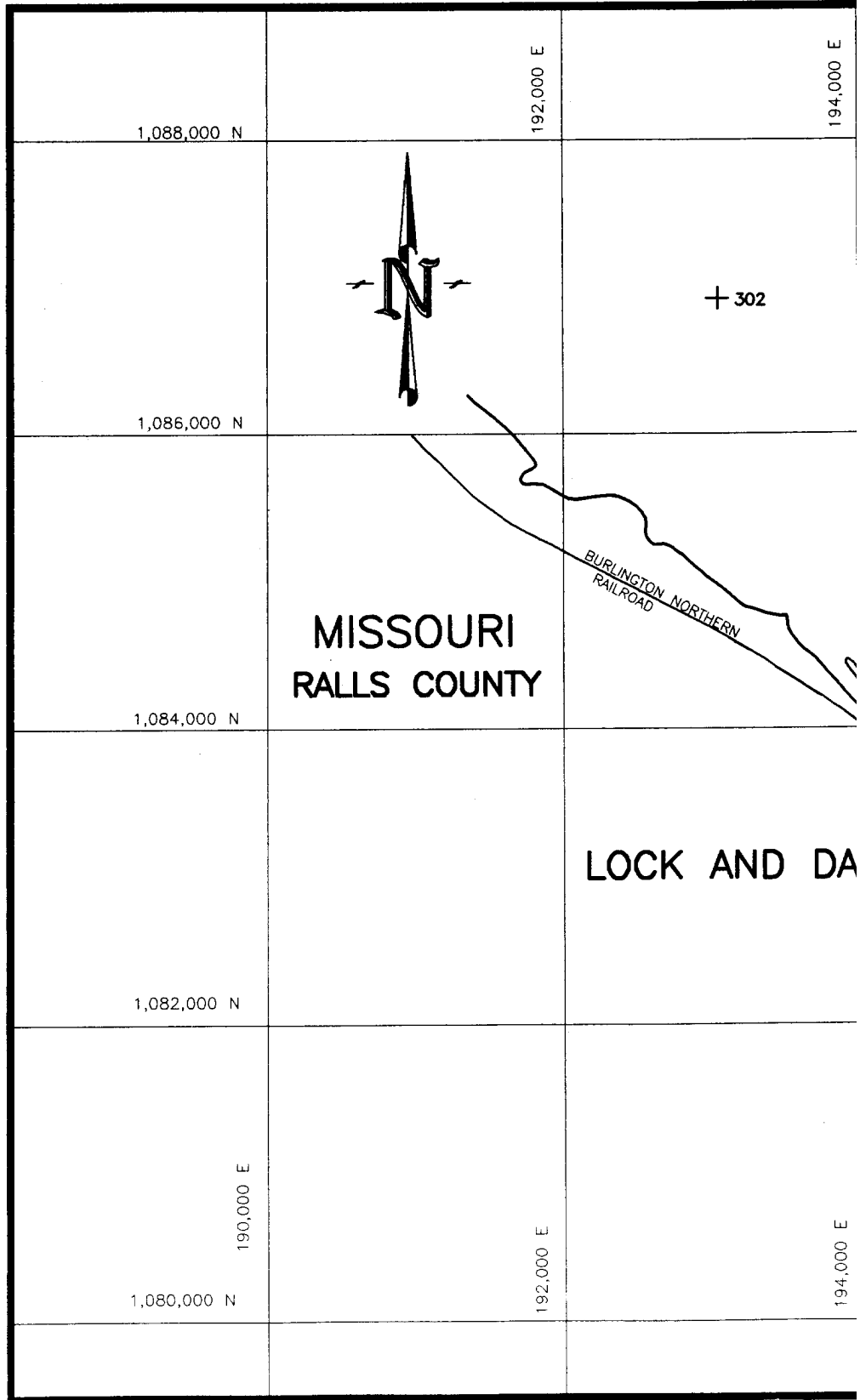
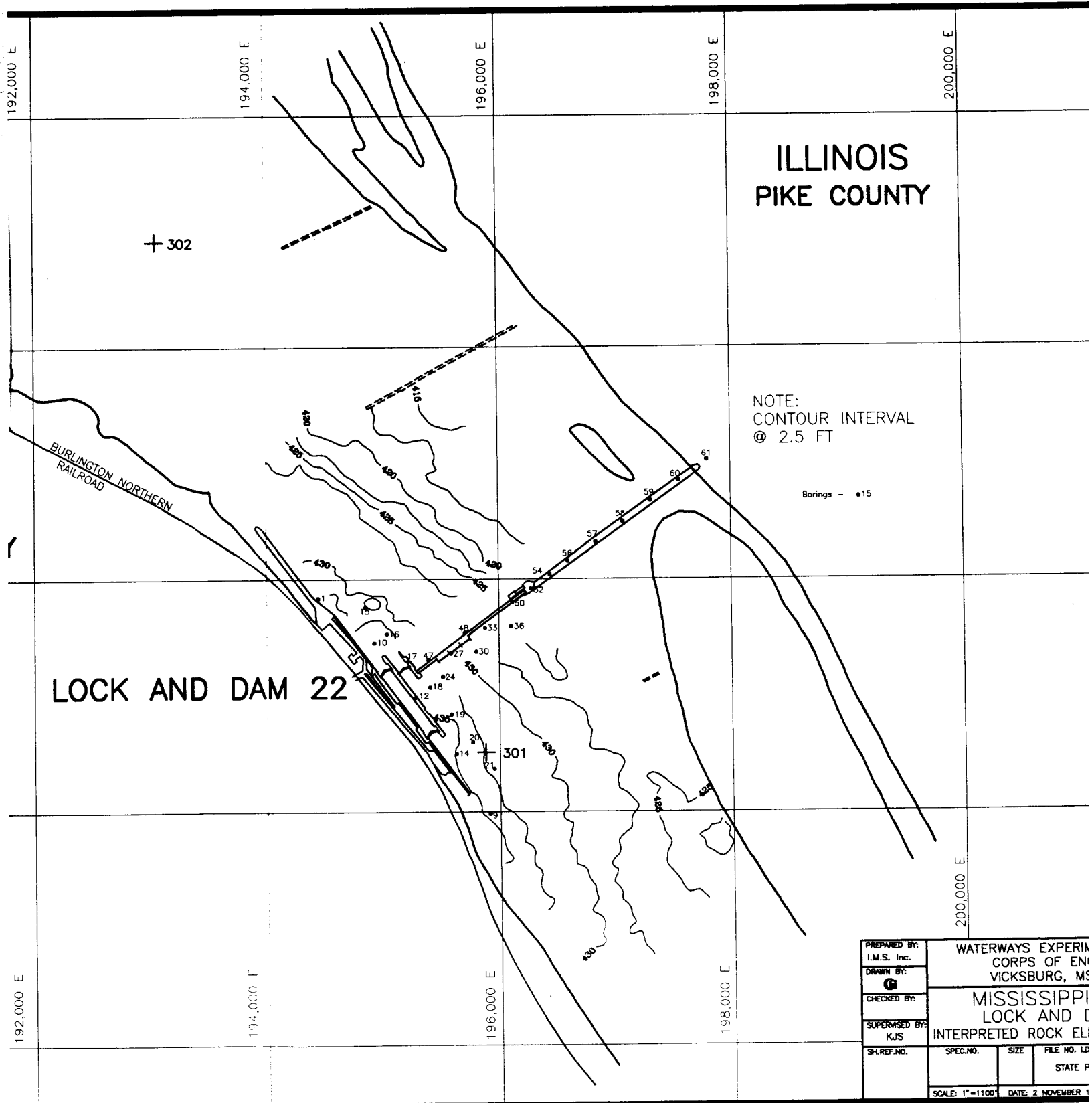
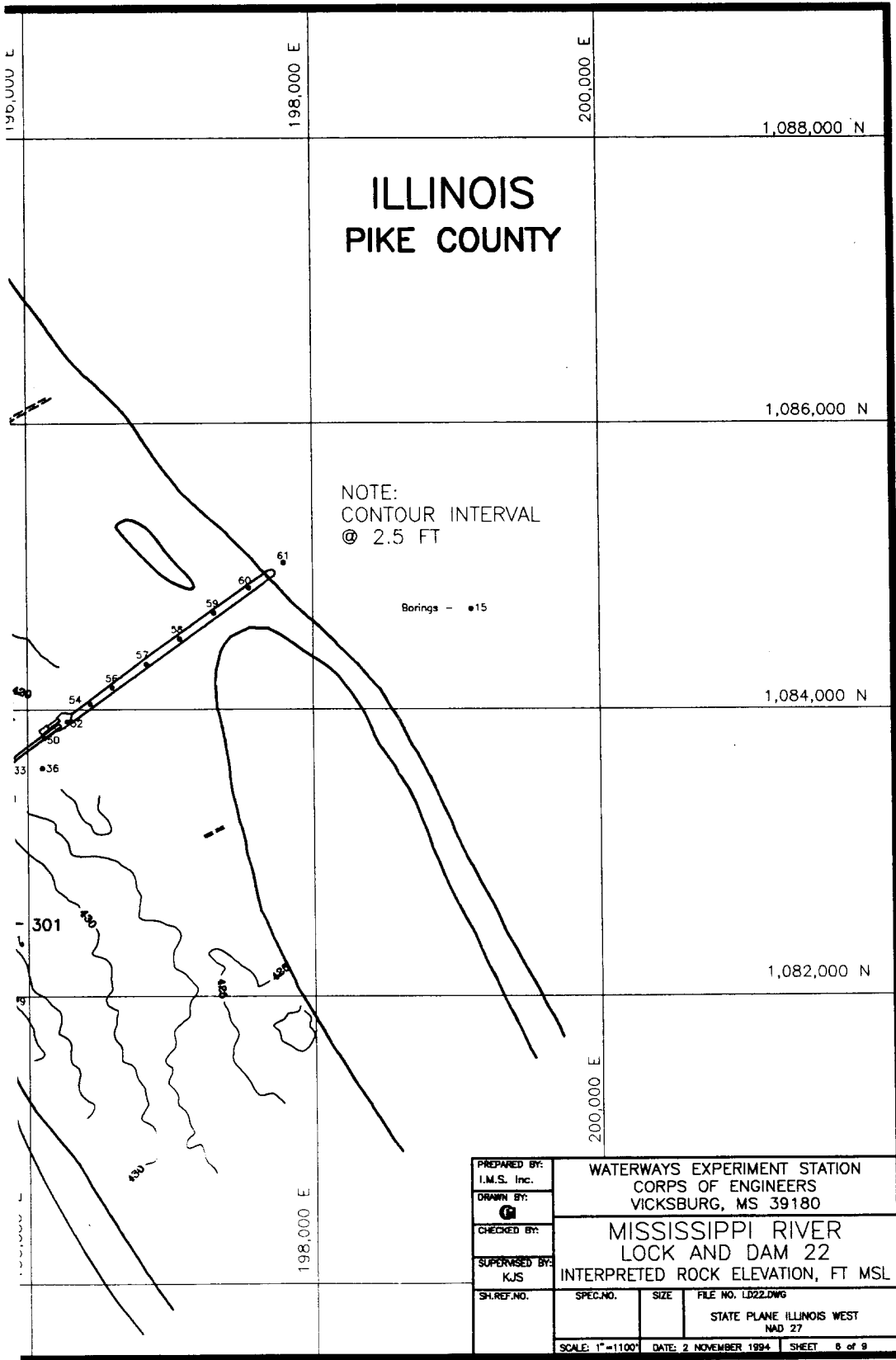


Figure 14. Interpreted rock surface elevation map, Lock and Dam 22. Repr



|                             |  |                       |             |
|-----------------------------|--|-----------------------|-------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENTAL<br>CORPS OF ENGINEERS<br>VICKSBURG, MISSISSIPPI |                       |             |
| DRAWN BY:<br>C              | MISSISSIPPI<br>LOCK AND DAM 22<br>INTERPRETED ROCK ELI                 |                       |             |
| CHECKED BY:                 | SPEC. NO.  | SIZE                  | FILE NO. LD |
| SUPERVISED BY:<br>KJS       |  |                       | STATE P     |
| SH. REF. NO.                |  |                       |             |
| SCALE: 1" = 1100'           |  | DATE: 2 NOVEMBER 1961 |             |

map, Lock and Dam 22. Representative CENCR core locations are also illustrated



**ILLINOIS  
PIKE COUNTY**

NOTE:  
CONTOUR INTERVAL  
@ 2.5 FT

Borings - ●15

|   |   |      |                   |
|---|---|------|-------------------|
| PREPARED BY:<br>I.M.S. Inc.                         | WATERWAYS EXPERIMENT STATION<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180 |      |                   |
| DRAWN BY:<br>G                                      | MISSISSIPPI RIVER<br>LOCK AND DAM 22                                      |      |                   |
| CHECKED BY:   | INTERPRETED ROCK ELEVATION, FT MSL  |      |                   |
| SUPERVISED BY:<br>KJS                               | SPEC. NO.   | SIZE | FILE NO. LD22.DWG |
| SH. REF. NO.  | STATE PLANE ILLINOIS WEST<br>NAD 27                                       |      |                   |
| SCALE: 1"=1100' DATE: 2 NOVEMBER, 1994 SHEET 5 of 9 |   |      |                   |

cations are also illustrated

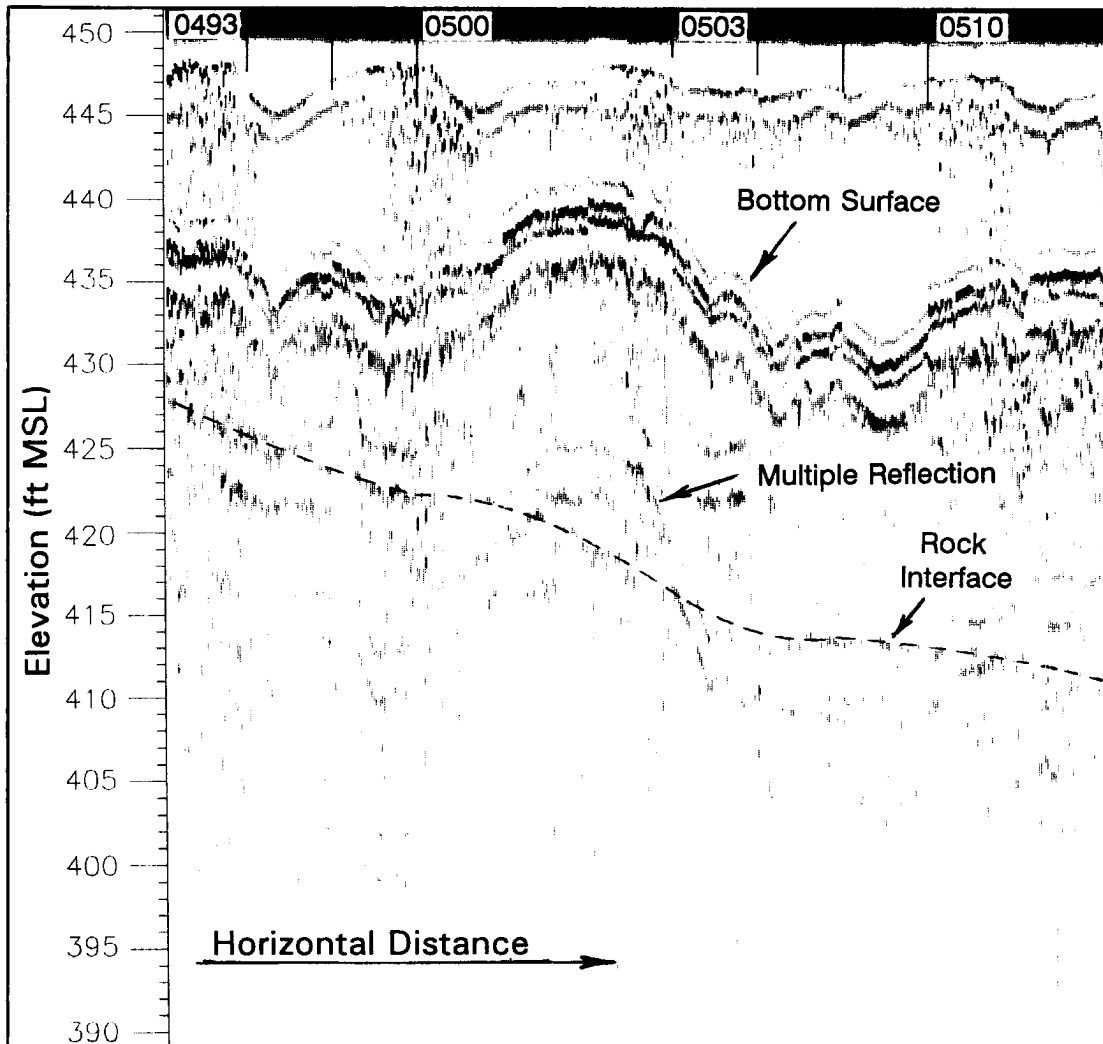


Figure 15. Subbottom seismic reflection record along 'boomer' survey line #67 (files 0493-0511), upstream of Lock and Dam 22

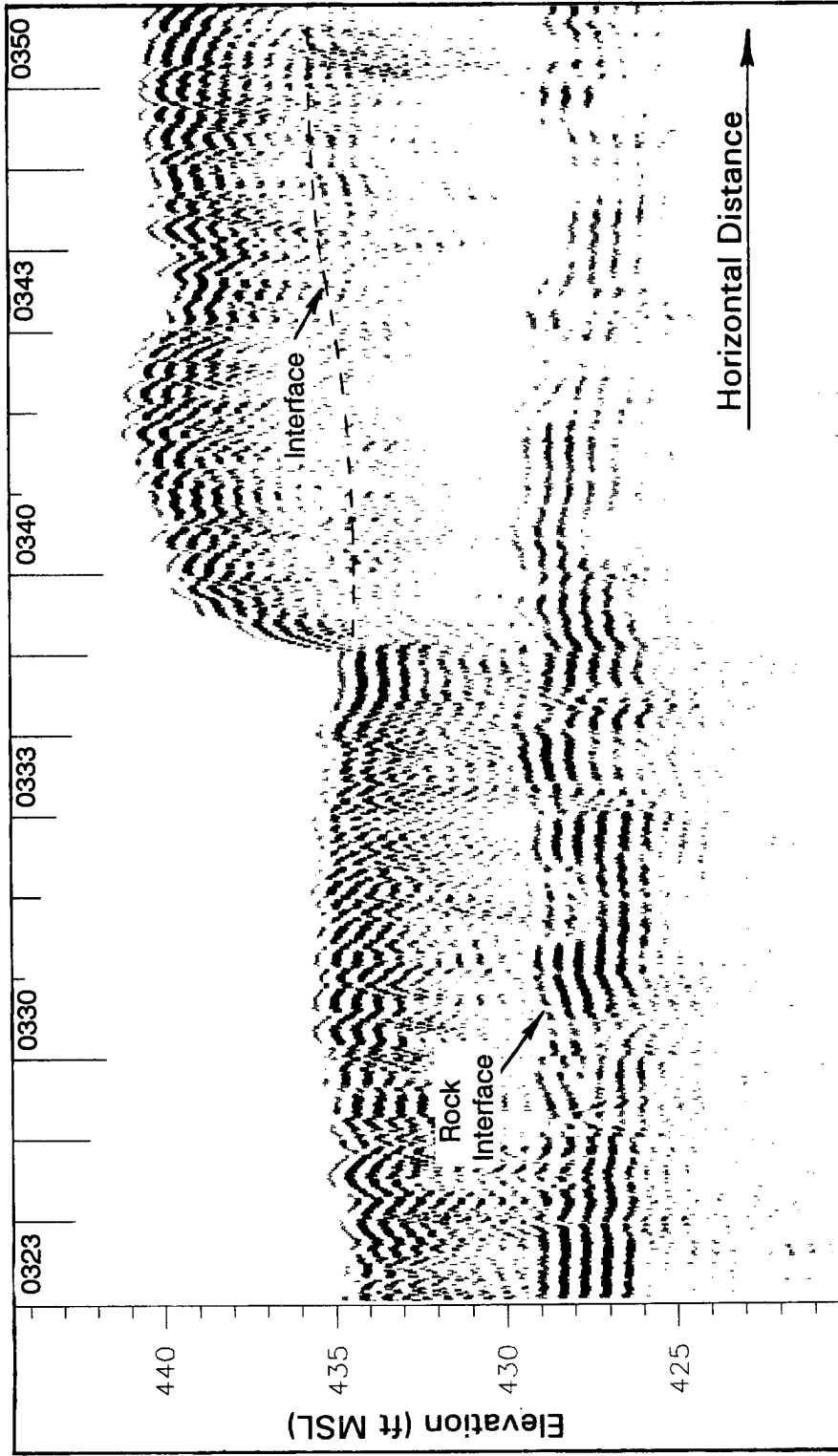


Figure 16. Subbottom seismic reflection record along 'pinger' survey line #33 (files 0323-0350), upstream of Lock and Dam 22

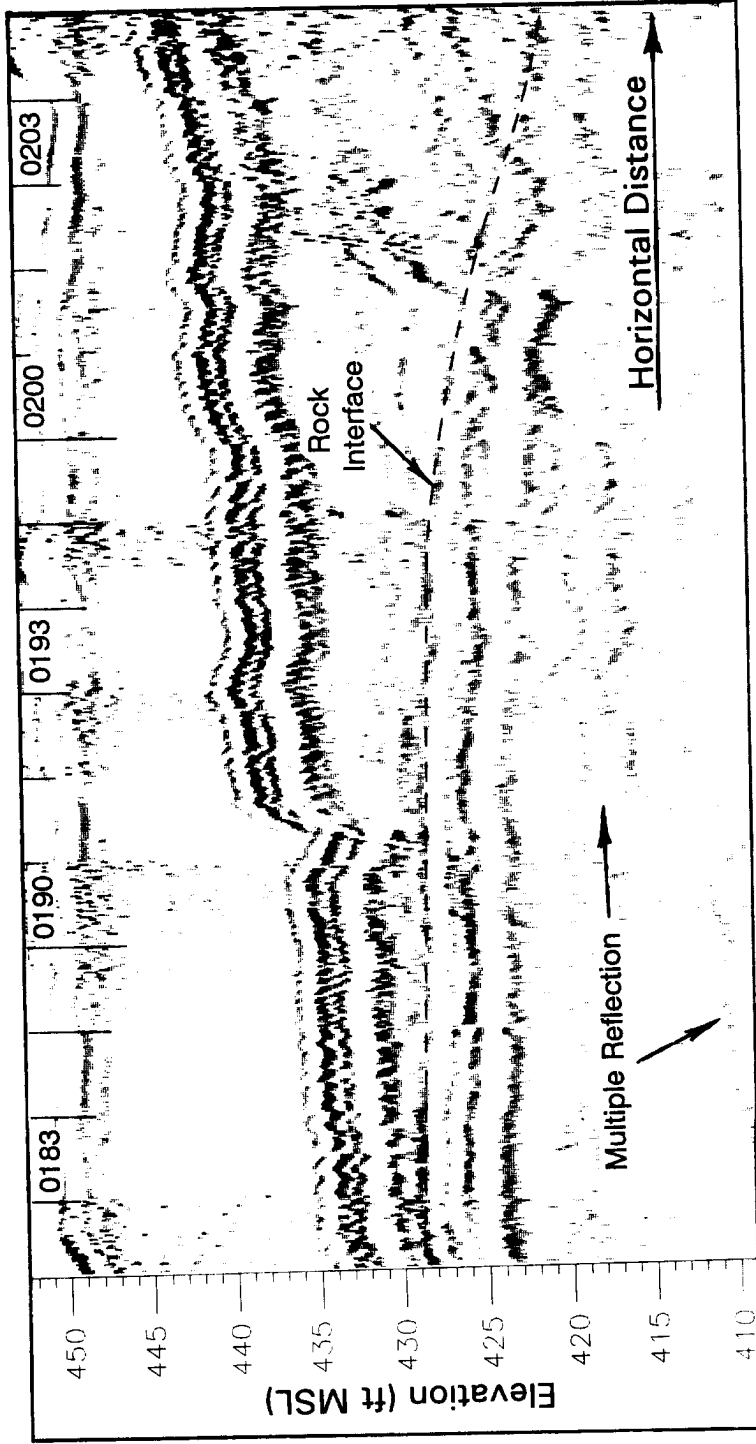


Figure 17. Subbottom seismic reflection record along 'boomer' survey line #33 (files 0182-0204), upstream of Lock and Dam 22

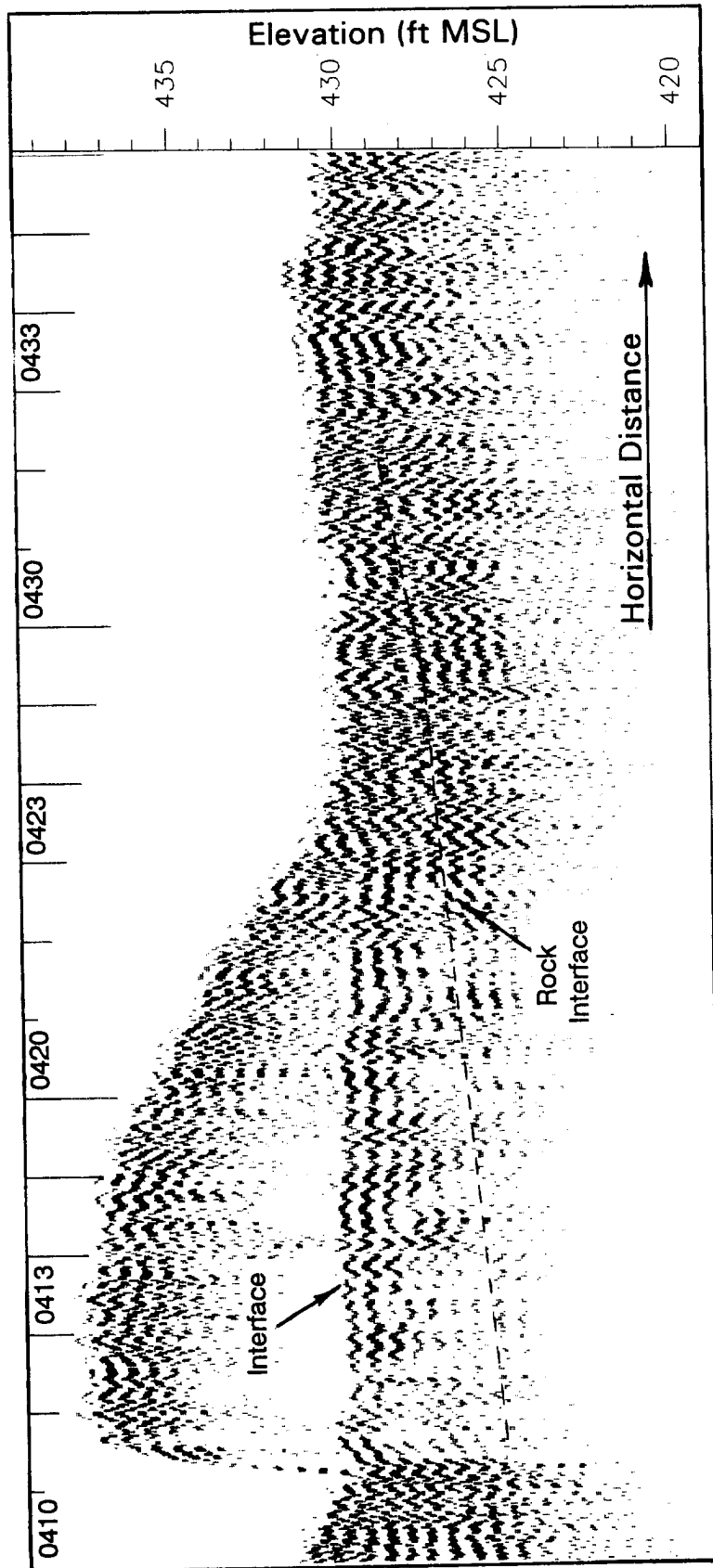


Figure 18. Subbottom seismic reflection record along 'pinger' survey line #10 (files 0410-0435), downstream of Lock and Dam 22

