FINAL REPORT

SUBSURFACE INVESTIGATION

PETTIT FLUME INLET &

LITTLE NIAGARA RIVER

NORTH TONAWANDA, NEW YORK

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20 December 1988

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1.0 INTRODUCTION

During the period of November 8-12 1988, Ocean Surveys (OSI) conducted a subsurface investigation in the vicinity of the Pettit Creek Flume Inlet (Figure 1) in support of remedial investigations being performed by Dunn Geoscience Corporation (DGC). OSI was assisted in these investigations by two subcontractors, Allen Marine Services (diving) and Margus Co. (pipeline location) and by our client, DGC (survey control and site specific health and safety planning and procedures).

The Pettit Creek Flume discharges water from the City of North Tonawanda storm water system into a small "Inlet" adjacent to the Lockport Pump Station and the Little Niagara River in North Tonawanda, NY. A municipal water supply intake pipe (Lockport Water Line, LWL) drawing water from the Niagara River is buried beneath the Little Niagara River and the Inlet immediately west of the Lockport Pump Station.

The subsurface investigations were designed to meet the following objectives relative to the Inlet, the LWL and the Little Niagara River:

1. Precisely locate the position of the LWL both vertically and horizontally from the Lockport Pump Station west approximately 600 feet below the Inlet and the Little Niagara River.

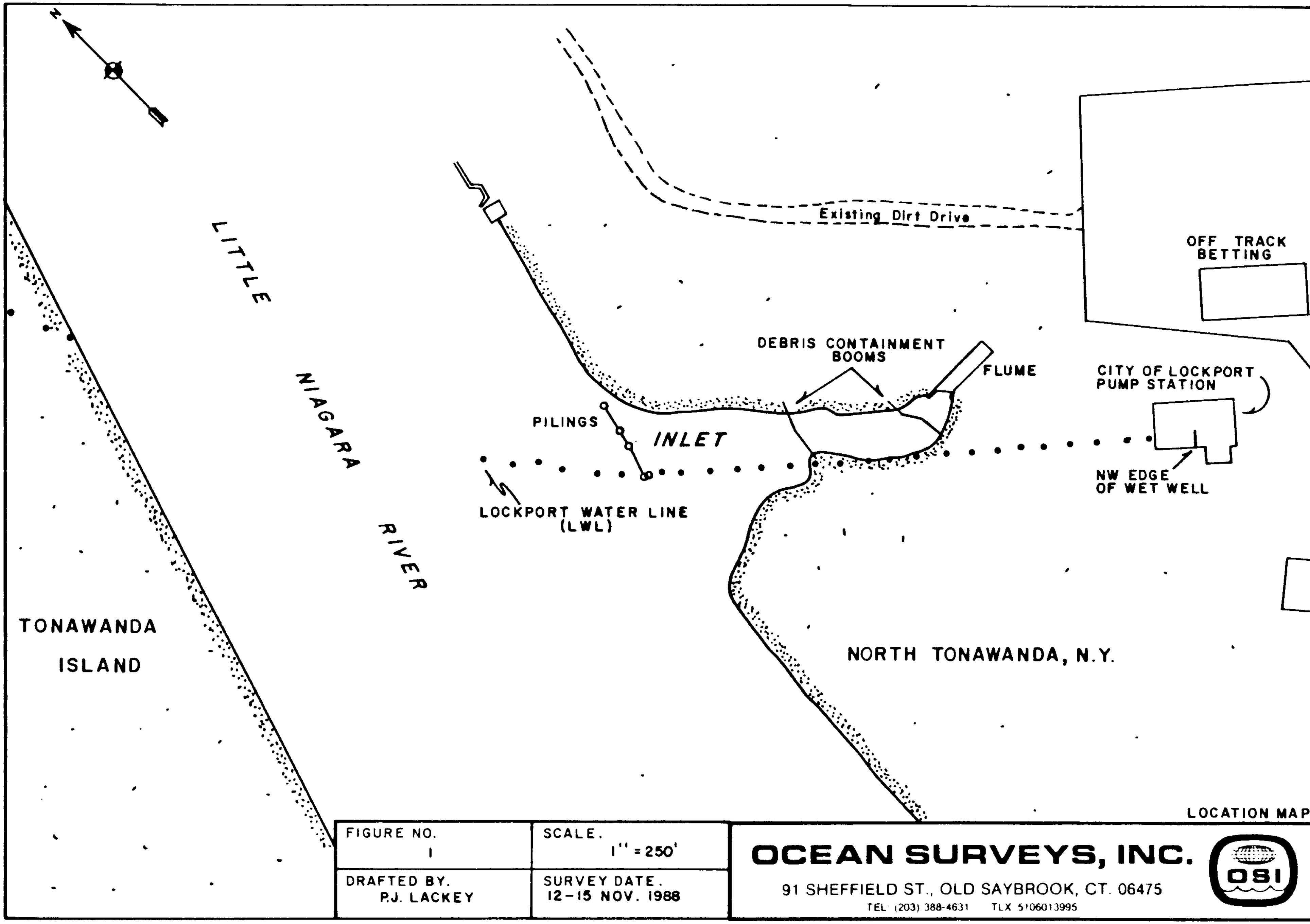


FIGURE NO. 1	SCALE. 1'' = 250'	**OCEAN SURVEYS, INC.** 91 SHEFFIELD ST., OLD SAYBROOK, CT. 06475 TEL (203) 388-4631 TLX 5106013995
DRAFTED BY. P.J. LACKEY	SURVEY DATE. 12-15 NOV. 1988	

2. Map the bottom topography of the Inlet and the Little Niagara River adjacent to the Inlet

3. Determine the stratigraphy of the near-surface sediments in the Inlet and Little Niagara River

The data needed to meet these objectives were acquired utilizing remote sensing techniques so as to leave the Inlet sediments undisturbed. Due to the potential site hazards, all survey personnel were apprised of and all work was performed in accordance with a Health and Safety Plan prepared by DGC.

The location of the LWL is presented on an OSI plan and profile drawing (#88ES114) at a 1"=20' horizontal scale and 1"=2' vertical scale. Horizontal accuracy is believed to be between 0.7-0.9 feet and 3.5 feet with vertical accuracy ±0.2 feet. (Section 3.1 discusses accuracies of the remote sensing techniques in greater detail.)

Elevations of the river and Inlet bottom are presented on the above mentioned plan and profile and as a revision to the DGC site base map (Drawing #M8044B) at a scale of 1"=50'. Elevations are contoured at two-foot intervals and are believed accurate to ±0.5 feet.

Sediment stratigraphy is presented in Appendix II of this report as a series of profiles depicting the river bottom and near subsurface acoustic reflectors. These profiles are drafted at a horizontal scale of 1"=50' and vertical scale of 1"=5' and represent reflector depths to an accuracy of ± 1.0 foot based on an assumed acoustic wave propagation velocity.

All objectives of this study were satisfied with the exception of limited acoustic profiling data in the Inlet.

An extremely low river level occurred on the final day of survey work severely limiting the area which could be profiled and reducing the quality of these data. Further discussion of these data appear in Section 4.0.

2.0 SURVEY EQUIPMENT AND PROCEDURES

2.1 Horizontal and Vertical Control and Survey Positioning

2.1.1 Horizontal Control

Horizontal control points for all aspects of these studies were established by DGC following selection by OSI. Various control points have been assigned coordinates in a local site grid for the purpose of this and future site work.

During acoustic profiling work the survey vessel was positioned utilizing a range-azimuth technique from control Point "F" located approximately 700 feet south of the study area on the northern-most fixed pier at the Smith Boys Marina on Tonawanda Island. One shore-reference station of a Cubic "Autotape" DM-40A and a Topcon DT 30 digital transit were set at Point "F." (Specification sheets for these instruments and other equipment used in this project are attached in Appendix I). The "Autotape" is comprised of one or more shore-reference responders and an on board interrogator unit. At one-second intervals the interrogator computes ranges by the phase comparison of microwave signals transmitted to and received from the responders. These ranges are displayed on the interrogator and may also be output to printers or data loggers. During this study the vessel was conned along a series of concentric arcs, which approximated cross river transects on the Little Niagara River, about Point "F." The position of the survey vessel along each transect was "fixed" by regularly recording transit angles referenced to Point "E" near the mouth of the Inlet.

During horizontal location of the LWL pipe within the Inlet, a series of ranges were created by setting parallel baselines along the north side of the Inlet. These ranges, marked at 20-foot intervals, were used to guide surveyors with the pipe locator sensor along lines perpendicular to the LWL alignment. At the point where sensor "contact" with the pipe was determined, DGC surveyors took a total station fix on a prism held at the sensor thereby establishing its precise position. A similar technique was utilized in the Little Niagara River where the survey boat was drifted in the current across the LWL. When pipe contact was determined, a total station fix was taken on a prism mounted on a mast directly above the pipe locator sensor. With surface conditions relatively flat and the drifting speed slowed with an upstream anchor, this technique worked well and provided greater accuracy than would have been attained using the "Autotape" and transit from Point "F" as had been originally planned.

2.1.2 Vertical Control

Vertical control was provided by DGC as an elevation on Point "B," a disc embedded in the top of the concrete structure forming the discharge flume at the head of the Inlet. In addition, the elevation of the top of a reinforcing rod ("stake") driven into the Inlet adjacent to the flume structure was provided, allowing direct measurement to the Inlet and River water levels.

During survey operations in the Little Niagara River, OSI maintained a Sea Data TDR-3A temperature and depth recorder. This instrument was used to record river stage allowing data processors to correct soundings to the Mean Sea Level (MSL) datum used for all measurements. During installation and recovery of the Sea Data TDR-3A, simultaneous water level measurements were made at a temporary benchmark (TBM) scribed on the piling on which the TDR was installed and at the "stake" in the Inlet. These measurements were used to transfer the MSL elevation from the stake to the depth recorder. During deployment of the depth recorder and other observations of river stage made during this project, river levels varied from 566.8 feet to 564.3 feet NGVD.

2.2 Horizontal Location of the LWL

Special pipe/cable locating equipment was provided for this project by Margus Co. The technique involves inducing a tone onto the pipe/cable being located and, using a highly sensitive search coil, locating the electromagnetic field generated around the pipe/cable. Because it was known that the original iron pipe was exposed to the soil thereby providing a ground for any signal impressed on the pipe, a signal wire had to be pulled through the LWL and used as the carrier for the induced tone. This was accomplished by having Allen Marine Services, a diving contractor from Orchard Park, NY, thread a 3/8" polypropylene line through the approximately 2,550-foot LWL prior to the arrival of the OSI survey team. This line was used to pull both the signal cable for horizontal LWL location and the depth sensor for vertical LWL location.

Once the signal wire had been pulled from the wet well inside the Lockport Pump Station to the intake crib in the Niagara River and grounded at the crib, an AC signal generator was connected to the wire in the Pump Station to induce a 200 kHz detectable tone. Two types of signal sensors were then utilized to locate the cable and thus the LWL pipe.

From the Pump Station building to the Inlet and aboard the boat in the Little Niagara River, a hand-held sensor was used. As the sensor is carried across the alignment of the pipe, a null is achieved when the sensor is directly over the pipe. A level is attached to the sensor to assure its plumb orientation. As described earlier, a position fix was taken at each null, nominally every 50 feet along the LWL alignment.

In the Inlet, a remote sensor, hard wired to a readout unit, was installed on a small disposable raft fabricated for this project. The raft was towed, by lines from opposite banks, across the LWL alignment until the proper null was achieved on the shore readout unit. Again, a prism attached to the raft was used to obtain the precise sensor position when the null was registered.

A total of 26 LWL positions were established at 20-foot intervals from the Pump Station building west 500 feet. Three additional LWL positions were taken on Tonawanda Island to confirm the pipe orientation beyond a turning point located at the mouth of the Inlet.

2.3 Vertical Location of the LWL

To establish the precise elevation of the top inside surface of the polyethylene liner in the LWL pipe, OSI utilized precision depth recorders, Sea Data Model TDR-3A. These instruments, which are normally used as tide gauges, measure total pressure to an accuracy which equates to 0.07 feet of water. With the pumps in the Lockport Pump Station shut down and the water levels within the pump station wet well allowed to equalize with the Niagara River level, measuring the static head inside the LWL will determine its elevation.

To make these measurements two (for redundancy) TDR-3As were installed inside a specially designed housing with a smoothly faired exterior to prevent hangups within the pipe. The housing is fabricated from 8 inch diameter PVC pipe. It is 6 feet long to hold the two 5.5 inch diameter 16 inch long TDR's and is made positively buoyant such that it will ride along the top inside of the pipe. The TDR's are positioned such that their depth sensor is located precisely in the center of the housing eliminating variations which would result from rotation of the housing during measurements. Once inserted into the pipe at the wet well wall (by Allen Marine Service divers) the housing was pulled 600 feet into the pipe using the line at the intake crib. A second line attached to the tail of the housing was run through a line counter to establish distances into the pipe. Time and distance were logged at nominal 20-foot distances for pulls both into the pipe and back to the wet well.

The TDR-3As were set to record pressure into their solid state memory at 5-second intervals. At the pulling rates used, about 50 feet per minute, this equates to pressure/depth readings at nominally 4-foot intervals along the pipe.

During the TDR-3A pull, water levels both inside the wet well and at the stake in the Inlet were recorded. Although differences in changes between water levels in the wet well and at the Inlet of several tenths of a foot were recorded prior to the LWL depth measurements the changes at both locations were identical and less than 0.1 feet during the pull, providing confidence that the recorded pressures were taken under a static condition with water levels similar at both ends of the line.

