# ACOUSTIC AND MAGNETIC REMOTE SENSING AND SITE IDENTIFICATION SURVEY ALONG THE ALEXANDRIA, VIRGINIA WATERFRONT BETWEEN ORONOCO AND FRANKLIN STREETS AND ORONOCO BAY

Purchase Order No. 19460

Submitted to:

City of Alexandria Virginia
Finance Department
P. O. Box 178
City Hall, Alexandria
Virginia

Submitted by:

Gordon P. Watts, Jr.
Tidewater Atlantic Research
105 Meadow Drive
Washington, North Carolina 27889
919-946-9369

6 January 1986

ABSTRACT

In anticipation of dredging activity along the waterfront and additional alteration on Oronoco Bay in Alexandria, Virginia, the City of Alexandria contracted with Tidewater Atlantic Research of Washington, North Carolina, to conduct a remote sensing survey of the bay and central waterfront in order to identify and assess the potential project impacts on submerged cultural resources. During the period August 13-17, 1985, Tidewater Atlantic Research carried out a proton precession magnetometer survey of Oronoco Bay and a side scan sonar survey of the Alexandria water front from Franklin Street to Madison Street. The magnetometer survey of Oronoco Bay confirmed that modern debris used in filling the bay, sheet pile bulkheads, steel piers, and abandoned pump station pipelines masked the natural magnetic background in the area making identification of more subtle historically significant magnetic anomalies virtually impossible. The side scan sonar survey of the Potomac River waterfront between Franklin Street and Oronoco Bay identified a total of seven potentially significant anomalies. An on-site examination of the sonar targets confirmed that all cultural material associated with the signatures was of modern origin. None of the target sites contained cultural material considered to be historically or archaeologically significant, and no additional investigation of the survey areas or target sites is recommended unless future development threatens the present or historic environment. Any dredging or other disturbance of the river bottom along the Alexandria waterfront, including Oronoco Bay, should be monitored by City of Alexandria or other qualified archaeologists.

TABLE OF CONTENTS

Page

Abstract.....i

Table of Contents.....ii

List of Figures.....iii

Introduction.....1

Project Objectives.....3

Project Location and Environment.....3

Description of the Work.....4

Description of Equipment.....7

Description of Findings.....9

Conclusions.....19

Recommendations.....24

Bibliography.....25

LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1 | Project Location Map | 2 |
| 2 | Baseline Location Map | 5 |
| 3 | Targets A-900, B-1025:Location Plate Number 1 | 8 |
| 4 | Target A-900 Sonagram | 10 |
| 5 | Target B-1000/1050 Sonagram | 11 |
| 6 | Target C-2875:Location Plate Number 2 | 13 |
| 7 | Target C-2875 Sonagram | 14 |
| 8 | Targets D-3740, E-3900, F-5050, G-5375: Location Plate Number 3 | 15 |
| 9 | Target D-3740 Sonagram | 16 |
| 10 | Target E-3900 Sonagram | 17 |
| 11 | Target F-5050 Sonagram | 20 |
| 12 | Target G-5375 Sonagram | 21 |
| 13 | Oronoco Bay Magnetic Chart | 22 |

INTRODUCTION

In anticipation of dredging activity along Alexandria's Potomac River waterfront the City of Alexandria sponsored an acoustic and magnetic remote sensing and site identification survey designed to identify and assess the potential impacts of the proposed dredging on submerged cultural resources as required by the National Environmental Policy Act, Section 106 and 110 (formerly E. O. 11593) of the National Historic Preservation Act of 1966 as amended following the Advisory Council on Historic Preservation Regulations (36 CFR 800). The remote sensing survey was to be designed to locate and identify submerged cultural resources in the area of proposed dredging and generate sufficient data to make an initial assessment of their significance in accordance with criteria established for determining eligibility to the National Register of Historic Places.

The survey was carried out by Tidewater Atlantic Research of Washington, North Carolina between August 13-17, 1985, in accordance with Purchase Order number 19460 from the City of Alexandria, Virginia. The investigation was carried out from a light draft vessel suitable for shallow water operations. A proton precession magnetometer capable of + or - 1 gamma resolution was employed to collect the magnetic data. The instruments marine sensor was spar mounted on the bow of the survey vessel to minimize the influence of modern debris. To provide acoustic data a high resolution side scan sonar was operateded in conjunction with the magnetometer. Positioning to control data collection during the survey was accomplished using a transit equipped with an electronic distance meter. To assure that the remains of sunken vessels and submerged waterfront structures would be reliably identified a total of nine sonar passes were made along the Potomac River baseline. In Oronoco Bay lane spacing for the magnetic survey was designed to assure a maximum separation of fifty feet to insure identification of small targets. Each anomaly located during the survey were refined to permit highly accurate positioning and to facilitate signature analysis. All magnetic data generated during the survey was contoured for analysis.