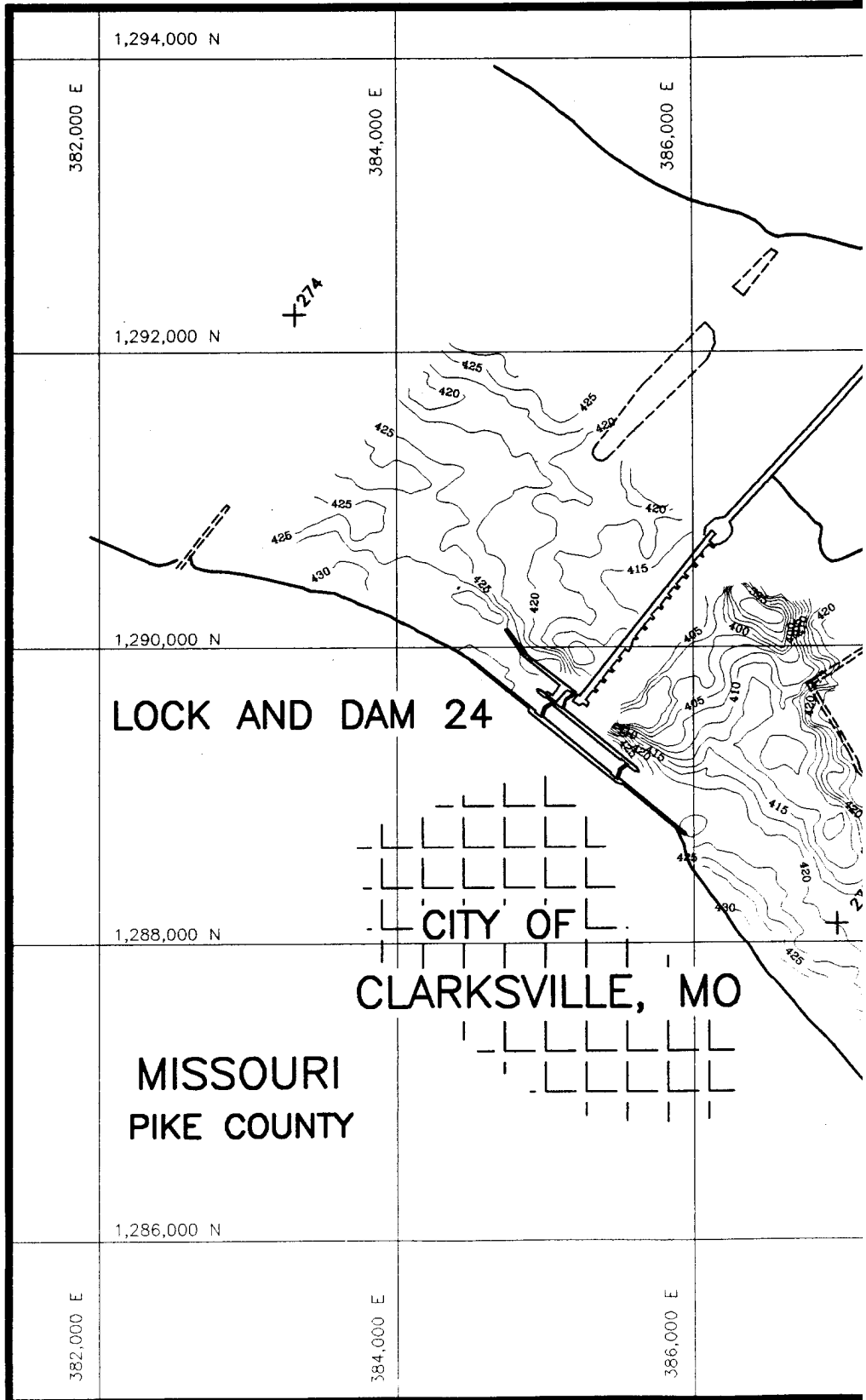
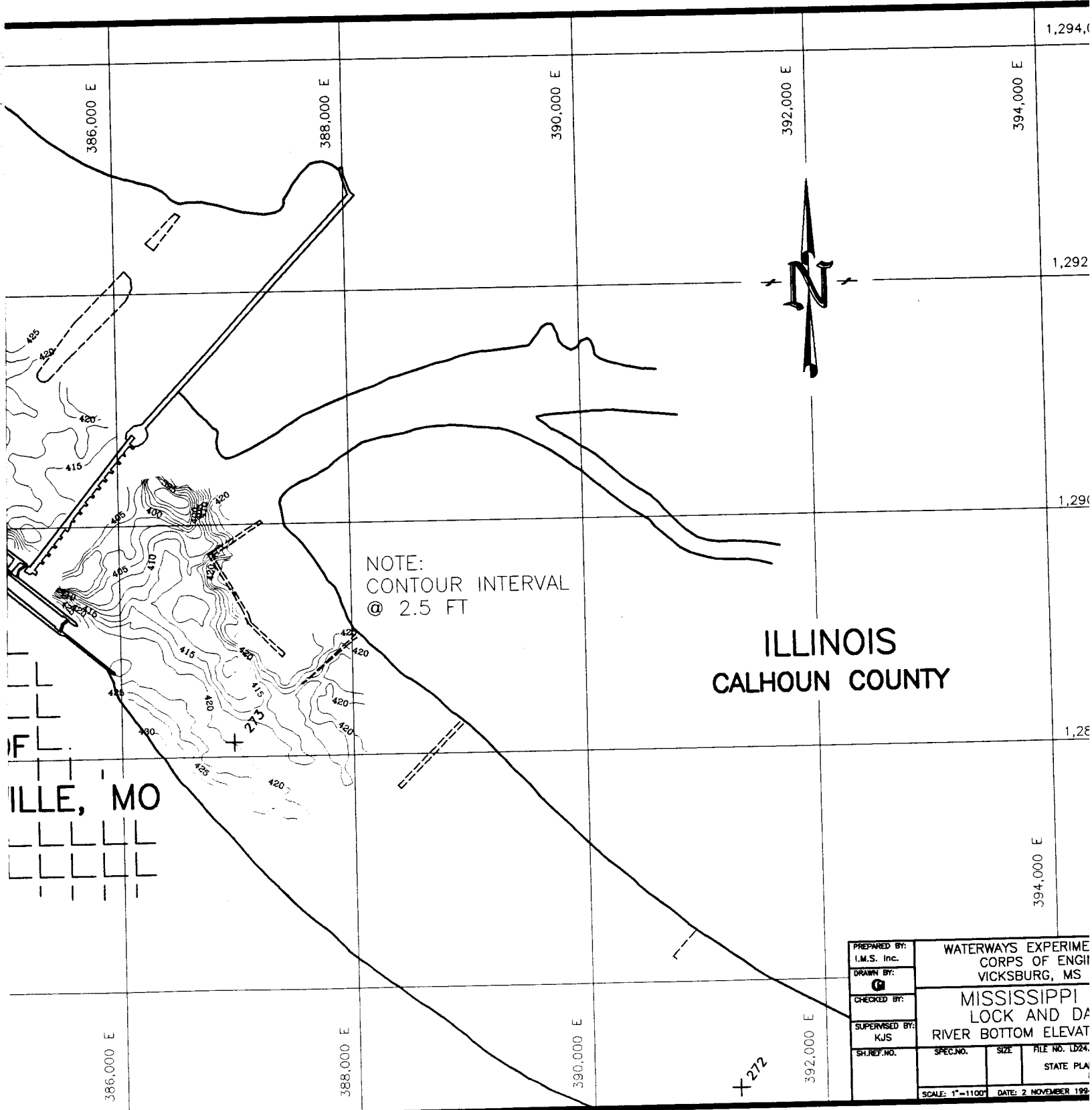


Figure 19. River bottom elevation plot, Lock and Dam 24



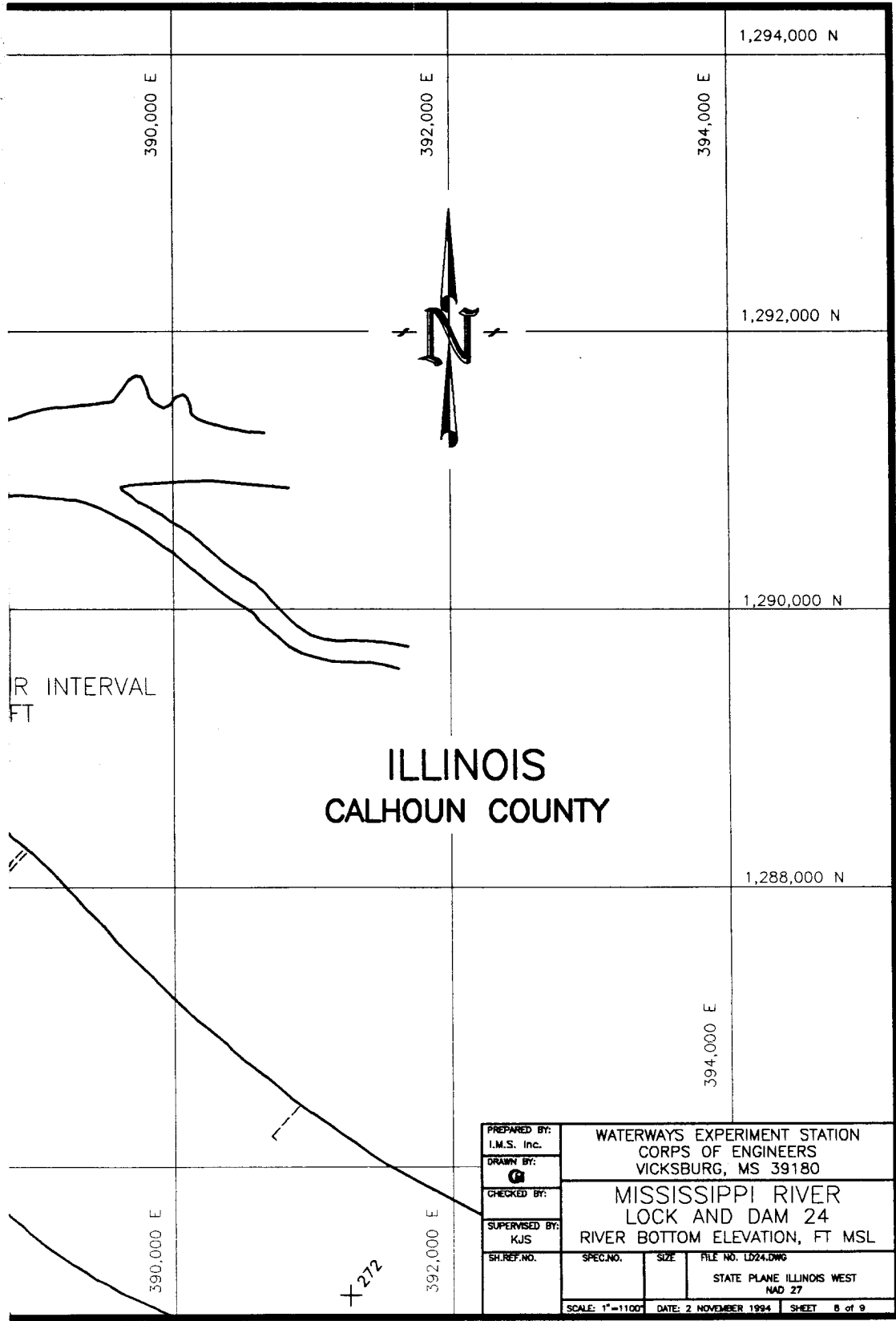
NOTE:  
CONTOUR INTERVAL  
@ 2.5 FT

ILLINOIS  
CALHOUN COUNTY

VILLE, MO

|                                      |   |           |               |
|--------------------------------------|---|-----------|---------------|
| PREPARED BY:<br>I.M.S. Inc.          | WATERWAYS EXPERIMENTAL<br>CORPS OF ENGINEERS<br>VICKSBURG, MS |           |               |
| DRAWN BY:<br>G                       | MISSISSIPPI<br>LOCK AND DAM<br>RIVER BOTTOM ELEVATION         |           |               |
| CHECKED BY:                          | SH. REF. NO.  | SPEC. NO. | FILE NO. LD24 |
| SUPERVISED BY:<br>KJS                |   | SIZE      | STATE PLAN    |
| SCALE: 1"=1100' DATE: 2 NOVEMBER 199 |   |           |               |

D Dam 24



R INTERVAL  
FT

ILLINOIS  
CALHOUN COUNTY

|                             |   |      |                   |
|-----------------------------|---|------|-------------------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS EXPERIMENT STATION<br>CORPS OF ENGINEERS<br>VICKSBURG, MS 39180 |      |                   |
| DRAWN BY:<br>               | MISSISSIPPI RIVER<br>LOCK AND DAM 24<br>RIVER BOTTOM ELEVATION, FT MSL    |      |                   |
| CHECKED BY:                 | SPEC. NO.   | SIZE | FILE NO. LD24.DWG |
| SUPERVISED BY:<br>KJS       | STATE PLANE ILLINOIS WEST<br>NAD 27                                       |      |                   |
| SH. REF. NO.                | SCALE: 1"=1100' DATE: 2 NOVEMBER 1994 SHEET 8 of 9                        |      |                   |

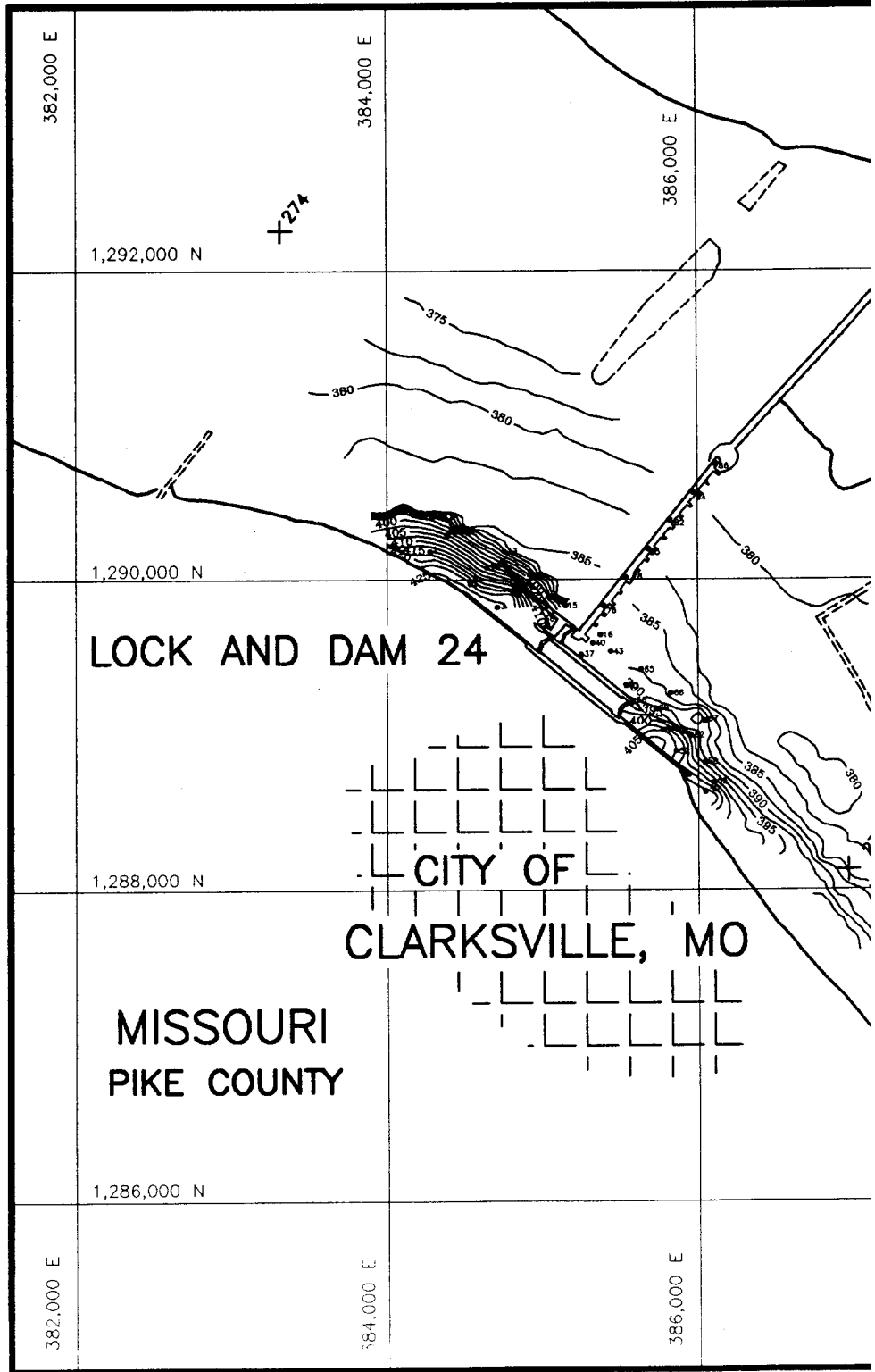
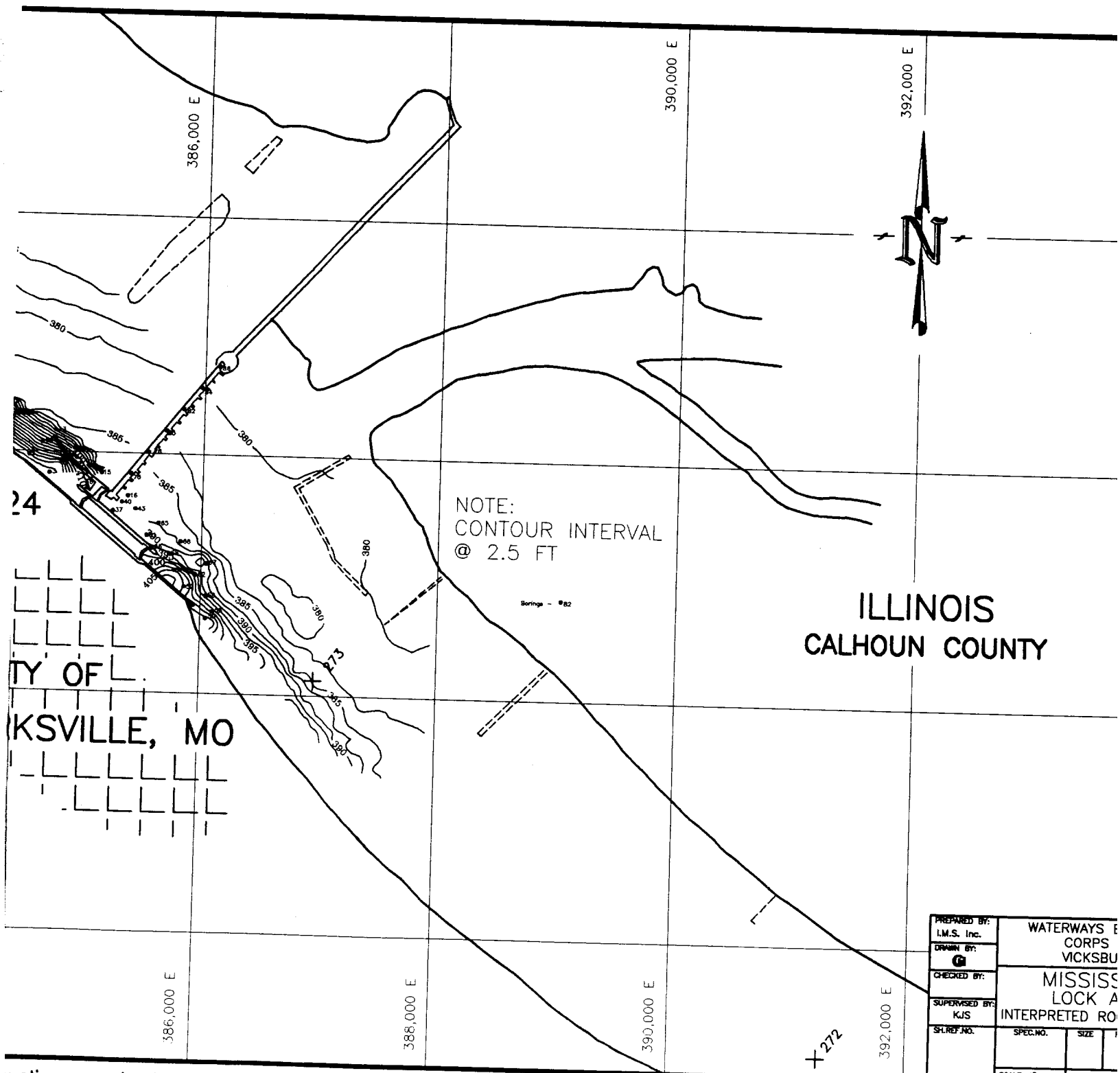


Figure 20. Interpreted rock surface elevation map, Lock and Dam 24. Re



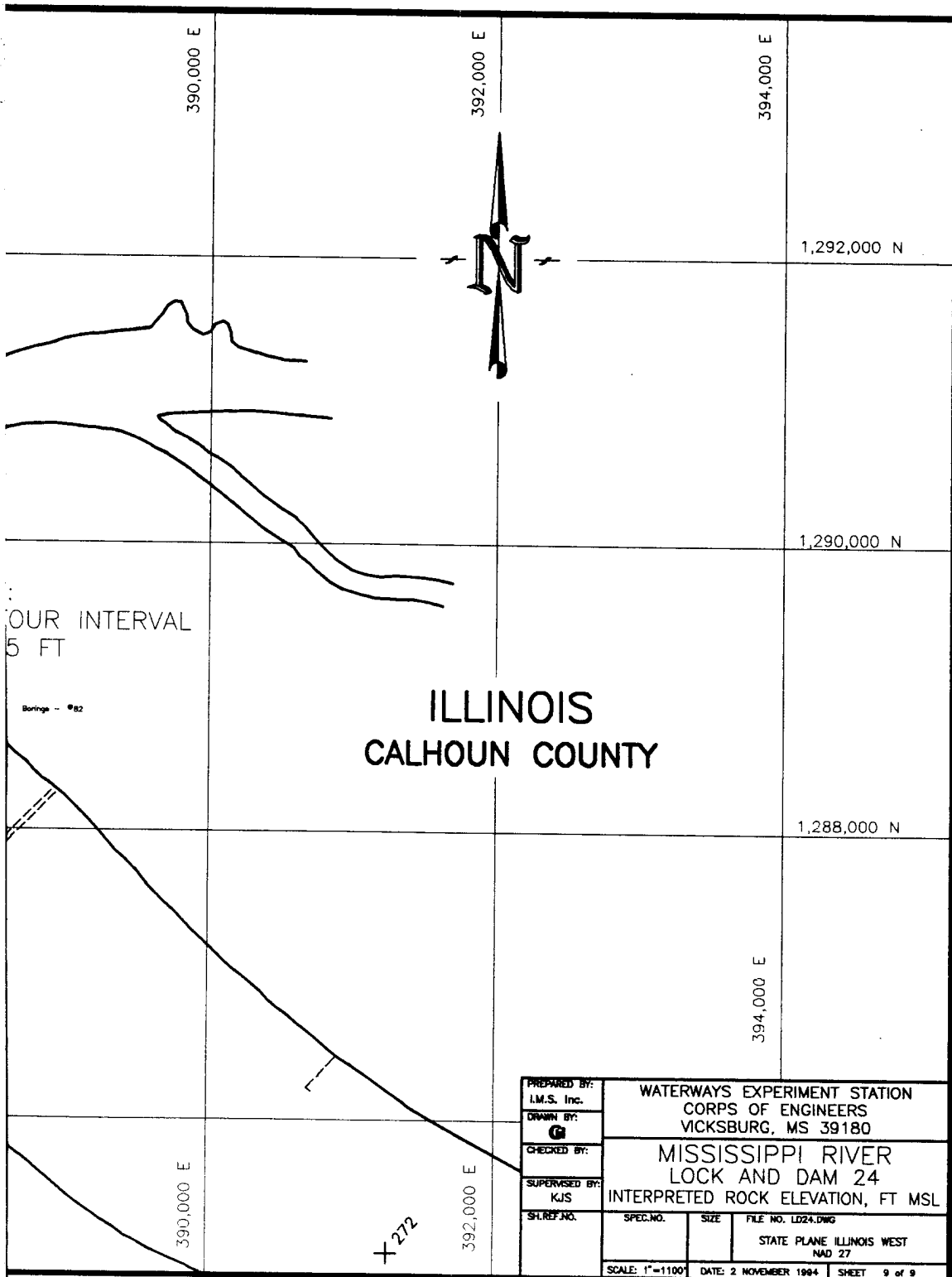
NOTE:  
CONTOUR INTERVAL  
@ 2.5 FT

ILLINOIS  
CALHOUN COUNTY

24  
CITY OF  
VICKSVILLE, MO

|                             |  |              |      |
|-----------------------------|--|--------------|------|
| PREPARED BY:<br>I.M.S. Inc. | WATERWAYS ENGINEERING<br>CORP.<br>VICKSBURG, MISSISSIPPI |              |      |
| DRAWN BY:<br>G              | MISSISSIPPI<br>LOCK AND DAM<br>INTERPRETED RECORD        |              |      |
| CHECKED BY:                 | SPEC. NO.  | SIZE         | DATE |
| SUPERVISED BY:<br>K/S       |  |              |      |
| SKETCH NO.                  |  |              |      |
| SCALE: 1"=1100'             |  | DATE: 2/1/61 |      |

Topographic map, Lock and Dam 24. Representative CENCR core locations are also illustrated



core locations are also illustrated

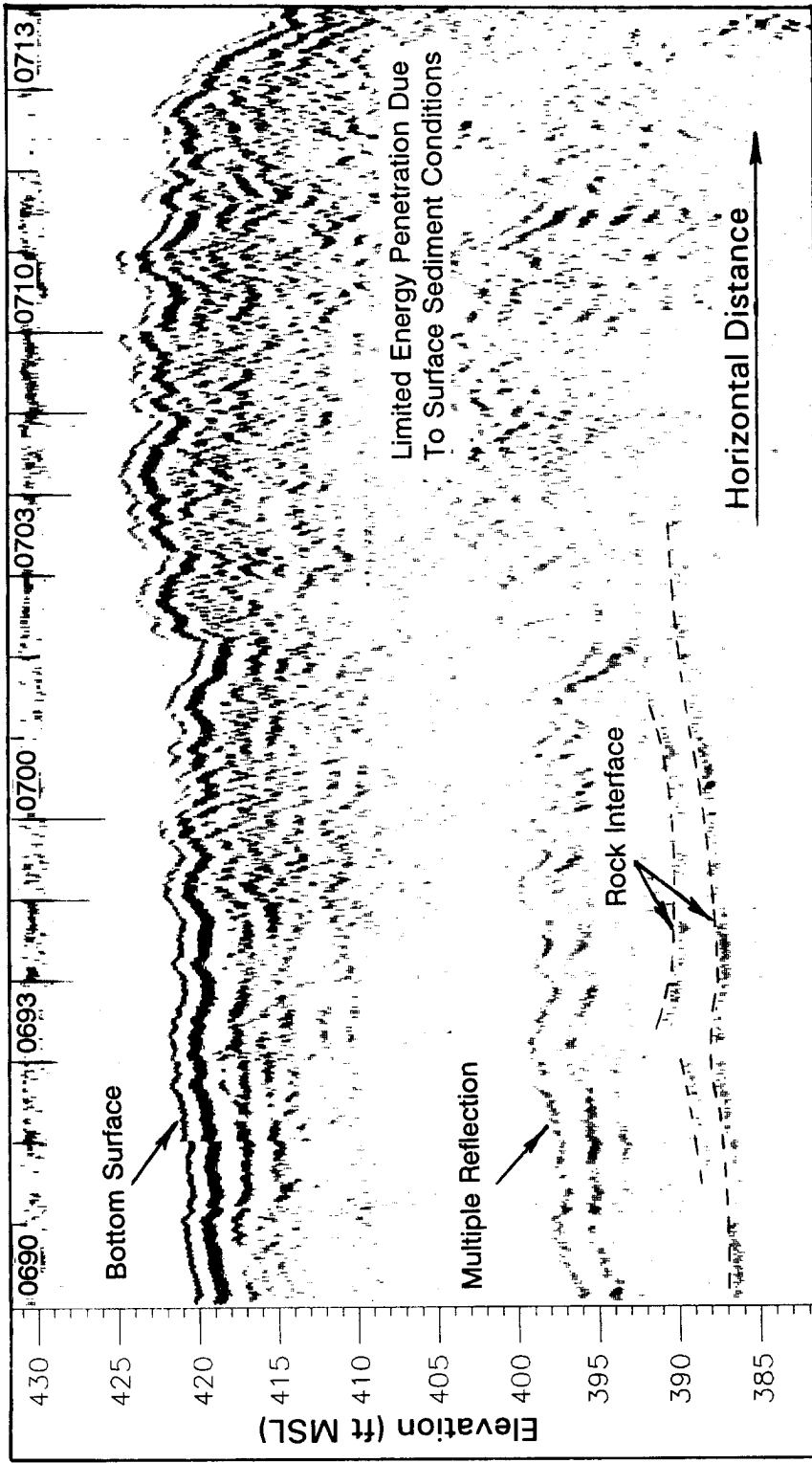


Figure 21. Subbottom seismic reflection record along 'boomer' survey line #4 (files 0690-0713), downstream of Lock and Dam 24

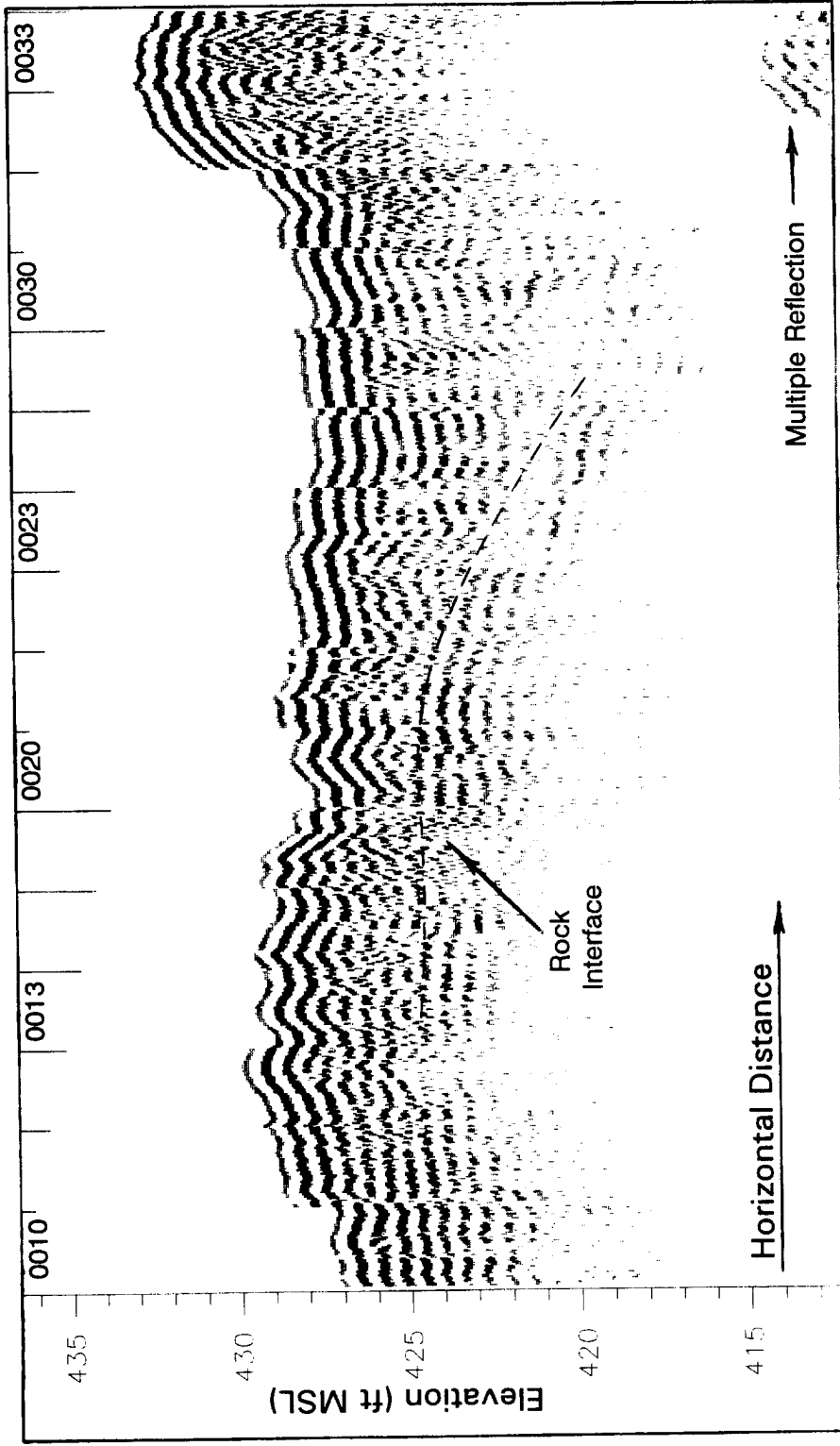


Figure 22. Subbottom seismic reflection record along 'pinger' survey line #26 (files 0010-0033), upstream of Lock and Dam 24