2.4 River and Inlet Topography and Stratigraphy

Profiles of the Inlet and river bed and near surface sediment stratigraphy were recorded on an Odom Echotrack Model DF 3200 dual-frequency depth sounder/subbottom profiler. The high-frequency side of this system operates at 200 kHz, typical of survey quality depth sounders, and is ideal for accurately determining water depths. The low frequency transceiver operates at 24 kHz with sufficient power to penetrate soft sediments and provide reflections from near subsurface layers having differing acoustic properties.

Prior to commencement of the profiling work a Sea Data TDR-3A water level recorder was installed on a piling about 400 feet north of the site to monitor water level changes during the survey. Bar check calibrations of the Echotrac were also performed to establish a water mass sound speed in the Little Niagara River.

The bar check procedure consists of lowering an acoustic target on a calibrated line to a known depth. The speed of sound control of the depth sounder is then adjusted until the target is recorded at its known depth. The target is then raised to successively shallower depths and the recordings annotated at each. Variations which exist between the recorded and calibration depths at these points are noted and applied as corrections during data processing.

In the Little Niagara River profiles were recorded along seven survey transects adjacent to the Inlet area, along three additional transects north of the site, and along three tie lines run parallel to the axis of the river.

Attempts were also made to run profiles within the Inlet. In anticipation of shallow water, a disposable raft had been fabricated to hold the Echotrac transducer 3-1/2 feet above the water surface inside a water filled housing with an acoustically transparent bottom. A 120-foot extension cable connecting the transducer to the Echotrac recorder on shore was also provided for this purpose. It was expected that the raft could be pulled from one side of the Inlet to the other along the 20-foot spaced range lines established for this purpose and the pipe location tasks. However, low river levels on November 15 had reduced the Inlet to a narrow thread of water with sufficient depths (6") for the raft only in the outer one third of the Inlet and only across a small portion of its width (10-15 feet). Consequently, only limited data were acquired within the Inlet.

3.0 DATA PROCESSING AND PRESENTATION

3.1 Location of LWL Pipeline

3.1.1 Horizontal Location

The horizontal location (coordinates) of sensor null points at approximately 30-foot intervals along the LWL from the pump station to a point about 500 feet west of the pump station and three additional points on Tonawanda Island were calculated from total station fixes taken by DGC. These points have been plotted on two plan view presentations, a 1"=50' site plan (DGC Drawing #M8044B) and on a 1"=20' plan and profile (OSI Drawing #88ES114).

Several factors contribute to the accuracy estimates for the horizontal location of the LWL. The cable detector's sensitivity to displacement from the energized wire indicates an ability to detect the wire location to an accuracy of

±0.3-0.4 feet. This accuracy must be combined with the ability to level the sensor and the distance from the sensor to the wire. To minimize errors in sensor orientation a 6 inch contractor's level was mounted on the sensor housing and the housing was plumbed before each reading taken on land and from the vessel outside the Inlet. Within the Inlet, the sensor was installed on the float in the gimballed mounting to assure a plumb orientation. Based on an orientation accuracy of 0.2 degrees on land and within the Inlet and a distance to the LWL of 15-25 feet, this factor contributes potential errors of 0.1-0.2 feet in horizontal position of the wire. Outside the Inlet where boat motion contributes to the ability to level the sensor, these errors could be as high as 0.5 feet based on a 1.0-degree sensor tilt.

The third factor contributing to LWL location accuracy is the accuracy with which the sensor was positioned in the local grid system after the null was determined. On land, stakes were driven at the nulls and subsequently located with a total station. In the Inlet, the float was stopped at each null and a total station fix taken on a prism mounted directly above the sensor. These two techniques contribute insignificant errors in LWL position. Outside the Inlet, total station fixes were taken as the boat drifted across the LWL and a null was radioed to the total station operator. Although fix accuracy is excellent, the ability to coordinate timing of the fix with the null could introduce an additional error. We estimate this error to be less than 2 feet.

Fourth, the precise location of the wire within the LWL is not known. The sensor cable was a two conductor polyethylene jacketed steel wire which is quite negatively buoyant. The LWL liner is also polyethylene and according to the divers is extremely slippery. We have, therefore, assumed that the wire would lie on the bottom and in the center of the LWL.

We believe this is a good assumption along the straight section from the pump house to the pilings at the mouth of the Inlet. Northwest of the Inlet, the pipe turns to the north. At this turn, the cable could lay slightly to the inside of the turn. We estimate that this would not exceed 0.3 feet from center.

Finally, the polyethylene liner may not be located precisely in the center of the original LWL steel pipe. Based on a 48" I.D. steel pipe and a 40" OD liner, it would appear that a displacement of 0.3 feet could exist at any point.

If the potential errors are summed, the location of the LWL on land and below the Inlet would be accurate to ±0.7-0.9 feet. Below the Little Niagara River outside the Inlet, this accuracy would be ±3.5 feet.

3.1.2 Vertical Location

Two sets of data logged during the depth gauge pulling task, a time and distance tabulation from the rope counter and a time and pressure tabulation from the Sea Data TDR-3A, have been combined to provide the vertical position of the LWL. The pressure data were first adjusted for barometric pressure variations (data obtained from Buffalo Airport for the period of this survey) and converted to feet of water at the ambient water temperature. These depths were then referenced to mean sea level (MSL) utilizing the water level data recorded in the wet well and at the staff gauge during the pulling operation.

The resulting pipe elevation data were combined with distances into the pipe to yield a profile of the top inside surface of the polyethelene liner. These data are plotted in profile on OSI Drawing 88ES114 at a horizontal scale of

1"=20' and a vertical scale of 1"=2'. Distances along this profile are actual distances along the LWL with the west wall of the wet wall inside the Lockport Pump Station used as the zero reference. This reference is shown of both plan view drawings.

3.2 Inlet and River Topography

Soundings recorded on strip chart were digitized and corrected for river elevation and bar check calibrations. For the data acquired adjacent to the Inlet, the final elevations were plotted in plan view along tracklines constructed from navigation fixes at the appropriate scales. These data were plotted at 1"=50' and contoured at a 2-foot interval for addition to the site plan prepared by DGC (Drawing #M8044B). As many of these same contours as possible were added to the 1"=20' plan and profile (OSI Drawing 88ES114) by plotting and contouring the elevations at the larger scale.

River bottom elevations are also presented in profile along the ten transects adjacent to and north of the Inlet area and one tie line run along the axis of the Little Niagara River. These profiles also include river bed stratigraphy discussed further in Section 3.3.

Topography within the western end of the Inlet was developed from a limited number of profiles run in the shallow water on November 15, 1988. The contours in the remainder of the Inlet were developed from visual field observations (without direct measurements) at low water conditions on November 15, 1988.

All contours within the Inlet should be considered approximate. Contours and spot elevations in the Little Niagara River are accurate to +/- 0.5 feet as proposed.

3.3 Inlet and River Sediment Stratigraphy

Sediment stratigraphy as interpreted from the 24 kHz subbottom profiling is presented as a series of ten cross-river profiles and one profile along the axis of the river. Each profile depicts the river bed and those subsurface reflectors which could be traced with reasonable continuity throughout the site. These profiles are presented at a horizontal scale of 1"=50' and a vertical scale of 1"=5' and are attached as Figures 3-13 in Appendix II of this report. The locations of Profiles 1-8 and 11 are shown on the 1"=50' base map and are identified by corresponding figure numbers. Distances along Profiles 1-8 are referenced to a base line shown on the base map. Profile 11 is referenced to its intersection with Profile 8. Profiles 9 and 10 are located 200 and 550 feet north of and are parallel to Profile 8 and are referenced to the bulkhead/pile line on the east bank of the Little Niagara River.

The vertical axis of the subbottom profiler record, as discussed in Section 2.4, was set to correspond to the average water mass sound speed during bar check calibrations for the river bed profiling. Acoustic propagation velocities in the soft sediments likely to be penetrated with the 24 kHz sound source will probably be very close to the velocity in river water, in this instance 4,758 ft/sec. Because the subbottom reflectors identifiable on the profiles are generally within 5-6 feet of the river bed, we have assumed the same velocity (4,758 ft/sec) for calculating depth to these reflectors. This assumption will result in reflectors being plotted either at or slightly shallower than their actual depth.

4.0 DISCUSSION OF DATA

4.1 Horizontal Location of LWL

The LWL is laid in a northwesterly direction from the Lockport Pump Station in a straight line along the southern edge of the Inlet. When it reaches the Little Niagara River (about 425 feet from the wet well) it makes a turn of 10 degrees to the north where it continues in a straight line to Tonawanda Island, the limit of observations made during this study.

4.2 Vertical Location of LWL

At its departure from the wet well inside the Lockport Pump Station, the LWL is located about 8-1/2 feet below the Little Niagara River water level (depending on river stage) and about 20 feet below existing grade outside the pump station. It pitches gently downward to the northwest for 260 feet where the pitch increases slightly to a point at the pilings along the mouth of the Inlet. At this point (420 feet west of the wet well and 24 feet below river level) it becomes nearly level and makes its turn to the north. Approximately one hundred feet beyond the turn a gentle downward pitch resumes.

Within the Inlet area, the pipe lies between 15 and 22 feet below the existing grade. It is closest to the existing grade at the head of the Inlet.

Beyond the Inlet into the Little Niagara River, the pipe is only about five feet below the river bottom. This depth is further verified on Profile 11 which shows the pipe trench in the subsurface. A sample of this profile record is attached as Figure 2.

4.3 River and Inlet Topography

The river adjacent to the Inlet is characterized by steeply sloping topography from a water depth of about 18 feet to either the shore (north and south of the Inlet) or to the mouth of the Inlet, in a distance of 30-50 feet. This steep slope is due largely to the presence of old bulkheading along the shore. Although the bulkheading is severely deteriorated, remnants of piling rows can be seen along most of the study area, the only exception being opposite the southern one- third of the Inlet. Here the riverbed slope rises from a depth of 20 feet to the shoals within the Inlet over a distance of about 100-120 feet. It is reported that the southern portion of the Inlet may at one time have been used for berthing of ships and may not have been bulkheaded.

The center portions of the River are relatively flat with depths ranging from 18-22 feet (elevations of 543-547 MSL). Slight depressions are seen on Profiles 4-6 which are believed to relate to the trenching for installation of the original LWL pipe.

Within the Inlet, sedimentary deposits form a relatively flat surface with only occasional, very narrow, pockets of deeper water along the thalweg of the Pettit Creek Flume discharge stream. These pockets appear in 2 locations immediately downstream of the containment booms, probably a consequence of scour under the booms during periods of high flow. Other than these pockets, sediment fills the Inlet westward almost to the old bulkhead line where depths are only slightly deeper, 1-3 feet (elevations of 563-567).

4.4 Sediment Stratigraphy

In the Little Niagara River two distinct reflectors are seen on all subbottom profiler records. Both are generally parallel to the river bed: the shallower are generally 1.5-2.5 feet below the river bed and the deeper one very consistently 5 feet below the river bed.

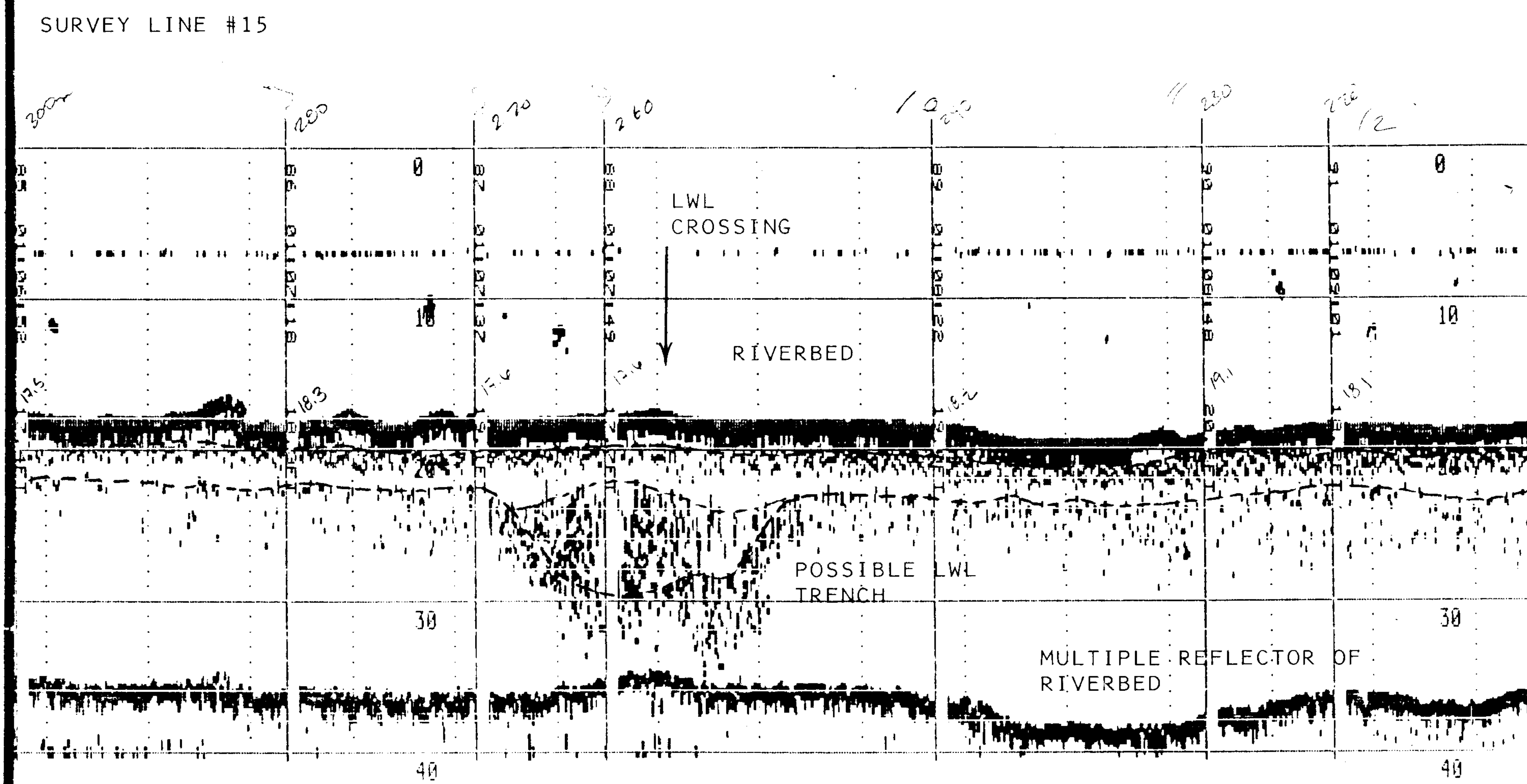
No samples were taken during this study. It is, therefore, not possible to positively identify these layers. However, some information was noted during anchoring and probing which relate to the near-surface sediments.