Analysis of the acoustic data confirmed the presence of a total of seven potentially significant anomalies in the Potomac adjacent to Alexandria. Sonargrams produced by the survey indicated that four of the targets could be considered bottom scours created by the currents, shipping activity, or possibly low profile bottom surface debris. The remaining three target signatures indicated the presence of material on the bottom surface. Each of these target sites was examined by SCUBA equipped members of the project staff to confirm the specific nature of material generating the target signature.

Analysis of the magnetic data confirmed that modern debris, pump station transfer pipelines, and steel bulkheads and pier structures had created sufficient disturbance in Oronoco Bay to mask most of the bay area. In the small area where the threshold of disturbance was low

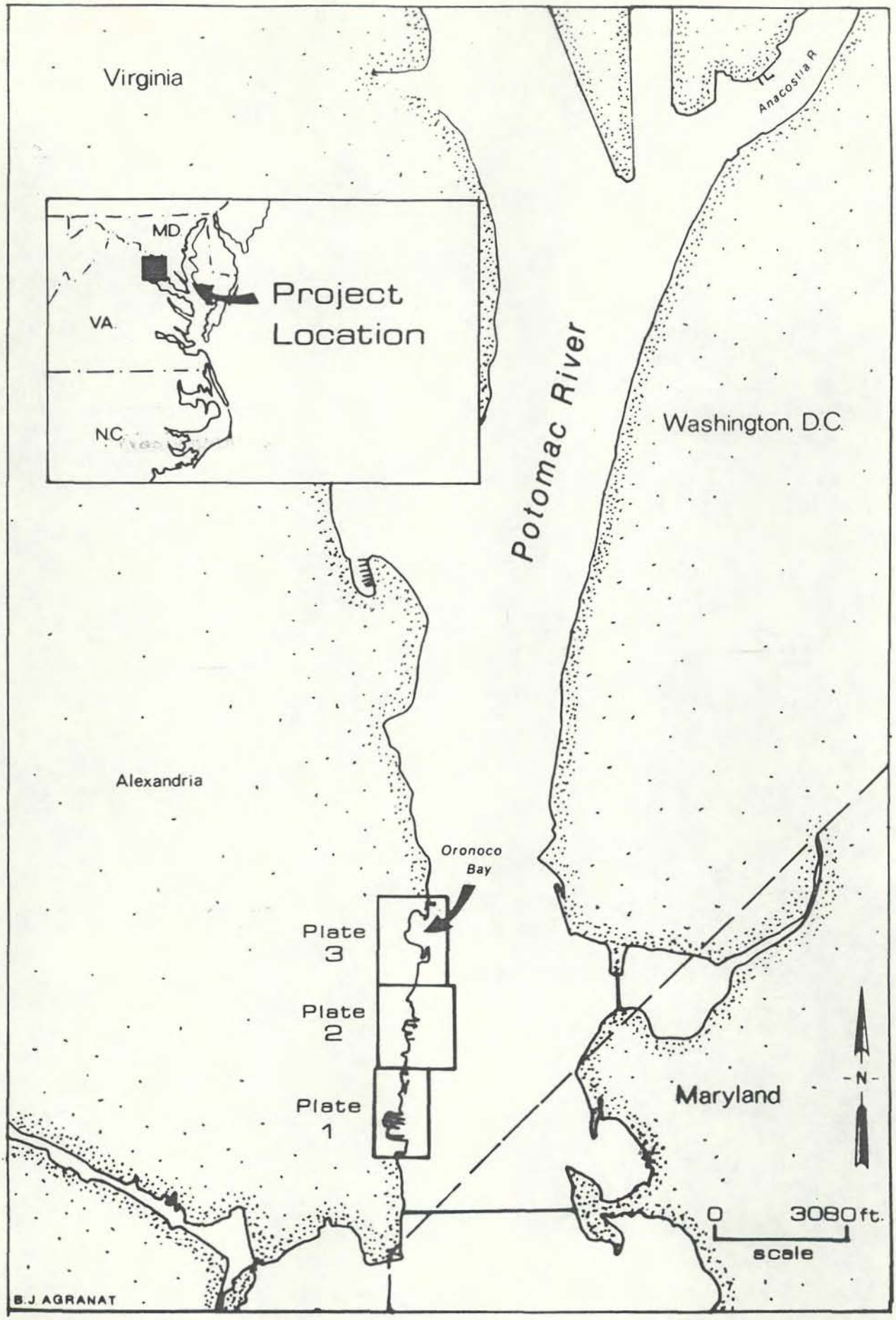



Figure 1. Project Location Map

enough to permit identification of concentrations of historically significant cultural material, no targets were found. An attempt to use side scan sonar in the shallow waters of the bay proved unsuccessful due to the high density of vegetation in the water column.

As none of the sonar target sites contained cultural material considered to be historically or archaeologically significant and no additional investigation of the Potomac River survey area or target sites is recommended. In Oronoco Bay only actual physical examination of the sub-bottom environment is likely to produce evidence of submerged cultural material. In light of the degree to which the bay has been filled and amount of modern debris abandoned at the site, this would be both difficult and costly. In light of the nature and potential significance of historically documented vessel remains abandoned in Oronoco Bay, no additional investigation of the area appears justified.

## PROJECT OBJECTIVES

The purpose of the acoustic and magnetic remote sensing and site identification survey of the Alexandria waterfront and Oronoco Bay was to locate, identify, and assess the significance of submerged cultural resources in areas where proposed dredging and other bottom disturbing activities could cause the destruction of underwater archaeological sites. Survey activities were designed to identify potential resources through magnetic and acoustic remote sensing. Target sites that generated signatures indicative of historic and/or prehistoric cultural material were examined and probed to confirm the nature of material creating each signature and prepare a preliminary evaluation in terms of criteria established in compliance with the National Historic Preservation Act of 1966 (Public Law 11-190), Executive Order 11593, and the Advisory Council on Historic Preservation Procedures for the protection of historic and cultural properties (36 CFR Part 800).