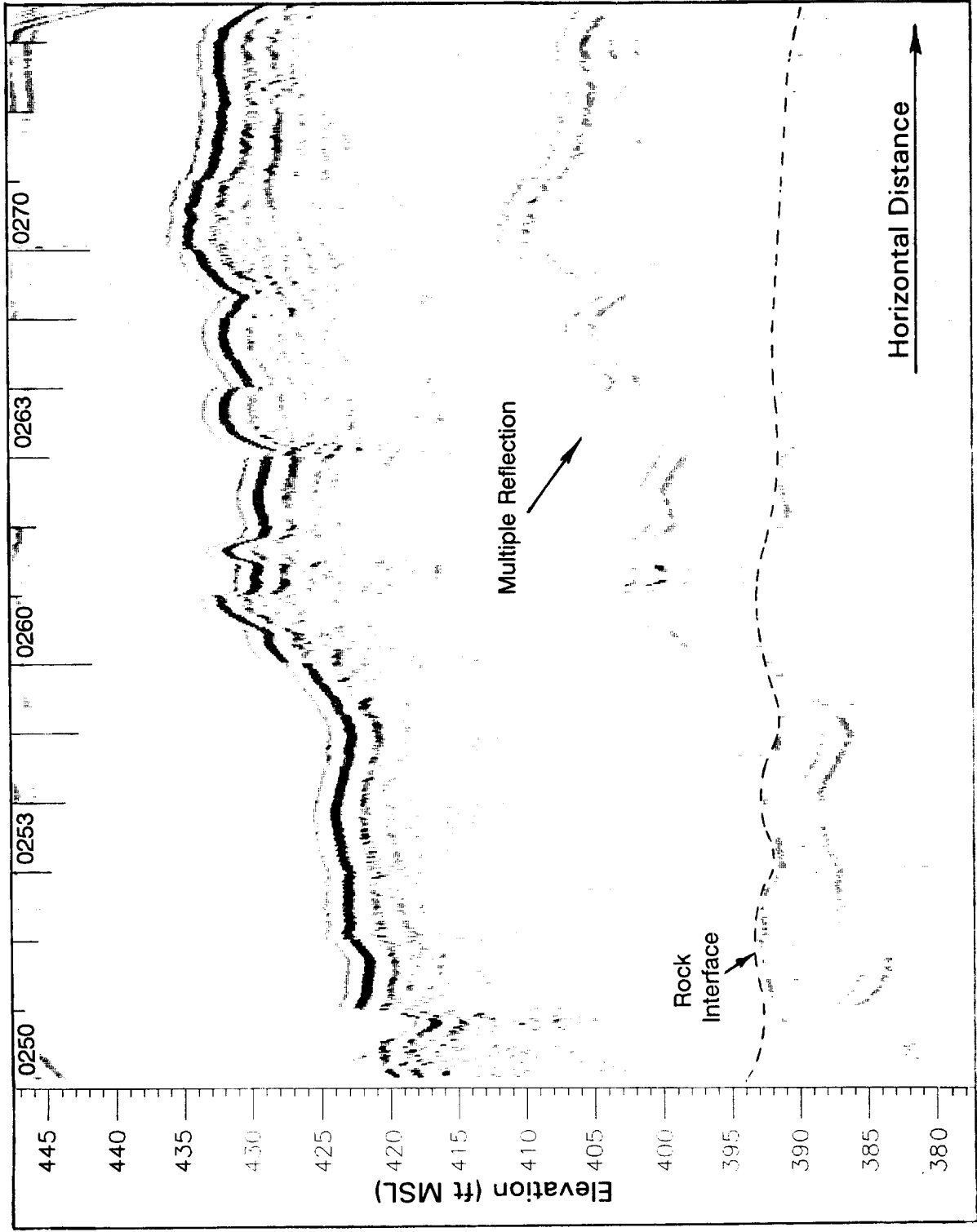


Figure 23. Subbottom seismic reflection record along 'boomer' survey line #35 (files 0250-0272), upstream of Lock and Dam 24

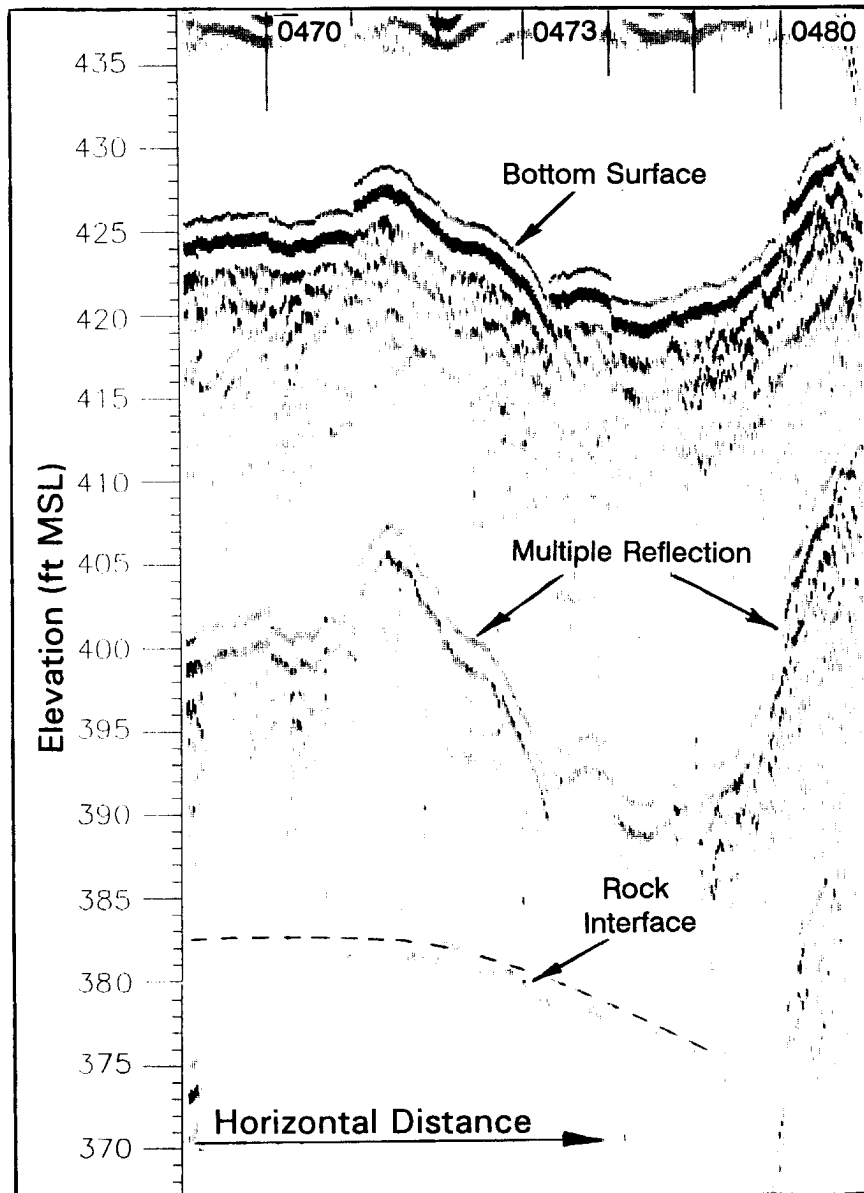


Figure 24. Subbottom seismic reflection record along 'boomer' survey line #75 (files 0464-0480), upstream of Lock and Dam 24

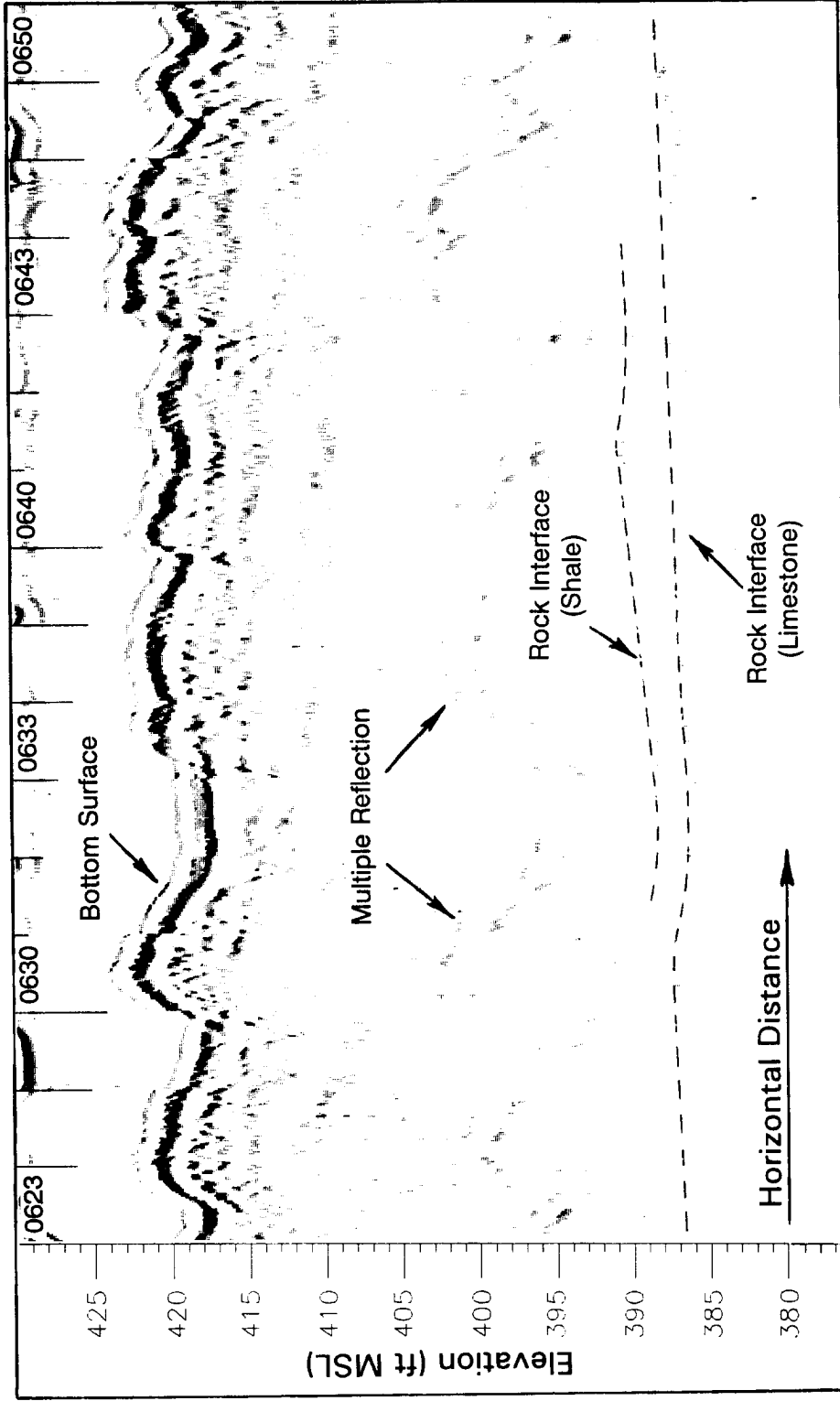


Figure 25. Subbottom seismic reflection record along 'boomer' survey line #3 (files 0623-0650), downstream of Lock and Dam 24

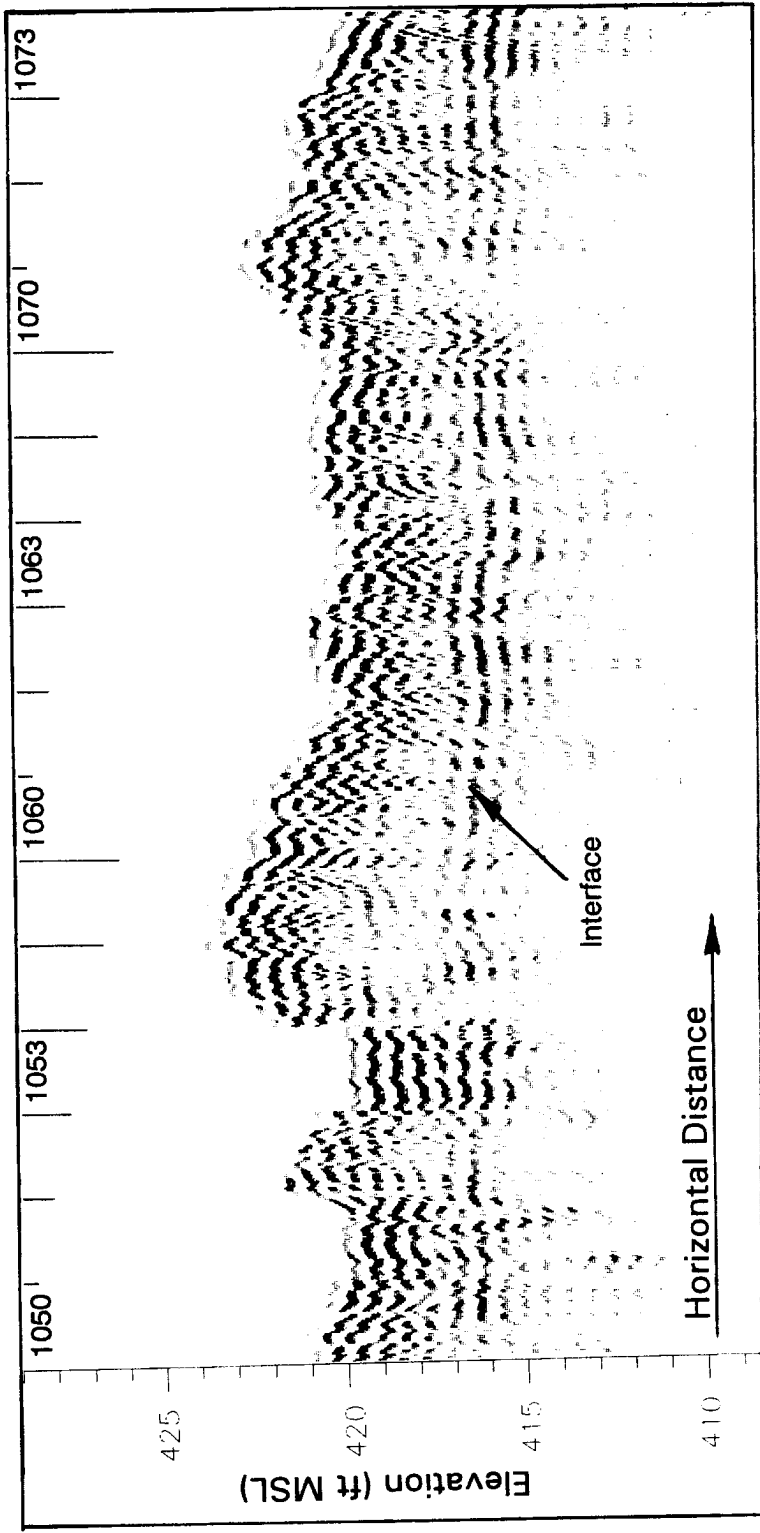


Figure 26. Subbottom seismic reflection record along 'pinger' survey line #3 (files 1050-1073), downstream of Lock and Dam 24

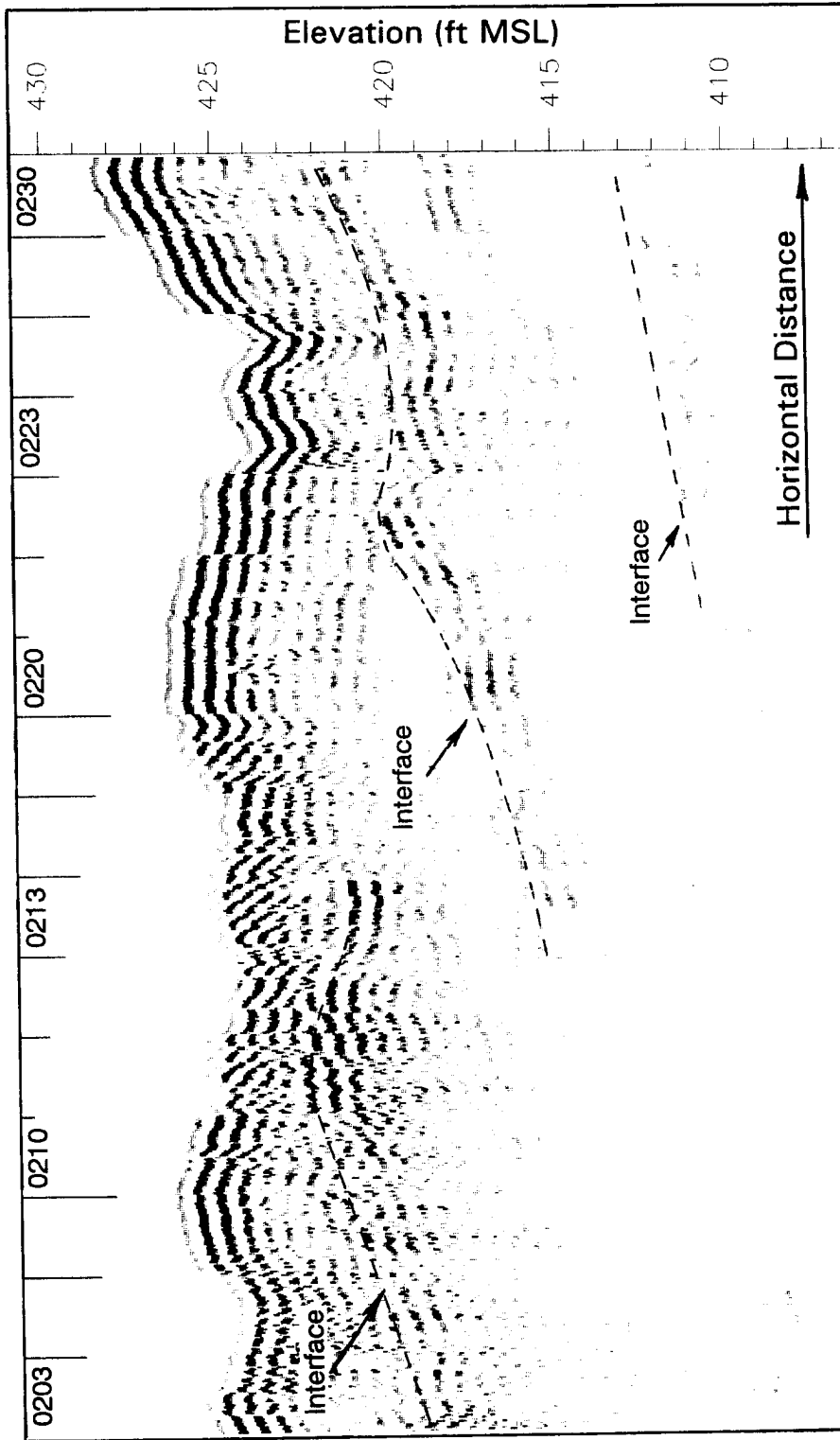


Figure 27. Subbottom seismic reflection record along 'pinger' survey line #30 (files 0203-0230), upstream of Lock and Dam 24