During probing and anchoring attempts in the Little Niagara River and probing in the Niagara River at the intake crib, OSI observed that the river bottom appeared to be covered with a 3-6" thick veneer of pebbles and gravel. One can speculate that this material was transported either as a bed load during high flow conditions in the rivers or possibly by ice from the shores of the river or Lake Erie. The later possibility seems more plausible as the shore of Lake Erie provides a source of material and the distribution seems to be relatively uniform in both Rivers. This layer of material was not visible on the subbottom record as would be expected due to its thickness.

In areas where probings penetrated the coarse veneer very little resistance was encountered for 1-2 feet of additional penetration at which point stiff resistance was met on a relatively harder material. A slight granular feeling indicates the presence of some sand in this material. Both the probe and the anchor where it penetrated the veneer returned a soft cohesive clayey material with some sand. We expect that the near surface reflector (1.5-2.5 feet below river bed) is the interface between the soft clayey material below the coarse veneer and the more resistant material which prevented further probe penetration.

No information is available on the deeper reflector. However, Profiles 4-6 and 11 show a consistent disturbance of material below this reflector. By coincidence, each of these disturbed areas relates closely to the position of the LWL pipe. Profile 11 correlates precisely with the pipe location and shows what may be the outline of the LWL trench and/or backfill material, (Figure 2).

Within the Inlet only limited subbottom information was recorded: from Station 3+00 on the baseline north of the Inlet (300 feet from the Lockport Pump Station) west to the old bulkhead and only in the deepest portions of the Inlet (elevations below 564 feet). In these records a weak discontinuous reflector is observed between 2.5 and 3.5 feet below the water surface (564.5 at the time of the survey). These depths wouuld relate to elevations of 562 to 561 feet (MSL).



SAMPLE RECORD

PROFILE #11

FIGURE NO. 2	DATE 12/19/88
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OCEAN SURVEYS, INC.

OLD SAYBROOK, CONNECTICUT

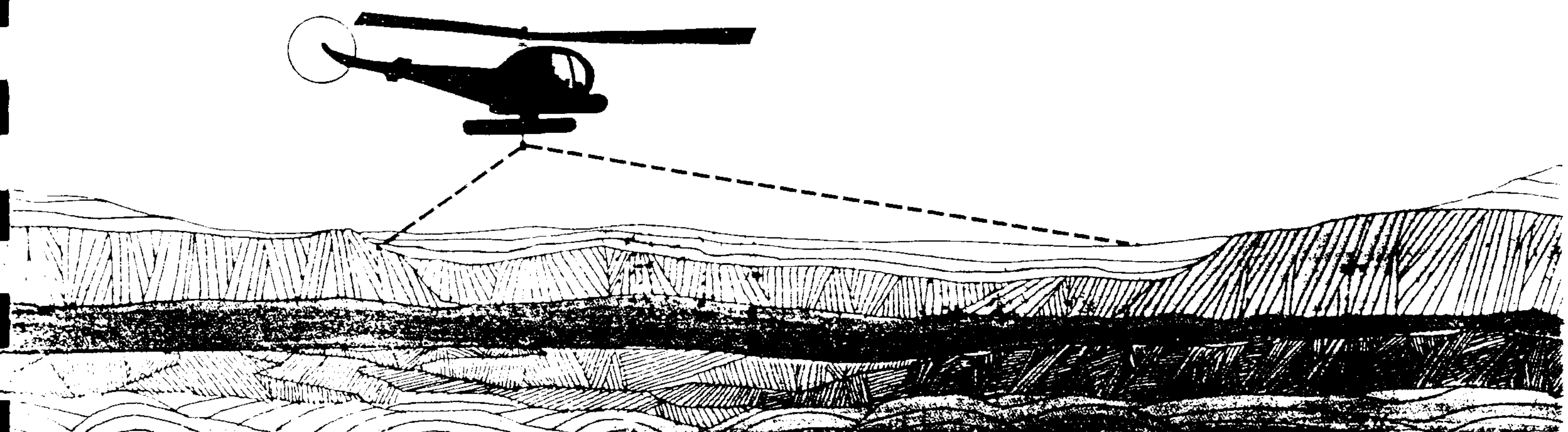
APPENDIX I

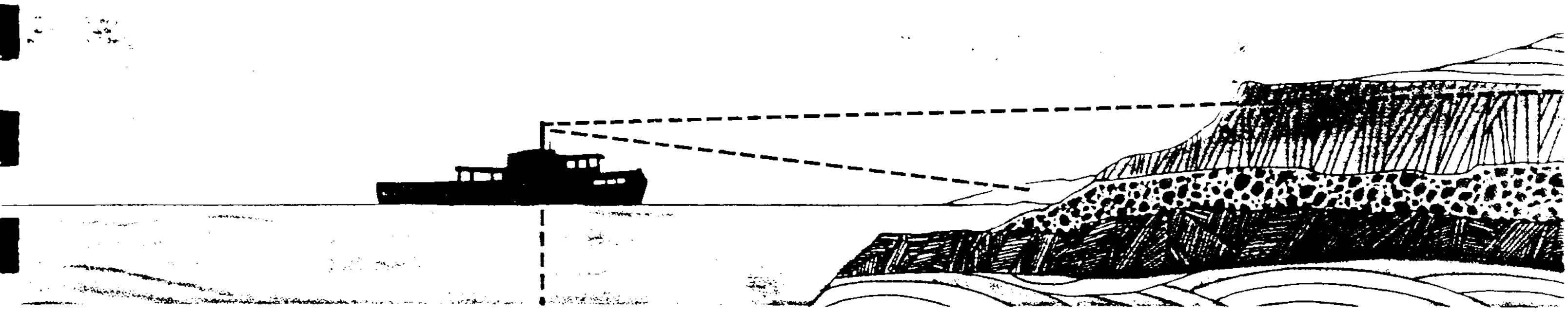
EQUIPMENT SPECIFICATIONS

CUBIC WESTERN DATA

AUTOTAPE DM-40A

Automatic positioning system for ships, dredges and helicopters



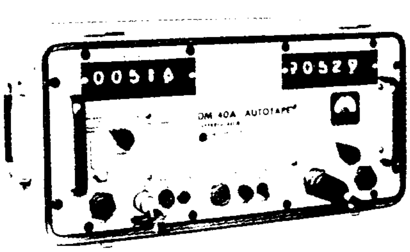


High accuracy and easy portability combined in the most reliable multi-purpose survey system money can buy.

Since 1966 the men who survey around the world, both over land and over water, have depended upon Cubic Western Data's easy-to-operate Autotape. This compact microwave range-range positioning system measures ranges from a survey boat, dredge or helicopter to each of several land-based responders. Today, no other type of positioning system—at any price—can equal Autotape's unique combination of automatic operation, accuracy and portability.

A real money maker

Ruggedly reliable. Autotape provides time-saving features that are like money in the bank. And that makes it the most practical way to fix and relocate positions at sea or on land. Autotape gives the industrial user a decided competitive advantage and



offers proven cost effectiveness in government operations involving surface ships, submarines and aircraft.

Fully automatic

With Autotape, there's no lane counting, no field calibration and no touchy adjustments that sacrifice expensive man-hours. Digital measurement of ranges is fully automatic and can even be done unattended with a printer or magnetic recording equipment.

True portability

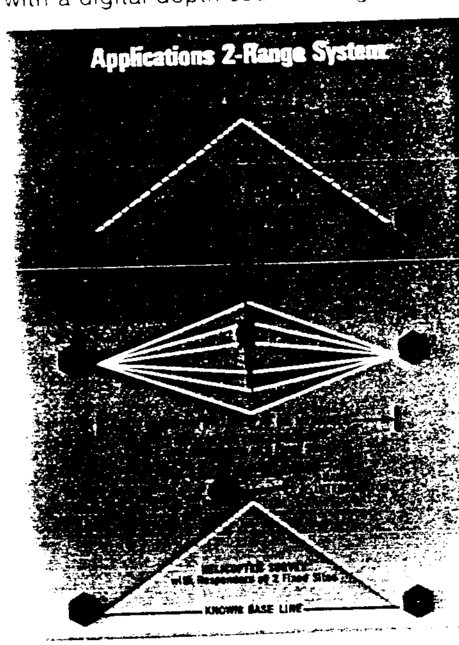
Autotape means efficiency combined with portability. The compact interrogator is easily installed on vessels or helicopters. The responders and antennas are even more compact and can be readily taken anywhere and set up by one person. Total installation takes under 30 minutes.

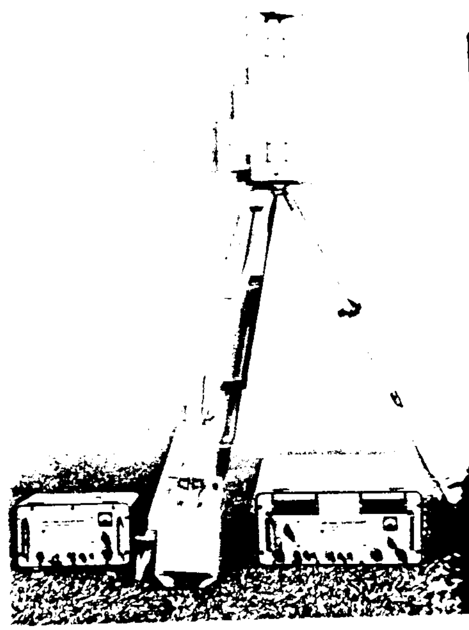
Power and warm-up are also no problem when you use Autotape. All units will operate from 12 or 24 VDC or 115 AC. A car battery will run the responders all day.

Temperature compensated crystal oscillators require practically zero warm-up time.

Complete multi-purpose survey systems

To meet specific survey requirements, Cubic manufactures a line of optional equipment including printers, recorders and plotters. Autotape can be coupled with a digital depth sounder, digital clock





and a complete recording system. All data can be recorded on magnetic or paper tape or be printed out in easy-to-read tabular form.

The Automatic Position Computing System (APCS) will automatically plot the track of the survey vehicle in any coordinate system from the Autotape ranges. The APCS includes left-right and to-from steering indicators for navigation purposes.

Synchronized outputs of the Autotape, the depth sounder and clock are all recorded on magnetic tape in computer compatible format. In this manner, the position, depth and time can then be processed to obtain a profile of the bottom contour.

The recorder will also record manually entered data such as job number, line number, coordinates of responder stations, date, and any other helpful information. One additional recording channel out is also available to record other data important to the user. Soundings may

be required at a once per second rate so the recorder may be set to record every 3, 5 or 10 seconds or on external command.

In addition to the DM-40A, Cubic now lists as standard the DM-43. The DM-43 is identical to the DM-40A except that it measures three simultaneous ranges instead of two. Cubic also supplies customized Autotape systems to fit unique requirements.

Pinpoint accuracy

Using the latest solid-state integrated circuitry, Autotape displays its ranges on an instrument front panel to the nearest 0.1 meter. Normal maximum range is 150 kilometers, but this can be extended to 200 Km by line-crossing techniques. Ranges can be simultaneously printed, recorded and plotted and remote control features are available as options.

Warranty & service

Every Autotape and system component carries a one-year unconditional warranty on materials and workmanship. Servicing, adjustment and parts replacement is done at the factory by trained specialists. Cubic service engineers are also available to provide service anywhere in the world when return to the factory is not convenient. Normal service turn around time is less than 48 hours.

Applications engineering

Cubic engineers are ready to tailor an Autotape system to your specific application. That means detailed assistance on everything from installation to software.

Used the world over

. . . from the Atlantic seaboard to the California shore and the Gulf of Mexico . . . in Alaska, Arabia, Mexico, Australia, Canada, Europe, Panama, Brazil, Venezuela, Africa, South Asia, North Sea, Persian Gulf, Japan. Here are a few examples:

In the Gulf of Mexico, Autotape does 90% of the surveying for John E. Chance & Associates. John Chance credits his company's speed and accuracy in placing drill barges at oil sites to two things: know-how and the right kind of equipment.

And, for John Chance, Cubic's Autotape has always been the right kind of equipment . . . for use in fair weather or foul, for accuracy and for dependability.

In Chance's part of the country there's bad fog and haze for six months out of the year. Autotape cuts through the weather and does away with expensive waiting time.

Compared to the savings in time and energy, Autotape is an economical investment. For John Chance, Autotape means efficiency and efficiency means profits.

Bureau of Land Management Alaskan Helicopter Survey. The Bureau of Land Management in Anchorage, with the cooperation of Cubic, has developed a helicopter system for cadastral surveying. Equipment consists of a four range Autotape with remote display.

The helicopter portion of the system includes a data controller with a magnetic tape recorder and printer that digitally records the ranges, time and other data. Ground recording equipment includes a computer, a magnetic tape unit, printer, data entry unit and paper tape recorder.

With Autotape, some 30 to 40 hovers/day can be accomplished — offering a great deal of flexibility under difficult terrain and climate conditions.