## PROJECT LOCATION AND ENVIRONMENT

The town of Alexandria, Virginia is situated on the Atlantic Coastal Plain physiographic provence and lies on the south shore of the Potomac River below the fall line (Figure 1). The Potomac River is a tributary to the western Chesapeake Bay and in the Alexandria vicinity is subject to tidal fluctuations. Water depth in the channel averages twenty-five feet and the bottom is relatively featureless due to the deposition sediments washed down from above the fall line. The channel lies adjacent to the south bank where a well defined shoulder slopes up to the water's edge at an angle of approximately thirty-five degrees. Along the north side of the river the shoreline consists of a

complex of shallow water estuaries. In the study area bottom material was found to be light unconsolidated sediments and viscous mud composed of heavier sediment materials. At several locations in the channel more than eight feet of these sediments were found to cover more consolidated clay. The water column was found to contain considerable suspended particulate and light penetration was limited to the upper five feet. Due to the amount of matter suspended in the water column visibility was limited to approximately eighteen inches near the surface and zero on the bottom. In the shallows hydrilla was found to have clogged the water column.

Oronoco Bay is a small shallow embayment on the south side of the Potomac River at the north end of the study area. Although originally significantly larger, Oronoco Bay has been reduced in size and depth through historically documented land reclaimation activities (Shomette, 1985). Today Oronoco is a small shallow flat bottom basin with an average depth is less than three feet. The bottom was found to slope gently toward the confluence with the Potomac. Bottom surface sediments were found to consist of unconsolidated light sediments, organic material, and modern debris. Visibility in Oronoco Bay was found to be approximately two to three feet as the water column was found to contain less suspended sediment than the Potomac. Like the Potomac shallows, hydrilla clogs the shallow water in the northern and northeastern extremities of the bay.

## DESCRIPTION OF THE WORK

Following a planning meeting with the staff of Alexandria Archaeology a preliminary reconnaissance of the Alexandria waterfront was carried out to identify control points for the remote sensing survey. An on-site examination of potential control points confirmed that the side scan sonar could be controlled from a transit/electronic distance meter station set up on the northeast corner of the Ford Plant dock off the foot of Franklin Street. This position provided an unrestricted view of the Alexandria waterfront from Franklin Street to a point well west of Oronoco Bay. An on-site examination of potential control points for the magnetometer survey of Oronoco Bay confirmed that the most advantageous location was the center point of a newly constructed dock structure on the west bank. This position provided an unrestricted view of the survey area and permitted maximum length survey lanes. Both reference stations were easily located on a survey area base map (Figure 2).