# **Appendix A**

## **Lock and Dam 20 Positioning Information for the 'Pinger' Data**

---

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #1</b> |                |                 |                            |   |
| 0000                  | 123094         | 1266637         | 16.9                       | 459.5                                     |
| 0003                  | 123037         | 1266963         | --                         | ---                                       |
| 0010                  | 123034         | 1267319         | --                         | ---                                       |
| 0013                  | 123028         | 1267661         | --                         | ---                                       |
| 0020                  | 123008         | 1268022         | --                         | ---                                       |
| <b>Survey Line #2</b> |                |                 |                            |   |
| 0023                  | 123170         | 1266317         | 18.2                       | 458.2                                     |
| 0030                  | 123152         | 1266650         | 19.1                       | 457.3                                     |
| 0033                  | 123148         | 1266993         | 19.7                       | 456.7                                     |
| 0040                  | 123102         | 1267332         | 20.9                       | 455.5                                     |
| 0043                  | 123112         | 1267690         | 18.7                       | 457.7                                     |
| 0050                  | 123098         | 1268064         | 18.2                       | 458.2                                     |
| <b>Survey Line #3</b> |                |                 |                            |   |
| 0053                  | 123230         | 1266600         | 18.3                       | 458.1                                     |
| 0060                  | 123218         | 1266953         | 20.2                       | 456.2                                     |
| 0063                  | 123222         | 1267317         | 18.1                       | 458.3                                     |
| 0070                  | 123197         | 1267686         | 18.6                       | 457.8                                     |
| 0073                  | 123212         | 1268087         | 18.9                       | 457.5                                     |
| 0080                  | 123185         | 1268544         | 17.4                       | 459.0                                     |
| <b>Survey Line #4</b> |                |                 |                            |   |
| 0090                  | 123319         | 1266265         | 18.5                       | 457.9                                     |
| 0093                  | 123311         | 1266588         | 21.1                       | 455.3                                     |
| 0100                  | 123325         | 1266936         | 19.0                       | 457.4                                     |
| 0103                  | 123317         | 1267296         | 18.3                       | 458.1                                     |
| 0110                  | 123306         | 1267663         | 20.0                       | 456.4                                     |
| 0113                  | 123284         | 1268038         | 18.6                       | 457.8                                     |
| 0120                  | 123281         | 1268413         | 20.4                       | 456.0                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #5</b> |                |                 |                            |   |
| 0130                  | 123429         | 1266117         | 22.2                       | 454.2                                     |
| 0133                  | 123460         | 1266456         | 24.0                       | 452.4                                     |
| 0140                  | 123438         | 1266793         | 22.6                       | 453.8                                     |
| 0143                  | 123432         | 1267148         | 21.4                       | 455.0                                     |
| 0150                  | 123421         | 1267502         | 23.2                       | 453.2                                     |
| 0153                  | 123390         | 1267861         | 22.6                       | 453.8                                     |
| 0160                  | 123445         | 1268237         | 29.9                       | 446.5                                     |
| 0163                  | 123408         | 1268640         | 31.8                       | 444.6                                     |
| <b>Survey Line #6</b> |                |                 |                            |   |
| 0170                  | 123559         | 1265928         | 25.9                       | 450.5                                     |
| 0173                  | 123544         | 1266217         | 25.1                       | 451.3                                     |
| 0180                  | 123516         | 1266506         | 23.3                       | 453.1                                     |
| 0183                  | 123527         | 1266812         | 22.2                       | 454.2                                     |
| 0190                  | 123505         | 1267143         | 21.5                       | 454.9                                     |
| 0193                  | 123533         | 1267474         | 25.3                       | 451.1                                     |
| 0200                  | 123517         | 1267838         | 27.4                       | 449.0                                     |
| 0203                  | 123493         | 1268189         | 30.9                       | 445.5                                     |
| 0210                  | 123505         | 1268575         | 33.1                       | 443.3                                     |
| <b>Survey Line #7</b> |                |                 |                            |   |
| 0220                  | 123654         | 1266180         | 25.5                       | 450.9                                     |
| 0223                  | 123627         | 1266458         | 24.5                       | 451.9                                     |
| 0230                  | 123637         | 1266745         | 24.1                       | 452.3                                     |
| 0233                  | 123632         | 1267061         | 24.5                       | 451.9                                     |
| 0240                  | 123610         | 1267336         | 26.1                       | 450.3                                     |
| 0243                  | 123633         | 1267594         | 28.1                       | 448.3                                     |
| 0250                  | 123601         | 1267885         | 30.9                       | 445.5                                     |
| 0253                  | 123571         | 1268244         | 30.2                       | 446.2                                     |
| 0260                  | 123617         | 1268648         | 33.5                       | 442.9                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #8</b>  |                |                 |                            |   |
| 0263                   | 123741         | 1265947         | 24.6                       | 451.8                                     |
| 0270                   | 123751         | 1266211         | 23.6                       | 452.8                                     |
| 0273                   | 123727         | 1266482         | 23.9                       | 452.5                                     |
| 0280                   | 123733         | 1266748         | 25.0                       | 451.4                                     |
| 0283                   | 123721         | 1267030         | 25.4                       | 451.0                                     |
| 0290                   | 123796         | 1267343         | 24.3                       | 452.1                                     |
| 0293                   | 123712         | 1267589         | 27.6                       | 448.8                                     |
| 0300                   | 123676         | 1267875         | 30.2                       | 446.2                                     |
| 0303                   | 123709         | 1268210         | 31.2                       | 445.2                                     |
| 0310                   | 123717         | 1268643         | 34.8                       | 441.6                                     |
| <b>Survey Line #10</b> |                |                 |                            |   |
| 0313                   | 123939         | 1265925         | 24.2                       | 452.2                                     |
| 0320                   | 123945         | 1266184         | 22.1                       | 454.3                                     |
| 0323                   | 123932         | 1266499         | 23.0                       | 453.4                                     |
| 0330                   | 123922         | 1266810         | 25.9                       | 450.5                                     |
| 0333                   | 123895         | 1267121         | 25.5                       | 450.9                                     |
| 0340                   | 123914         | 1267415         | 23.0                       | 453.4                                     |
| 0343                   | 123885         | 1267737         | 24.9                       | 451.5                                     |
| 0350                   | 123907         | 1268053         | 25.0                       | 451.4                                     |
| 0353                   | 123956         | 1268372         | 25.2                       | 451.2                                     |
| 0360                   | 123927         | 1268814         | 29.2                       | 447.2                                     |
| <b>Survey Line #12</b> |                |                 |                            |   |
| 0363                   | 124119         | 1266012         | 22.2                       | 454.2                                     |
| 0370                   | 124121         | 1266258         | 22.3                       | 454.1                                     |
| 0373                   | 124146         | 1266519         | 23.2                       | 453.2                                     |
| 0380                   | 124188         | 1266766         | 22.8                       | 453.6                                     |
| 0383                   | 124154         | 1267017         | 25.2                       | 451.2                                     |
| 0390                   | 124115         | 1267281         | 22.6                       | 453.8                                     |
| 0393                   | 124125         | 1267519         | 21.6                       | 454.8                                     |
| 0400                   | 124131         | 1267798         | 22.6                       | 453.8                                     |
| 0403                   | 124080         | 1268088         | 22.4                       | 454.0                                     |
| 0410                   | 124129         | 1268367         | 23.2                       | 453.2                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #14</b> |                |                 |                            |   |
| 0420                   | 124320         | 1266059         | 20.6                       | 455.8                                     |
| 0423                   | 124335         | 1266309         | 23.9                       | 452.5                                     |
| 0430                   | 124341         | 1266551         | 20.5                       | 455.9                                     |
| 0433                   | 124314         | 1266766         | 22.5                       | 453.9                                     |
| 0440                   | 124324         | 1266992         | 24.5                       | 451.9                                     |
| 0443                   | 124317         | 1267223         | 25.0                       | 451.4                                     |
| 0450                   | 124290         | 1267430         | 22.0                       | 454.4                                     |
| 0453                   | 124308         | 1267630         | 22.9                       | 453.5                                     |
| 0460                   | 124285         | 1267820         | 20.3                       | 456.1                                     |
| 0463                   | 124293         | 1268061         | 19.9                       | 456.5                                     |
| 0470                   | 124267         | 1268338         | 23.9                       | 452.5                                     |
| 0473                   | 124346         | 1268707         | 27.5                       | 448.9                                     |
| <b>Survey Line #16</b> |                |                 |                            |   |
| 0480                   | 124524         | 1265949         | 18.4                       | 458.0                                     |
| 0483                   | 124503         | 1266150         | 20.7                       | 455.7                                     |
| 0490                   | 124581         | 1266342         | 19.9                       | 456.5                                     |
| 0493                   | 124559         | 1266478         | 18.4                       | 458.0                                     |
| 0500                   | 124520         | 1266541         | 19.5                       | 456.9                                     |
| 0503                   | 124524         | 1266680         | 19.1                       | 457.3                                     |
| 0510                   | 124567         | 1266819         | 18.9                       | 457.5                                     |
| 0513                   | 124569         | 1266994         | 22.1                       | 454.3                                     |
| 0520                   | 124526         | 1267107         | 24.0                       | 452.4                                     |
| 0523                   | 124502         | 1267231         | 25.8                       | 450.6                                     |
| 0530                   | 124543         | 1267362         | 23.6                       | 452.8                                     |
| 0533                   | 124473         | 1267516         | 26.1                       | 450.3                                     |
| 0540                   | 124488         | 1267701         | 24.5                       | 451.9                                     |
| 0543                   | 124455         | 1267872         | 23.3                       | 453.1                                     |
| 0550                   | 124522         | 1268106         | 27.0                       | 449.4                                     |
| 0553                   | 124489         | 1268435         | 23.6                       | 452.8                                     |
| 0560                   | 124434         | 1268894         | 25.9                       | 450.5                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #18</b> |                |                 |                            |   |
| 0563                   | 124725         | 1266130         | 20.0                       | 456.4                                     |
| 0570                   | 124782         | 1266530         | 15.2                       | 461.2                                     |
| 0573                   | 124802         | 1266882         | 17.9                       | 458.5                                     |
| 0580                   | 124779         | 1267327         | 15.9                       | 460.5                                     |
| 0583                   | 124757         | 1267850         | 26.3                       | 450.1                                     |
| 0590                   | 124648         | 1268260         | --                         | ---                                       |
| 0593                   | 124641         | 1268466         | --                         | ---                                       |
| 0600                   | 124694         | 1268720         | --                         | ---                                       |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
 Survey Date/Time : 25 July 1994, 1338 to 1507 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water Depth, ft</u> | <u>River Bottom Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|------------------------|---------------------------------------|
| <b>Survey Line #50</b> |                |                 |                        |                                       |
| 0610                   | 123450         | 1266193         | 24.0                   | 452.4                                 |
| 0613                   | 123871         | 1266106         | 22.0                   | 454.4                                 |
| 0620                   | 124209         | 1266182         | 21.1                   | 455.3                                 |
| 0623                   | 124579         | 1266208         | 22.8                   | 453.6                                 |
| 0630                   | 124980         | 1266229         | 18.0                   | 458.4                                 |
| <b>Survey Line #51</b> |                |                 |                        |                                       |
| 0633                   | 123170         | 1266563         | 19.9                   | 456.5                                 |
| 0640                   | 123584         | 1266601         | 24.3                   | 452.1                                 |
| 0643                   | 123992         | 1266612         | 23.9                   | 452.5                                 |
| 0650                   | 124395         | 1266627         | 22.4                   | 454.0                                 |
| 0653                   | 124843         | 1266612         | 15.7                   | 460.7                                 |
| <b>Survey Line #52</b> |                |                 |                        |                                       |
| 0660                   | 123176         | 1266972         | 20.2                   | 456.2                                 |
| 0663                   | 123577         | 1267014         | 24.2                   | 452.2                                 |
| 0670                   | 124025         | 1267009         | 23.9                   | 452.5                                 |
| 0673                   | 124404         | 1267071         | 23.6                   | 452.8                                 |
| 0680                   | 124874         | 1266988         | 16.2                   | 460.2                                 |
| <b>Survey Line #53</b> |                |                 |                        |                                       |
| 0683                   | 123182         | 1267368         | 18.2                   | 458.2                                 |
| 0690                   | 123655         | 1267373         | 26.2                   | 450.2                                 |
| 0693                   | 124057         | 1267412         | 21.0                   | 455.4                                 |
| 0700                   | 124431         | 1267424         | 25.6                   | 450.8                                 |
| 0703                   | 124812         | 1267376         | 17.7                   | 458.7                                 |
| <b>Survey Line #54</b> |                |                 |                        |                                       |
| 0710                   | 123241         | 1267760         | 14.9                   | 461.5                                 |
| 0713                   | 123638         | 1267796         | 27.9                   | 448.5                                 |
| 0720                   | 124027         | 1267804         | 23.2                   | 453.2                                 |
| 0723                   | 124392         | 1267808         | 21.3                   | 455.1                                 |
| 0730                   | 124680         | 1267794         | 27.6                   | 448.8                                 |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
Survey Date/Time : 25 July 1994, 1338 to 1507 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #55</b> |                |                 |                            |   |
| 0740                   | 123536         | 1268231         | 31.4                       | 445.0                                     |
| 0743                   | 123946         | 1268237         | 22.5                       | 453.9                                     |
| 0750                   | 124334         | 1268241         | 23.5                       | 452.9                                     |
| 0753                   | 124669         | 1268215         | 19.6                       | 456.8                                     |
| <b>Survey Line #56</b> |                |                 |                            |   |
| 0763                   | 123633         | 1268691         | 35.6                       | 440.8                                     |
| 0770                   | 124107         | 1268733         | 33.7                       | 442.7                                     |
| 0773                   | 124587         | 1268760         | --                         | ----                                      |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #25</b> |                |                 |                            |   |
| 0033                   | 123013         | 1269882         | 21.1                       | 457.9                                     |
| 0040                   | 122953         | 1270306         | 19.6                       | 459.4                                     |
| 0043                   | 122943         | 1270736         | 20.2                       | 458.8                                     |
| 0050                   | 122934         | 1271174         | 22.9                       | 456.1                                     |
| <b>Survey Line #26</b> |                |                 |                            |   |
| 0053                   | 123125         | 1269684         | 19.7                       | 459.3                                     |
| 0060                   | 123164         | 1269967         | 27.9                       | 451.1                                     |
| 0063                   | 123142         | 1270248         | 27.1                       | 451.9                                     |
| 0070                   | 123097         | 1270530         | 25.4                       | 453.6                                     |
| 0073                   | 123096         | 1270829         | 25.9                       | 453.1                                     |
| 0080                   | 123126         | 1271151         | 26.6                       | 452.4                                     |
| <b>Survey Line #27</b> |                |                 |                            |   |
| 0000                   | 123247         | 1269563         | 22.7                       | 456.3                                     |
| 0003                   | 123228         | 1269982         | 28.7                       | 450.3                                     |
| 0010                   | 123252         | 1270295         | 27.4                       | 451.6                                     |
| 0013                   | 123213         | 1270574         | 25.5                       | 453.5                                     |
| 0020                   | 123292         | 1270831         | 22.7                       | 456.3                                     |
| 0023                   | 123279         | 1271098         | 23.3                       | 455.7                                     |
| <b>Survey Line #28</b> |                |                 |                            |   |
| 0083                   | 123188         | 1271468         | 23.9                       | 455.1                                     |
| 0090                   | 123376         | 1269750         | 32.5                       | 446.5                                     |
| 0093                   | 123376         | 1270079         | 27.0                       | 452.0                                     |
| 0100                   | 123349         | 1270411         | 22.7                       | 456.3                                     |
| 0103                   | 123397         | 1270739         | 21.3                       | 457.7                                     |
| 0110                   | 123359         | 1271062         | 21.4                       | 457.6                                     |
| <b>Survey Line #29</b> |                |                 |                            |   |
| 0113                   | 123430         | 1271378         | 21.5                       | 457.5                                     |
| 0120                   | 123499         | 1269688         | 34.6                       | 444.4                                     |
| 0123                   | 123446         | 1270013         | 27.1                       | 451.9                                     |
| 0130                   | 123466         | 1270350         | 21.8                       | 457.2                                     |
| 0133                   | 123407         | 1270692         | 20.8                       | 458.2                                     |
| 0140                   | 123444         | 1271042         | 20.0                       | 459.0                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #30</b> |                |                 |                            |   |
| 0143                   | 123488         | 1271394         | 20.5                       | 458.5                                     |
| 0150                   | 123588         | 1269682         | 31.1                       | 447.9                                     |
| 0153                   | 123559         | 1270024         | 21.4                       | 457.6                                     |
| 0160                   | 123540         | 1270341         | 17.9                       | 461.1                                     |
| 0163                   | 123567         | 1270660         | 19.0                       | 460.0                                     |
| 0170                   | 123531         | 1270989         | 18.3                       | 460.7                                     |
| 0173                   | 123585         | 1271322         | 18.6                       | 460.4                                     |
| <b>Survey Line #31</b> |                |                 |                            |   |
| 0180                   | 123680         | 1269537         | 29.3                       | 449.7                                     |
| 0183                   | 123651         | 1269864         | 23.4                       | 455.6                                     |
| 0190                   | 123666         | 1270179         | 18.5                       | 460.5                                     |
| 0193                   | 123611         | 1270514         | 17.8                       | 461.2                                     |
| 0200                   | 123659         | 1270837         | 16.9                       | 462.1                                     |
| 0203                   | 123647         | 1271161         | 17.9                       | 461.1                                     |
| <b>Survey Line #32</b> |                |                 |                            |   |
| 0210                   | 123750         | 1269419         | 26.6                       | 452.4                                     |
| 0213                   | 123760         | 1269752         | 20.8                       | 458.2                                     |
| 0220                   | 123716         | 1270070         | 17.3                       | 461.7                                     |
| 0223                   | 123771         | 1270381         | 15.8                       | 463.2                                     |
| 0230                   | 123751         | 1270702         | 15.7                       | 463.3                                     |
| 0233                   | 123721         | 1271012         | 16.5                       | 462.5                                     |
| 0240                   | 123756         | 1271314         | 17.1                       | 461.9                                     |
| <b>Survey Line #34</b> |                |                 |                            |   |
| 0243                   | 123984         | 1269486         | 18.2                       | 460.8                                     |
| 0250                   | 123961         | 1269794         | 16.1                       | 462.9                                     |
| 0253                   | 123944         | 1270094         | 14.6                       | 464.4                                     |
| 0260                   | 123962         | 1270396         | 16.0                       | 463.0                                     |
| 0263                   | 123915         | 1270683         | 14.4                       | 464.6                                     |
| 0270                   | 123945         | 1270972         | 16.8                       | 462.2                                     |
| 0273                   | 123975         | 1271257         | 16.7                       | 462.3                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #36</b> |                |                 |                            |   |
| 0280                   | 124138         | 1269399         | 23.0                       | 456.0                                     |
| 0283                   | 124150         | 1269727         | 17.8                       | 461.2                                     |
| 0290                   | 124176         | 1270020         | 14.2                       | 464.8                                     |
| 0293                   | 124148         | 1270315         | 14.3                       | 464.7                                     |
| 0300                   | 124167         | 1270598         | 13.4                       | 465.6                                     |
| 0303                   | 124148         | 1270871         | 13.6                       | 465.4                                     |
| 0310                   | 124158         | 1271146         | 15.3                       | 463.7                                     |
| <b>Survey Line #38</b> |                |                 |                            |   |
| 0320                   | 124361         | 1269696         | 19.3                       | 459.7                                     |
| 0323                   | 124359         | 1270008         | 16.1                       | 462.9                                     |
| 0330                   | 124353         | 1270323         | 15.2                       | 463.8                                     |
| 0333                   | 124349         | 1270623         | 12.4                       | 466.6                                     |
| 0340                   | 124351         | 1270918         | 13.6                       | 465.4                                     |
| 0343                   | 124311         | 1271222         | 15.1                       | 463.9                                     |
| <b>Survey Line #40</b> |                |                 |                            |   |
| 0350                   | 124552         | 1269392         | 26.0                       | 453.0                                     |
| 0353                   | 124542         | 1269704         | 23.8                       | 455.2                                     |
| 0360                   | 124579         | 1270029         | 18.4                       | 460.6                                     |
| 0363                   | 124562         | 1270352         | 14.9                       | 464.1                                     |
| 0370                   | 124584         | 1270657         | 16.1                       | 462.9                                     |
| 0373                   | 124563         | 1270970         | 13.3                       | 465.7                                     |
| 0380                   | 124502         | 1271269         | 15.7                       | 463.3                                     |
| <b>Survey Line #42</b> |                |                 |                            |   |
| 0383                   | 124748         | 1269490         | 24.2                       | 454.8                                     |
| 0390                   | 124727         | 1269798         | 25.1                       | 453.9                                     |
| 0393                   | 124768         | 1270100         | 23.2                       | 455.8                                     |
| 0400                   | 124743         | 1270416         | 18.1                       | 460.9                                     |
| 0403                   | 124750         | 1270731         | 16.9                       | 462.1                                     |
| 0410                   | 124805         | 1271047         | 12.7                       | 466.3                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #44</b> |                |                 |                            |   |
| 0410                   | 124805         | 1271047         | 12.7                       | 466.3                                     |
| 0413                   | 124708         | 1271373         | 14.6                       | 464.4                                     |
| 0420                   | 124946         | 1269605         | 21.2                       | 457.8                                     |
| 0423                   | 124906         | 1269909         | 25.3                       | 453.7                                     |
| 0430                   | 124934         | 1270206         | 24.8                       | 454.2                                     |
| 0433                   | 124923         | 1270499         | 20.8                       | 458.2                                     |
| 0440                   | 124891         | 1270803         | 18.9                       | 460.1                                     |
| 0443                   | 124963         | 1271144         | 13.0                       | 466.0                                     |
| <b>Survey Line #46</b> |                |                 |                            |   |
| 0450                   | 124790         | 1271406         | 14.5                       | 464.5                                     |
| 0453                   | 125145         | 1269807         | 17.8                       | 461.2                                     |
| 0460                   | 125146         | 1270126         | 20.3                       | 458.7                                     |
| 0463                   | 125138         | 1270436         | 22.2                       | 456.8                                     |
| 0470                   | 125181         | 1270744         | 22.1                       | 456.9                                     |
| 0473                   | 125262         | 1271038         | 20.0                       | 459.0                                     |
| 0480                   | 125282         | 1271350         | 17.2                       | 461.8                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
 Survey Date/Time : 24 July 1994, 1516 to 1651 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #61</b> |                |                 |                            |   |
| 0483                   | 123659         | 1269291         | 28.5                       | 450.5                                     |
| 0490                   | 124145         | 1269278         | 25.9                       | 453.1                                     |
| 0493                   | 124619         | 1269266         | 25.1                       | 453.9                                     |
| 0500                   | 125060         | 1269270         | 16.5                       | 462.5                                     |
| <b>Survey Line #62</b> |                |                 |                            |   |
| 0500                   | 125060         | 1269270         | 16.5                       | 462.5                                     |
| 0503                   | 123602         | 1269463         | 30.3                       | 448.7                                     |
| 0510                   | 124201         | 1269447         | 21.8                       | 457.2                                     |
| 0513                   | 124732         | 1269458         | 23.7                       | 455.3                                     |
| <b>Survey Line #63</b> |                |                 |                            |   |
| 0520                   | 125184         | 1269546         | 14.3                       | 464.7                                     |
| 0523                   | 123959         | 1269690         | 17.7                       | 461.3                                     |
| 0530                   | 124494         | 1269641         | 23.8                       | 455.2                                     |
| 0533                   | 124942         | 1269630         | 21.0                       | 458.0                                     |
| <b>Survey Line #64</b> |                |                 |                            |   |
| 0540                   | 125183         | 1269791         | 15.5                       | 463.5                                     |
| 0543                   | 123579         | 1270042         | 19.3                       | 459.7                                     |
| 0550                   | 123996         | 1270123         | 15.0                       | 464.0                                     |
| 0553                   | 124449         | 1270040         | 17.9                       | 461.1                                     |
| 0560                   | 124853         | 1270065         | 27.1                       | 451.9                                     |
| 0563                   | 125199         | 1270131         | 19.1                       | 459.9                                     |
| <b>Survey Line #65</b> |                |                 |                            |   |
| 0570                   | 123275         | 1270438         | 22.8                       | 456.2                                     |
| 0573                   | 123709         | 1270452         | 15.8                       | 463.2                                     |
| 0580                   | 124154         | 1270433         | 14.5                       | 464.5                                     |
| 0583                   | 124554         | 1270490         | 15.2                       | 463.8                                     |
| 0590                   | 124949         | 1270509         | 21.5                       | 457.5                                     |
| <b>Survey Line #66</b> |                |                 |                            |   |
| 0600                   | 123456         | 1270823         | 19.0                       | 460.0                                     |
| 0603                   | 123887         | 1270820         | 15.2                       | 463.8                                     |
| 0610                   | 124299         | 1270834         | 13.0                       | 466.0                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
Survey Date/Time : 24 July 1994, 1516 to 1651 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #66 cont.</b> |                |                 |                            |   |
| 0613                         | 124700         | 1270857         | 17.2                       | 461.8                                     |
| 0620                         | 125110         | 1270837         | 21.3                       | 457.7                                     |
| <b>Survey Line #67</b>       |                |                 |                            |   |
| 0623                         | 123282         | 1271133         | 22.2                       | 456.8                                     |
| 0630                         | 123666         | 1271197         | 17.0                       | 462.0                                     |
| 0633                         | 124047         | 1271233         | 14.6                       | 464.4                                     |
| 0640                         | 124418         | 1271260         | 15.5                       | 463.5                                     |
| 0643                         | 124782         | 1271310         | 13.5                       | 465.5                                     |
| 0650                         | 125193         | 1271288         | 18.7                       | 460.3                                     |

# **Appendix B Lock and Dam 20 Positioning Information for the 'Boomer' Data**

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**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #1</b> |                |                 |                            |   |
| 0000                  | 123094         | 1266637         | 16.9                       | 459.5                                     |
| 0003                  | 123037         | 1266963         | --                         | ---                                       |
| 0010                  | 123034         | 1267319         | --                         | ---                                       |
| 0013                  | 123028         | 1267661         | --                         | ---                                       |
| 0020                  | 123008         | 1268022         | --                         | ---                                       |
| <b>Survey Line #2</b> |                |                 |                            |   |
| 0023                  | 123170         | 1266317         | 18.2                       | 458.2                                     |
| 0030                  | 123152         | 1266650         | 19.1                       | 457.3                                     |
| 0033                  | 123148         | 1266993         | 19.7                       | 456.7                                     |
| 0040                  | 123102         | 1267332         | 20.9                       | 455.5                                     |
| 0043                  | 123112         | 1267690         | 18.7                       | 457.7                                     |
| 0050                  | 123098         | 1268064         | 18.2                       | 458.2                                     |
| <b>Survey Line #3</b> |                |                 |                            |   |
| 0053                  | 123230         | 1266600         | 18.3                       | 458.1                                     |
| 0060                  | 123218         | 1266953         | 20.2                       | 456.2                                     |
| 0063                  | 123222         | 1267317         | 18.1                       | 458.3                                     |
| 0070                  | 123197         | 1267686         | 18.6                       | 457.8                                     |
| 0073                  | 123212         | 1268087         | 18.9                       | 457.5                                     |
| 0080                  | 123185         | 1268544         | 17.4                       | 459.0                                     |
| <b>Survey Line #4</b> |                |                 |                            |   |
| 0090                  | 123319         | 1266265         | 18.5                       | 457.9                                     |
| 0093                  | 123311         | 1266588         | 21.1                       | 455.3                                     |
| 0100                  | 123325         | 1266936         | 19.0                       | 457.4                                     |
| 0103                  | 123317         | 1267296         | 18.3                       | 458.1                                     |
| 0110                  | 123306         | 1267663         | 20.0                       | 456.4                                     |
| 0113                  | 123284         | 1268038         | 18.6                       | 457.8                                     |
| 0120                  | 123281         | 1268413         | 20.4                       | 456.0                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #5</b> |                |                 |                            |   |
| 0130                  | 123429         | 1266117         | 22.2                       | 454.2                                     |
| 0133                  | 123460         | 1266456         | 24.0                       | 452.4                                     |
| 0140                  | 123438         | 1266793         | 22.6                       | 453.8                                     |
| 0143                  | 123432         | 1267148         | 21.4                       | 455.0                                     |
| 0150                  | 123421         | 1267502         | 23.2                       | 453.2                                     |
| 0153                  | 123390         | 1267861         | 22.6                       | 453.8                                     |
| 0160                  | 123445         | 1268237         | 29.9                       | 446.5                                     |
| 0163                  | 123408         | 1268640         | 31.8                       | 444.6                                     |
| <b>Survey Line #6</b> |                |                 |                            |   |
| 0170                  | 123559         | 1265928         | 25.9                       | 450.5                                     |
| 0173                  | 123544         | 1266217         | 25.1                       | 451.3                                     |
| 0180                  | 123516         | 1266506         | 23.3                       | 453.1                                     |
| 0183                  | 123527         | 1266812         | 22.2                       | 454.2                                     |
| 0190                  | 123505         | 1267143         | 21.5                       | 454.9                                     |
| 0193                  | 123533         | 1267474         | 25.3                       | 451.1                                     |
| 0200                  | 123517         | 1267838         | 27.4                       | 449.0                                     |
| 0203                  | 123493         | 1268189         | 30.9                       | 445.5                                     |
| 0210                  | 123505         | 1268575         | 33.1                       | 443.3                                     |
| <b>Survey Line #7</b> |                |                 |                            |   |
| 0220                  | 123654         | 1266180         | 25.5                       | 450.9                                     |
| 0223                  | 123627         | 1266458         | 24.5                       | 451.9                                     |
| 0230                  | 123637         | 1266745         | 24.1                       | 452.3                                     |
| 0233                  | 123632         | 1267061         | 24.5                       | 451.9                                     |
| 0240                  | 123610         | 1267336         | 26.1                       | 450.3                                     |
| 0243                  | 123633         | 1267594         | 28.1                       | 448.3                                     |
| 0250                  | 123601         | 1267885         | 30.9                       | 445.5                                     |
| 0253                  | 123571         | 1268244         | 30.2                       | 446.2                                     |
| 0260                  | 123617         | 1268648         | 33.5                       | 442.9                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #8</b>  |                |                 |                            |   |
| 0263                   | 123741         | 1265947         | 24.6                       | 451.8                                     |
| 0270                   | 123751         | 1266211         | 23.6                       | 452.8                                     |
| 0273                   | 123727         | 1266482         | 23.9                       | 452.5                                     |
| 0280                   | 123733         | 1266748         | 25.0                       | 451.4                                     |
| 0283                   | 123721         | 1267030         | 25.4                       | 451.0                                     |
| 0290                   | 123796         | 1267343         | 24.3                       | 452.1                                     |
| 0293                   | 123712         | 1267589         | 27.6                       | 448.8                                     |
| 0300                   | 123676         | 1267875         | 30.2                       | 446.2                                     |
| 0303                   | 123709         | 1268210         | 31.2                       | 445.2                                     |
| 0310                   | 123717         | 1268643         | 34.8                       | 441.6                                     |
| <b>Survey Line #10</b> |                |                 |                            |   |
| 0313                   | 123939         | 1265925         | 24.2                       | 452.2                                     |
| 0320                   | 123945         | 1266184         | 22.1                       | 454.3                                     |
| 0323                   | 123932         | 1266499         | 23.0                       | 453.4                                     |
| 0330                   | 123922         | 1266810         | 25.9                       | 450.5                                     |
| 0333                   | 123895         | 1267121         | 25.5                       | 450.9                                     |
| 0340                   | 123914         | 1267415         | 23.0                       | 453.4                                     |
| 0343                   | 123885         | 1267737         | 24.9                       | 451.5                                     |
| 0350                   | 123907         | 1268053         | 25.0                       | 451.4                                     |
| 0353                   | 123956         | 1268372         | 25.2                       | 451.2                                     |
| 0360                   | 123927         | 1268814         | 29.2                       | 447.2                                     |
| <b>Survey Line #12</b> |                |                 |                            |   |
| 0363                   | 124119         | 1266012         | 22.2                       | 454.2                                     |
| 0370                   | 124121         | 1266258         | 22.3                       | 454.1                                     |
| 0373                   | 124146         | 1266519         | 23.2                       | 453.2                                     |
| 0380                   | 124188         | 1266766         | 22.8                       | 453.6                                     |
| 0383                   | 124154         | 1267017         | 25.2                       | 451.2                                     |
| 0390                   | 124115         | 1267281         | 22.6                       | 453.8                                     |
| 0393                   | 124125         | 1267519         | 21.6                       | 454.8                                     |
| 0400                   | 124131         | 1267798         | 22.6                       | 453.8                                     |
| 0403                   | 124080         | 1268088         | 22.4                       | 454.0                                     |
| 0410                   | 124129         | 1268367         | 23.2                       | 453.2                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #14</b> |                |                 |                            |   |
| 0420                   | 124320         | 1266059         | 20.6                       | 455.8                                     |
| 0423                   | 124335         | 1266309         | 23.9                       | 452.5                                     |
| 0430                   | 124341         | 1266551         | 20.5                       | 455.9                                     |
| 0433                   | 124314         | 1266766         | 22.5                       | 453.9                                     |
| 0440                   | 124324         | 1266992         | 24.5                       | 451.9                                     |
| 0443                   | 124317         | 1267223         | 25.0                       | 451.4                                     |
| 0450                   | 124290         | 1267430         | 22.0                       | 454.4                                     |
| 0453                   | 124308         | 1267630         | 22.9                       | 453.5                                     |
| 0460                   | 124285         | 1267820         | 20.3                       | 456.1                                     |
| 0463                   | 124293         | 1268061         | 19.9                       | 456.5                                     |
| 0470                   | 124267         | 1268338         | 23.9                       | 452.5                                     |
| 0473                   | 124346         | 1268707         | 27.5                       | 448.9                                     |
| <b>Survey Line #16</b> |                |                 |                            |   |
| 0480                   | 124524         | 1265949         | 18.4                       | 458.0                                     |
| 0483                   | 124503         | 1266150         | 20.7                       | 455.7                                     |
| 0490                   | 124581         | 1266342         | 19.9                       | 456.5                                     |
| 0493                   | 124559         | 1266478         | 18.4                       | 458.0                                     |
| 0500                   | 124520         | 1266541         | 19.5                       | 456.9                                     |
| 0503                   | 124524         | 1266680         | 19.1                       | 457.3                                     |
| 0510                   | 124567         | 1266819         | 18.9                       | 457.5                                     |
| 0513                   | 124569         | 1266994         | 22.1                       | 454.3                                     |
| 0520                   | 124526         | 1267107         | 24.0                       | 452.4                                     |
| 0523                   | 124502         | 1267231         | 25.8                       | 450.6                                     |
| 0530                   | 124543         | 1267362         | 23.6                       | 452.8                                     |
| 0533                   | 124473         | 1267516         | 26.1                       | 450.3                                     |
| 0540                   | 124488         | 1267701         | 24.5                       | 451.9                                     |
| 0543                   | 124455         | 1267872         | 23.3                       | 453.1                                     |
| 0550                   | 124522         | 1268106         | 27.0                       | 449.4                                     |
| 0553                   | 124489         | 1268435         | 23.6                       | 452.8                                     |
| 0560                   | 124434         | 1268894         | 25.9                       | 450.5                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
Survey Date/Time : 25 July 1994, 0848 to 1325 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #18</b> |                |                 |                            |   |
| 0563                   | 124725         | 1266130         | 20.0                       | 456.4                                     |
| 0570                   | 124782         | 1266530         | 15.2                       | 461.2                                     |
| 0573                   | 124802         | 1266882         | 17.9                       | 458.5                                     |
| 0580                   | 124779         | 1267327         | 15.9                       | 460.5                                     |
| 0583                   | 124757         | 1267850         | 26.3                       | 450.1                                     |
| 0590                   | 124648         | 1268260         | --                         | ---                                       |
| 0593                   | 124641         | 1268466         | --                         | ---                                       |
| 0600                   | 124694         | 1268720         | --                         | ---                                       |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
 Survey Date/Time : 25 July 1994, 1338 to 1507 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #50</b> |                |                 |                            |   |
| 0610                   | 123450         | 1266193         | 24.0                       | 452.4                                     |
| 0613                   | 123871         | 1266106         | 22.0                       | 454.4                                     |
| 0620                   | 124209         | 1266182         | 21.1                       | 455.3                                     |
| 0623                   | 124579         | 1266208         | 22.8                       | 453.6                                     |
| 0630                   | 124980         | 1266229         | 18.0                       | 458.4                                     |
| <b>Survey Line #51</b> |                |                 |                            |   |
| 0633                   | 123170         | 1266563         | 19.9                       | 456.5                                     |
| 0640                   | 123584         | 1266601         | 24.3                       | 452.1                                     |
| 0643                   | 123992         | 1266612         | 23.9                       | 452.5                                     |
| 0650                   | 124395         | 1266627         | 22.4                       | 454.0                                     |
| 0653                   | 124843         | 1266612         | 15.7                       | 460.7                                     |
| <b>Survey Line #52</b> |                |                 |                            |   |
| 0660                   | 123176         | 1266972         | 20.2                       | 456.2                                     |
| 0663                   | 123577         | 1267014         | 24.2                       | 452.2                                     |
| 0670                   | 124025         | 1267009         | 23.9                       | 452.5                                     |
| 0673                   | 124404         | 1267071         | 23.6                       | 452.8                                     |
| 0680                   | 124874         | 1266988         | 16.2                       | 460.2                                     |
| <b>Survey Line #53</b> |                |                 |                            |   |
| 0683                   | 123182         | 1267368         | 18.2                       | 458.2                                     |
| 0690                   | 123655         | 1267373         | 26.2                       | 450.2                                     |
| 0693                   | 124057         | 1267412         | 21.0                       | 455.4                                     |
| 0700                   | 124431         | 1267424         | 25.6                       | 450.8                                     |
| 0703                   | 124812         | 1267376         | 17.7                       | 458.7                                     |
| <b>Survey Line #54</b> |                |                 |                            |   |
| 0710                   | 123241         | 1267760         | 14.9                       | 461.5                                     |
| 0713                   | 123638         | 1267796         | 27.9                       | 448.5                                     |
| 0720                   | 124027         | 1267804         | 23.2                       | 453.2                                     |
| 0723                   | 124392         | 1267808         | 21.3                       | 455.1                                     |
| 0730                   | 124680         | 1267794         | 27.6                       | 448.8                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
Survey Date/Time : 25 July 1994, 1338 to 1507 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 476.4 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #55</b> |                |                 |                            |   |
| 0740                   | 123536         | 1268231         | 31.4                       | 445.0                                     |
| 0743                   | 123946         | 1268237         | 22.5                       | 453.9                                     |
| 0750                   | 124334         | 1268241         | 23.5                       | 452.9                                     |
| 0753                   | 124669         | 1268215         | 19.6                       | 456.8                                     |
| <b>Survey Line #56</b> |                |                 |                            |   |
| 0763                   | 123633         | 1268691         | 35.6                       | 440.8                                     |
| 0770                   | 124107         | 1268733         | 33.7                       | 442.7                                     |
| 0773                   | 124587         | 1268760         | --                         | ---                                       |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #25</b> |                |                 |                            |   |
| 0033                   | 123013         | 1269882         | 21.1                       | 457.9                                     |
| 0040                   | 122953         | 1270306         | 19.6                       | 459.4                                     |
| 0043                   | 122943         | 1270736         | 20.2                       | 458.8                                     |
| 0050                   | 122934         | 1271174         | 22.9                       | 456.1                                     |
| <b>Survey Line #26</b> |                |                 |                            |   |
| 0053                   | 123125         | 1269684         | 19.7                       | 459.3                                     |
| 0060                   | 123164         | 1269967         | 27.9                       | 451.1                                     |
| 0063                   | 123142         | 1270248         | 27.1                       | 451.9                                     |
| 0070                   | 123097         | 1270530         | 25.4                       | 453.6                                     |
| 0073                   | 123096         | 1270829         | 25.9                       | 453.1                                     |
| 0080                   | 123126         | 1271151         | 26.6                       | 452.4                                     |
| <b>Survey Line #27</b> |                |                 |                            |   |
| 0000                   | 123247         | 1269563         | 22.7                       | 456.3                                     |
| 0003                   | 123228         | 1269982         | 28.7                       | 450.3                                     |
| 0010                   | 123252         | 1270295         | 27.4                       | 451.6                                     |
| 0013                   | 123213         | 1270574         | 25.5                       | 453.5                                     |
| 0020                   | 123292         | 1270831         | 22.7                       | 456.3                                     |
| 0023                   | 123279         | 1271098         | 23.3                       | 455.7                                     |
| <b>Survey Line #28</b> |                |                 |                            |   |
| 0083                   | 123188         | 1271468         | 23.9                       | 455.1                                     |
| 0090                   | 123376         | 1269750         | 32.5                       | 446.5                                     |
| 0093                   | 123376         | 1270079         | 27.0                       | 452.0                                     |
| 0100                   | 123349         | 1270411         | 22.7                       | 456.3                                     |
| 0103                   | 123397         | 1270739         | 21.3                       | 457.7                                     |
| 0110                   | 123359         | 1271062         | 21.4                       | 457.6                                     |
| <b>Survey Line #29</b> |                |                 |                            |   |
| 0113                   | 123430         | 1271378         | 21.5                       | 457.5                                     |
| 0120                   | 123499         | 1269688         | 34.6                       | 444.4                                     |
| 0123                   | 123446         | 1270013         | 27.1                       | 451.9                                     |
| 0130                   | 123466         | 1270350         | 21.8                       | 457.2                                     |
| 0133                   | 123407         | 1270692         | 20.8                       | 458.2                                     |
| 0140                   | 123444         | 1271042         | 20.0                       | 459.0                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #30</b> |                |                 |                            |   |
| 0143                   | 123488         | 1271394         | 20.5                       | 458.5                                     |
| 0150                   | 123588         | 1269682         | 31.1                       | 447.9                                     |
| 0153                   | 123559         | 1270024         | 21.4                       | 457.6                                     |
| 0160                   | 123540         | 1270341         | 17.9                       | 461.1                                     |
| 0163                   | 123567         | 1270660         | 19.0                       | 460.0                                     |
| 0170                   | 123531         | 1270989         | 18.3                       | 460.7                                     |
| 0173                   | 123585         | 1271322         | 18.6                       | 460.4                                     |
| <b>Survey Line #31</b> |                |                 |                            |   |
| 0180                   | 123680         | 1269537         | 29.3                       | 449.7                                     |
| 0183                   | 123651         | 1269864         | 23.4                       | 455.6                                     |
| 0190                   | 123666         | 1270179         | 18.5                       | 460.5                                     |
| 0193                   | 123611         | 1270514         | 17.8                       | 461.2                                     |
| 0200                   | 123659         | 1270837         | 16.9                       | 462.1                                     |
| 0203                   | 123647         | 1271161         | 17.9                       | 461.1                                     |
| <b>Survey Line #32</b> |                |                 |                            |   |
| 0210                   | 123750         | 1269419         | 26.6                       | 452.4                                     |
| 0213                   | 123760         | 1269752         | 20.8                       | 458.2                                     |
| 0220                   | 123716         | 1270070         | 17.3                       | 461.7                                     |
| 0223                   | 123771         | 1270381         | 15.8                       | 463.2                                     |
| 0230                   | 123751         | 1270702         | 15.7                       | 463.3                                     |
| 0233                   | 123721         | 1271012         | 16.5                       | 462.5                                     |
| 0240                   | 123756         | 1271314         | 17.1                       | 461.9                                     |
| <b>Survey Line #34</b> |                |                 |                            |   |
| 0243                   | 123984         | 1269486         | 18.2                       | 460.8                                     |
| 0250                   | 123961         | 1269794         | 16.1                       | 462.9                                     |
| 0253                   | 123944         | 1270094         | 14.6                       | 464.4                                     |
| 0260                   | 123962         | 1270396         | 16.0                       | 463.0                                     |
| 0263                   | 123915         | 1270683         | 14.4                       | 464.6                                     |
| 0270                   | 123945         | 1270972         | 16.8                       | 462.2                                     |
| 0273                   | 123975         | 1271257         | 16.7                       | 462.3                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
 Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #36</b> |                |                 |                            |   |
| 0280                   | 124138         | 1269399         | 23.0                       | 456.0                                     |
| 0283                   | 124150         | 1269727         | 17.8                       | 461.2                                     |
| 0290                   | 124176         | 1270020         | 14.2                       | 464.8                                     |
| 0293                   | 124148         | 1270315         | 14.3                       | 464.7                                     |
| 0300                   | 124167         | 1270598         | 13.4                       | 465.6                                     |
| 0303                   | 124148         | 1270871         | 13.6                       | 465.4                                     |
| 0310                   | 124158         | 1271146         | 15.3                       | 463.7                                     |
| <b>Survey Line #38</b> |                |                 |                            |   |
| 0320                   | 124361         | 1269696         | 19.3                       | 459.7                                     |
| 0323                   | 124359         | 1270008         | 16.1                       | 462.9                                     |
| 0330                   | 124353         | 1270323         | 15.2                       | 463.8                                     |
| 0333                   | 124349         | 1270623         | 12.4                       | 466.6                                     |
| 0340                   | 124351         | 1270918         | 13.6                       | 465.4                                     |
| 0343                   | 124311         | 1271222         | 15.1                       | 463.9                                     |
| <b>Survey Line #40</b> |                |                 |                            |   |
| 0350                   | 124552         | 1269392         | 26.0                       | 453.0                                     |
| 0353                   | 124542         | 1269704         | 23.8                       | 455.2                                     |
| 0360                   | 124579         | 1270029         | 18.4                       | 460.6                                     |
| 0363                   | 124562         | 1270352         | 14.9                       | 464.1                                     |
| 0370                   | 124584         | 1270657         | 16.1                       | 462.9                                     |
| 0373                   | 124563         | 1270970         | 13.3                       | 465.7                                     |
| 0380                   | 124502         | 1271269         | 15.7                       | 463.3                                     |
| <b>Survey Line #42</b> |                |                 |                            |   |
| 0383                   | 124748         | 1269490         | 24.2                       | 454.8                                     |
| 0390                   | 124727         | 1269798         | 25.1                       | 453.9                                     |
| 0393                   | 124768         | 1270100         | 23.2                       | 455.8                                     |
| 0400                   | 124743         | 1270416         | 18.1                       | 460.9                                     |
| 0403                   | 124750         | 1270731         | 16.9                       | 462.1                                     |
| 0410                   | 124805         | 1271047         | 12.7                       | 466.3                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : North (Upstream)  
Survey Date/Time : 24 July 1994, 1127 to 1508 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #44</b> |                |                 |                            |   |
| 0410                   | 124805         | 1271047         | 12.7                       | 466.3                                     |
| 0413                   | 124708         | 1271373         | 14.6                       | 464.4                                     |
| 0420                   | 124946         | 1269605         | 21.2                       | 457.8                                     |
| 0423                   | 124906         | 1269909         | 25.3                       | 453.7                                     |
| 0430                   | 124934         | 1270206         | 24.8                       | 454.2                                     |
| 0433                   | 124923         | 1270499         | 20.8                       | 458.2                                     |
| 0440                   | 124891         | 1270803         | 18.9                       | 460.1                                     |
| 0443                   | 124963         | 1271144         | 13.0                       | 466.0                                     |
| <b>Survey Line #46</b> |                |                 |                            |   |
| 0450                   | 124790         | 1271406         | 14.5                       | 464.5                                     |
| 0453                   | 125145         | 1269807         | 17.8                       | 461.2                                     |
| 0460                   | 125146         | 1270126         | 20.3                       | 458.7                                     |
| 0463                   | 125138         | 1270436         | 22.2                       | 456.8                                     |
| 0470                   | 125181         | 1270744         | 22.1                       | 456.9                                     |
| 0473                   | 125262         | 1271038         | 20.0                       | 459.0                                     |
| 0480                   | 125282         | 1271350         | 17.2                       | 461.8                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
 Survey Date/Time : 24 July 1994, 1516 to 1651 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #61</b> |                |                 |                            |   |
| 0483                   | 123659         | 1269291         | 28.5                       | 450.5                                     |
| 0490                   | 124145         | 1269278         | 25.9                       | 453.1                                     |
| 0493                   | 124619         | 1269266         | 25.1                       | 453.9                                     |
| 0500                   | 125060         | 1269270         | 16.5                       | 462.5                                     |
| <b>Survey Line #62</b> |                |                 |                            |   |
| 0500                   | 125060         | 1269270         | 16.5                       | 462.5                                     |
| 0503                   | 123602         | 1269463         | 30.3                       | 448.7                                     |
| 0510                   | 124201         | 1269447         | 21.8                       | 457.2                                     |
| 0513                   | 124732         | 1269458         | 23.7                       | 455.3                                     |
| <b>Survey Line #63</b> |                |                 |                            |   |
| 0520                   | 125184         | 1269546         | 14.3                       | 464.7                                     |
| 0523                   | 123959         | 1269690         | 17.7                       | 461.3                                     |
| 0530                   | 124494         | 1269641         | 23.8                       | 455.2                                     |
| 0533                   | 124942         | 1269630         | 21.0                       | 458.0                                     |
| <b>Survey Line #64</b> |                |                 |                            |   |
| 0540                   | 125183         | 1269791         | 15.5                       | 463.5                                     |
| 0543                   | 123579         | 1270042         | 19.3                       | 459.7                                     |
| 0550                   | 123996         | 1270123         | 15.0                       | 464.0                                     |
| 0553                   | 124449         | 1270040         | 17.9                       | 461.1                                     |
| 0560                   | 124853         | 1270065         | 27.1                       | 451.9                                     |
| 0563                   | 125199         | 1270131         | 19.1                       | 459.9                                     |
| <b>Survey Line #65</b> |                |                 |                            |   |
| 0570                   | 123275         | 1270438         | 22.8                       | 456.2                                     |
| 0573                   | 123709         | 1270452         | 15.8                       | 463.2                                     |
| 0580                   | 124154         | 1270433         | 14.5                       | 464.5                                     |
| 0583                   | 124554         | 1270490         | 15.2                       | 463.8                                     |
| 0590                   | 124949         | 1270509         | 21.5                       | 457.5                                     |
| <b>Survey Line #66</b> |                |                 |                            |   |
| 0600                   | 123456         | 1270823         | 19.0                       | 460.0                                     |
| 0603                   | 123887         | 1270820         | 15.2                       | 463.8                                     |
| 0610                   | 124299         | 1270834         | 13.0                       | 466.0                                     |