Tranarg, C. A. — a privately owned Venezuelan surveying company uses their three-range Autotape for accurate aerial photo-map control.

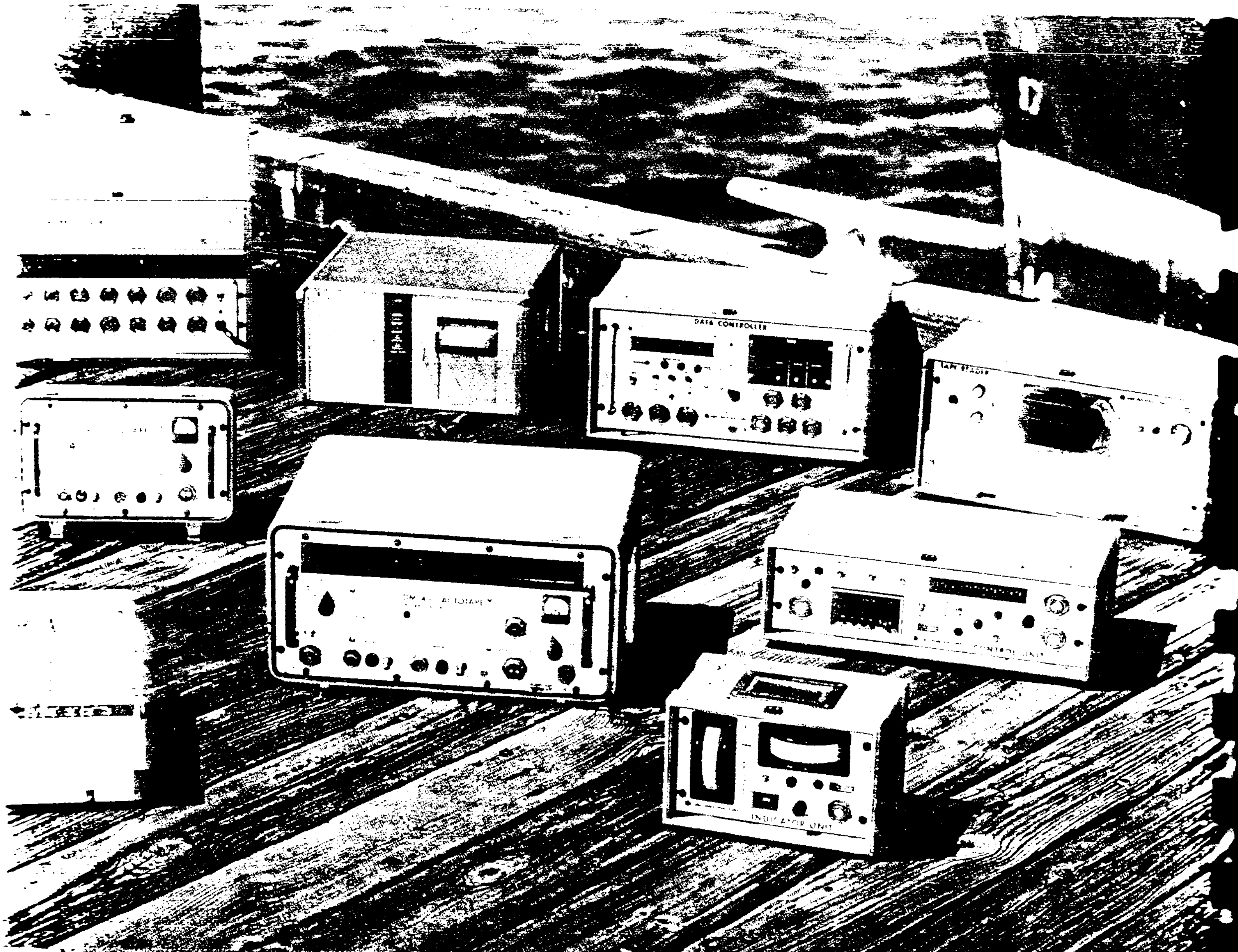
Responders are set at points to be surveyed, then a helicopter flies across the theoretical line joining two of the responders at as low an altitude as possible.

Ranges are recorded on a printer, processed and the range sums calculated. The minimum range sum is then selected, reduced to ground level by means of the helicopter pressure altitude, and the geodetic distance between the responder sites is calculated.

Autotape positions Brown & Root pipeline. In 100-foot-deep water off the coast of Iran, Brown & Root, Inc., constructed the most accurately placed oil pipeline ever laid in the area. Secret to the company's success on the 27-mile route was a Cubic Autotape system linked to a computer on board the lay barge "L. E. Minor."

The system was developed to display both the barge's actual coordinate position and its pre-planned target location. Thus, the barge anchor winch operators could make right or left corrections for any displayed error. Absolute accuracy of the plotted coordinates was verified on the job site to be ±2 meters — and Autotape units were subjected to temperatures in excess of 150°F during most of the operation.

Army Corps of Engineers. Many districts of the U.S. Army Corps of Engineers utilize Autotape with various peripheral equipment for river, harbor and reserv-



Specifications – [illegible]

Operating Range [illegible]

[illegible]

Range Accuracy [illegible]

Maximum Range [illegible]
possible with [illegible]

Operating [illegible]

[illegible]

[illegible]

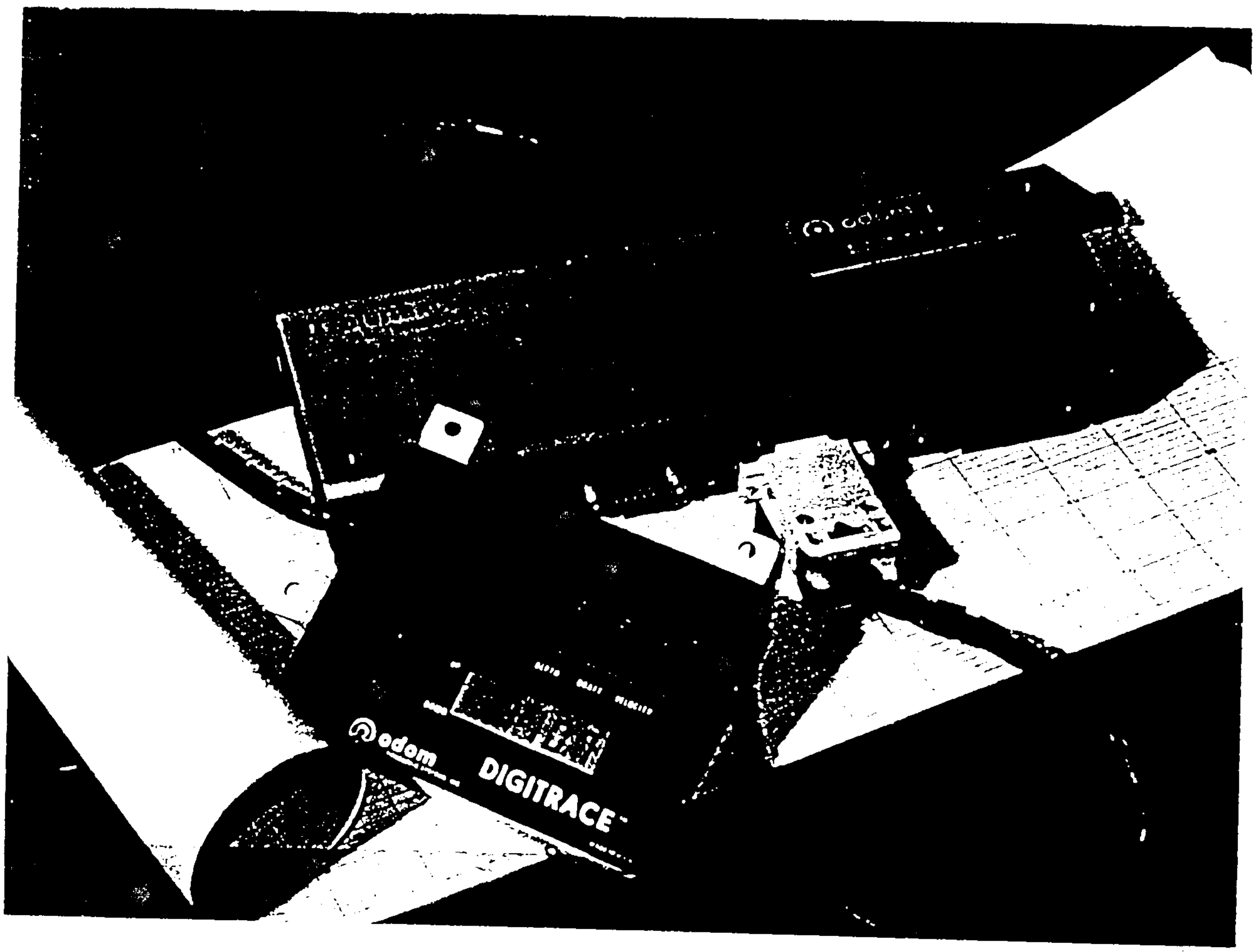
CUBIC WESTERN DATA

DIGITRACE™

Precision Depth Sounder Digitizer

Models DT-2H-FS and DT-2H-FP

(Feet - Serial/Parallel)



1.6 Specifications

- Range -------------- 1.4 feet to sounder limit
- Draft Range -------- 0 to 25 feet
- Vel of Sound Range - 4600 to 5200 feet/sec
- Accuracy ---------- .1 Feet Displayed (.1% Total Depth)
- Data Update Rate --- Equal to sounder cycle rate
- Display ----------- 4 Digits, LCD, .35 inches high
- Computer Output --- RS232c, 9600 BAUD, (Optional BCD Parallel)
- Environmental --- -20 to +55° C
- Dimensions:
  - Control/ Display Unit ------ 4.35W x 3.3H x .7 D inches
  - Electronics Unit ----------- 10.8W x 3.4H x 1.25D inches
- Weight:
  - Control/Display Unit ------ 11 oz
  - Electronics Unit ----------- 24 oz

Sea Data, Inc.

TDR-3A

TIDE RECORDER

TDR3A.DS.1286

12/86

The TDR-3A Tide Recorder is a low-cost digital pressure and temperature recorder designed for the precise measurement of water level. The instrument can be moored on the ocean bottom or attached to a structure where it will record pressure data with an accuracy of one centimeter per 15 meters of water. Recorded data are available in engineering units for output to a printer or terminal. The TDR-3A can also be configured for use as a real-time tide monitoring instrument. The measurement rate is switch selectable in 16 increments ranging from five seconds to one hour.

The TDR-3A Tide Recorder belongs to a group of Sea Data instruments known as Microloggers, and is the solid-state recording replacement for the TDR-2 Tide Recorder. The TDR-3A stores up to 21,000 pressure/temperature data pairs in its standard 92 kilobyte memory.

Solid-state storage eliminates the need for an expensive tape reader for data playback. Data can be downloaded to any compatible computer in any of four formats, including formatted engineering units. Second-order calibration coefficients stored in the EEPROM of the TDR-3A assure that engineering unit output reflects actual pressures and temperatures. The instrument is powered by the main system battery; a five-year memory back-up battery protects against data loss in the event of main battery failure.

TIDE MODE

The TDR-3A features an operating mode where frequent pressure samples are averaged (128 averaged pressure measurements are taken over a 160 second interval) to reveal only tide-induced changes in the water level. This rapid sample and average technique eliminates wave-induced fluctuations from the water level data without the need for a stilling well. First introduced by Sea Data in 1979, this technique is now a standard for the National Oceanic and Atmospheric Administration (NOAA) and the National Oceanographic Survey (NOS) for their next generation tide gauges. The TDR-3A will also record raw pressure/temperature data in situations where wave influence is insignificant. A DIP switch is used to select or deselect tide mode.

GENERAL DESCRIPTION

The standard TDR-3A is equipped with two data channels for pressure and temperature. The pressure sensor is a strain gauge with a creep-relieved stainless diaphragm and a vacuum reference chamber sealed with electron beam welding. Each sensor is individually temperature compensated with custom, wire-wound precision resistors for truly superior pressure accuracy.

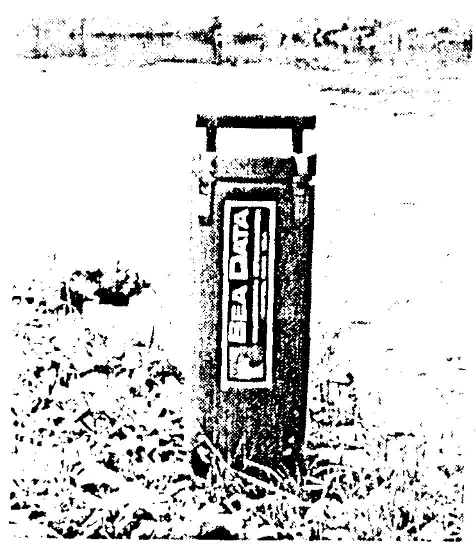
The standard temperature sensor is externally mounted on the bulkhead of the TDR-3A and has a time constant of 20 seconds in water. Temperature range is set at the factory: −5 to +35°C is standard; 25 to 80°C and 0 to 20°C ranges are also available. The standard TDR-3A Tide Recorder includes a 92 kilobyte RAM storage memory, battery pack, and PVC pressure housing rated to 750 psi (150 meters). PVC pressure housings are individually pressure tested by special order. The TDR-3A will operate either in averaging tide mode or in single-sample mode.

DEPLOYMENT DURATION

The flexible TDR-3A accommodates a wide range of experiment lengths, from short-term deployments with high sampling rates, to unattended deployments of more than a year. The following table shows several possible deployment durations. For each configuration of data channels and scanning intervals, the table shows the time it takes to completely fill the 92K memory, and the number of deployments that can be completed before the battery must be replaced.