After survey control points had been identified the transit and electronic distance meter (EDM) were set up on the northwest corner of the Ford Plant dock. The side scan was mounted in the survey vessel with the sonar transducer deployed from the starboard side. Prisms for the EDM were mounted amidships on a spar fitted into a socket in the vessel console. Radio communications were established between the survey vessel and transit station to permit transmission of positioning data. Once the side scan sonar had been tuned for maximum

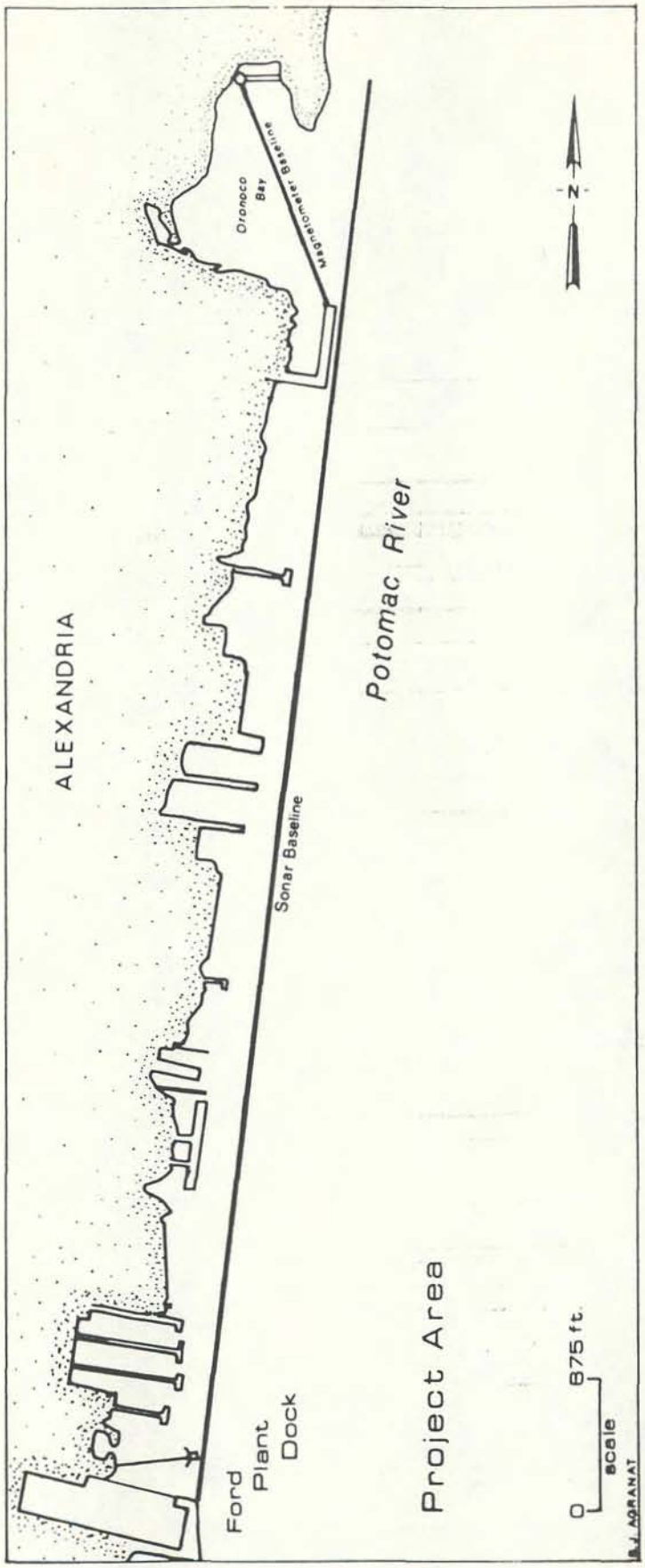



Figure 2. Baseline Location Map

record qualtiy in the Potomac environment a baseline survey lane was established between the Ford Plant station and a dolphin cluster associated with an abandoned pump station west of the mouth of Oronoco Bay. The survey lane would provide reliable baseline positioning for the survey vessel and permit highly accurate target location. With positioning control established and the sonar functioning, survey activities were initiated.