**Lock and Dam 20  
Upper Mississippi River**

Survey Direction : East  
Survey Date/Time : 24 July 1994, 1516 to 1651 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 479.0 ft MSL (Above the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #66 cont.</b> |                |                 |                            |   |
| 0613                         | 124700         | 1270857         | 17.2                       | 461.8                                     |
| 0620                         | 125110         | 1270837         | 21.3                       | 457.7                                     |
| <b>Survey Line #67</b>       |                |                 |                            |   |
| 0623                         | 123282         | 1271133         | 22.2                       | 456.8                                     |
| 0630                         | 123666         | 1271197         | 17.0                       | 462.0                                     |
| 0633                         | 124047         | 1271233         | 14.6                       | 464.4                                     |
| 0640                         | 124418         | 1271260         | 15.5                       | 463.5                                     |
| 0643                         | 124782         | 1271310         | 13.5                       | 465.5                                     |
| 0650                         | 125193         | 1271288         | 18.7                       | 460.3                                     |

# **Appendix C**

## **Lock and Dam 22 Positioning Information for the 'Pinger' Data**

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**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #3</b> |                |                 |                            |   |
| 0000                  | 196869         | 1080625         | 13.0                       | 442.0                                     |
| 0003                  | 196786         | 1080750         | --                         | ---                                       |
| 0010                  | 196691         | 1080868         | 14.8                       | 440.2                                     |
| 0013                  | 196606         | 1080984         | 13.0                       | 442.0                                     |
| 0020                  | 196517         | 1081084         | 14.1                       | 440.9                                     |
| 0023                  | 196430         | 1081194         | 16.2                       | 438.8                                     |
| 0030                  | 196344         | 1081303         | 16.0                       | 439.0                                     |
| 0033                  | 196249         | 1081440         | 15.7                       | 439.3                                     |
| 0040                  | 196139         | 1081579         | 15.8                       | 439.2                                     |
| 0043                  | 196026         | 1081718         | 16.6                       | 438.4                                     |
| 0050                  | 195899         | 1081877         | 16.5                       | 438.5                                     |
| <b>Survey Line #4</b> |                |                 |                            |   |
| 0060                  | 196966         | 1080652         | 15.4                       | 439.6                                     |
| 0063                  | 196849         | 1080804         | 16.2                       | 438.8                                     |
| 0070                  | 196746         | 1080955         | 14.6                       | 440.4                                     |
| 0073                  | 196636         | 1081095         | 16.2                       | 438.8                                     |
| 0080                  | 196534         | 1081240         | 17.1                       | 437.9                                     |
| 0083                  | 196433         | 1081385         | 17.8                       | 437.2                                     |
| 0090                  | 196325         | 1081528         | 18.3                       | 436.7                                     |
| 0093                  | 196211         | 1081669         | 17.7                       | 437.3                                     |
| 0100                  | 196094         | 1081812         | 18.2                       | 436.8                                     |
| 0103                  | 195999         | 1081970         | 21.0                       | 434.0                                     |
| 0110                  | 195900         | 1082131         | 19.1                       | 435.9                                     |
| 0113                  | 195818         | 1082307         | --                         | ---                                       |
| 0120                  | 195694         | 1082492         | 17.0                       | 438.0                                     |
| 0123                  | 195529         | 1082752         | 15.7                       | 439.3                                     |
| <b>Survey Line #5</b> |                |                 |                            |   |
| 0130                  | 197046         | 1080710         | 17.1                       | 437.9                                     |
| 0133                  | 196927         | 1080876         | 17.5                       | 437.5                                     |
| 0140                  | 196800         | 1081036         | 16.6                       | 438.4                                     |
| 0143                  | 196699         | 1081211         | 19.1                       | 435.9                                     |
| 0150                  | 196590         | 1081394         | 18.4                       | 436.6                                     |
| 0153                  | 196448         | 1081568         | 16.5                       | 438.5                                     |
| 0160                  | 196299         | 1081736         | 17.7                       | 437.3                                     |
| 0163                  | 196147         | 1081917         | 19.2                       | 435.8                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>               | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #5 cont.</b> |                |                 |                            |   |
| 0170                        | 196003         | 1082132         | 20.4                       | 434.6                                     |
| 0173                        | 195876         | 1082418         | 22.9                       | 432.1                                     |
| 0180                        | 195728         | 1082649         | 18.5                       | 436.5                                     |
| 0183                        | 195557         | 1082905         | 19.0                       | 436.0                                     |
| <b>Survey Line #6</b>       |                |                 |                            |   |
| 0190                        | 197122         | 1080792         | 17.7                       | 437.3                                     |
| 0193                        | 196967         | 1080965         | 18.2                       | 436.8                                     |
| 0200                        | 196838         | 1081161         | 17.8                       | 437.2                                     |
| 0203                        | 196697         | 1081349         | 18.1                       | 436.9                                     |
| 0210                        | 196568         | 1081536         | 18.2                       | 436.8                                     |
| 0213                        | 196411         | 1081734         | 18.7                       | 436.3                                     |
| 0220                        | 196274         | 1081935         | 20.4                       | 434.6                                     |
| 0223                        | 196144         | 1082177         | 21.7                       | 433.3                                     |
| 0230                        | 196028         | 1082430         | 23.5                       | 431.5                                     |
| 0233                        | 195853         | 1082643         | 21.5                       | 433.5                                     |
| 0240                        | 195705         | 1082859         | 20.2                       | 434.8                                     |
| <b>Survey Line #7</b>       |                |                 |                            |   |
| 0243                        | 197230         | 1080795         | 16.8                       | 438.2                                     |
| 0250                        | 197098         | 1080933         | 17.1                       | 437.9                                     |
| 0253                        | 196993         | 1081113         | 17.5                       | 437.5                                     |
| 0260                        | 196864         | 1081316         | 17.0                       | 438.0                                     |
| 0263                        | 196683         | 1081502         | 18.9                       | 436.1                                     |
| 0270                        | 196527         | 1081725         | 20.7                       | 434.3                                     |
| 0273                        | 196416         | 1081989         | 21.5                       | 433.5                                     |
| 0280                        | 196279         | 1082221         | 22.3                       | 432.7                                     |
| 0283                        | 196143         | 1082459         | 23.9                       | 431.1                                     |
| 0290                        | 195988         | 1082670         | 21.7                       | 433.3                                     |
| 0293                        | 195849         | 1082888         | 21.0                       | 434.0                                     |
| <b>Survey Line #8</b>       |                |                 |                            |   |
| 0300                        | 197342         | 1080871         | 16.2                       | 438.8                                     |
| 0303                        | 197241         | 1081042         | 16.2                       | 438.8                                     |
| 0310                        | 197110         | 1081210         | 17.3                       | 437.7                                     |
| 0313                        | 196957         | 1081389         | 19.1                       | 435.9                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>               | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #8 cont.</b> |                |                 |                            |   |
| 0320                        | 196796         | 1081588         | 21.3                       | 433.7                                     |
| 0323                        | 196644         | 1081794         | 22.2                       | 432.8                                     |
| 0330                        | 196530         | 1081991         | 22.1                       | 432.9                                     |
| 0333                        | 196421         | 1082184         | 22.3                       | 432.7                                     |
| 0340                        | 196254         | 1082407         | 23.2                       | 431.8                                     |
| 0343                        | 196136         | 1082627         | 24.0                       | 431.0                                     |
| 0350                        | 195896         | 1082816         | 22.5                       | 432.5                                     |
| <b>Survey Line #9</b>       |                |                 |                            |   |
| 0353                        | 197358         | 1080918         | 24.6                       | 430.4                                     |
| 0360                        | 197306         | 1081066         | 16.0                       | 439.0                                     |
| 0363                        | 197159         | 1081186         | 17.6                       | 437.4                                     |
| 0370                        | 197054         | 1081368         | 20.3                       | 434.7                                     |
| 0373                        | 196923         | 1081578         | 24.0                       | 431.0                                     |
| 0380                        | 196805         | 1081807         | 23.6                       | 431.4                                     |
| 0383                        | 196685         | 1082001         | 23.4                       | 431.6                                     |
| 0390                        | 196513         | 1082151         | 22.5                       | 432.5                                     |
| 0393                        | 196340         | 1082398         | 23.6                       | 431.4                                     |
| 0400                        | 196234         | 1082698         | 24.2                       | 430.8                                     |
| 0403                        | 195998         | 1082944         | --                         | ---                                       |
| <b>Survey Line #10</b>      |                |                 |                            |   |
| 0410                        | 197462         | 1080999         | 24.2                       | 430.8                                     |
| 0413                        | 197355         | 1081192         | 17.5                       | 437.5                                     |
| 0420                        | 197182         | 1081329         | 20.1                       | 434.9                                     |
| 0423                        | 197032         | 1081524         | 24.3                       | 430.7                                     |
| 0430                        | 196947         | 1081768         | 24.3                       | 430.7                                     |
| 0433                        | 196860         | 1081924         | 23.9                       | 431.1                                     |
| 0440                        | 196778         | 1082073         | 24.9                       | 430.1                                     |
| 0443                        | 196654         | 1082250         | 24.2                       | 430.8                                     |
| 0450                        | 196474         | 1082456         | 22.7                       | 432.3                                     |
| 0453                        | 196270         | 1082687         | 23.3                       | 431.7                                     |
| 0460                        | 196050         | 1082960         | 24.8                       | 430.2                                     |
| <b>Survey Line #11</b>      |                |                 |                            |   |
| 0463                        | 197548         | 1081034         | 24.2                       | 430.8                                     |
| 0470                        | 197458         | 1081216         | 19.7                       | 435.3                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #11 cont.</b> |                |                 |                            |   |
| 0473                         | 197299         | 1081396         | 21.0                       | 434.0                                     |
| 0480                         | 197138         | 1081602         | 24.8                       | 430.2                                     |
| 0483                         | 196999         | 1081866         | 24.4                       | 430.6                                     |
| 0490                         | 196846         | 1082131         | 24.8                       | 430.2                                     |
| 0493                         | 196638         | 1082354         | 23.0                       | 432.0                                     |
| 0500                         | 196471         | 1082586         | 23.3                       | 431.7                                     |
| 196638                       | 1082354        | 23.0            | 432.0                      | 0493                                      |
| 0500                         | 196471         | 1082586         | 23.3                       | 431.7                                     |
| 0503                         | 196340         | 1082773         | 23.7                       | 431.3                                     |
| 0510                         | 196214         | 1083018         | 25.2                       | 429.8                                     |
| 0513                         | 195994         | 1083171         | 25.7                       | 429.3                                     |
| <b>Survey Line #12</b>       |                |                 |                            |   |
| 0520                         | 197599         | 1081150         | 21.4                       | 433.6                                     |
| 0523                         | 197468         | 1081344         | 22.2                       | 432.8                                     |
| 0530                         | 197344         | 1081592         | 25.3                       | 429.7                                     |
| 0533                         | 197165         | 1081835         | 24.6                       | 430.4                                     |
| 0540                         | 196914         | 1082072         | 23.8                       | 431.2                                     |
| 0543                         | 196749         | 1082318         | 23.1                       | 431.9                                     |
| 0550                         | 196612         | 1082550         | 24.0                       | 431.0                                     |
| 0553                         | 196478         | 1082823         | 25.5                       | 429.5                                     |
| 0560                         | 196312         | 1082997         | 27.3                       | 427.7                                     |
| <b>Survey Line #13</b>       |                |                 |                            |   |
| 0563                         | 196164         | 1083126         | 5.4                        | 449.6                                     |
| 0570                         | 197667         | 1081256         | 19.6                       | 435.4                                     |
| 0573                         | 197444         | 1081508         | 25.0                       | 430.0                                     |
| 0580                         | 197241         | 1081756         | 23.6                       | 431.4                                     |
| 0583                         | 197098         | 1082036         | 25.8                       | 429.2                                     |
| 0590                         | 196953         | 1082277         | 26.1                       | 428.9                                     |
| 0593                         | 196807         | 1082455         | 25.3                       | 429.7                                     |
| 0600                         | 196655         | 1082683         | 22.9                       | 432.1                                     |
| 0603                         | 196527         | 1082931         | 26.1                       | 428.9                                     |
| 0610                         | 196447         | 1083092         | 28.2                       | 426.8                                     |
| 0613                         | 196307         | 1083245         | 27.3                       | 427.7                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #14</b> |                |                 |                            |   |
| 0623                   | 197658         | 1081376         | 21.4                       | 433.6                                     |
| 0630                   | 197482         | 1081569         | 26.3                       | 428.7                                     |
| 0633                   | 197332         | 1081812         | 26.2                       | 428.8                                     |
| 0640                   | 197232         | 1082070         | 26.7                       | 428.3                                     |
| 0643                   | 197058         | 1082305         | 27.2                       | 427.8                                     |
| 0650                   | 196945         | 1082527         | 26.9                       | 428.1                                     |
| 0653                   | 196807         | 1082673         | 26.7                       | 428.3                                     |
| 0660                   | 196710         | 1082812         | 25.1                       | 429.9                                     |
| 0663                   | 196619         | 1082973         | 27.1                       | 427.9                                     |
| 0670                   | 196450         | 1083169         | 29.3                       | 425.7                                     |
| 0673                   | 196248         | 1083400         | 29.5                       | 425.5                                     |
| <b>Survey Line #15</b> |                |                 |                            |   |
| 0680                   | 197846         | 1081300         | 19.9                       | 435.1                                     |
| 0683                   | 197719         | 1081485         | 24.9                       | 430.1                                     |
| 0690                   | 197576         | 1081702         | 24.8                       | 430.2                                     |
| 0693                   | 197428         | 1081958         | 25.4                       | 429.6                                     |
| 0700                   | 197262         | 1082219         | 26.0                       | 429.0                                     |
| 0703                   | 197097         | 1082465         | 27.1                       | 427.9                                     |
| 0710                   | 196891         | 1082693         | 27.8                       | 427.2                                     |
| 0713                   | 196683         | 1082926         | 26.1                       | 428.9                                     |
| 0720                   | 196487         | 1083191         | 30.1                       | 424.9                                     |
| <b>Survey Line #16</b> |                |                 |                            |   |
| 0730                   | 197829         | 1081517         | 19.8                       | 435.2                                     |
| 0733                   | 197685         | 1081709         | 22.2                       | 432.8                                     |
| 0740                   | 197557         | 1081965         | 20.0                       | 435.0                                     |
| 0743                   | 197378         | 1082229         | 21.9                       | 433.1                                     |
| 0750                   | 197136         | 1082478         | 26.3                       | 428.7                                     |
| 0753                   | 196909         | 1082750         | 27.9                       | 427.1                                     |
| <b>Survey Line #17</b> |                |                 |                            |   |
| 0770                   | 197976         | 1080857         | 17.5                       | 437.5                                     |
| 0773                   | 198009         | 1081475         | 20.7                       | 434.3                                     |
| 0780                   | 197857         | 1081696         | 20.3                       | 434.7                                     |
| 0783                   | 197684         | 1081940         | 15.6                       | 439.4                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #17 cont.</b> |                |                 |                            |   |
| 0790                         | 197485         | 1082204         | 16.6                       | 438.4                                     |
| 0793                         | 197258         | 1082456         | 19.2                       | 435.8                                     |
| 0800                         | 197063         | 1082724         | 19.5                       | 435.5                                     |
| 0803                         | 196871         | 1082984         | 16.5                       | 438.5                                     |
| 0810                         | 196642         | 1083245         | 13.9                       | 441.1                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 50 E  
Survey Date/Time : 23 July 1994, 1325 to 1419 hours  
Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #52</b> |                |                 |                            |   |
| 0820                   | 196898         | 1080726         | 17.9                       | 437.1                                     |
| 0823                   | 197121         | 1080866         | 16.9                       | 438.1                                     |
| 0830                   | 197318         | 1081013         | 15.7                       | 439.3                                     |
| 0833                   | 197511         | 1081138         | 20.1                       | 434.9                                     |
| 0840                   | 197699         | 1081244         | 22.9                       | 432.1                                     |
| 0843                   | 197862         | 1081375         | 22.0                       | 433.0                                     |
| 0850                   | 197986         | 1081546         | 22.1                       | 432.9                                     |
| <b>Survey Line #53</b> |                |                 |                            |   |
| 0853                   | 196626         | 1080974         | 13.0                       | 442.0                                     |
| 0860                   | 196789         | 1081139         | 17.8                       | 437.2                                     |
| 0863                   | 197029         | 1081281         | 18.4                       | 436.6                                     |
| 0870                   | 197216         | 1081451         | 22.5                       | 432.5                                     |
| 0873                   | 197465         | 1081605         | 28.1                       | 426.9                                     |
| 0880                   | 197669         | 1081755         | 20.5                       | 434.5                                     |
| 0883                   | 197839         | 1081949         | 16.2                       | 438.8                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 50 E  
 Survey Date/Time : 23 July 1994, 1325 to 1419 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #54</b> |                |                 |                            |   |
| 0890                   | 196489         | 1081396         | 18.0                       | 437.0                                     |
| 0893                   | 196691         | 1081582         | 20.4                       | 434.6                                     |
| 0900                   | 196983         | 1081716         | 24.7                       | 430.3                                     |
| 0903                   | 197201         | 1081858         | 27.3                       | 427.7                                     |
| 0910                   | 197412         | 1082022         | 23.0                       | 432.0                                     |
| 0913                   | 197610         | 1082237         | --                         | ---                                       |
| <b>Survey Line #55</b> |                |                 |                            |   |
| 0920                   | 196146         | 1081679         | 16.4                       | 438.6                                     |
| 0923                   | 196356         | 1081796         | 20.5                       | 434.5                                     |
| 0930                   | 196549         | 1081954         | 22.5                       | 432.5                                     |
| 0933                   | 196790         | 1082101         | 25.2                       | 429.8                                     |
| 0940                   | 197045         | 1082224         | 28.1                       | 426.9                                     |
| 0943                   | 197214         | 1082381         | 21.1                       | 433.9                                     |
| <b>Survey Line #56</b> |                |                 |                            |   |
| 0950                   | 195899         | 1082009         | 19.6                       | 435.4                                     |
| 0953                   | 196212         | 1082122         | 22.1                       | 432.9                                     |
| 0960                   | 196396         | 1082288         | 22.9                       | 432.1                                     |
| 0963                   | 196620         | 1082456         | 23.5                       | 431.5                                     |
| 0970                   | 196858         | 1082603         | 28.0                       | 427.0                                     |
| 0973                   | 196966         | 1082837         | 20.4                       | 434.6                                     |
| <b>Survey Line #57</b> |                |                 |                            |   |
| 0980                   | 195908         | 1082467         | --                         | ---                                       |
| 0983                   | 196174         | 1082589         | --                         | ---                                       |
| 0990                   | 196388         | 1082705         | --                         | ---                                       |
| 0993                   | 196600         | 1082805         | --                         | ---                                       |
| 1000                   | 196682         | 1082974         | --                         | ---                                       |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #27</b> |                |                 |                            |   |
| 0000                   | 194886         | 1083540         | 14.4                       | 445.1                                     |
| 0003                   | 194783         | 1083623         | --                         | ---                                       |
| 0010                   | 194707         | 1083723         | 17.3                       | 442.2                                     |
| 0013                   | 194625         | 1083829         | 16.6                       | 442.9                                     |
| 0020                   | 194555         | 1083946         | 17.0                       | 442.5                                     |
| 0023                   | 194496         | 1084046         | 17.3                       | 442.2                                     |
| 0030                   | 194422         | 1084139         | 17.6                       | 441.9                                     |
| 0033                   | 194333         | 1084243         | 19.0                       | 440.5                                     |
| 0040                   | 194232         | 1084390         | 20.8                       | 438.7                                     |
| 0043                   | 194122         | 1084540         | 21.2                       | 438.3                                     |
| 0050                   | 194003         | 1084694         | 23.1                       | 436.4                                     |
| <b>Survey Line #28</b> |                |                 |                            |   |
| 0063                   | 194788         | 1083822         | --                         | ---                                       |
| 0070                   | 194678         | 1083937         | 18.3                       | 441.2                                     |
| 0073                   | 194587         | 1084074         | 18.4                       | 441.1                                     |
| 0080                   | 194502         | 1084180         | 19.0                       | 440.5                                     |
| 0083                   | 194418         | 1084307         | 19.5                       | 440.0                                     |
| 0090                   | 194327         | 1084416         | 21.5                       | 438.0                                     |
| 0093                   | 194249         | 1084554         | 21.7                       | 437.8                                     |
| 0100                   | 194147         | 1084658         | 20.2                       | 439.3                                     |
| 0103                   | 194060         | 1084791         | 19.5                       | 440.0                                     |
| <b>Survey Line #29</b> |                |                 |                            |   |
| 0113                   | 195071         | 1083603         | 20.2                       | 439.3                                     |
| 0120                   | 194948         | 1083731         | 17.8                       | 441.7                                     |
| 0123                   | 194860         | 1083892         | 18.1                       | 441.4                                     |
| 0130                   | 194745         | 1084022         | 19.8                       | 439.7                                     |
| 0133                   | 194663         | 1084161         | 19.3                       | 440.2                                     |
| 0140                   | 194544         | 1084294         | 19.5                       | 440.0                                     |
| 0143                   | 194447         | 1084444         | 19.9                       | 439.6                                     |
| 0150                   | 194324         | 1084585         | 20.2                       | 439.3                                     |
| 0153                   | 194208         | 1084735         | 17.0                       | 442.5                                     |
| 0160                   | 194105         | 1084900         | 15.5                       | 444.0                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #30</b> |                |                 |                            |   |
| 0163                   | 195181         | 1083602         | 23.8                       | 435.7                                     |
| 0170                   | 195114         | 1083737         | 23.9                       | 435.6                                     |
| 0173                   | 194997         | 1083871         | 20.5                       | 439.0                                     |
| 0180                   | 194876         | 1084011         | 20.4                       | 439.1                                     |
| 0183                   | 194777         | 1084172         | 20.6                       | 438.9                                     |
| 0190                   | 194661         | 1084301         | 20.2                       | 439.3                                     |
| 0193                   | 194574         | 1084452         | 21.9                       | 437.6                                     |
| 0200                   | 194462         | 1084586         | 18.9                       | 440.6                                     |
| 0203                   | 194341         | 1084733         | 17.8                       | 441.7                                     |
| 0210                   | 194234         | 1084889         | 15.6                       | 443.9                                     |
| <b>Survey Line #31</b> |                |                 |                            |   |
| 0220                   | 195179         | 1083785         | 24.9                       | 434.6                                     |
| 0223                   | 195047         | 1083923         | 24.0                       | 435.5                                     |
| 0230                   | 194961         | 1084086         | 22.8                       | 436.7                                     |
| 0233                   | 194829         | 1084234         | 22.7                       | 436.8                                     |
| 0240                   | 194722         | 1084378         | 20.4                       | 439.1                                     |
| 0243                   | 194610         | 1084558         | 19.3                       | 440.2                                     |
| 0250                   | 194466         | 1084716         | 16.2                       | 443.3                                     |
| 0253                   | 194352         | 1084878         | 15.7                       | 443.8                                     |
| 0260                   | 194244         | 1085072         | 14.2                       | 445.3                                     |
| <b>Survey Line #32</b> |                |                 |                            |   |
| 0270                   | 195347         | 1083652         | 25.5                       | 434.0                                     |
| 0273                   | 195280         | 1083795         | 25.2                       | 434.3                                     |
| 0280                   | 195180         | 1083938         | 25.5                       | 434.0                                     |
| 0283                   | 195079         | 1084081         | 24.7                       | 434.8                                     |
| 0290                   | 194960         | 1084214         | 22.6                       | 436.9                                     |
| 0293                   | 194852         | 1084356         | 22.0                       | 437.5                                     |
| 0300                   | 194747         | 1084510         | 19.6                       | 439.9                                     |
| 0303                   | 194650         | 1084680         | 18.6                       | 440.9                                     |
| 0310                   | 194514         | 1084822         | 15.5                       | 444.0                                     |
| 0313                   | 194394         | 1084974         | 15.8                       | 443.7                                     |
| 0320                   | 194314         | 1085159         | 14.8                       | 444.7                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #33</b> |                |                 |                            |   |
| 0323                   | 195381         | 1083841         | 25.3                       | 434.2                                     |
| 0330                   | 195275         | 1083974         | 24.7                       | 434.8                                     |
| 0333                   | 195161         | 1084108         | 24.7                       | 434.8                                     |
| 0340                   | 195064         | 1084258         | 20.1                       | 439.4                                     |
| 0343                   | 194945         | 1084395         | 20.6                       | 438.9                                     |
| 0350                   | 194829         | 1084536         | 20.4                       | 439.1                                     |
| 0353                   | 194730         | 1084705         | 17.7                       | 441.8                                     |
| 0360                   | 194633         | 1084876         | 18.4                       | 441.1                                     |
| 0363                   | 194506         | 1085033         | 16.4                       | 443.1                                     |
| 0370                   | 194353         | 1085162         | 15.9                       | 443.6                                     |
| <b>Survey Line #34</b> |                |                 |                            |   |
| 0373                   | 195444         | 1083854         | 25.5                       | 434.0                                     |
| 0380                   | 195368         | 1084015         | 24.6                       | 434.9                                     |
| 0383                   | 195256         | 1084159         | 25.8                       | 433.7                                     |
| 0390                   | 195135         | 1084289         | 17.7                       | 441.8                                     |
| 0393                   | 195056         | 1084449         | 17.8                       | 441.7                                     |
| 0400                   | 194959         | 1084599         | 16.9                       | 442.6                                     |
| 0403                   | 194827         | 1084741         | 18.0                       | 441.5                                     |
| 0410                   | 194704         | 1084891         | 18.6                       | 440.9                                     |
| 0413                   | 194612         | 1085064         | 18.1                       | 441.4                                     |
| 0420                   | 194502         | 1085233         | 17.6                       | 441.9                                     |
| <b>Survey Line #35</b> |                |                 |                            |   |
| 0423                   | 195520         | 1083960         | 25.3                       | 434.2                                     |
| 0430                   | 195423         | 1084106         | 25.0                       | 434.5                                     |
| 0433                   | 195328         | 1084264         | 19.6                       | 439.9                                     |
| 0440                   | 195216         | 1084409         | 16.3                       | 443.2                                     |
| 0443                   | 195098         | 1084549         | 16.0                       | 443.5                                     |
| 0450                   | 194994         | 1084702         | 16.6                       | 442.9                                     |
| 0453                   | 194869         | 1084850         | 17.5                       | 442.0                                     |
| 0460                   | 194755         | 1085012         | 19.9                       | 439.6                                     |
| 0463                   | 194652         | 1085180         | 18.0                       | 441.5                                     |
| 0470                   | 194496         | 1085302         | 17.2                       | 442.3                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #36</b> |                |                 |                            |   |
| 0473                   | 195628         | 1083946         | 25.6                       | 433.9                                     |
| 0480                   | 195552         | 1084103         | 24.4                       | 435.1                                     |
| 0483                   | 195399         | 1084234         | 19.5                       | 440.0                                     |
| 0490                   | 195321         | 1084402         | 17.7                       | 441.8                                     |
| 0493                   | 195205         | 1084550         | 15.5                       | 444.0                                     |
| 0500                   | 195080         | 1084694         | 16.0                       | 443.5                                     |
| 0503                   | 194994         | 1084862         | 17.1                       | 442.4                                     |
| 0510                   | 194865         | 1085023         | 19.5                       | 440.0                                     |
| 0513                   | 194733         | 1085170         | 16.0                       | 443.5                                     |
| 0520                   | 194643         | 1085344         | 15.5                       | 444.0                                     |
| <b>Survey Line #37</b> |                |                 |                            |   |
| 0523                   | 195723         | 1084008         | 27.3                       | 432.2                                     |
| 0530                   | 195596         | 1084151         | 21.3                       | 438.2                                     |
| 0533                   | 195505         | 1084304         | 20.1                       | 439.4                                     |
| 0540                   | 195393         | 1084465         | 18.5                       | 441.0                                     |
| 0543                   | 195273         | 1084620         | 17.4                       | 442.1                                     |
| 0550                   | 195195         | 1084794         | 17.0                       | 442.5                                     |
| 0553                   | 195044         | 1084954         | 18.3                       | 441.2                                     |
| 0560                   | 194909         | 1085116         | 15.9                       | 443.6                                     |
| 0563                   | 194815         | 1085314         | 18.4                       | 441.1                                     |
| <b>Survey Line #38</b> |                |                 |                            |   |
| 0573                   | 195723         | 1084168         | 23.6                       | 435.9                                     |
| 0580                   | 195656         | 1084327         | 21.3                       | 438.2                                     |
| 0583                   | 195492         | 1084469         | 19.7                       | 439.8                                     |
| 0590                   | 195421         | 1084655         | 22.2                       | 437.3                                     |
| 0593                   | 195233         | 1084768         | 17.1                       | 442.4                                     |
| 0600                   | 195171         | 1084946         | 20.6                       | 438.9                                     |
| 0603                   | 195049         | 1085118         | 16.9                       | 442.6                                     |
| 0610                   | 194935         | 1085294         | 17.5                       | 442.0                                     |
| 0613                   | 194767         | 1085444         | 17.0                       | 442.5                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #39</b> |                |                 |                            |   |
| 0620                   | 195797         | 1084264         | 25.1                       | 434.4                                     |
| 0623                   | 195685         | 1084438         | 22.4                       | 437.1                                     |
| 0630                   | 195549         | 1084600         | 24.2                       | 435.3                                     |
| 0633                   | 195442         | 1084777         | 22.9                       | 436.6                                     |
| 0640                   | 195302         | 1084945         | 20.9                       | 438.6                                     |
| 0643                   | 195160         | 1085112         | 18.8                       | 440.7                                     |
| 0650                   | 195031         | 1085288         | 18.1                       | 441.4                                     |
| 0653                   | 194913         | 1085464         | 16.6                       | 442.9                                     |
| <b>Survey Line #40</b> |                |                 |                            |   |
| 0660                   | 195989         | 1084118         | 33.2                       | 426.3                                     |
| 0663                   | 195879         | 1084300         | 28.8                       | 430.7                                     |
| 0670                   | 195770         | 1084492         | 23.8                       | 435.7                                     |
| 0673                   | 195645         | 1084666         | 24.3                       | 435.2                                     |
| 0680                   | 195529         | 1084847         | 23.9                       | 435.6                                     |
| 0683                   | 195378         | 1085001         | 21.9                       | 437.6                                     |
| 0690                   | 195260         | 1085185         | 18.8                       | 440.7                                     |
| 0693                   | 195140         | 1085356         | 17.3                       | 442.2                                     |
| <b>Survey Line #41</b> |                |                 |                            |   |
| 0703                   | 196017         | 1084310         | 26.8                       | 432.7                                     |
| 0710                   | 195873         | 1084517         | 27.4                       | 432.1                                     |
| 0713                   | 195746         | 1084714         | 24.2                       | 435.3                                     |
| 0720                   | 195604         | 1084883         | 23.3                       | 436.2                                     |
| 0723                   | 195484         | 1085067         | 22.9                       | 436.6                                     |
| 0730                   | 195344         | 1085228         | 18.7                       | 440.8                                     |
| 0733                   | 195239         | 1085405         | 19.3                       | 440.2                                     |
| <b>Survey Line #42</b> |                |                 |                            |   |
| 0743                   | 196124         | 1084325         | 24.8                       | 434.7                                     |
| 0750                   | 196002         | 1084532         | 24.8                       | 434.7                                     |
| 0753                   | 195837         | 1084722         | 23.0                       | 436.5                                     |
| 0760                   | 195715         | 1084924         | 23.9                       | 435.6                                     |
| 0763                   | 195549         | 1085094         | 22.2                       | 437.3                                     |
| 0770                   | 195429         | 1085276         | 23.1                       | 436.4                                     |
| 0773                   | 195291         | 1085433         | 20.3                       | 439.2                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #43</b> |                |                 |                            |   |
| 0780                   | 196122         | 1084464         | 22.7                       | 436.8                                     |
| 0783                   | 196010         | 1084682         | 23.0                       | 436.5                                     |
| 0790                   | 195841         | 1084880         | 21.9                       | 437.6                                     |
| 0793                   | 195710         | 1085096         | 23.7                       | 435.8                                     |
| 0800                   | 195558         | 1085281         | 23.0                       | 436.5                                     |
| 0803                   | 195407         | 1085465         | 24.9                       | 434.6                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 50 E  
 Survey Date/Time : 23 July 1994, 1550 to 1633 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #69</b> |                |                 |                            |   |
| 0810                   | 193847         | 1084716         | 23.6                       | 435.9                                     |
| 0813                   | 194051         | 1084887         | 16.2                       | 443.3                                     |
| 0820                   | 194221         | 1085072         | 14.6                       | 444.9                                     |
| 0823                   | 194497         | 1085191         | 17.4                       | 442.1                                     |
| 0830                   | 194721         | 1085357         | 17.7                       | 441.8                                     |
| 0833                   | 194914         | 1085516         | 17.1                       | 442.4                                     |
| <b>Survey Line #68</b> |                |                 |                            |   |
| 0840                   | 194219         | 1084543         | 20.4                       | 439.1                                     |
| 0843                   | 194466         | 1084718         | 15.8                       | 443.7                                     |
| 0850                   | 194732         | 1084881         | 18.3                       | 441.2                                     |
| 0853                   | 195003         | 1085059         | 16.5                       | 443.0                                     |
| 0860                   | 195294         | 1085186         | 19.5                       | 440.0                                     |
| 0863                   | 195515         | 1085342         | 22.9                       | 436.6                                     |
| 0870                   | 195714         | 1085560         | --                         | ---                                       |
| <b>Survey Line #67</b> |                |                 |                            |   |
| 0873                   | 194508         | 1084270         | 20.2                       | 439.3                                     |
| 0880                   | 194767         | 1084431         | 21.3                       | 438.2                                     |
| 0883                   | 195051         | 1084595         | 15.8                       | 443.7                                     |
| 0890                   | 195291         | 1084763         | 20.8                       | 438.7                                     |
| 0893                   | 195568         | 1084930         | 22.9                       | 436.6                                     |
| 0900                   | 195786         | 1085133         | 21.0                       | 438.5                                     |
| <b>Survey Line #66</b> |                |                 |                            |   |
| 0910                   | 194759         | 1083946         | 18.5                       | 441.0                                     |
| 0913                   | 195024         | 1084127         | 25.3                       | 434.2                                     |
| 0920                   | 195288         | 1084313         | 20.0                       | 439.5                                     |
| 0923                   | 195522         | 1084481         | 22.0                       | 437.5                                     |
| 0930                   | 195746         | 1084652         | 24.1                       | 435.4                                     |
| 0933                   | 195950         | 1084835         | 21.3                       | 438.2                                     |
| <b>Survey Line #65</b> |                |                 |                            |   |
| 0940                   | 195085         | 1083662         | 23.5                       | 436.0                                     |
| 0943                   | 195347         | 1083844         | 25.2                       | 434.3                                     |
| 0950                   | 195615         | 1084009         | 25.6                       | 433.9                                     |
| 0953                   | 195862         | 1084163         | 31.0                       | 428.5                                     |
| 0960                   | 196117         | 1084286         | 24.8                       | 434.7                                     |