FEATURES

- **Solid-state recording; 92 kilobytes with 5 year memory**
- **RS-232 output; no reader needed**
- **Engineering unit output**
- **Special tide mode to eliminate wave noise**
- **0.15cm Accuracy: 0.5cm Resolution**
- **0.1°C Accuracy; 0.01°C Resolution**
- **Switch-selectable scanning rates**



COMMUNICATION AND DATA PLAYBACK

The TDR-3A communicates with the user via RS-232 signals. The RS-232 port on the TDR-3A is used to initialize storage and to play back stored data. Commands are issued from a terminal, modem or computer; commands compatible with the Sea Data Microreader are included in the command set. The TDR-3A also has a built-in enhanced command set for advanced data logging, annotation, segmentation and playback.

Five minutes is all it takes to download stored data and to reinitialize the TDR-3A in the field. Plug a computer with an RS-232 port into the Micrologger; choose from among four output formats (engineering units, formatted or unformatted Microreader output or compressed format); and dump the data to a computer for processing or for immediate display.

Built-in hardware and software safety features protect valuable data against loss in the unlikely event of a system crash. Special memory mapping is implemented in hardware to facilitate access to the storage memory, while eliminating the possibility of overwriting previously recorded data.

Sea Data, Inc. • A Pacer Systems Co. • One Bridge Street, Newton, MA 02158 USA • 617-244-8191 • Tlx:951107 • Fax:617-244-3624

OPTIONS

Aluminum Pressure Housing: Aluminum pressure housing rated to 10,000 psi (6800 meters) for deep ocean applications. Housing is anodized and overcoated with polyurethane paint for protection against corrosion.

Backup Recorder: Wafer tape recorder system formerly used in all versions of the Micrologger. Can be used as a backup recorder.

Pressure Testing: Standard PVC pressure housing pressure tested to 750 psi (150 meters).

In-line Mooring Cage: Two-piece stainless steel cage for use in in-line tension mooring. Model TDR-3A/SC.

Endcap with Underwater Data Connector: Allows for real-time data monitoring. Model TDR-3A/EC.

Additional Data Channels: Two additional data channels (for a total of four) to accommodate other temperature sensors, conductivity sensor, etc. Consult factory for details.

Other Pressure Sensors: Pressure sensors that can be used to a greater depth, or that go to the same depth with less accuracy.

OTHER VERSIONS

The following instruments are part of the Sea Data family of Microloggers:

TDR-3: Temperature and depth recorder for non-tidal applications.

CTR-3A: Conductivity and temperature recorder for tidal applications.

CTDR-3: Conductivity, temperature and depth recorder for non-tidal applications.

TR-3: A series of temperature recorders with sensors in a variety of configurations. Refer to separate data sheet.

MAXIMUM DEPLOYMENT TIME AT VARIOUS SWITCH SETTINGS *

(Capacity based on 92K RAM)

SCAN INTERVAL	DATA CHANNELS 1	2 **	Tide Mode
5 seconds	60 hours (45)	30 hours (50)	---
1 minute	30 days (10)	15 days (20)	15 days (2)
6 minutes	180 days (3)	90 days (5)	90 days (1.5)
1 hour	900 days (0.7)	450 days (1)	450 days (0.6)

Number of full-duration deployments possible with one battery shown in ( ).

* Unattended deployments of more than a year in length reqauire a high-power battery pack. Deployment times can be extended by disabling temperature sampling on the DIP switch.

** Normal mode, no tide averaging.

ORDERING INFORMATION

Contact your Sea Data sales representative to place an order. Be sure to specify any non-standard temperature or depth requirements at the time of order.

GENERAL SPECIFICATIONS

TIMEBASE	
Type	32.768 Hz quartz crystal oscillator
Stability	5ppm/year, 40ppm over -5 to +40°C
PRESSURE	
Sensor	Strain gauge with a creep-relieved stainless diaphragm vacuum reference chamber sealed with electron-beam welding
Range	20 m; tolerates up to 80 m of overranging
Accuracy	1 cm (with corrections)
Resolution	0.5 cm (one part in 4096)
TEMPERATURE	
Sensor	30K Ohm bulkhead-mounted precision thermistor
Range	-5 to +35°C
Accuracy	0.15°C
Resolution	0.01°C (one part in 4096)
Time Constant	20 seconds in water
MEASUREMENT RATE	
	Switch-selectable from five seconds to one hour: 5, 10, 15, 30 sec, 1, 1.5, 2, 3, 5, 6, 7.5, 10, 15, 20, 30 and 60 min
DATA STORAGE	
Media	CMOS solid-state static RAM with backup power supply
Playback	via RS-232; 300 to 9600 baud
Capacity	21,000 pressure/temperature data pairs
Format	record length, model number, S/N, record number, time, time since last record, pressure/temperature data
POWER	
Battery	Sea Data BP-7 10.5 V, 6 AHr alkaline battery pack; good for six months, 1.5 full tide memories
Data Backup	Built-in 160 mAhr memory backup battery to prevent data loss in event of BP-7 failure
CURRENT DRAIN	
RAM Recorder	less than 5 uA at 20°C or 20 uA at 40°C (typical)
Processor	15 mA when recording; 17 mA in tide mode, 0.3 mA in standby
Sensors	Normal Mode: 2.6 x 10-6 Ahr per pressure and temperature measurement. Tide Mode: 0.8 x 10-4 Ahr per 64-sample pressure measurement, 1.5 x 10- for temperature plus 128-sample pressure measurement.
PROCESSOR	
Type	64180 CPU at 3.072 MHz with EPROM, RAM and oscillator self-test procedu
Memory	32 kilobytes of EPROM, 96 kilobytes of CMOS RAM storage
HOUSING	
Material	PVC rated to 750 psi (500m)with stainless steel fittings (pressure tested by request only)
Size	14 cm (5.5") diameter by 41.5 cm (16.25") long
Weight	13 lbs in air, 2 lbs in water

Sea Data reserves the right to change specifications without advance notice.

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MARGUS

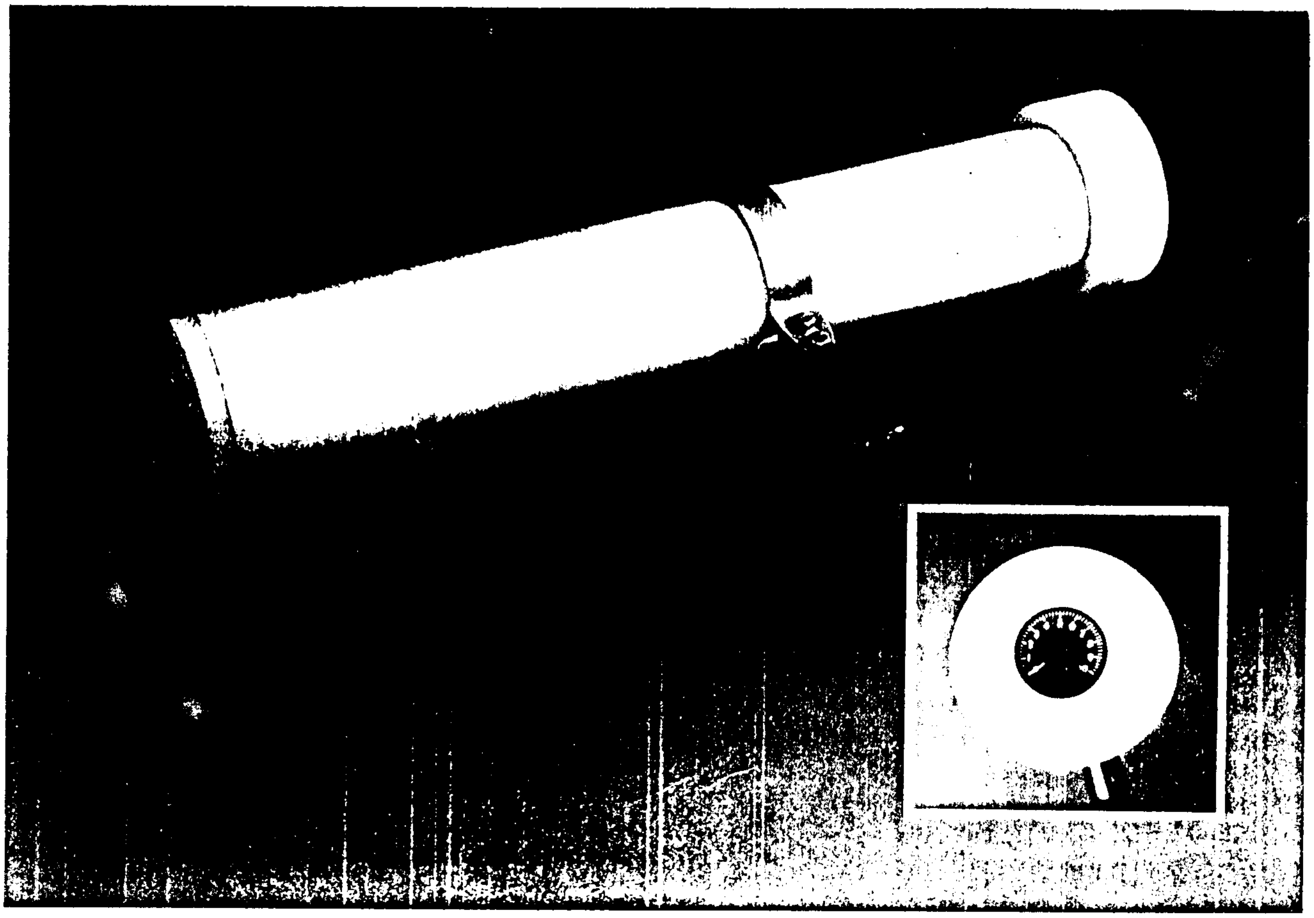
Offshore Services

OCEAN SURVEYS, INC.

91 Sheffield Street
Old Saybrook, CT 06475

Phone: (203) 388-4631
Telex: 5106013995

SUBMARINE CABLE DETECTOR MODEL 101



SUBMARINE CABLE DETECTION SYSTEM

The Margus Offshore Active Submarine Cable Detection System provides the capability for accurate location and tracking of submarine cables. This "active" system senses the presence of an alternating current signal injected into the cable. The resultant magnetic field is detected and used to provide pinpoint positioning data. Shown above is the Model 101 Submarine Cable Detector which is the basic sensor. This device is shown configured for hand-held operator use and can be used from a surface vessel* or deployed via a diver. Configurations for mounting on a manned submersible or unmanned Remotely Operated Vehicle (R.O.V.) are available.

**When utilized from a surface vessel the operational water depth limit is dependent on A.C. signal strength injection limits of the cable system in question.*

APPLICATIONS

TELECOMMUNICATIONS

- Telephone operating companies can locate and track river crossings, ocean cables, and other submerged plant.
- In areas where multiple cables come ashore, different systems can be identified and surveyed for correct position.
- If a cable fault is localized to a submarine cable section, accurate cable detection can minimize system down time, increase repair crew efficiency and thereby save money.
- Submerged plant repair records and as-laid survey data can be updated in order to ascertain current position and be ready in case of emergency situations.

ELECTRIC UTILITY INDUSTRY

- Basically the same applications as those stated for telephone companies in connection with submerged plant.

OIL AND GAS PIPELINE INDUSTRY

- If a **submarine pipeline** has a reasonably intact insulation covering, then the submarine cable detection system can be used to locate and track pipelines, flowlines, hydraulic control lines and other submerged methods of transportation.
- **River crossings** can be checked in order to ascertain "depth of cover."
- **Offshore pipelines** can be located prior to maintenance or construction operations.

SYSTEM SPECIFICATIONS

SUBMARINE CABLE DETECTOR MODEL 101

Dimensions:	Length O.A. 21.75 inches Max. Dia. 4.5 inches (detector is supplied with aluminum carrying case)
Weight in Air:	10 lb.
Weight in Water:	3.5 lb. (approx.)
Operational Depth Limit:	1500 F.S.W.
Power Supply:	8 "AA" Batteries
Operating Frequency:	Variable depending on application.