Once the survey vessel was maneuvered onto the baseline lane a begin-run distance was transmitted from the transit station. Each start distance was noted on the acoustic records and the survey vessel initiated its run. A maximum vessel speed of two knots was maintained throughout the remote sensing operation. During each run the transit was used to keep the vessel on lane and the EDM was used to provide positioning events as a factor of distance from the transit station. Positioning data was transmitted via radio and each event mark was noted on the acoustic records as a designated event mark. At the end of each lane the survey vessel returned to the northern extremity of the Alexandria waterfront to a position appropriate for the start of the next run. A total of 5 runs were required to assure adequate coverage of the survey area.

On the following day, August 15, 1985, the transit station was set up at the center point of a newly constructed dock structure near the north end of Oronoco Bay (Figure 2). A baseline was established between that point and the northwest corner of a dock structure located immediately east of the mouth of Oronoco Bay. The sonar baseline was approximately 400 feet from shore at the base of Duke Street and 250 feet from shore at the base of Oronoco Street. From this baseline a series of survey lanes were established by turning angles to the north and south of the baseline. To assure that maximum lane spacing would not exceed thirty feet, transit angles were calculated in accordance with the maximum distance from the transit station. Lanes in Oronoco were initiated at the southern extremity of the bay and run north to the transit station on the dock structure.

Once on the appropriate lane a begin-run distance was transmitted from the transit station and noted on the magnetic records. With the start run event confirmed the survey vessel initiated its run. During each run the transit was used to keep the vessel on lane and the EDM was used to provide positioning events. Reference station data was transmitted via radio and each station was noted on the magnetic records as a designated event mark. At the end of each lane the survey vessel returned to the southern extremity of Oronoco Bay to a position appropriate for the start of the next run. A total of 28 runs were required to assure adaquate coverage of the survey area.

Following completion of the magnetometer survey in Oronoco Bay, the transit control station was reestablished on the northwest corner of the Ford Plant dock and the magnetometer was used to examine an area downstream of the dock structure located immediately east of the mouth of Oronoco Bay and an acoustic target west of the designated survey

area. Using the same techniques previously employed for controlling survey data, six additional side scan sonar runs were also carried out along the baseline lane to refine target signatures identified in the previously generated sonagram records and facilitate placement of target buoys. Buoys would be used to identify each target designated for an on-site examination.

On August 16, the data from both survey areas was analized to identify anomalies requiring additional examination. Each survey lane in Oronoco Bay was plotted on a basemap provided by Alexandria Archaeology. Magnetic data associated with each survey lane was reviewed and the background magnetics and each significant anomaly was identified and noted on the chart. Initial plotting of the data confirmed that virtually all of Oronoco Bay was masked by modern fill material, pier structures, bulkheads, pipelines, and a recently constructed dock.

Analysis of the sonagram records identified a total of seven potentially significant anomalies in the Potomac survey area. These occurred at stations 900, 1000-1050, 2875, 3740, 3900, 5050, and 5375 feet north of the Ford Plant Dock transit/electronic distance meter station and were all confirmed on more than one side scan sonar pass along the waterfront. Analysis of the sonagram records indicated that four of the targets could be considered bottom scours created by currents, shipping activity, or possibly low profile bottom surface debris. The remaining three target signatures indicated the presence of material on the bottom surface.

During the afternoon of August 16, three targets sites were examined by members of the project staff using SCUBA diving equipment. At each site the survey vessel was anchored in the immediate vicinity of the target buoy. Divers then systematically examined the bottom until bottom features or material generating the signature were located. Due to the high sediment content of the water visability was limited above ten feet and zero below ten feet. Examination of the target sites was carried out by feel and probing to insure that sub-bottom material would be located if present. On August 17, on-site investigation of the targets resumed and the final four anomalies were examined.

## DESCRIPTION OF THE EQUIPMENT

Survey activities were carried out from a 20-foot fiberglass boat. Designed and constructed for commercial purposes by Privateer Manufacturing, Inc., the center console vessel provided a servicable shallow-draft platform for survey operations.