# **Appendix D**

## **Lock and Dam 22 Positioning Information for the 'Boomer' Data**

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**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #3</b> |                |                 |                            |   |
| 0000                  | 196862         | 1080637         | --                         | ---                                       |
| 0003                  | 196706         | 1080841         | 15.7                       | 439.3                                     |
| 0010                  | 196560         | 1081043         | 13.9                       | 441.1                                     |
| 0013                  | 196405         | 1081233         | 16.6                       | 438.4                                     |
| 0020                  | 196244         | 1081447         | 15.5                       | 439.5                                     |
| 0023                  | 196045         | 1081698         | 16.3                       | 438.7                                     |
| 0030                  | 195843         | 1082008         | 18.1                       | 436.9                                     |
| <b>Survey Line #4</b> |                |                 |                            |   |
| 0033                  | 196923         | 1080711         | 18.0                       | 437.0                                     |
| 0040                  | 196729         | 1080973         | 16.4                       | 438.6                                     |
| 0043                  | 196538         | 1081232         | 17.2                       | 437.8                                     |
| 0050                  | 196352         | 1081488         | 17.6                       | 437.4                                     |
| 0053                  | 196155         | 1081739         | 17.9                       | 437.1                                     |
| 0060                  | 195976         | 1081998         | 19.7                       | 435.3                                     |
| 0063                  | 195821         | 1082300         | --                         | ---                                       |
| 0070                  | 195572         | 1082699         | 18.2                       | 436.8                                     |
| <b>Survey Line #5</b> |                |                 |                            |   |
| 0073                  | 197023         | 1080740         | 17.7                       | 437.3                                     |
| 0080                  | 196800         | 1081036         | 17.1                       | 437.9                                     |
| 0083                  | 196609         | 1081371         | 18.0                       | 437.0                                     |
| 0090                  | 196348         | 1081680         | 17.0                       | 438.0                                     |
| 0093                  | 196079         | 1082012         | 20.1                       | 434.9                                     |
| 0100                  | 195853         | 1082483         | 21.9                       | 433.1                                     |
| 0103                  | 195557         | 1082905         | 19.0                       | 436.0                                     |
| <b>Survey Line #6</b> |                |                 |                            |   |
| 0110                  | 196952         | 1080983         | 17.9                       | 437.1                                     |
| 0113                  | 196709         | 1081332         | 18.3                       | 436.7                                     |
| 0120                  | 196466         | 1081659         | 18.8                       | 436.2                                     |
| 0123                  | 196206         | 1082020         | 20.4                       | 434.6                                     |
| 0130                  | 195999         | 1082474         | 22.5                       | 432.5                                     |
| 0133                  | 195705         | 1082868         | 20.6                       | 434.4                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #7</b>  |                |                 |                            |   |
| 0140                   | 197168         | 1080843         | 18.1                       | 436.9                                     |
| 0143                   | 196955         | 1081169         | 18.1                       | 436.9                                     |
| 0150                   | 196675         | 1081513         | 18.7                       | 436.3                                     |
| 0153                   | 196424         | 1081924         | 22.0                       | 433.0                                     |
| 0160                   | 196187         | 1082366         | 23.2                       | 431.8                                     |
| 0163                   | 195914         | 1082756         | 22.1                       | 432.9                                     |
| <b>Survey Line #8</b>  |                |                 |                            |   |
| 0173                   | 197152         | 1081176         | 17.8                       | 437.2                                     |
| 0180                   | 196866         | 1081502         | 20.5                       | 434.5                                     |
| 0183                   | 196598         | 1081879         | 22.7                       | 432.3                                     |
| 0190                   | 196374         | 1082230         | 22.6                       | 432.4                                     |
| 0193                   | 196136         | 1082627         | 23.9                       | 431.1                                     |
| <b>Survey Line #9</b>  |                |                 |                            |   |
| 0203                   | 197208         | 1081141         | 18.1                       | 436.9                                     |
| 0210                   | 196988         | 1081465         | 23.0                       | 432.0                                     |
| 0213                   | 196783         | 1081880         | 24.0                       | 431.0                                     |
| 0220                   | 196490         | 1082177         | 23.3                       | 431.7                                     |
| 0223                   | 196253         | 1082677         | 23.6                       | 431.4                                     |
| <b>Survey Line #10</b> |                |                 |                            |   |
| 0233                   | 197335         | 1081210         | 17.3                       | 437.7                                     |
| 0240                   | 197038         | 1081511         | 23.8                       | 431.2                                     |
| 0243                   | 196886         | 1081890         | 23.9                       | 431.1                                     |
| 0250                   | 196719         | 1082163         | 24.2                       | 430.8                                     |
| 0253                   | 196406         | 1082529         | 23.6                       | 431.4                                     |
| 0260                   | 196022         | 1083002         | 25.1                       | 429.9                                     |
| <b>Survey Line #11</b> |                |                 |                            |   |
| 0263                   | 197507         | 1081142         | 18.7                       | 436.3                                     |
| 0270                   | 197244         | 1081458         | 21.9                       | 433.1                                     |
| 0273                   | 196993         | 1081877         | 25.7                       | 429.3                                     |
| 0280                   | 196678         | 1082319         | 23.8                       | 431.2                                     |
| 0283                   | 196401         | 1082698         | 24.6                       | 430.4                                     |
| 0290                   | 196141         | 1083070         | 26.3                       | 428.7                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #12</b> |                |                 |                            |   |
| 0293                   | 197584         | 1081164         | 21.0                       | 434.0                                     |
| 0300                   | 197367         | 1081544         | 24.5                       | 430.5                                     |
| 0303                   | 197016         | 1081962         | 26.1                       | 428.9                                     |
| 0310                   | 196728         | 1082359         | 24.0                       | 431.0                                     |
| 0313                   | 196478         | 1082823         | 25.4                       | 429.6                                     |
| <b>Survey Line #13</b> |                |                 |                            |   |
| 0323                   | 197652         | 1081273         | 19.7                       | 435.3                                     |
| 0330                   | 197292         | 1081689         | 25.3                       | 429.7                                     |
| 0333                   | 197037         | 1082149         | 25.8                       | 429.2                                     |
| 0340                   | 196790         | 1082469         | 25.1                       | 429.9                                     |
| 0343                   | 196535         | 1082895         | 26.0                       | 429.0                                     |
| 0350                   | 196370         | 1083163         | 28.8                       | 426.2                                     |
| <b>Survey Line #14</b> |                |                 |                            |   |
| 0360                   | 197507         | 1081545         | 25.7                       | 429.3                                     |
| 0363                   | 197293         | 1081974         | 25.9                       | 429.1                                     |
| 0370                   | 197014         | 1082369         | 25.1                       | 429.9                                     |
| 0373                   | 196814         | 1082668         | 27.1                       | 427.9                                     |
| 0380                   | 196655         | 1082900         | 26.5                       | 428.5                                     |
| 0383                   | 196380         | 1083240         | 29.4                       | 425.6                                     |
| <b>Survey Line #15</b> |                |                 |                            |   |
| 0390                   | 197844         | 1081320         | 21.0                       | 434.0                                     |
| 0393                   | 197616         | 1081642         | 24.3                       | 430.7                                     |
| 0400                   | 197378         | 1082078         | 25.8                       | 429.2                                     |
| 0403                   | 197080         | 1082485         | 27.1                       | 427.9                                     |
| 0410                   | 196739         | 1082871         | 25.8                       | 429.2                                     |
| 0413                   | 196413         | 1083296         | 30.1                       | 424.9                                     |
| <b>Survey Line #16</b> |                |                 |                            |   |
| 0420                   | 197871         | 1081443         | 17.8                       | 437.2                                     |
| 0423                   | 197645         | 1081795         | 20.6                       | 434.4                                     |
| 0430                   | 197386         | 1082216         | 22.0                       | 433.0                                     |
| 0433                   | 196990         | 1082660         | 28.2                       | 426.8                                     |
| 0440                   | 196641         | 1083131         | 29.2                       | 425.8                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
Survey Date/Time : 23 July 1994, 0904 to 1304 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #17</b> |                |                 |                            |   |
| 0450                   | 197813         | 1081763         | 17.2                       | 437.8                                     |
| 0453                   | 197455         | 1082244         | 15.6                       | 439.4                                     |
| 0460                   | 197063         | 1082724         | 19.9                       | 435.1                                     |
| 0463                   | 196667         | 1083208         | 13.6                       | 441.4                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 50 E  
 Survey Date/Time : 23 July 1994, 1325 to 1419 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 455.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #52</b> |                |                 |                            |   |
| 0473                   | 197171         | 1080915         | 17.7                       | 437.3                                     |
| 0480                   | 197561         | 1081158         | 21.3                       | 433.7                                     |
| 0483                   | 197868         | 1081382         | 21.6                       | 433.4                                     |
| <b>Survey Line #53</b> |                |                 |                            |   |
| 0493                   | 196981         | 1081244         | 18.1                       | 436.9                                     |
| 0500                   | 197363         | 1081552         | 25.9                       | 429.1                                     |
| 0503                   | 197715         | 1081846         | 15.1                       | 439.9                                     |
| <b>Survey Line #54</b> |                |                 |                            |   |
| 0510                   | 196530         | 1081430         | 17.5                       | 437.5                                     |
| 0513                   | 196998         | 1081720         | 24.6                       | 430.4                                     |
| 0520                   | 197392         | 1082005         | 25.1                       | 429.9                                     |
| <b>Survey Line #55</b> |                |                 |                            |   |
| 0530                   | 196482         | 1081886         | 21.7                       | 433.3                                     |
| 0533                   | 196932         | 1082150         | 26.3                       | 428.7                                     |
| 0540                   | 197303         | 1082444         | 16.1                       | 438.9                                     |
| <b>Survey Line #56</b> |                |                 |                            |   |
| 0543                   | 196246         | 1082142         | 21.9                       | 433.1                                     |
| 0550                   | 196609         | 1082449         | 24.2                       | 430.8                                     |
| 0553                   | 196959         | 1082790         | 22.0                       | 433.0                                     |
| <b>Survey Line #57</b> |                |                 |                            |   |
| 0560                   | 196064         | 1082542         | 6.5                        | 448.5                                     |
| 0563                   | 196490         | 1082738         | 5.4                        | 449.6                                     |
| 0570                   | 196702         | 1083025         | 6.4                        | 448.6                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #27</b> |                |                 |                            |   |
| 0000                   | 194883         | 1083543         | --                         | ---                                       |
| 0003                   | 194724         | 1083699         | 17.0                       | 442.5                                     |
| 0010                   | 194587         | 1083894         | 17.6                       | 441.9                                     |
| 0013                   | 194473         | 1084076         | 14.8                       | 444.7                                     |
| 0020                   | 194323         | 1084254         | 19.0                       | 440.5                                     |
| 0023                   | 194141         | 1084512         | 21.5                       | 438.0                                     |
| 0030                   | 193934         | 1084796         | 23.5                       | 436.0                                     |
| <b>Survey Line #28</b> |                |                 |                            |   |
| 0033                   | 194862         | 1083687         | --                         | ---                                       |
| 0040                   | 194678         | 1083937         | 18.2                       | 441.3                                     |
| 0043                   | 194511         | 1084166         | 19.4                       | 440.1                                     |
| 0050                   | 194360         | 1084366         | 20.8                       | 438.7                                     |
| 0053                   | 194215         | 1084583         | 21.1                       | 438.4                                     |
| 0060                   | 194060         | 1084791         | 19.6                       | 439.9                                     |
| <b>Survey Line #29</b> |                |                 |                            |   |
| 0063                   | 195090         | 1083576         | 20.2                       | 439.3                                     |
| 0070                   | 194906         | 1083816         | 19.6                       | 439.9                                     |
| 0073                   | 194744         | 1084066         | 19.7                       | 439.8                                     |
| 0080                   | 194544         | 1084294         | 19.6                       | 439.9                                     |
| 0083                   | 194365         | 1084537         | 19.8                       | 439.7                                     |
| 0090                   | 194172         | 1084777         | 16.5                       | 443.0                                     |
| <b>Survey Line #30</b> |                |                 |                            |   |
| 0100                   | 195016         | 1083845         | 20.7                       | 438.8                                     |
| 0103                   | 194834         | 1084084         | 21.3                       | 438.2                                     |
| 0110                   | 194650         | 1084321         | 20.0                       | 439.5                                     |
| 0113                   | 194472         | 1084564         | 18.8                       | 440.7                                     |
| 0120                   | 194289         | 1084819         | 14.6                       | 444.9                                     |
| <b>Survey Line #31</b> |                |                 |                            |   |
| 0130                   | 195053         | 1083917         | 24.5                       | 435.0                                     |
| 0133                   | 194872         | 1084174         | 21.8                       | 437.7                                     |
| 0140                   | 194688         | 1084439         | 20.3                       | 439.2                                     |
| 0143                   | 194472         | 1084712         | 16.1                       | 443.4                                     |
| 0150                   | 194280         | 1084995         | 14.0                       | 445.5                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #32</b> |                |                 |                            |   |
| 0160                   | 195142         | 1083982         | 24.5                       | 435.0                                     |
| 0163                   | 194941         | 1084240         | 22.2                       | 437.3                                     |
| 0170                   | 194743         | 1084518         | 19.5                       | 440.0                                     |
| 0173                   | 194529         | 1084809         | 16.1                       | 443.4                                     |
| <b>Survey Line #33</b> |                |                 |                            |   |
| 0183                   | 195286         | 1083964         | 24.7                       | 434.8                                     |
| 0190                   | 195087         | 1084221         | 20.6                       | 438.9                                     |
| 0193                   | 194873         | 1084484         | 20.0                       | 439.5                                     |
| 0200                   | 194679         | 1084782         | 17.5                       | 442.0                                     |
| 0203                   | 194453         | 1085075         | 16.5                       | 443.0                                     |
| <b>Survey Line #34</b> |                |                 |                            |   |
| 0210                   | 195435         | 1083872         | 25.3                       | 434.2                                     |
| 0213                   | 195256         | 1084159         | 25.8                       | 433.7                                     |
| 0220                   | 195066         | 1084427         | 18.2                       | 441.3                                     |
| 0223                   | 194865         | 1084702         | 17.8                       | 441.7                                     |
| 0230                   | 194650         | 1084989         | 19.8                       | 439.7                                     |
| <b>Survey Line #35</b> |                |                 |                            |   |
| 0240                   | 195411         | 1084128         | 25.4                       | 434.1                                     |
| 0243                   | 195216         | 1084409         | 16.3                       | 443.2                                     |
| 0250                   | 195007         | 1084690         | 16.8                       | 442.7                                     |
| 0253                   | 194776         | 1084971         | 19.6                       | 439.9                                     |
| 0260                   | 194554         | 1085253         | 17.2                       | 442.3                                     |
| <b>Survey Line #36</b> |                |                 |                            |   |
| 0263                   | 195588         | 1084037         | 25.4                       | 434.1                                     |
| 0270                   | 195359         | 1084292         | 20.8                       | 438.7                                     |
| 0273                   | 195156         | 1084605         | 16.0                       | 443.5                                     |
| 0280                   | 194966         | 1084898         | 17.4                       | 442.1                                     |
| 0283                   | 194727         | 1085177         | 16.1                       | 443.4                                     |
| <b>Survey Line #37</b> |                |                 |                            |   |
| 0293                   | 195522         | 1084272         | 20.9                       | 438.6                                     |
| 0300                   | 195306         | 1084569         | 16.9                       | 442.6                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
 Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>                 | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line # 37 cont.</b> |                |                 |                            |   |
| 0303                          | 195108         | 1084885         | 18.0                       | 441.5                                     |
| 0310                          | 194863         | 1085201         | 18.5                       | 441.0                                     |
| <b>Survey Line #38</b>        |                |                 |                            |   |
| 0313                          | 194690         | 1085509         | 16.7                       | 442.8                                     |
| 0320                          | 195649         | 1084334         | 21.5                       | 438.0                                     |
| 0323                          | 195434         | 1084619         | 21.2                       | 438.3                                     |
| 0330                          | 195164         | 1084858         | 18.3                       | 441.2                                     |
| 0333                          | 194974         | 1085183         | 17.1                       | 442.4                                     |
| 0340                          | 194756         | 1085463         | 16.3                       | 443.2                                     |
| <b>Survey Line #39</b>        |                |                 |                            |   |
| 0343                          | 195727         | 1084384         | 23.9                       | 435.6                                     |
| 0350                          | 195531         | 1084667         | 23.7                       | 435.8                                     |
| 0353                          | 195302         | 1084945         | 20.9                       | 438.6                                     |
| 0360                          | 195080         | 1085233         | 17.9                       | 441.6                                     |
| 0363                          | 194793         | 1085470         | 16.5                       | 443.0                                     |
| <b>Survey Line #40</b>        |                |                 |                            |   |
| 0370                          | 195879         | 1084309         | 28.6                       | 430.9                                     |
| 0373                          | 195677         | 1084623         | 24.3                       | 435.2                                     |
| 0380                          | 195461         | 1084917         | 23.0                       | 436.5                                     |
| 0383                          | 195241         | 1085225         | 19.4                       | 440.1                                     |
| 0390                          | 195004         | 1085498         | 18.2                       | 441.3                                     |
| <b>Survey Line #41</b>        |                |                 |                            |   |
| 0393                          | 195939         | 1084437         | 27.4                       | 432.1                                     |
| 0400                          | 195719         | 1084785         | 24.5                       | 435.0                                     |
| 0403                          | 195480         | 1085075         | 23.8                       | 435.7                                     |
| 0410                          | 195262         | 1085367         | 13.7                       | 445.8                                     |
| <b>Survey Line #42</b>        |                |                 |                            |   |
| 0420                          | 195902         | 1084635         | 24.9                       | 434.6                                     |
| 0423                          | 195664         | 1084976         | 25.4                       | 434.1                                     |
| 0430                          | 195424         | 1085283         | 23.5                       | 436.0                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 40 W (Upstream)  
Survey Date/Time : 22 July 1994, 1416 to 1735 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #43</b> |                |                 |                            |   |
| 0433                   | 196149         | 1084410         | 24.1                       | 435.4                                     |
| 0440                   | 195917         | 1084777         | 26.1                       | 433.4                                     |
| 0443                   | 195661         | 1085137         | 20.9                       | 438.6                                     |
| 0450                   | 195414         | 1085458         | 25.9                       | 433.6                                     |