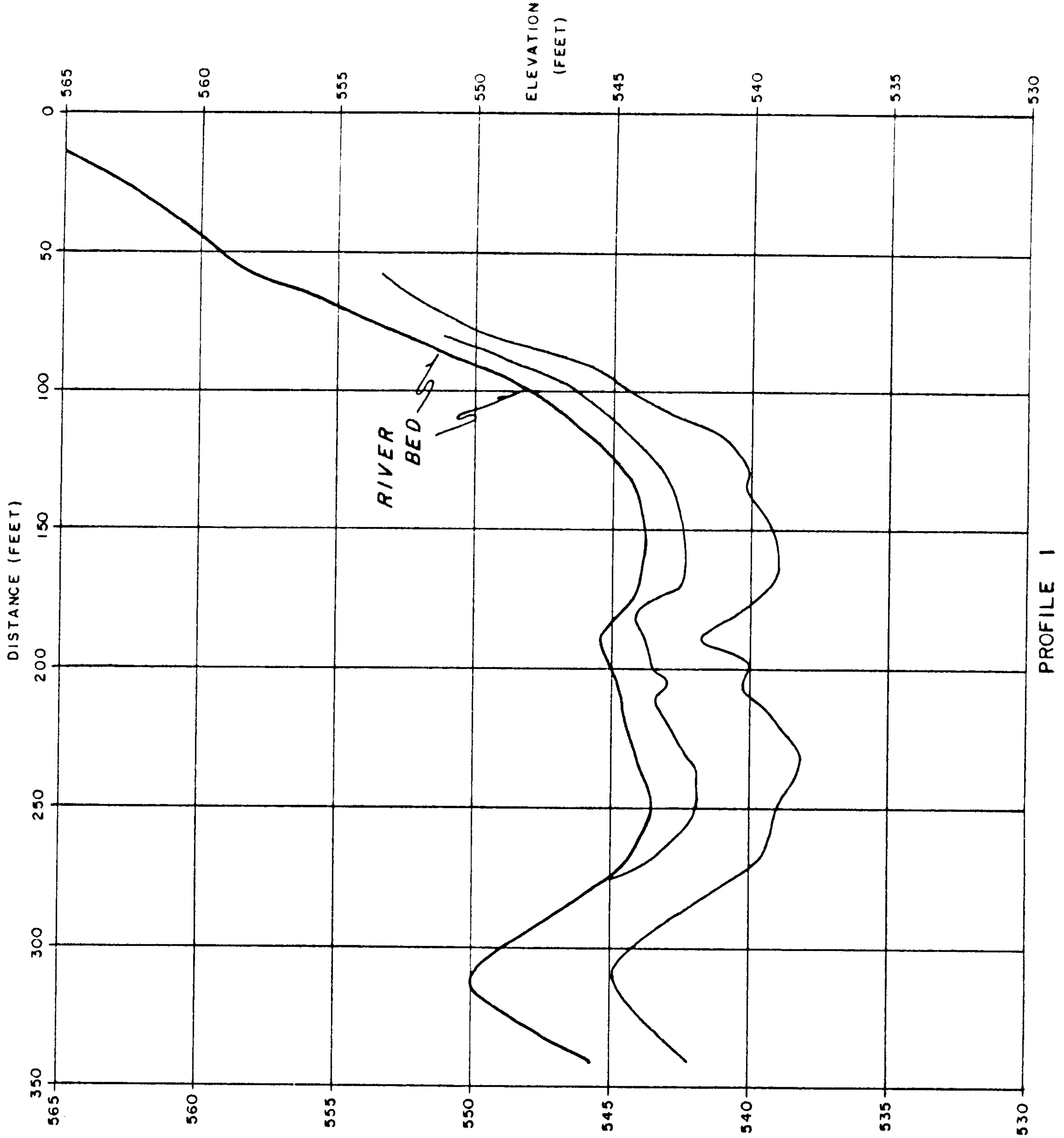
PATENT APPLIED FOR

MARGUS OFFSHORE SERVICES

The staff at Margus Offshore are available to provide engineering and operational support services in connection with all facets of submarine cable operations. Our extensive background in this field allows us to offer field-proven solutions to our client's project needs.

APPENDIX II

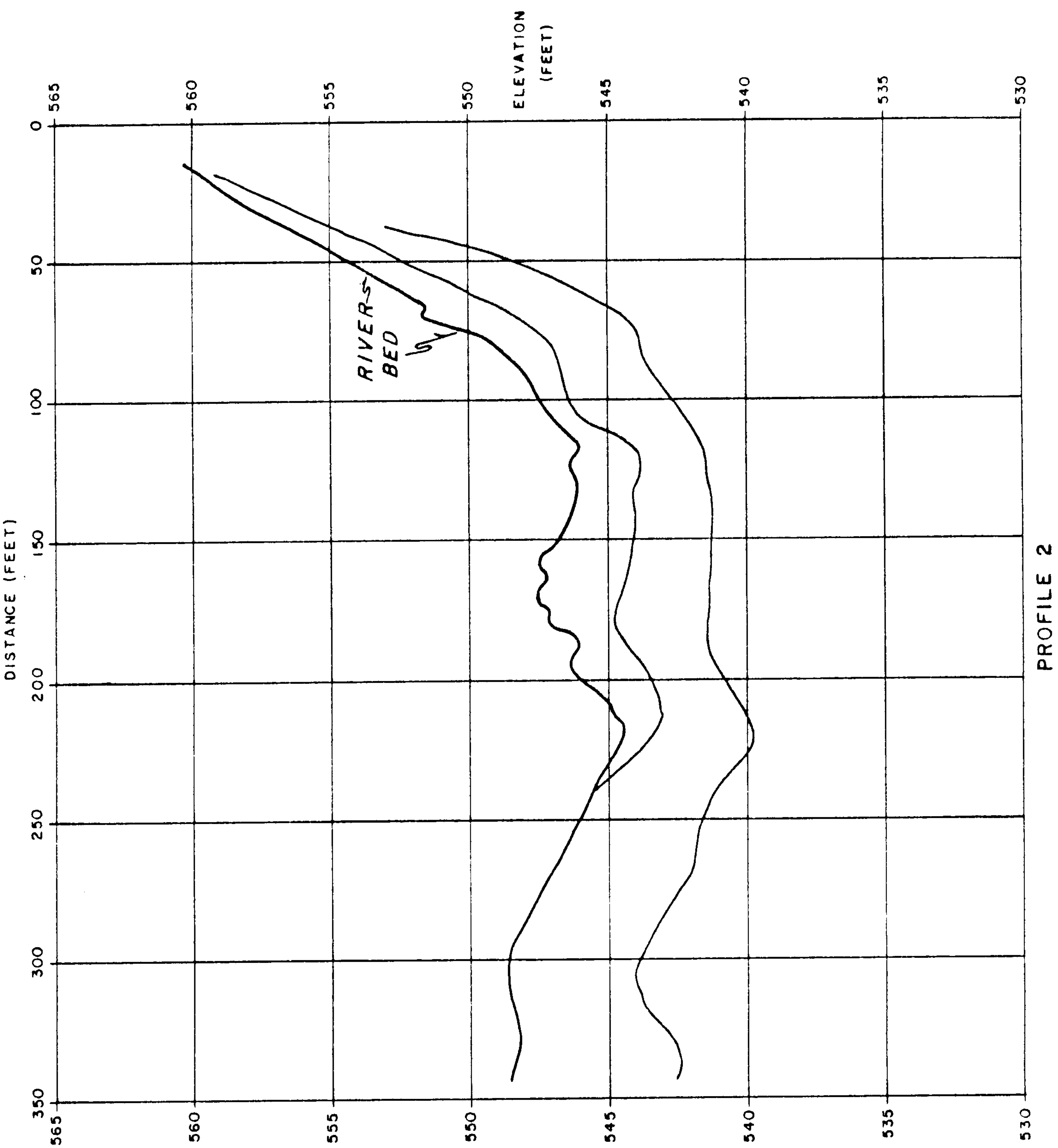
SEISMIC PROFILES



SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

FIGURE NO. 3

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL. (203) 388-4631 TLX 5106013995



SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

FIGURE NO. 4

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631

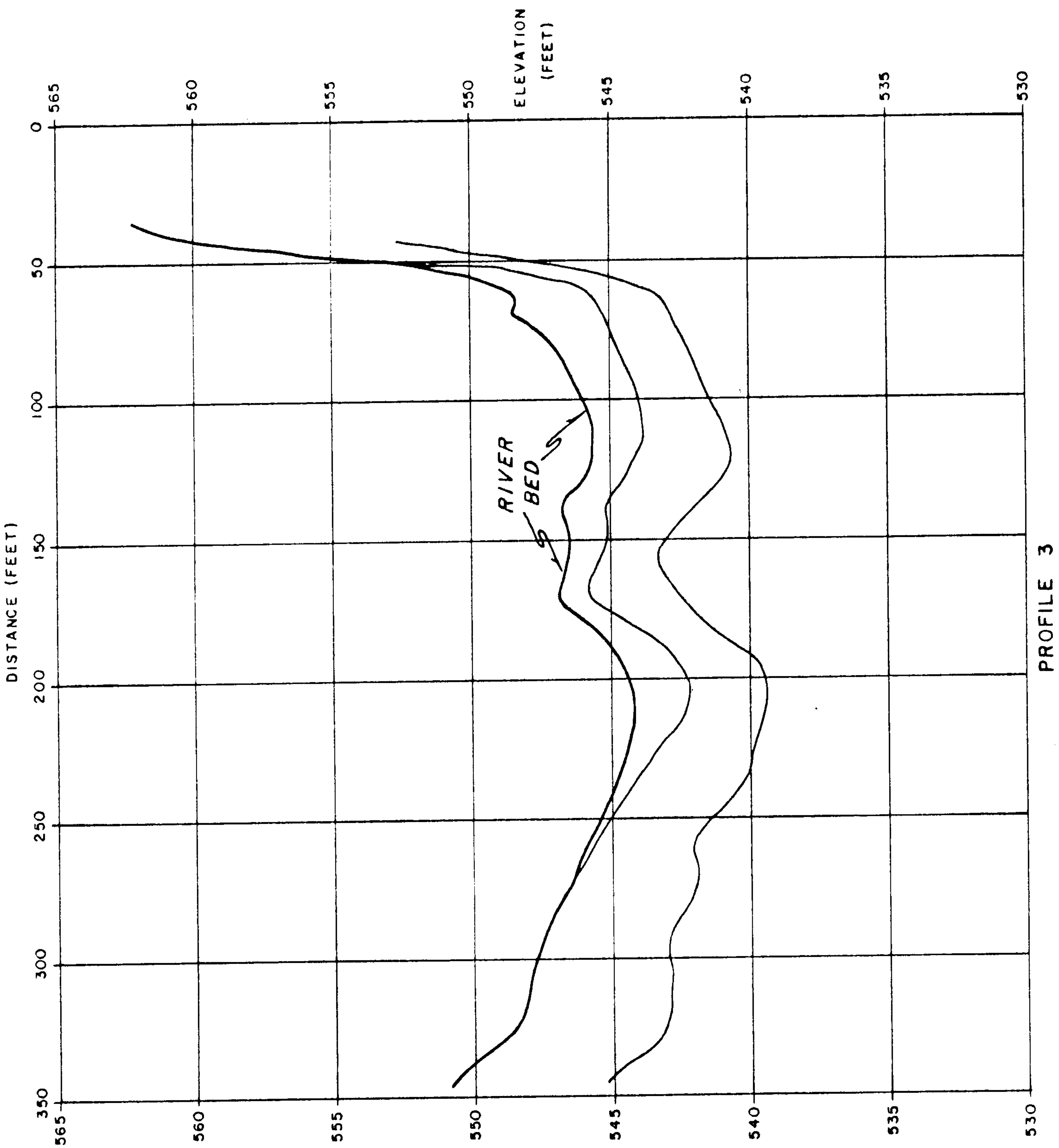
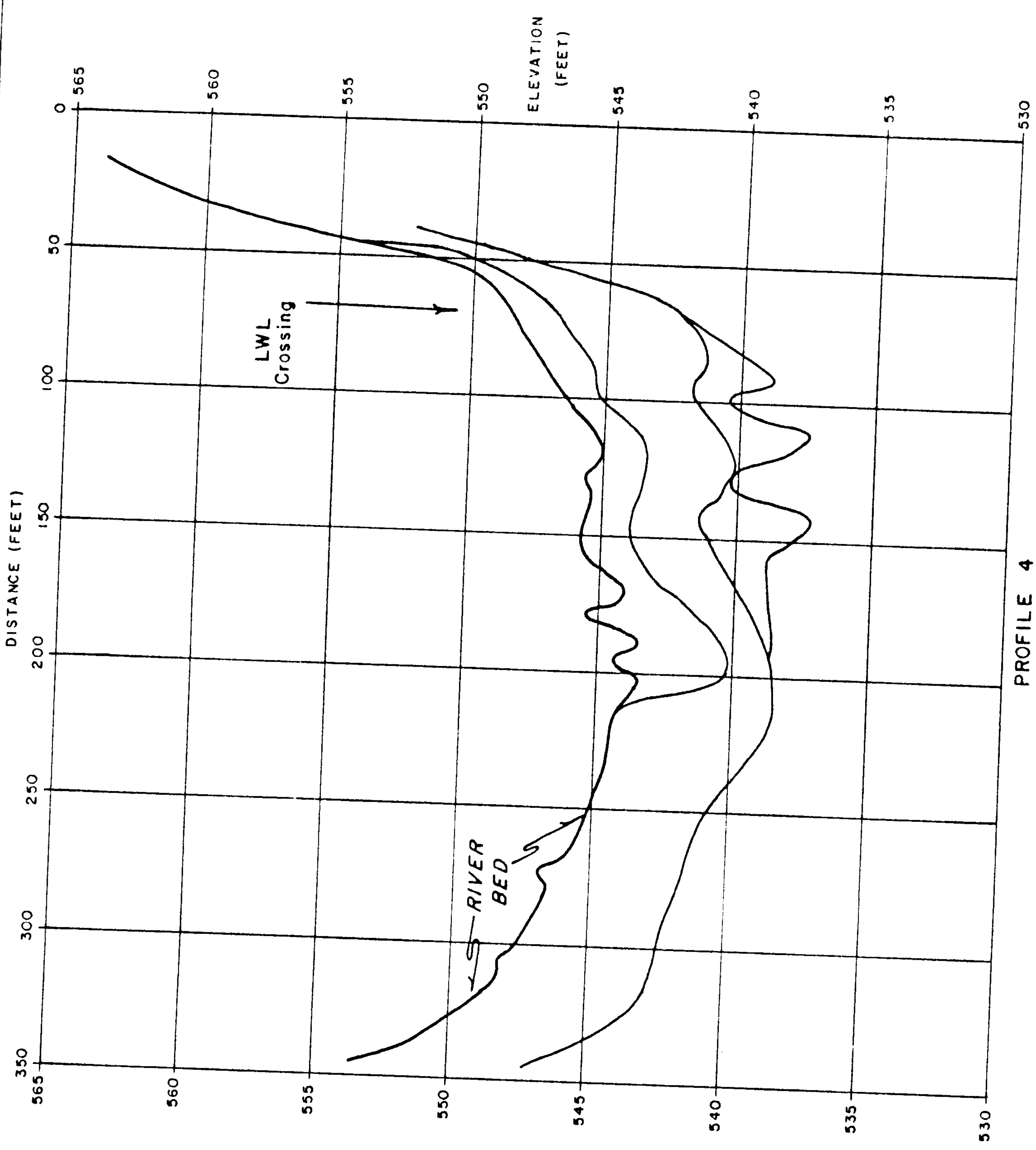