Magnetic data was collected using a Littlemore Scientific Proton Precession Magnetometer. The instrument was designed to provide +- 1 gamma resolution. To minimize the influence of small, modern debris in the shallow water, the sensor was spar-mounted on the bow of the

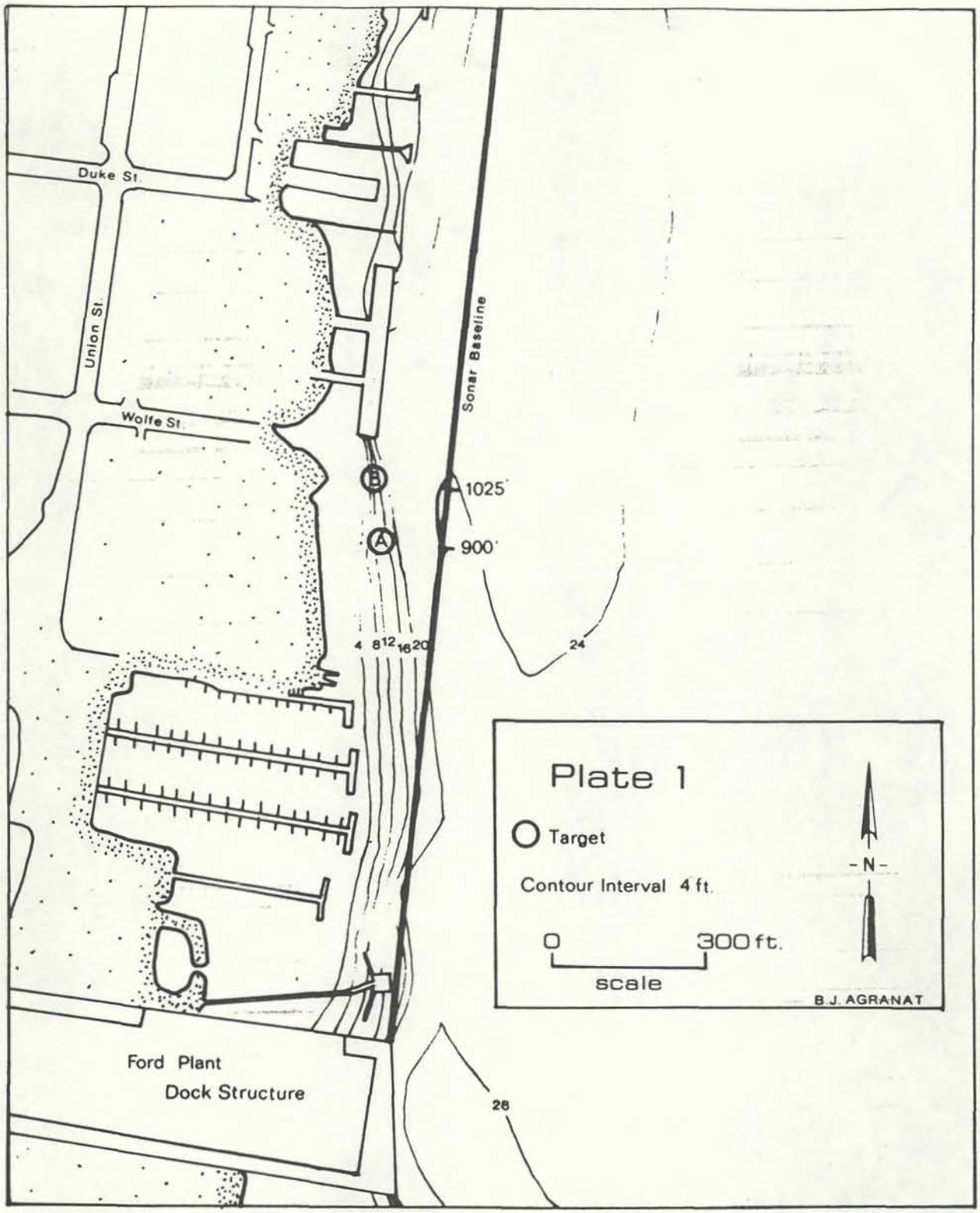



Figure 3. Targets A-900, B-1025: Location Plate Number 1

vessel rather than towed in the water column. All magnetic data was recorded on paper on the instrument's analog recorder.

Acoustic data was collected using a Klein high resolution Model 431 side scan sonar. The instrument was designed to provide high quality sonargram records of the bottom surface and exposed cultural material. To maximize the sonagram record quality in shallow water the sensor was suspended from the starboard side of the survey vessel at a depth of five feet. All sonagram data was recorded on wet chemical paper.

Bathymetric and surface sediment data were generated by an Aquameter Instruments Model 390 bathymetric recorder. The instrument was designed to operate at 200 kHz through a transom-mounted transducer. All data were recorded on paper on an analog recorder.

Precise positioning necessary to control data collection was accomplished using a Leitz transit and electronic distance meter (EDM). The transit provided one minute azmuth survey accuracy and the EDM provided distance measurement accurate to tenths of a foot in the tracking mode and hundredths of a foot in the survey mode.