**Lock and Dam 22  
Upper Mississippi River**

Survey Direction : N 50 E  
 Survey Date/Time : 22 July 1994, 1550 to 1633 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 459.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #65</b> |                |                 |                            |   |
| 0533                   | 195397         | 1083884         | 25.4                       | 434.1                                     |
| 0540                   | 195834         | 1084143         | 30.3                       | 429.2                                     |
| 0543                   | 196269         | 1084361         | 15.3                       | 444.2                                     |
| <b>Survey Line #66</b> |                |                 |                            |   |
| 0513                   | 194842         | 1083985         | 20.5                       | 439.0                                     |
| 0520                   | 195266         | 1084297         | 19.8                       | 439.7                                     |
| 0523                   | 195657         | 1084585         | 24.4                       | 435.1                                     |
| 0530                   | 196019         | 1084902         | 20.6                       | 438.9                                     |
| <b>Survey Line #67</b> |                |                 |                            |   |
| 0493                   | 194521         | 1084277         | 21.0                       | 438.5                                     |
| 0500                   | 195008         | 1084563         | 16.2                       | 443.3                                     |
| 0503                   | 195443         | 1084853         | 23.1                       | 436.4                                     |
| 0510                   | 195834         | 1085179         | 19.7                       | 439.8                                     |
| <b>Survey Line #68</b> |                |                 |                            |   |
| 0473                   | 194283         | 1084562         | 20.0                       | 439.5                                     |
| 0480                   | 194717         | 1084877         | 18.1                       | 441.4                                     |
| 0483                   | 195197         | 1085151         | 19.1                       | 440.4                                     |
| 0490                   | 195618         | 1085443         | 18.0                       | 441.5                                     |
| <b>Survey Line #69</b> |                |                 |                            |   |
| 0460                   | 194005         | 1084824         | 18.5                       | 441.0                                     |
| 0463                   | 194363         | 1085142         | 16.9                       | 442.6                                     |
| 0470                   | 194790         | 1085409         | 18.0                       | 441.5                                     |

# **Appendix E Lock and Dam 24 Positioning Information for the 'Pinger' Data**

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**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 0934 to 1241 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #1</b> |                |                 |                            |   |
| 0933                  | 387095         | 1287358         | 15.6                       | 425.4                                     |
| 0940                  | 386932         | 1287534         | 14.2                       | 426.8                                     |
| 0943                  | 386751         | 1287719         | 11.4                       | 429.6                                     |
| 0950                  | 386599         | 1287905         | 14.7                       | 426.3                                     |
| 0953                  | 386431         | 1288068         | 11.7                       | 429.3                                     |
| 0960                  | 386268         | 1288252         | 11.2                       | 429.8                                     |
| <b>Survey Line #2</b> |                |                 |                            |   |
| 0963                  | 387408         | 1287419         | 16.5                       | 424.5                                     |
| 0970                  | 387236         | 1287537         | 18.4                       | 422.6                                     |
| 0973                  | 387111         | 1287643         | 16.2                       | 424.8                                     |
| 0980                  | 387001         | 1287732         | 18.2                       | 422.8                                     |
| 0983                  | 386896         | 1287816         | 16.9                       | 424.1                                     |
| 0990                  | 386782         | 1287918         | 19.1                       | 421.9                                     |
| 0993                  | 386666         | 1288013         | 18.4                       | 422.6                                     |
| 1000                  | 386561         | 1288094         | 13.8                       | 427.2                                     |
| 1003                  | 386488         | 1288176         | 16.2                       | 424.8                                     |
| 1010                  | 386400         | 1288238         | 12.9                       | 428.1                                     |
| 1013                  | 386314         | 1288306         | 12.7                       | 428.3                                     |
| 1020                  | 386217         | 1288379         | 12.0                       | 429.0                                     |
| 1023                  | 386107         | 1288466         | 13.1                       | 427.9                                     |
| <b>Survey Line #3</b> |                |                 |                            |   |
| 1033                  | 387470         | 1287463         | 17.2                       | 423.8                                     |
| 1040                  | 387389         | 1287535         | 21.1                       | 419.9                                     |
| 1043                  | 387294         | 1287617         | 18.2                       | 422.8                                     |
| 1050                  | 387213         | 1287683         | 19.9                       | 421.1                                     |
| 1053                  | 387131         | 1287755         | 20.6                       | 420.4                                     |
| 1060                  | 387036         | 1287824         | 18.3                       | 422.7                                     |
| 1063                  | 386955         | 1287895         | 20.7                       | 420.3                                     |
| 1070                  | 386869         | 1287970         | 18.4                       | 422.6                                     |
| 1073                  | 386787         | 1288033         | 20.7                       | 420.3                                     |
| 1080                  | 386697         | 1288099         | 17.7                       | 423.3                                     |
| 1083                  | 386619         | 1288169         | 17.3                       | 423.7                                     |
| 1090                  | 386523         | 1288242         | 17.1                       | 423.9                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 0934 to 1241 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>               | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #3 cont.</b> |                |                 |                            |   |
| 1093                        | 386437         | 1288318         | 15.9                       | 425.1                                     |
| 1100                        | 386351         | 1288388         | 16.9                       | 424.1                                     |
| 1103                        | 386269         | 1288461         | 17.5                       | 423.5                                     |
| 1110                        | 386188         | 1288531         | 16.4                       | 424.6                                     |
| 1113                        | 386086         | 1288603         | 17.9                       | 423.1                                     |
| <b>Survey Line #4</b>       |                |                 |                            |   |
| 1120                        | 387606         | 1287468         | 20.9                       | 420.1                                     |
| 1123                        | 387450         | 1287620         | 20.9                       | 420.1                                     |
| 1130                        | 387273         | 1287780         | 20.2                       | 420.8                                     |
| 1133                        | 387086         | 1287929         | 20.2                       | 420.8                                     |
| 1140                        | 386902         | 1288081         | 19.6                       | 421.4                                     |
| 1143                        | 386708         | 1288234         | 20.3                       | 420.7                                     |
| 1150                        | 386519         | 1288385         | 17.8                       | 423.2                                     |
| 1153                        | 386343         | 1288526         | 18.1                       | 422.9                                     |
| 1160                        | 386171         | 1288671         | 20.1                       | 420.9                                     |
| 1163                        | 385999         | 1288805         | 24.0                       | 417.0                                     |
| 1170                        | 385816         | 1288946         | 20.2                       | 420.8                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 20 July 1994, 1420 to 1617 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #5</b> |                |                 |                            |   |
| 0000                  | 387497         | 1287704         | --                         | ---                                       |
| 0003                  | 387347         | 1287839         | 22.7                       | 418.3                                     |
| 0010                  | 387175         | 1287976         | 23.2                       | 417.8                                     |
| 0013                  | 387007         | 1288118         | 22.7                       | 418.3                                     |
| 0020                  | 386831         | 1288262         | 22.4                       | 418.6                                     |
| 0023                  | 386653         | 1288413         | 20.1                       | 420.9                                     |
| 0030                  | 386462         | 1288556         | 21.0                       | 420.0                                     |
| 0033                  | 386281         | 1288725         | 20.5                       | 420.5                                     |
| 0040                  | 386060         | 1288881         | 20.4                       | 420.6                                     |
| 0043                  | 385836         | 1289095         | 20.4                       | 420.6                                     |
| 0050                  | 385535         | 1289314         | 10.9                       | 430.1                                     |
| 0053                  | 385629         | 1289467         | 41.7                       | 399.3                                     |
| <b>Survey Line #6</b> |                |                 |                            |   |
| 0063                  | 387950         | 1287558         | 23.8                       | 417.2                                     |
| 0070                  | 387827         | 1287587         | 22.9                       | 418.1                                     |
| 0073                  | 387670         | 1287689         | 22.3                       | 418.7                                     |
| 0080                  | 387522         | 1287828         | 22.4                       | 418.6                                     |
| 0083                  | 387363         | 1287949         | 21.5                       | 419.5                                     |
| 0090                  | 387214         | 1288081         | 20.6                       | 420.4                                     |
| 0093                  | 387070         | 1288206         | 21.8                       | 419.2                                     |
| 0100                  | 386905         | 1288338         | 22.0                       | 419.0                                     |
| 0103                  | 386722         | 1288473         | 19.7                       | 421.3                                     |
| 0110                  | 386565         | 1288616         | 20.3                       | 420.7                                     |
| 0113                  | 386383         | 1288753         | 19.1                       | 421.9                                     |
| 0120                  | 386206         | 1288900         | 18.8                       | 422.2                                     |
| 0123                  | 386022         | 1289051         | 21.3                       | 419.7                                     |
| 0130                  | 385800         | 1289263         | 28.0                       | 413.0                                     |
| 0133                  | 385527         | 1289444         | 29.7                       | 411.3                                     |
| <b>Survey Line #7</b> |                |                 |                            |   |
| 0143                  | 387876         | 1287521         | 23.9                       | 417.1                                     |
| 0150                  | 387810         | 1287716         | 22.6                       | 418.4                                     |
| 0153                  | 387655         | 1287846         | 21.3                       | 419.7                                     |
| 0160                  | 387503         | 1287977         | 18.4                       | 422.6                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 20 July 1994, 1420 to 1617 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line # 7 cont.</b> |                |                 |                            |   |
| 0163                         | 387342         | 1288103         | 21.8                       | 419.2                                     |
| 0170                         | 387178         | 1288233         | 20.0                       | 421.0                                     |
| 0173                         | 387017         | 1288359         | 24.4                       | 416.6                                     |
| 0180                         | 386852         | 1288493         | 24.2                       | 416.8                                     |
| 0183                         | 386686         | 1288642         | 20.4                       | 420.6                                     |
| 0190                         | 386514         | 1288785         | 21.9                       | 419.1                                     |
| 0193                         | 386338         | 1288922         | 19.7                       | 421.3                                     |
| 0200                         | 386168         | 1289075         | 22.2                       | 418.8                                     |
| 0203                         | 385992         | 1289240         | 28.6                       | 412.4                                     |
| 0210                         | 385749         | 1289415         | 41.5                       | 399.5                                     |
| 0213                         | 385477         | 1289659         | --                         | ---                                       |
| <b>Survey Line #8</b>        |                |                 |                            |   |
| 0220                         | 387826         | 1287841         | 22.4                       | 418.6                                     |
| 0223                         | 387669         | 1287958         | 22.2                       | 418.8                                     |
| 0230                         | 387518         | 1288088         | 20.4                       | 420.6                                     |
| 0233                         | 387289         | 1288270         | 23.1                       | 417.9                                     |
| 0240                         | 387114         | 1288412         | 26.5                       | 414.5                                     |
| 0243                         | 386936         | 1288570         | 31.1                       | 409.9                                     |
| 0250                         | 386743         | 1288716         | 24.7                       | 416.3                                     |
| 0253                         | 386577         | 1288861         | 24.4                       | 416.6                                     |
| 0260                         | 386382         | 1289024         | 24.1                       | 416.9                                     |
| 0263                         | 386169         | 1289195         | 24.5                       | 416.5                                     |
| 0270                         | 385941         | 1289411         | 34.8                       | 406.2                                     |
| 0273                         | 385597         | 1289639         | 35.6                       | 405.4                                     |
| <b>Survey Line #9</b>        |                |                 |                            |   |
| 0280                         | 387940         | 1287743         | 23.7                       | 417.3                                     |
| 0283                         | 387878         | 1287934         | 24.2                       | 416.8                                     |
| 0290                         | 387721         | 1288050         | 22.9                       | 418.1                                     |
| 0293                         | 387573         | 1288173         | 21.0                       | 420.0                                     |
| 0300                         | 387429         | 1288283         | 23.0                       | 418.0                                     |
| 0303                         | 387306         | 1288399         | 23.5                       | 417.5                                     |
| 0310                         | 387143         | 1288526         | 29.0                       | 412.0                                     |
| 0313                         | 386965         | 1288665         | 30.1                       | 410.9                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 20 July 1994, 1420 to 1617 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line # 9 cont.</b> |                |                 |                            |   |
| 0320                         | 386782         | 1288817         | 28.5                       | 412.5                                     |
| 0323                         | 386595         | 1288960         | 28.0                       | 413.0                                     |
| 0330                         | 386432         | 1289108         | 27.7                       | 413.3                                     |
| 0333                         | 386255         | 1289251         | 27.3                       | 413.7                                     |
| 0340                         | 386015         | 1289462         | 30.7                       | 410.3                                     |
| 0343                         | 385684         | 1289685         | 41.8                       | 399.2                                     |
| <b>Survey Line #10</b>       |                |                 |                            |   |
| 0350                         | 387983         | 1287842         | 23.0                       | 418.0                                     |
| 0353                         | 387876         | 1288051         | 25.4                       | 415.6                                     |
| 0360                         | 387685         | 1288204         | 25.0                       | 416.0                                     |
| 0363                         | 387520         | 1288340         | 22.4                       | 418.6                                     |
| 0370                         | 387374         | 1288471         | 21.9                       | 419.1                                     |
| 0373                         | 387212         | 1288590         | 24.4                       | 416.6                                     |
| 0380                         | 387070         | 1288700         | 29.0                       | 412.0                                     |
| 0383                         | 386911         | 1288839         | 30.9                       | 410.1                                     |
| 0390                         | 386729         | 1288994         | 31.2                       | 409.8                                     |
| 0393                         | 386518         | 1289161         | 31.5                       | 409.5                                     |
| 0400                         | 386299         | 1289332         | 28.6                       | 412.4                                     |
| 0403                         | 386093         | 1289530         | 31.8                       | 409.2                                     |
| 0410                         | 385787         | 1289733         | 46.3                       | 394.7                                     |
| <b>Survey Line #11</b>       |                |                 |                            |   |
| 0413                         | 387931         | 1288135         | 23.6                       | 417.4                                     |
| 0420                         | 387701         | 1288317         | 21.7                       | 419.3                                     |
| 0423                         | 387503         | 1288480         | 23.1                       | 417.9                                     |
| 0430                         | 387314         | 1288619         | 20.8                       | 420.2                                     |
| 0433                         | 387176         | 1288747         | 22.7                       | 418.3                                     |
| 0440                         | 387007         | 1288885         | 30.8                       | 410.2                                     |
| 0443                         | 386835         | 1289011         | 30.8                       | 410.2                                     |
| 0450                         | 386663         | 1289154         | 30.8                       | 410.2                                     |
| 0453                         | 386461         | 1289335         | 30.5                       | 410.5                                     |
| 0460                         | 386246         | 1289513         | 30.9                       | 410.1                                     |
| 0463                         | 386031         | 1289702         | 37.0                       | 404.0                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
Survey Date/Time : 20 July 1994, 1420 to 1617 hours  
Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #12</b> |                |                 |                            |   |
| 0473                   | 388040         | 1288058         | 20.5                       | 420.5                                     |
| 0480                   | 387918         | 1288263         | 19.6                       | 421.4                                     |
| 0483                   | 387712         | 1288449         | 19.4                       | 421.6                                     |
| 0490                   | 387486         | 1288622         | 19.0                       | 422.0                                     |
| 0493                   | 387336         | 1288741         | 14.6                       | 426.4                                     |
| 0500                   | 387231         | 1288837         | 12.7                       | 428.3                                     |
| 0503                   | 387097         | 1288946         | 13.1                       | 427.9                                     |
| 0510                   | 386934         | 1289075         | 19.0                       | 422.0                                     |
| 0513                   | 386788         | 1289184         | 29.6                       | 411.4                                     |
| 0520                   | 386678         | 1289305         | 32.8                       | 408.2                                     |
| 0523                   | 386498         | 1289435         | 31.0                       | 410.0                                     |
| 0530                   | 386304         | 1289597         | 29.5                       | 411.5                                     |
| 0533                   | 386044         | 1289794         | 41.2                       | 399.8                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 0934 to 1241 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>                                 | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|---|----------------|-----------------|----------------------------|---|
| <b>Survey Line #15</b>                        |                |                 |                            |   |
| 0810  | 387139         | 1289045         | 13.8                       | 427.2                                     |
| 0813  | 386930         | 1289204         | 24.0                       | 417.0                                     |
| 0820  | 386657         | 1289422         | 29.1                       | 411.9                                     |
| 0823  | 386395         | 1289640         | 26.9                       | 414.1                                     |
| 0830  | 386114         | 1289852         | 39.3                       | 401.7                                     |
| <b>Survey Line #16</b>                        |                |                 |                            |   |
| 0840  | 387006         | 1289359         | --                         | ---                                       |
| 0843  | 386716         | 1289492         | 31.6                       | 409.4                                     |
| 0850  | 386460         | 1289716         | 26.4                       | 414.6                                     |
| 0853  | 386196         | 1289926         | 35.4                       | 405.6                                     |
| <b>Survey Line #17</b>                        |                |                 |                            |   |
| 0873  | 386390         | 1289873         | 30.1                       | 410.9                                     |
| 0880  | 386164         | 1290090         | 39.0                       | 402.0                                     |
| <b>Survey Line #18</b>                        |                |                 |                            |   |
| 0890  | 386472         | 1289940         | 32.2                       | 408.8                                     |
| 0893  | 386253         | 1290116         | 40.4                       | 400.6                                     |
| <b>Survey Line #19</b>                        |                |                 |                            |   |
| 0913  | 386766         | 1290094         | 30.9                       | 410.1                                     |
| 0920  | 386441         | 1290259         | 57.1                       | 383.9                                     |
| 0923  | 386207         | 1290456         | 26.7                       | 414.3                                     |
| <b>Survey Line #20</b>                        |                |                 |                            |   |
| 0903  | 386554         | 1290045         | 48.9                       | 392.1                                     |
| 0910  | 386262         | 1290275         | 43.4                       | 397.6                                     |
| <b>Survey Line #21</b>                        |                |                 |                            |   |
| No Positioning or Depth Information Available |                |                 |                            |   |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 40 E  
 Survey Date/Time : 20 July 1994, 1658 to 1804 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #56</b> |                |                 |                            |   |
| 0610                   | 388077         | 1288607         | 23.3                       | 417.7                                     |
| 0613                   | 387880         | 1288313         | 18.2                       | 422.8                                     |
| 0620                   | 387680         | 1288022         | 19.7                       | 421.3                                     |
| 0623                   | 387461         | 1287779         | 20.1                       | 420.9                                     |
| 0630                   | 387240         | 1287541         | 15.8                       | 425.2                                     |
| <b>Survey Line #57</b> |                |                 |                            |   |
| 0570                   | 387206         | 1287655         | 20.9                       | 420.1                                     |
| 0573                   | 387263         | 1287813         | 22.7                       | 418.3                                     |
| 0580                   | 387382         | 1287965         | 21.4                       | 419.6                                     |
| 0583                   | 387504         | 1288108         | 20.5                       | 420.5                                     |
| 0590                   | 387584         | 1288254         | 23.0                       | 418.0                                     |
| 0593                   | 387738         | 1288394         | 21.2                       | 419.8                                     |
| 0600                   | 387799         | 1288612         | 19.8                       | 421.2                                     |
| 0603                   | 388039         | 1288728         | --                         | ---                                       |
| <b>Survey Line #58</b> |                |                 |                            |   |
| 0640                   | 386829         | 1287820         | 16.5                       | 424.5                                     |
| 0643                   | 386919         | 1288037         | 19.9                       | 421.1                                     |
| 0650                   | 387109         | 1288244         | 18.1                       | 422.9                                     |
| 0653                   | 387302         | 1288445         | 19.4                       | 421.6                                     |
| 0660                   | 387435         | 1288668         | 15.8                       | 425.2                                     |
| 0663                   | 387619         | 1288922         | 13.4                       | 427.6                                     |
| 0670                   | 387838         | 1289124         | 16.1                       | 424.9                                     |
| <b>Survey Line #59</b> |                |                 |                            |   |
| 0673                   | 386552         | 1287941         | 13.9                       | 427.1                                     |
| 0680                   | 386721         | 1288157         | 19.8                       | 421.2                                     |
| 0683                   | 386914         | 1288380         | 24.0                       | 417.0                                     |
| 0690                   | 387117         | 1288588         | 24.8                       | 416.2                                     |
| 0693                   | 387293         | 1288824         | 11.9                       | 429.1                                     |
| <b>Survey Line #60</b> |                |                 |                            |   |
| 0700                   | 386301         | 1288273         | 12.9                       | 428.1                                     |
| 0703                   | 386507         | 1288486         | 17.3                       | 423.7                                     |
| 0710                   | 386689         | 1288714         | 21.7                       | 419.3                                     |
| 0713                   | 386869         | 1288928         | 28.0                       | 413.0                                     |
| 0720                   | 387055         | 1289150         | 17.8                       | 423.2                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 40 E  
 Survey Date/Time : 20 July 1994, 1658 to 1804 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #61</b> |                |                 |                            |   |
| 0723                   | 386147         | 1288675         | 18.2                       | 422.8                                     |
| 0730                   | 386336         | 1288908         | 19.4                       | 421.6                                     |
| 0733                   | 386531         | 1289144         | 27.5                       | 413.5                                     |
| 0740                   | 386687         | 1289377         | 30.6                       | 410.4                                     |
| <b>Survey Line #62</b> |                |                 |                            |   |
| 0750                   | 385938         | 1289053         | 19.8                       | 421.2                                     |
| 0753                   | 386111         | 1289294         | 24.5                       | 416.5                                     |
| 0760                   | 386369         | 1289500         | 25.0                       | 416.0                                     |
| 0763                   | 386489         | 1289770         | 29.2                       | 411.8                                     |
| 0770                   | 386710         | 1290046         | 29.6                       | 411.4                                     |
| <b>Survey Line #63</b> |                |                 |                            |   |
| 0780                   | 385682         | 1289379         | 35.3                       | 405.7                                     |
| 0783                   | 385871         | 1289603         | 35.9                       | 405.1                                     |
| 0790                   | 386092         | 1289854         | 37.7                       | 403.3                                     |
| 0793                   | 386313         | 1290115         | 39.3                       | 401.7                                     |
| 0800                   | 386491         | 1290404         | --                         | ---                                       |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #26</b> |                |                 |                            |   |
| 0000                   | 384791         | 1289750         | 20.1                       | 427.4                                     |
| 0003                   | 384617         | 1289898         | 21.6                       | 425.9                                     |
| 0010                   | 384443         | 1290015         | 20.3                       | 427.2                                     |
| 0013                   | 384290         | 1290119         | 18.7                       | 428.8                                     |
| 0020                   | 384161         | 1290229         | 19.3                       | 428.2                                     |
| 0023                   | 384030         | 1290335         | 19.7                       | 427.8                                     |
| 0030                   | 383884         | 1290446         | 19.6                       | 427.9                                     |
| 0033                   | 383734         | 1290562         | 16.8                       | 430.7                                     |
| 0040                   | 383590         | 1290683         | 17.0                       | 430.5                                     |
| 0043                   | 383446         | 1290794         | 21.4                       | 426.1                                     |
| <b>Survey Line #27</b> |                |                 |                            |   |
| 0050                   | 384837         | 1289816         | 19.8                       | 427.7                                     |
| 0053                   | 384684         | 1289970         | 16.7                       | 430.8                                     |
| 0060                   | 384523         | 1290093         | 17.9                       | 429.6                                     |
| 0063                   | 384353         | 1290212         | 18.4                       | 429.1                                     |
| 0070                   | 384186         | 1290339         | 19.9                       | 427.6                                     |
| 0073                   | 384020         | 1290476         | 19.6                       | 427.9                                     |
| 0080                   | 383846         | 1290604         | 21.3                       | 426.2                                     |
| 0083                   | 383691         | 1290741         | 23.2                       | 424.3                                     |
| 0090                   | 383539         | 1290870         | 22.2                       | 425.3                                     |
| <b>Survey Line #28</b> |                |                 |                            |   |
| 0093                   | 384732         | 1290092         | 17.4                       | 430.1                                     |
| 0100                   | 384539         | 1290186         | 17.9                       | 429.6                                     |
| 0103                   | 384397         | 1290336         | 17.0                       | 430.5                                     |
| 0110                   | 384227         | 1290444         | 19.5                       | 428.0                                     |
| 0113                   | 384068         | 1290569         | 19.8                       | 427.7                                     |
| 0120                   | 383902         | 1290694         | 21.9                       | 425.6                                     |
| 0123                   | 383739         | 1290831         | 24.4                       | 423.1                                     |
| 0130                   | 383587         | 1290958         | 23.4                       | 424.1                                     |
| <b>Survey Line #29</b> |                |                 |                            |   |
| 0133                   | 385141         | 1289873         | 24.3                       | 423.2                                     |
| 0140                   | 384956         | 1290026         | 28.9                       | 418.6                                     |
| 0143                   | 384769         | 1290164         | 19.7                       | 427.8                                     |
| 0150                   | 384599         | 1290287         | 16.2                       | 431.3                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #29 cont.</b> |                |                 |                            |   |
| 0153                         | 384421         | 1290418         | 18.7                       | 428.8                                     |
| 0160                         | 384249         | 1290557         | 19.6                       | 427.9                                     |
| 0163                         | 384097         | 1290694         | 20.4                       | 427.1                                     |
| 0170                         | 383916         | 1290806         | 22.7                       | 424.8                                     |
| 0173                         | 383759         | 1290955         | 24.9                       | 422.6                                     |
| 0180                         | 383596         | 1291075         | 21.2                       | 426.3                                     |
| <b>Survey Line #30</b>       |                |                 |                            |   |
| 0183                         | 385213         | 1289969         | 39.0                       | 408.5                                     |
| 0190                         | 385043         | 1290053         | 32.0                       | 415.5                                     |
| 0193                         | 384884         | 1290180         | 27.1                       | 420.4                                     |
| 0200                         | 384722         | 1290310         | 25.8                       | 421.7                                     |
| 0203                         | 384561         | 1290429         | 22.4                       | 425.1                                     |
| 0210                         | 384407         | 1290559         | 21.8                       | 425.7                                     |
| 0213                         | 384241         | 1290692         | 22.1                       | 425.4                                     |
| 0220                         | 384076         | 1290822         | 21.2                       | 426.3                                     |
| 0223                         | 383908         | 1290953         | 22.6                       | 424.9                                     |
| 0230                         | 383734         | 1291091         | 19.2                       | 428.3                                     |
| <b>Survey Line #31</b>       |                |                 |                            |   |
| 0233                         | 385350         | 1289886         | 34.8                       | 412.7                                     |
| 0240                         | 385269         | 1290041         | 34.2                       | 413.3                                     |
| 0243                         | 385084         | 1290157         | 31.2                       | 416.3                                     |
| 0250                         | 384929         | 1290233         | 27.2                       | 420.3                                     |
| 0253                         | 384792         | 1290386         | 26.7                       | 420.8                                     |
| 0260                         | 384622         | 1290505         | 24.8                       | 422.7                                     |
| 0263                         | 384459         | 1290638         | 21.9                       | 425.6                                     |
| 0270                         | 384295         | 1290772         | 22.1                       | 425.4                                     |
| 0273                         | 384128         | 1290907         | 21.6                       | 425.9                                     |
| 0280                         | 383952         | 1291036         | 21.3                       | 426.2                                     |
| 0283                         | 383784         | 1291177         | 19.7                       | 427.8                                     |
| <b>Survey Line #32</b>       |                |                 |                            |   |
| 0290                         | 385332         | 1290050         | 31.6                       | 415.9                                     |
| 0293                         | 385196         | 1290188         | 30.0                       | 417.5                                     |
| 0300                         | 385027         | 1290312         | 29.5                       | 418.0                                     |
| 0303                         | 384865         | 1290444         | 27.4                       | 420.1                                     |
| 0310                         | 384706         | 1290581         | 24.8                       | 422.7                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #32 cont.</b> |                |                 |                            |   |
| 0313                         | 384541         | 1290711         | 24.8                       | 422.7                                     |
| 0320                         | 384378         | 1290845         | 21.6                       | 425.9                                     |
| 0323                         | 384201         | 1290964         | 22.1                       | 425.4                                     |
| 0330                         | 384038         | 1291109         | 18.6                       | 428.9                                     |
| 0333                         | 383871         | 1291249         | 20.5                       | 427.0                                     |
| <b>Survey Line #33</b>       |                |                 |                            |   |
| 0340                         | 385513         | 1290088         | 33.4                       | 414.1                                     |
| 0343                         | 385349         | 1290171         | 30.5                       | 417.0                                     |
| 0350                         | 385188         | 1290297         | 28.9                       | 418.6                                     |
| 0353                         | 385031         | 1290432         | 29.2                       | 418.3                                     |
| 0360                         | 384862         | 1290561         | 26.6                       | 420.9                                     |
| 0363                         | 384703         | 1290702         | 25.4                       | 422.1                                     |
| 0370                         | 384533         | 1290832         | 26.9                       | 420.6                                     |
| 0373                         | 384361         | 1290958         | 22.4                       | 425.1                                     |
| 0380                         | 384195         | 1291096         | 19.1                       | 428.4                                     |
| 0383                         | 384036         | 1291233         | 19.7                       | 427.8                                     |
| 0390                         | 383862         | 1291364         | 19.9                       | 427.6                                     |
| <b>Survey Line #34</b>       |                |                 |                            |   |
| 0393                         | 385419         | 1290250         | 30.3                       | 417.2                                     |
| 0400                         | 385290         | 1290409         | 30.6                       | 416.9                                     |
| 0403                         | 385127         | 1290522         | 29.8                       | 417.7                                     |
| 0410                         | 384961         | 1290634         | 28.1                       | 419.4                                     |
| 0413                         | 384819         | 1290765         | 25.2                       | 422.3                                     |
| 0420                         | 384645         | 1290876         | 26.5                       | 421.0                                     |
| 0423                         | 384499         | 1291021         | 22.9                       | 424.6                                     |
| 0430                         | 384319         | 1291129         | 20.4                       | 427.1                                     |
| 0433                         | 384162         | 1291259         | 21.5                       | 426.0                                     |
| 0440                         | 383992         | 1291380         | 20.4                       | 427.1                                     |
| <b>Survey Line #35</b>       |                |                 |                            |   |
| 0443                         | 385643         | 1290272         | 34.2                       | 413.3                                     |
| 0450                         | 385443         | 1290364         | 31.6                       | 415.9                                     |
| 0453                         | 385282         | 1290501         | 30.7                       | 416.8                                     |
| 0460                         | 385112         | 1290632         | 30.4                       | 417.1                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #35 cont.</b> |                |                 |                            |   |
| 0463                         | 384942         | 1290765         | 24.1                       | 423.4                                     |
| 0470                         | 384790         | 1290902         | 25.9                       | 421.6                                     |
| 0473                         | 384614         | 1291022         | 24.8                       | 422.7                                     |
| 0480                         | 384452         | 1291164         | 21.7                       | 425.8                                     |
| 0483                         | 384274         | 1291283         | 23.0                       | 424.5                                     |
| 0490                         | 384122         | 1291431         | 23.7                       | 423.8                                     |
| <b>Survey Line #36</b>       |                |                 |                            |   |
| 0503                         | 385631         | 1290380         | 35.1                       | 412.4                                     |
| 0510                         | 385435         | 1290482         | 33.9                       | 413.6                                     |
| 0513                         | 385283         | 1290642         | 28.4                       | 419.1                                     |
| 0520                         | 385098         | 1290766         | 28.3                       | 419.2                                     |
| 0523                         | 384930         | 1290909         | 26.9                       | 420.6                                     |
| 0530                         | 384758         | 1291049         | 24.2                       | 423.3                                     |
| 0533                         | 384582         | 1291189         | 23.4                       | 424.1                                     |
| 0540                         | 384399         | 1291320         | 24.7                       | 422.8                                     |
| 0553                         | 384309         | 1291397         | 25.2                       | 422.3                                     |
| 0560                         | 384133         | 1291542         | 24.2                       | 423.3                                     |
| <b>Survey Line #37</b>       |                |                 |                            |   |
| 0570                         | 385605         | 1290487         | 35.2                       | 412.3                                     |
| 0573                         | 385442         | 1290625         | 31.4                       | 416.1                                     |
| 0580                         | 385279         | 1290762         | 28.1                       | 419.4                                     |
| 0583                         | 385107         | 1290895         | 28.2                       | 419.3                                     |
| 0590                         | 384941         | 1291040         | 27.0                       | 420.5                                     |
| 0593                         | 384756         | 1291159         | 26.1                       | 421.4                                     |
| 0600                         | 384593         | 1291319         | 24.9                       | 422.6                                     |
| 0603                         | 384395         | 1291438         | 23.0                       | 424.5                                     |
| 0610                         | 384228         | 1291600         | 27.2                       | 420.3                                     |
| <b>Survey Line #38</b>       |                |                 |                            |   |
| 0620                         | 385657         | 1290548         | 31.3                       | 416.2                                     |
| 0623                         | 385520         | 1290701         | 31.1                       | 416.4                                     |
| 0630                         | 385350         | 1290823         | 29.1                       | 418.4                                     |
| 0633                         | 385185         | 1290966         | 28.2                       | 419.3                                     |
| 0640                         | 385013         | 1291098         | 23.4                       | 424.1                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>                 | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line # 38 cont.</b> |                |                 |                            |   |
| 0643                          | 384822         | 1291231         | 23.9                       | 423.6                                     |
| 0650                          | 384667         | 1291386         | 24.2                       | 423.3                                     |
| 0653                          | 384484         | 1291513         | 25.8                       | 421.7                                     |
| 0660                          | 384314         | 1291658         | 28.1                       | 419.4                                     |
| <b>Survey Line #39</b>        |                |                 |                            |   |
| 0670                          | 385714         | 1290668         | 28.9                       | 418.6                                     |
| 0673                          | 385548         | 1290790         | 31.9                       | 415.6                                     |
| 0680                          | 385396         | 1290938         | 29.2                       | 418.3                                     |
| 0683                          | 385217         | 1291043         | 26.9                       | 420.6                                     |
| 0690                          | 385071         | 1291185         | 26.6                       | 420.9                                     |
| 0693                          | 384897         | 1291300         | 24.8                       | 422.7                                     |
| 0700                          | 384741         | 1291444         | 25.3                       | 422.2                                     |
| 0703                          | 384569         | 1291582         | 26.2                       | 421.3                                     |
| 0710                          | 384390         | 1291720         | 28.6                       | 418.9                                     |
| 0713                          | 384201         | 1291849         | 28.2                       | 419.3                                     |
| <b>Survey Line #40</b>        |                |                 |                            |   |
| 0720                          | 385751         | 1290717         | 29.5                       | 418.0                                     |
| 0723                          | 385607         | 1290878         | 30.1                       | 417.4                                     |
| 0730                          | 385427         | 1291021         | 29.8                       | 417.7                                     |
| 0733                          | 385250         | 1291166         | 28.1                       | 419.4                                     |
| 0740                          | 385063         | 1291303         | 27.1                       | 420.4                                     |
| 0743                          | 384889         | 1291450         | 26.2                       | 421.3                                     |
| 0750                          | 384709         | 1291592         | 26.4                       | 421.1                                     |
| 0753                          | 384526         | 1291734         | 27.0                       | 420.5                                     |
| 0760                          | 384350         | 1291879         | 24.2                       | 423.3                                     |
| <b>Survey Line #41</b>        |                |                 |                            |   |
| 0763                          | 385964         | 1290744         | 33.4                       | 414.1                                     |
| 0770                          | 385771         | 1290906         | 30.7                       | 416.8                                     |
| 0773                          | 385545         | 1291036         | 28.9                       | 418.6                                     |
| 0780                          | 385352         | 1291212         | 29.5                       | 418.0                                     |
| 0783                          | 385154         | 1291363         | 26.4                       | 421.1                                     |
| 0790                          | 384965         | 1291526         | 25.7                       | 421.8                                     |
| 0793                          | 384765         | 1291663         | 24.3                       | 423.2                                     |
| 0800                          | 384583         | 1291821         | 23.8                       | 423.7                                     |
| 0803                          | 384394         | 1291982         | 21.9                       | 425.6                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 40 E  
 Survey Date/Time : 21 July 1994, 1628 to 1720 hours  
 Acoustic Source : 'Pinger' System operating at 3.5 kHz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #76</b> |                |                 |                            |   |
| 0820                   | 383331         | 1290729         | 19.5                       | 428.0                                     |
| 0823                   | 383515         | 1290928         | 23.4                       | 424.1                                     |
| 0830                   | 383737         | 1291223         | 19.9                       | 427.6                                     |
| 0833                   | 383986         | 1291494         | 25.8                       | 421.7                                     |
| 0840                   | 384192         | 1291785         | 27.7                       | 419.8                                     |
| 0843                   | 384437         | 1292073         | 16.7                       | 430.8                                     |
| <b>Survey Line #75</b> |                |                 |                            |   |
| 0850                   | 383753         | 1290619         | 19.0                       | 428.5                                     |
| 0853                   | 383953         | 1290872         | 21.8                       | 425.7                                     |
| 0860                   | 384165         | 1291120         | 19.4                       | 428.1                                     |
| 0863                   | 384354         | 1291359         | 24.5                       | 423.0                                     |
| 0870                   | 384551         | 1291602         | 25.4                       | 422.1                                     |
| 0873                   | 384749         | 1291847         | 19.1                       | 428.4                                     |
| <b>Survey Line #73</b> |                |                 |                            |   |
| 0920                   | 384171         | 1290506         | 18.8                       | 428.7                                     |
| 0923                   | 384377         | 1290766         | 23.8                       | 423.7                                     |
| 0930                   | 384570         | 1291003         | 25.2                       | 422.3                                     |
| 0933                   | 384768         | 1291253         | 24.6                       | 422.9                                     |
| 0940                   | 384972         | 1291493         | 24.5                       | 423.0                                     |
| 0943                   | 385164         | 1291732         | --                         | ---                                       |
| <b>Survey Line #72</b> |                |                 |                            |   |
| 0880                   | 384223         | 1290447         | 18.4                       | 429.1                                     |
| 0883                   | 384022         | 1290347         | 19.4                       | 428.1                                     |
| 0890                   | 383785         | 1290386         | 17.1                       | 430.4                                     |
| 0893                   | 383524         | 1290446         | --                         | ---                                       |
| 0900                   | 383218         | 1290532         | --                         | ---                                       |
| <b>Survey Line #70</b> |                |                 |                            |   |
| 0950                   | 384938         | 1290246         | 28.5                       | 419.0                                     |
| 0953                   | 385200         | 1290488         | 30.8                       | 416.7                                     |
| 0960                   | 385384         | 1290740         | 31.7                       | 415.8                                     |
| 0963                   | 385586         | 1290984         | 26.4                       | 421.1                                     |
| 0970                   | 385760         | 1291234         | --                         | ---                                       |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 75 W  
Survey Date/Time : 21 July 1994, 1645 hours