FIGURE NO. 5

SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

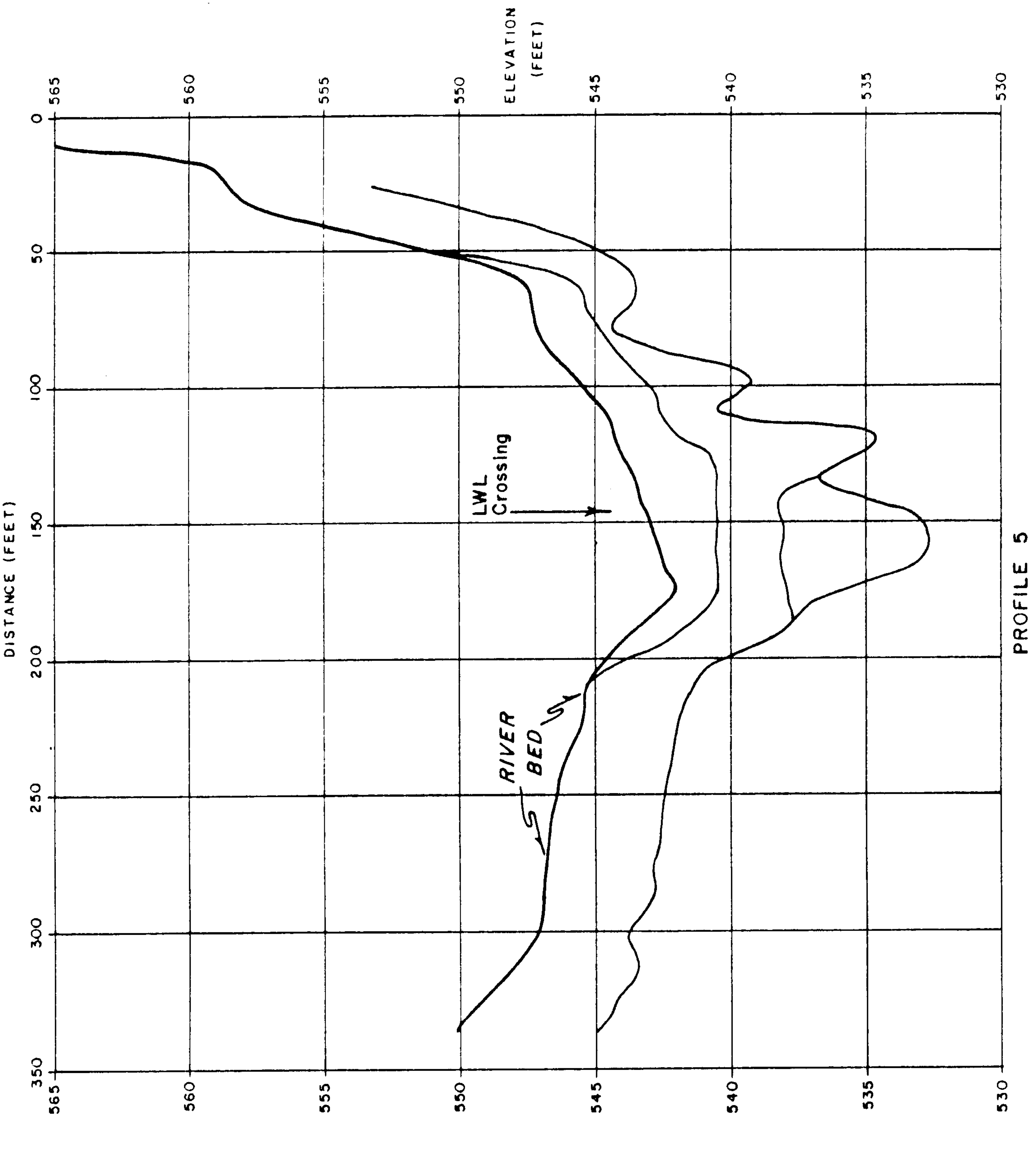
OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631 TLX 5106013995



SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

FIGURE NO. 6

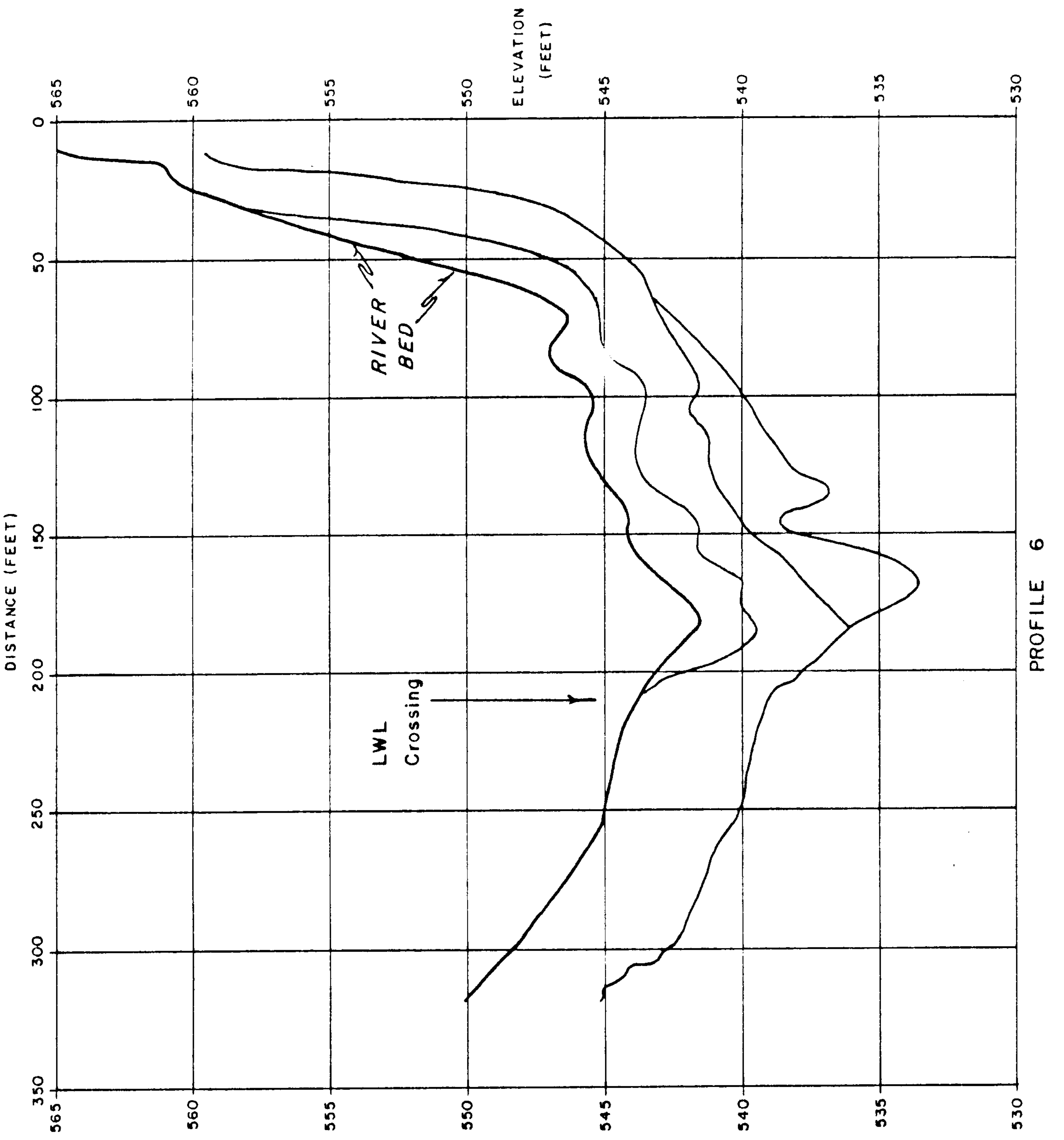
OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475



SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

FIGURE NO. 7

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631 TLX 5106013995



SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

FIGURE NO. 8

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631 TLX 5106013995

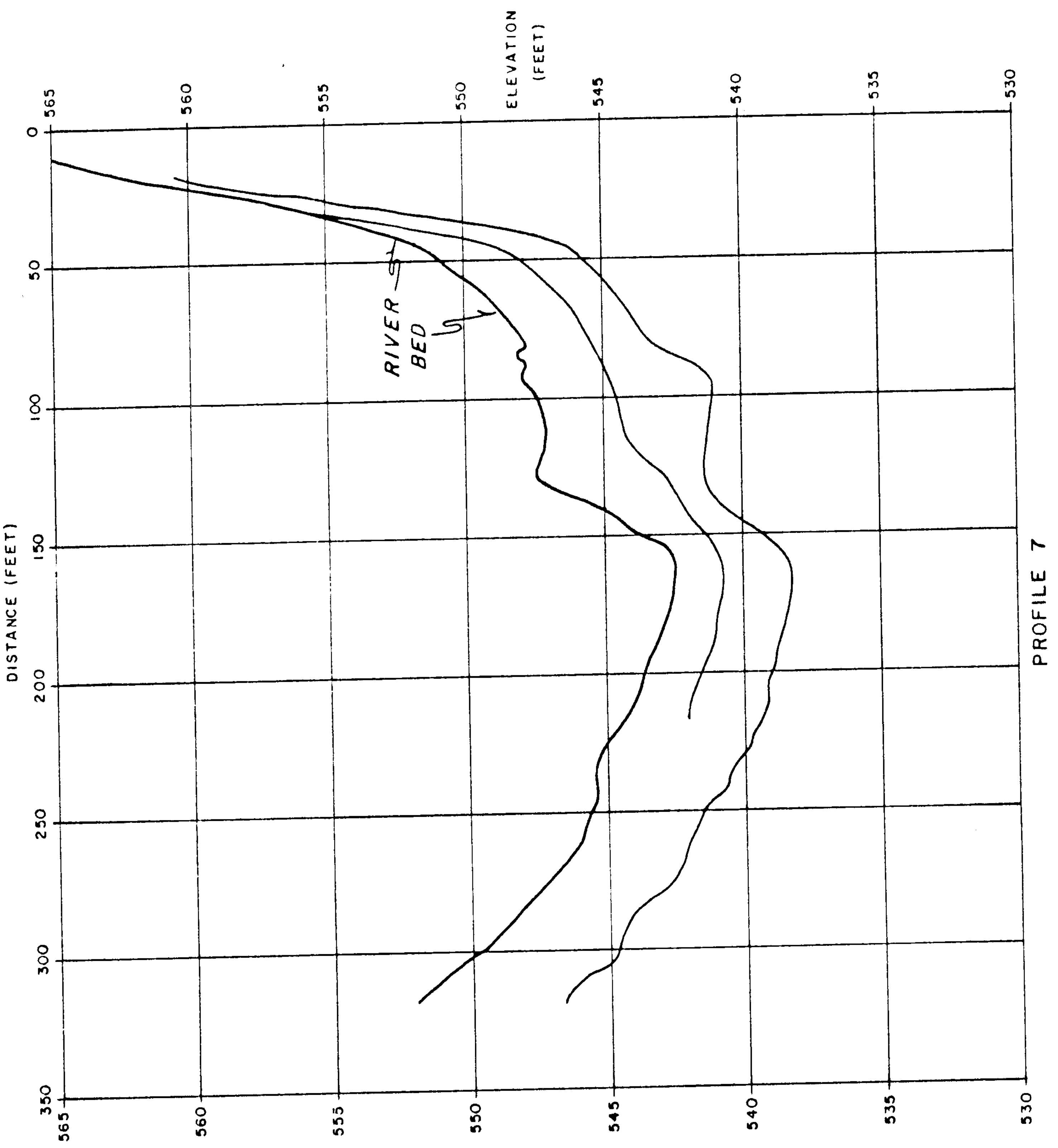


FIGURE NO. 9

SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

OCEAN SURVEYS, INC. OSI
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631 TLX 5106013995