Continuously updated positioning data was transmitted to the survey vessel using Ray Jefferson 55 channel high frequency (VHF) radio.

Diving activities were carried out using standard self contained underwater breathing aparatus (SCUBA) tanks and regulators. Each diver was equipped with a protective wet suit, buoyancy compensator vest, weight belt, mask, fins, knife, and probe.

## DESCRIPTION OF THE FINDINGS

### Potomac River Sonar Survey

Analysis of the sonagram records identified a total of seven potentially significant anomalies in the Potomac survey area. These occurred at stations 900, 1000-1050, 2875, 3740, 3900, 5050, and 5375 feet north of the Ford Plant Dock transit/electronic distance meter station and were all confirmed on more than one of the nine side scan sonar passes along the waterfront. Analysis of the sonagram records indicated that four of the targets could be considered bottom scours created by currents, shipping activity, or possibly low profile bottom surface debris. The remaining three target signatures indicated the presence of material on the bottom surface.

### Target A-900

Target A-900 was identified 900 feet north of the transit station on the northwest corner of the Ford Plant Dock (Figure 3) in fourteen feet of water. Analysis of the signature (Figure 4) suggested that the

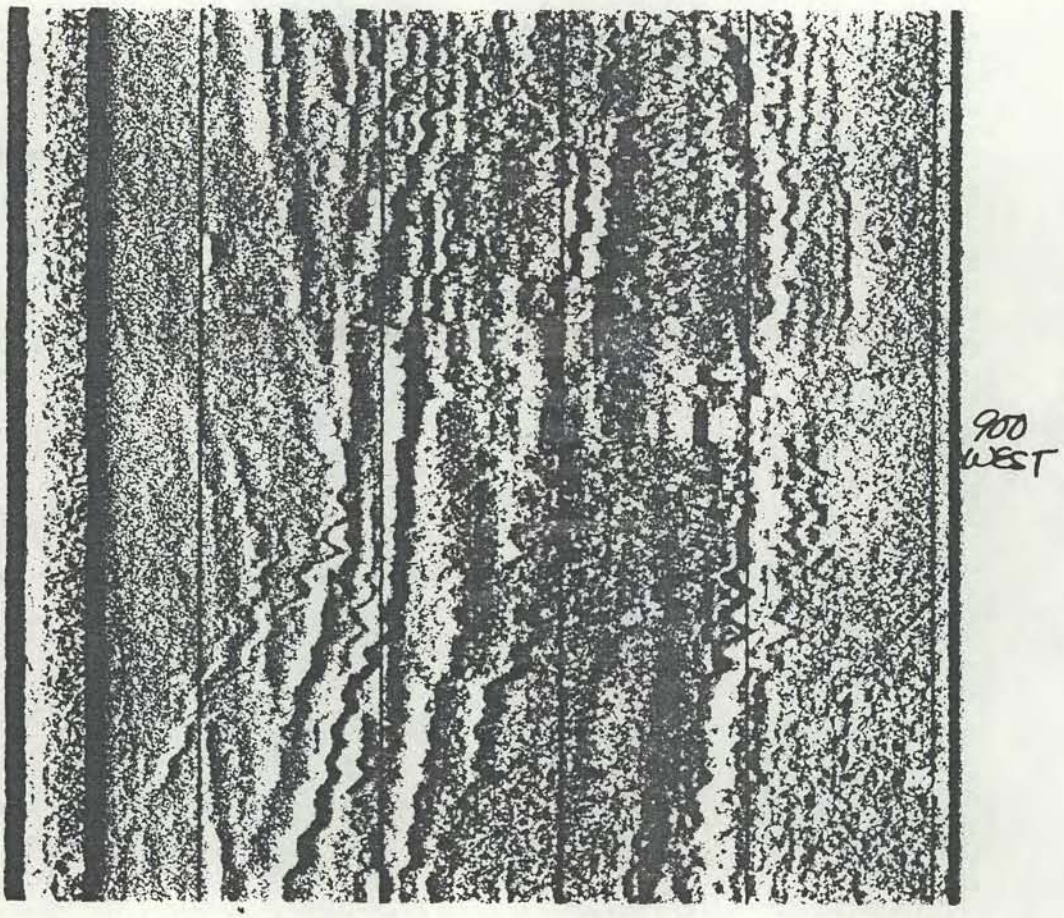



Figure 4. Target A-900 Sonagram

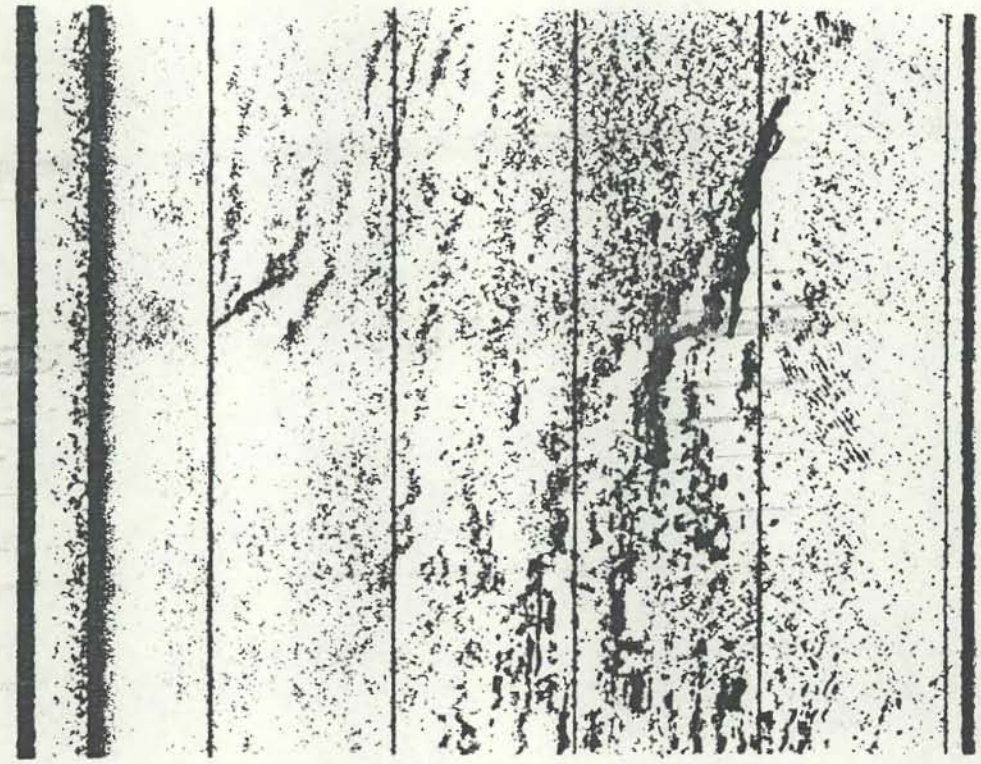


Figure 5. B-1000/1050 Sonagram

return was generated by material on the bottom surface. An examination of the bottom in the vicinity of the target confirmed that the signature was returned by a complex of piling fragments associated with a modern dolphin or dock structure. No additional material was found on the bottom surface at target site and probing of the bottom produced no indication of subbottom structure.

Target B-1000/1050