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #69</b> |                |                 |                            |   |
| 0973                   | 385060         | 1290113         | 31.0                       | 416.5                                     |
| 0980                   | 385300         | 1290310         | 30.4                       | 417.1                                     |
| 0983                   | 385487         | 1290536         | 31.7                       | 415.8                                     |
| 0990                   | 385691         | 1290760         | 29.6                       | 417.9                                     |
| 0993                   | 385843         | 1290994         | --                         | ---                                       |

# **Appendix F**

## **Lock and Dam 24 Positioning Information for the 'Boomer' Data**

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**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 0934 to 1241 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #1</b> |                |                 |                            |   |
| 0563                  | 386938         | 1287526         | 14.4                       | 426.6                                     |
| 0570                  | 386678         | 1287798         | 12.8                       | 428.2                                     |
| 0573                  | 386431         | 1288068         | 12.0                       | 429.0                                     |
| <b>Survey Line #2</b> |                |                 |                            |   |
| 0583                  | 387197         | 1287569         | 19.8                       | 421.2                                     |
| 0590                  | 387016         | 1287716         | 17.3                       | 423.7                                     |
| 0593                  | 386862         | 1287856         | 18.0                       | 423.0                                     |
| 0600                  | 386675         | 1288006         | 20.1                       | 420.9                                     |
| 0603                  | 386533         | 1288128         | 14.0                       | 427.0                                     |
| 0610                  | 386406         | 1288232         | 13.3                       | 427.7                                     |
| 0613                  | 386275         | 1288338         | 12.3                       | 428.7                                     |
| 0620                  | 386116         | 1288457         | 12.8                       | 428.2                                     |
| <b>Survey Line #3</b> |                |                 |                            |   |
| 0623                  | 387500         | 1287415         | 21.3                       | 419.7                                     |
| 0630                  | 387387         | 1287536         | 21.3                       | 419.7                                     |
| 0633                  | 387251         | 1287655         | 19.6                       | 421.4                                     |
| 0640                  | 387120         | 1287760         | 20.1                       | 420.9                                     |
| 0643                  | 386983         | 1287873         | 19.5                       | 421.5                                     |
| 0650                  | 386856         | 1287982         | 18.4                       | 422.6                                     |
| 0653                  | 386725         | 1288077         | 17.1                       | 423.9                                     |
| 0660                  | 386600         | 1288186         | 18.1                       | 422.9                                     |
| 0663                  | 386463         | 1288300         | 17.0                       | 424.0                                     |
| 0670                  | 386338         | 1288399         | 17.8                       | 423.2                                     |
| 0673                  | 386218         | 1288501         | 16.3                       | 424.7                                     |
| 0680                  | 386082         | 1288608         | 18.4                       | 422.6                                     |
| <b>Survey Line #4</b> |                |                 |                            |   |
| 0683                  | 387499         | 1287584         | 21.1                       | 419.9                                     |
| 0690                  | 387243         | 1287798         | 20.1                       | 420.9                                     |
| 0693                  | 386962         | 1288027         | 20.2                       | 420.8                                     |
| 0700                  | 386682         | 1288248         | 21.2                       | 419.8                                     |
| 0703                  | 386424         | 1288459         | 18.3                       | 422.7                                     |
| 0710                  | 386171         | 1288671         | 20.2                       | 420.8                                     |
| 0713                  | 385922         | 1288865         | 20.0                       | 421.0                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 20 July 1994, 1420 to 1617 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>         | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #5</b> |                |                 |                            |   |
| 0000                  | 387495         | 1287708         | --                         | ---                                       |
| 0003                  | 387171         | 1287980         | 23.1                       | 417.9                                     |
| 0010                  | 386818         | 1288272         | 22.1                       | 418.9                                     |
| 0013                  | 386462         | 1288556         | 20.8                       | 420.2                                     |
| 0020                  | 386032         | 1288912         | 18.4                       | 422.6                                     |
| 0023                  | 385477         | 1289362         | 10.3                       | 430.7                                     |
| <b>Survey Line #6</b> |                |                 |                            |   |
| 0030                  | 387788         | 1287605         | 22.6                       | 418.4                                     |
| 0033                  | 387442         | 1287887         | 22.2                       | 418.8                                     |
| 0040                  | 387120         | 1288162         | 22.4                       | 418.6                                     |
| 0043                  | 386757         | 1288448         | 18.3                       | 422.7                                     |
| 0050                  | 386400         | 1288739         | 20.5                       | 420.5                                     |
| 0053                  | 386039         | 1289033         | 21.2                       | 419.8                                     |
| 0060                  | 385564         | 1289414         | 28.0                       | 413.0                                     |
| <b>Survey Line #7</b> |                |                 |                            |   |
| 0070                  | 387604         | 1287888         | 21.7                       | 419.3                                     |
| 0073                  | 387327         | 1288114         | 21.7                       | 419.3                                     |
| 0080                  | 387047         | 1288334         | 24.0                       | 417.0                                     |
| 0083                  | 386761         | 1288574         | 21.4                       | 419.6                                     |
| 0090                  | 386456         | 1288827         | 24.3                       | 416.7                                     |
| 0093                  | 386158         | 1289082         | 22.9                       | 418.1                                     |
| 0100                  | 385814         | 1289359         | 37.0                       | 404.0                                     |
| <b>Survey Line #8</b> |                |                 |                            |   |
| 0110                  | 387635         | 1287985         | 21.8                       | 419.2                                     |
| 0113                  | 387364         | 1288202         | 19.4                       | 421.6                                     |
| 0120                  | 387074         | 1288447         | 28.3                       | 412.7                                     |
| 0123                  | 386753         | 1288710         | 24.9                       | 416.1                                     |
| 0130                  | 386450         | 1288963         | 25.4                       | 415.6                                     |
| 0133                  | 386081         | 1289249         | 27.0                       | 414.0                                     |
| 0140                  | 385589         | 1289646         | 36.5                       | 404.5                                     |
| <b>Survey Line #9</b> |                |                 |                            |   |
| 0143                  | 387884         | 1287927         | 23.9                       | 417.1                                     |
| 0150                  | 387622         | 1288131         | 22.3                       | 418.7                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 20 July 1994, 1420 to 1617 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>               | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|-----------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #9 cont.</b> |                |                 |                            |   |
| 0153                        | 387379         | 1288327         | 21.4                       | 419.6                                     |
| 0160                        | 387130         | 1288536         | 29.5                       | 411.5                                     |
| 0163                        | 386827         | 1288778         | 30.2                       | 410.8                                     |
| 0170                        | 386526         | 1289026         | 28.6                       | 412.4                                     |
| 0173                        | 386232         | 1289270         | 27.3                       | 413.7                                     |
| 0180                        | 385761         | 1289620         | 44.8                       | 396.2                                     |
| <b>Survey Line #10</b>      |                |                 |                            |   |
| 0183                        | 387889         | 1288042         | 24.8                       | 416.2                                     |
| 0190                        | 387593         | 1288278         | 22.9                       | 418.1                                     |
| 0193                        | 387352         | 1288484         | 21.0                       | 420.0                                     |
| 0200                        | 387107         | 1288672         | 27.0                       | 414.0                                     |
| 0203                        | 386843         | 1288882         | 28.4                       | 412.6                                     |
| 0210                        | 386527         | 1289154         | 31.2                       | 409.8                                     |
| 0213                        | 386176         | 1289438         | 31.1                       | 409.9                                     |
| 0220                        | 385729         | 1289766         | 42.6                       | 398.4                                     |
| <b>Survey Line #11</b>      |                |                 |                            |   |
| 0223                        | 387830         | 1288216         | 26.6                       | 414.4                                     |
| 0230                        | 387488         | 1288490         | 22.9                       | 418.1                                     |
| 0233                        | 387226         | 1288711         | 21.1                       | 419.9                                     |
| 0240                        | 386948         | 1288919         | 30.3                       | 410.7                                     |
| 0243                        | 386678         | 1289140         | 31.1                       | 409.9                                     |
| 0250                        | 386340         | 1289416         | 29.0                       | 412.0                                     |
| 0253                        | 385988         | 1289742         | 37.8                       | 403.2                                     |
| <b>Survey Line #12</b>      |                |                 |                            |   |
| 0263                        | 387865         | 1288302         | 19.4                       | 421.6                                     |
| 0270                        | 387508         | 1288605         | 15.7                       | 425.3                                     |
| 0273                        | 387284         | 1288797         | 13.1                       | 427.9                                     |
| 0280                        | 387070         | 1288974         | 15.7                       | 425.3                                     |
| 0283                        | 386822         | 1289172         | 24.3                       | 416.7                                     |
| 0290                        | 386592         | 1289356         | 32.8                       | 408.2                                     |
| 0293                        | 386289         | 1289612         | 30.0                       | 411.0                                     |
| 0300                        | 385812         | 1289950         | 33.3                       | 407.7                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
Survey Date/Time : 21 July 1994, 0934 to 1241 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>                                 | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|---|----------------|-----------------|----------------------------|---|
| <b>Survey Line #15</b>                        |                |                 |                            |   |
| 0480  | 387137         | 1289084         | 10.7                       | 430.3                                     |
| 0483  | 386758         | 1289353         | 29.6                       | 411.4                                     |
| 0490  | 386352         | 1289675         | 28.4                       | 412.6                                     |
| 0493  | 385925         | 1290046         | 35.7                       | 405.3                                     |
| <b>Survey Line #16</b>                        |                |                 |                            |   |
| 0500  | 386998         | 1289369         | --                         | ---                                       |
| 0503  | 386574         | 1289608         | 32.9                       | 408.1                                     |
| 0510  | 386187         | 1289934         | 36.1                       | 404.9                                     |
| <b>Survey Line #17</b>                        |                |                 |                            |   |
| 0523  | 386136         | 1290109         | 38.4                       | 402.6                                     |
| <b>Survey Line #18</b>                        |                |                 |                            |   |
| 0530  | 38664          | 1289911         | 32.9                       | 408.1                                     |
| 0533  | 386231         | 1290130         | 40.4                       | 400.6                                     |
| <b>Survey Line #19</b>                        |                |                 |                            |   |
| 0550  | 386417         | 1290273         | 56.9                       | 384.1                                     |
| <b>Survey Line #20</b>                        |                |                 |                            |   |
| 0543  | 386140         | 1290409         | 24.8                       | 416.2                                     |
| <b>Survey Line #21</b>                        |                |                 |                            |   |
| No Positioning or Depth Information Available |                |                 |                            |   |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 40 E  
 Survey Date/Time : 20 July 1994, 1658 to 1804 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #56</b> |                |                 |                            |   |
| 0350                   | 387947         | 1288366         | 18.5                       | 422.5                                     |
| 0353                   | 387615         | 1287955         | 19.0                       | 422.0                                     |
| 0360                   | 387277         | 1287584         | 16.9                       | 424.1                                     |
| <b>Survey Line #57</b> |                |                 |                            |   |
| 0323                   | 387278         | 1287824         | 23.2                       | 417.8                                     |
| 0330                   | 387439         | 1288048         | 20.9                       | 420.1                                     |
| 0333                   | 387599         | 1288276         | 25.3                       | 415.7                                     |
| 0340                   | 387792         | 1288546         | 19.7                       | 421.3                                     |
| 0343                   | 388072         | 1288781         | --                         | ---                                       |
| <b>Survey Line #58</b> |                |                 |                            |   |
| 0370                   | 386975         | 1288091         | 20.0                       | 421.0                                     |
| 0373                   | 387242         | 1288395         | 21.1                       | 419.9                                     |
| 0380                   | 387487         | 1288721         | 15.1                       | 425.9                                     |
| 0383                   | 387812         | 1289067         | 17.7                       | 423.3                                     |
| <b>Survey Line #59</b> |                |                 |                            |   |
| 0390                   | 386656         | 1288108         | 18.6                       | 422.4                                     |
| 0393                   | 386974         | 1288441         | 26.2                       | 414.8                                     |
| 0400                   | 387258         | 1288783         | 12.3                       | 428.7                                     |
| <b>Survey Line #60</b> |                |                 |                            |   |
| 0403                   | 386426         | 1288371         | 17.3                       | 423.7                                     |
| 0410                   | 386697         | 1288724         | 22.6                       | 418.4                                     |
| 0413                   | 386971         | 1289061         | 17.1                       | 423.9                                     |
| <b>Survey Line #61</b> |                |                 |                            |   |
| 0420                   | 386240         | 1288793         | 17.7                       | 423.3                                     |
| 0423                   | 386531         | 1289144         | 27.5                       | 413.5                                     |
| 0430                   | 386824         | 1289495         | 12.8                       | 428.2                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 40 E  
Survey Date/Time : 20 July 1994, 1658 to 1804 hours  
Acoustic Source : 'Boomer' System operating at 500-2000  
Hertz

Water Level Elevation : 441.0 ft MSL (Below the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #62</b> |                |                 |                            |   |
| 0433                   | 385948         | 1289060         | 20.1                       | 420.9                                     |
| 0440                   | 386237         | 1289418         | 26.5                       | 414.5                                     |
| 0443                   | 386521         | 1289814         | 31.9                       | 409.1                                     |
| 0450                   | 386907         | 1290234         | 9.1                        | 431.9                                     |
| <b>Survey Line #63</b> |                |                 |                            |   |
| 0453                   | 385738         | 1289401         | 36.5                       | 404.5                                     |
| 0460                   | 386021         | 1289797         | 37.9                       | 403.1                                     |
| 0463                   | 386348         | 1290200         | 53.2                       | 387.8                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #26</b> |                |                 |                            |   |
| 0000                   | 384727         | 1289820         | 19.6                       | 427.9                                     |
| 0003                   | 384398         | 1290045         | 18.5                       | 429.0                                     |
| 0010                   | 384133         | 1290252         | 18.9                       | 428.6                                     |
| 0013                   | 383876         | 1290453         | 19.7                       | 427.8                                     |
| 0020                   | 383605         | 1290672         | 16.9                       | 430.6                                     |
| <b>Survey Line #27</b> |                |                 |                            |   |
| 0030                   | 384575         | 1290047         | 17.9                       | 429.6                                     |
| 0033                   | 384267         | 1290277         | 19.5                       | 428.0                                     |
| 0040                   | 383956         | 1290528         | 18.7                       | 428.8                                     |
| 0043                   | 383646         | 1290782         | 20.8                       | 426.7                                     |
| <b>Survey Line #28</b> |                |                 |                            |   |
| 0050                   | 384706         | 1290107         | 18.3                       | 429.2                                     |
| 0053                   | 384397         | 1290336         | 16.8                       | 430.7                                     |
| 0060                   | 384092         | 1290549         | 19.9                       | 427.6                                     |
| 0063                   | 383791         | 1290785         | 22.5                       | 425.0                                     |
| 0070                   | 383555         | 1291034         | 21.7                       | 425.8                                     |
| <b>Survey Line #29</b> |                |                 |                            |   |
| 0073                   | 384956         | 1290026         | 28.9                       | 418.6                                     |
| 0080                   | 384630         | 1290259         | 16.0                       | 431.5                                     |
| 0083                   | 384301         | 1290506         | 19.9                       | 427.6                                     |
| 0090                   | 384002         | 1290750         | 21.6                       | 425.9                                     |
| 0093                   | 383690         | 1291000         | 21.8                       | 425.7                                     |
| <b>Survey Line #30</b> |                |                 |                            |   |
| 0100                   | 385217         | 1289959         | 38.5                       | 409.0                                     |
| 0103                   | 384918         | 1290162         | 27.4                       | 420.1                                     |
| 0110                   | 384615         | 1290390         | 22.4                       | 425.1                                     |
| 0113                   | 384323         | 1290629         | 22.4                       | 425.1                                     |
| 0120                   | 384015         | 1290873         | 21.5                       | 426.0                                     |
| 0123                   | 383691         | 1291123         | 20.7                       | 426.8                                     |
| <b>Survey Line #31</b> |                |                 |                            |   |
| 0130                   | 385187         | 1290069         | 33.8                       | 413.7                                     |
| 0133                   | 384891         | 1290276         | 27.5                       | 420.0                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction: N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #31 cont.</b> |                |                 |                            |   |
| 0290                         | 384857         | 1290968         | 26.3                       | 421.2                                     |
| 0140                         | 384596         | 1290522         | 23.9                       | 423.6                                     |
| 0143                         | 384295         | 1290772         | 22.1                       | 425.4                                     |
| 0150                         | 383975         | 1291016         | 21.4                       | 426.1                                     |
| <b>Survey Line #32</b>       |                |                 |                            |   |
| 0160                         | 385112         | 1290242         | 28.9                       | 418.6                                     |
| 0163                         | 384812         | 1290490         | 26.3                       | 421.2                                     |
| 0170                         | 384511         | 1290736         | 24.6                       | 422.9                                     |
| 0173                         | 384195         | 1290971         | 22.2                       | 425.3                                     |
| 0180                         | 383890         | 1291238         | 20.3                       | 427.2                                     |
| <b>Survey Line #33</b>       |                |                 |                            |   |
| 0183                         | 384819         | 1290218         | 26.6                       | 420.9                                     |
| 0190                         | 385385         | 1289922         | 37.6                       | 409.9                                     |
| 0193                         | 385326         | 1290188         | 29.9                       | 417.6                                     |
| 0200                         | 385031         | 1290432         | 29.2                       | 418.3                                     |
| 0203                         | 384726         | 1290682         | 25.7                       | 421.8                                     |
| 0210                         | 384410         | 1290923         | 22.2                       | 425.3                                     |
| 0213                         | 384103         | 1291174         | 18.8                       | 428.7                                     |
| <b>Survey Line #34</b>       |                |                 |                            |   |
| 0223                         | 385269         | 1290440         | 30.5                       | 417.0                                     |
| 0230                         | 384955         | 1290644         | 27.7                       | 419.8                                     |
| 0233                         | 384660         | 1290865         | 26.3                       | 421.2                                     |
| 0240                         | 384357         | 1291098         | 24.2                       | 423.3                                     |
| 0243                         | 384052         | 1291330         | 21.2                       | 426.3                                     |
| <b>Survey Line #35</b>       |                |                 |                            |   |
| 0250                         | 385505         | 1290341         | 33.6                       | 413.9                                     |
| 0253                         | 385187         | 1290579         | 31.5                       | 416.0                                     |
| 0260                         | 384880         | 1290825         | 24.6                       | 422.9                                     |
| 0263                         | 384568         | 1291064         | 23.6                       | 423.9                                     |
| 0270                         | 384250         | 1291300         | 23.0                       | 424.5                                     |
| <b>Survey Line #36</b>       |                |                 |                            |   |
| 0280                         | 385482         | 1290439         | 34.3                       | 413.2                                     |
| 0283                         | 385177         | 1290714         | 27.9                       | 419.6                                     |
| 0290                         | 384857         | 1290968         | 26.3                       | 421.2                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction: N 50 W (Upstream)  
 Survey Date/Time : 21 July 1994, 1312 to 1610 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>                | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #36 cont.</b> |                |                 |                            |   |
| 0293                         | 384528         | 1291225         | 23.2                       | 424.3                                     |
| 0300                         | 384560         | 1291214         | 23.3                       | 424.2                                     |
| 0303                         | 384221         | 1291478         | 24.4                       | 423.1                                     |
| <b>Survey Line #37</b>       |                |                 |                            |   |
| 0313                         | 385442         | 1290625         | 31.4                       | 416.1                                     |
| 0320                         | 385130         | 1290875         | 28.1                       | 419.4                                     |
| 0323                         | 384806         | 1291121         | 25.9                       | 421.6                                     |
| 0330                         | 384481         | 1291389         | 24.6                       | 422.9                                     |
| 0333                         | 384148         | 1291659         | 28.2                       | 419.3                                     |
| <b>Survey Line #38</b>       |                |                 |                            |   |
| 0340                         | 385623         | 1290596         | 30.1                       | 417.4                                     |
| 0343                         | 385322         | 1290844         | 29.3                       | 418.2                                     |
| 0350                         | 385013         | 1291098         | 23.4                       | 424.1                                     |
| 0353                         | 384704         | 1291366         | 24.2                       | 423.3                                     |
| 0360                         | 384370         | 1291608         | 26.5                       | 421.0                                     |
| <b>Survey Line #39</b>       |                |                 |                            |   |
| 0370                         | 385490         | 1290836         | 29.5                       | 418.0                                     |
| 0373                         | 385192         | 1291072         | 27.1                       | 420.4                                     |
| 0380                         | 384889         | 1291307         | 24.8                       | 422.7                                     |
| 0383                         | 384584         | 1291568         | 26.1                       | 421.4                                     |
| 0390                         | 384246         | 1291820         | 27.4                       | 420.1                                     |
| <b>Survey Line #40</b>       |                |                 |                            |   |
| 0393                         | 385687         | 1290841         | 28.9                       | 418.6                                     |
| 0400                         | 385343         | 1291095         | 29.7                       | 417.8                                     |
| 0403                         | 385008         | 1291356         | 27.2                       | 420.3                                     |
| 0410                         | 384677         | 1291620         | 25.9                       | 421.6                                     |
| 0413                         | 384341         | 1291889         | 24.5                       | 423.0                                     |
| <b>Survey Line #41</b>       |                |                 |                            |   |
| 0420                         | 385780         | 1290898         | 30.5                       | 417.0                                     |
| 0423                         | 385399         | 1291175         | 28.1                       | 419.4                                     |
| 0430                         | 385047         | 1291469         | 25.3                       | 422.2                                     |
| 0433                         | 384697         | 1291732         | 24.6                       | 422.9                                     |
| 0440                         | 384342         | 1292021         | 21.9                       | 425.6                                     |

**Lock and Dam 24  
Upper Mississippi River**

Survey Direction : N 40 E  
 Survey Date/Time : 21 July 1994, 1628 to 1720 hours  
 Acoustic Source : 'Boomer' System operating at 500-2000  
 Hertz

Water Level Elevation : 447.5 ft MSL (Above the Dam)

| <u>File #</u>          | <u>Easting</u> | <u>Northing</u> | <u>Water<br/>Depth, ft</u> | <u>River Bottom<br/>Elevation, ft MSL</u> |
|------------------------|----------------|-----------------|----------------------------|---|
| <b>Survey Line #76</b> |                |                 |                            |   |
| 0453                   | 383789         | 1291291         | 19.9                       | 427.6                                     |
| 0460                   | 384212         | 1291814         | 27.1                       | 420.4                                     |
| <b>Survey Line #75</b> |                |                 |                            |   |
| 0470                   | 384148         | 1291096         | 19.3                       | 428.2                                     |
| 0473                   | 384497         | 1291546         | 26.7                       | 420.8                                     |
| 0480                   | 384870         | 1291993         | --                         | ---                                       |
| <b>Survey Line #73</b> |                |                 |                            |   |
| 0503                   | 384217         | 1290567         | 20.2                       | 427.3                                     |
| 0510                   | 384581         | 1291012         | 24.9                       | 422.6                                     |
| 0513                   | 384920         | 1291442         | 26.2                       | 421.3                                     |
| <b>Survey Line #72</b> |                |                 |                            |   |
| 0483                   | 383998         | 1290350         | 19.4                       | 428.1                                     |
| 0490                   | 383537         | 1290443         | --                         | ---                                       |
| <b>Survey Line #70</b> |                |                 |                            |   |
| 0523                   | 385287         | 1290602         | 29.9                       | 417.6                                     |
| 0530                   | 385621         | 1291041         | 25.7                       | 421.8                                     |
| <b>Survey Line #69</b> |                |                 |                            |   |
| 0533                   | 385142         | 1290173         | 29.6                       | 417.9                                     |
| 0540                   | 385509         | 1290568         | 31.0                       | 416.5                                     |
| 0543                   | 385823         | 1290976         | --                         | ---                                       |