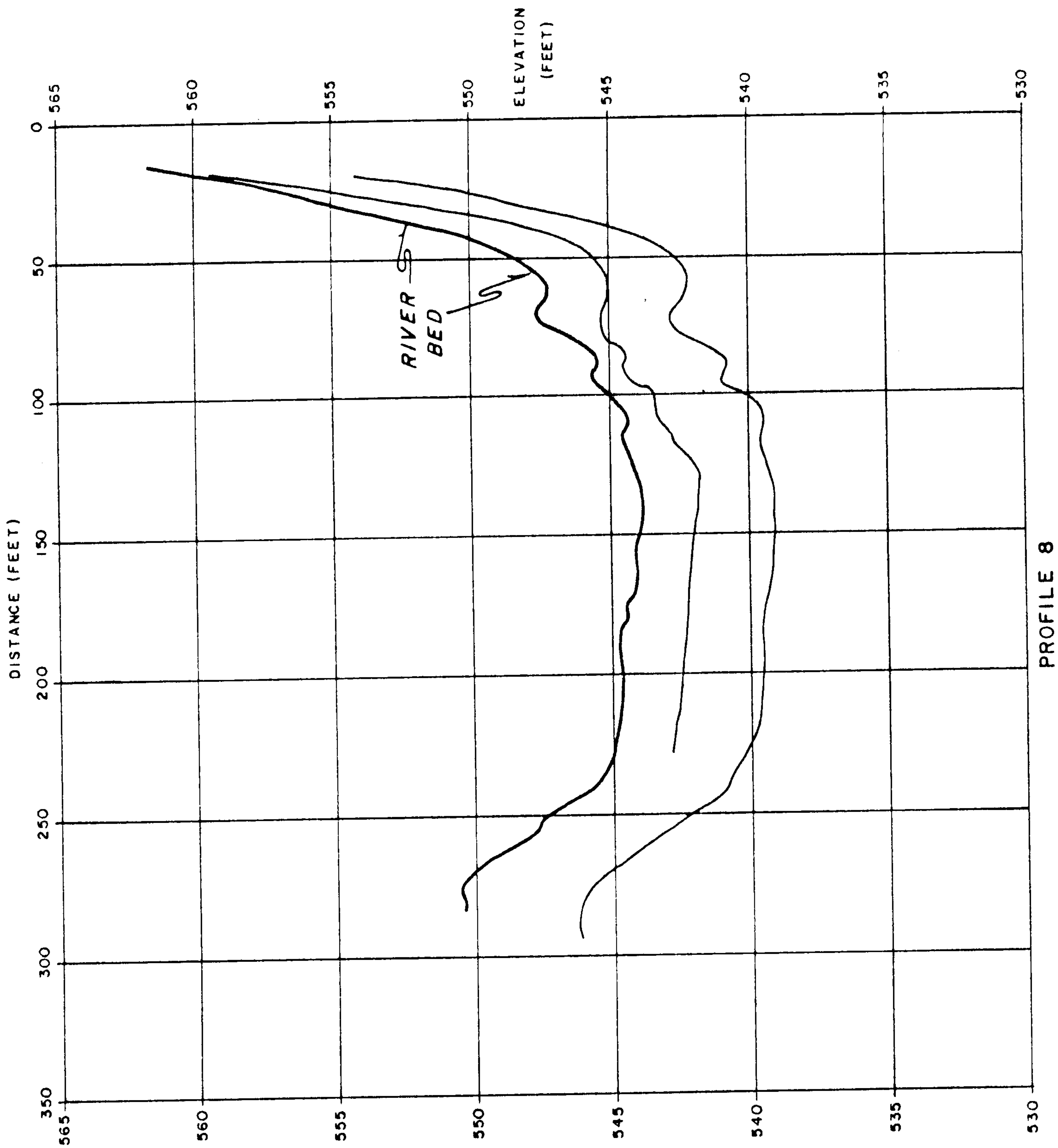
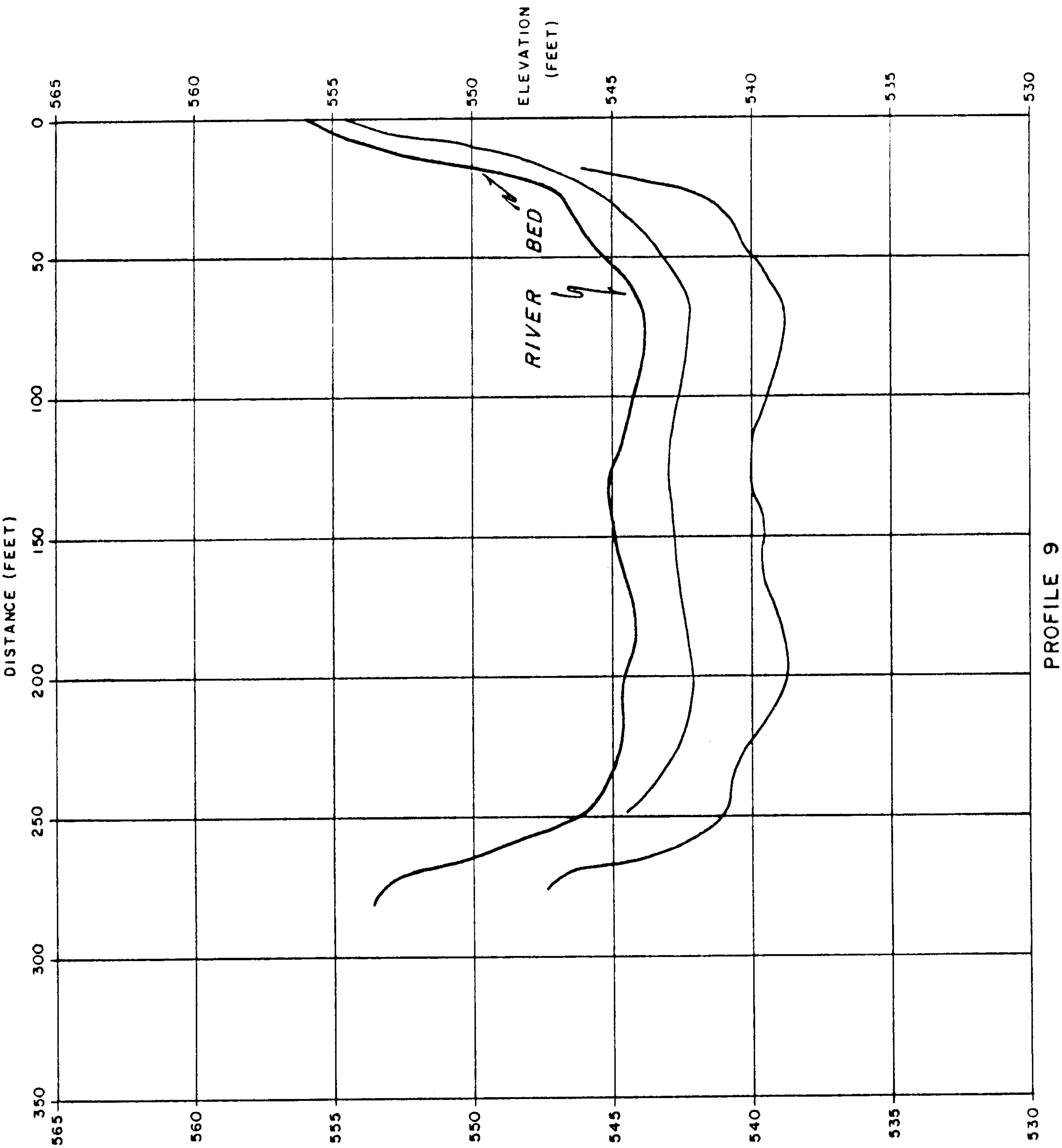


FIGURE NO. 10

SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631



SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

FIGURE NO. 11

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631

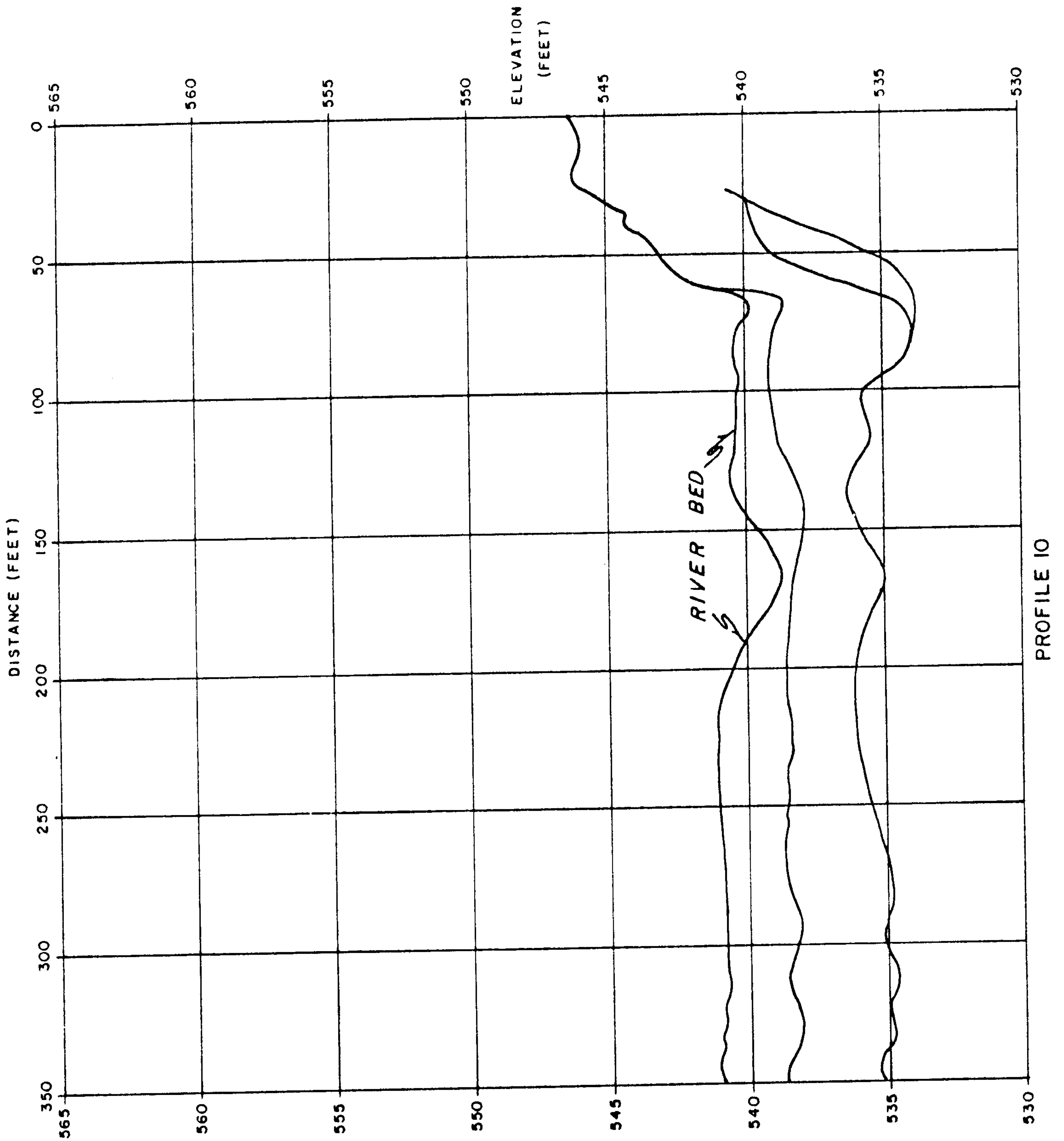
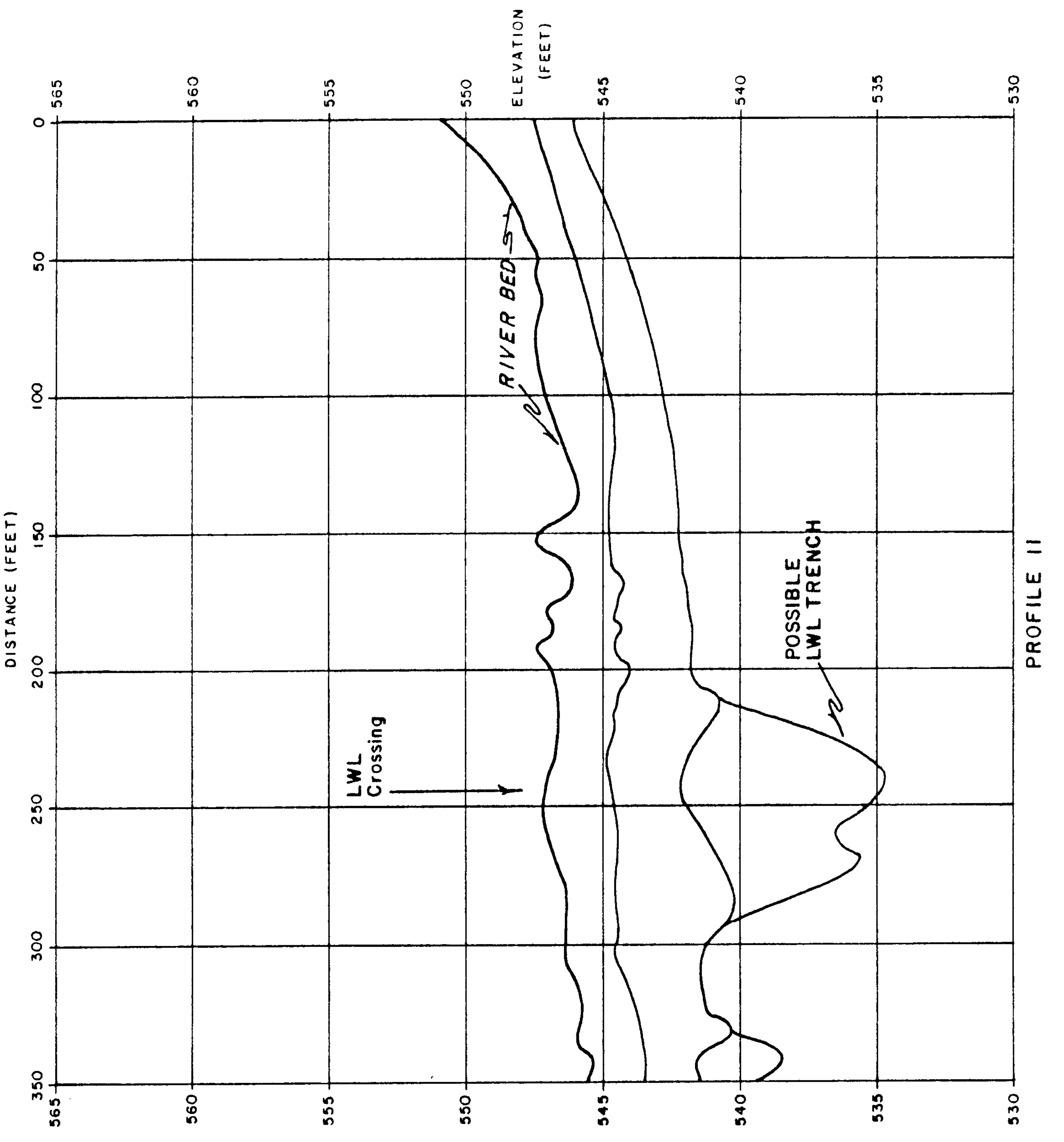


FIGURE NO. 13

SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631 TLX 5109013995



SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

FIGURE NO. 12

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475
TEL (203) 388-4631 TLX [illegible]