Target B-1000/1050 was identified 1000/1050 feet north of the transit station on the Ford Plant Dock (Figure 3) in twelve to sixteen feet of water. Analysis of the target signature (Figure 5) suggested that the return was generated by localized bottom sediment disturbances. An examination of the bottom in the vicinity of the target confirmed that the signature was returned by an anchor scour, more than five feet deep, produced by a vessel which departed the previous day. No additional material was found on the bottom surface at the target site and probing of the bottom produced no indication of subbottom structure.

Target C-2875

Target C-2875 was identified 2875 feet north of the transit station on the Ford Plant Dock in eight to twelve feet of water immediately west of the Torpedo Factory (Figure 6). Analysis of the target signature suggested that the return was generated by an extensive localized bottom disturbance and possibly material exposed on the bottom surface (Figure 7). Examination of the bottom confirmed that the signature had been returned by a pronounced disturbance in the bottom sediments. Between two docking dolphin a scoured trench with five feet of relief was identified. An examination of the feature identified no associated cultural material and probing produced no indication of subbottom structure.

Target D-3740

Target D-3740 was located 3740 feet north of the transit station on the Ford Plant Dock in eighteen to twenty feet of water approximately 240 feet from shore (Figure 8). Analysis of the target signature suggested that the return was generated by a long shallow natural bottom scour of exposed lense of sand or clay in the channel shoulder sediment profile (Figure 9). Examination of the bottom in the vicinity of the target confirmed that the signature was returned by a long shallow scour in the soft silt. The scour was oriented roughly parallel to the channel shoulder and contained no evidence of cultural

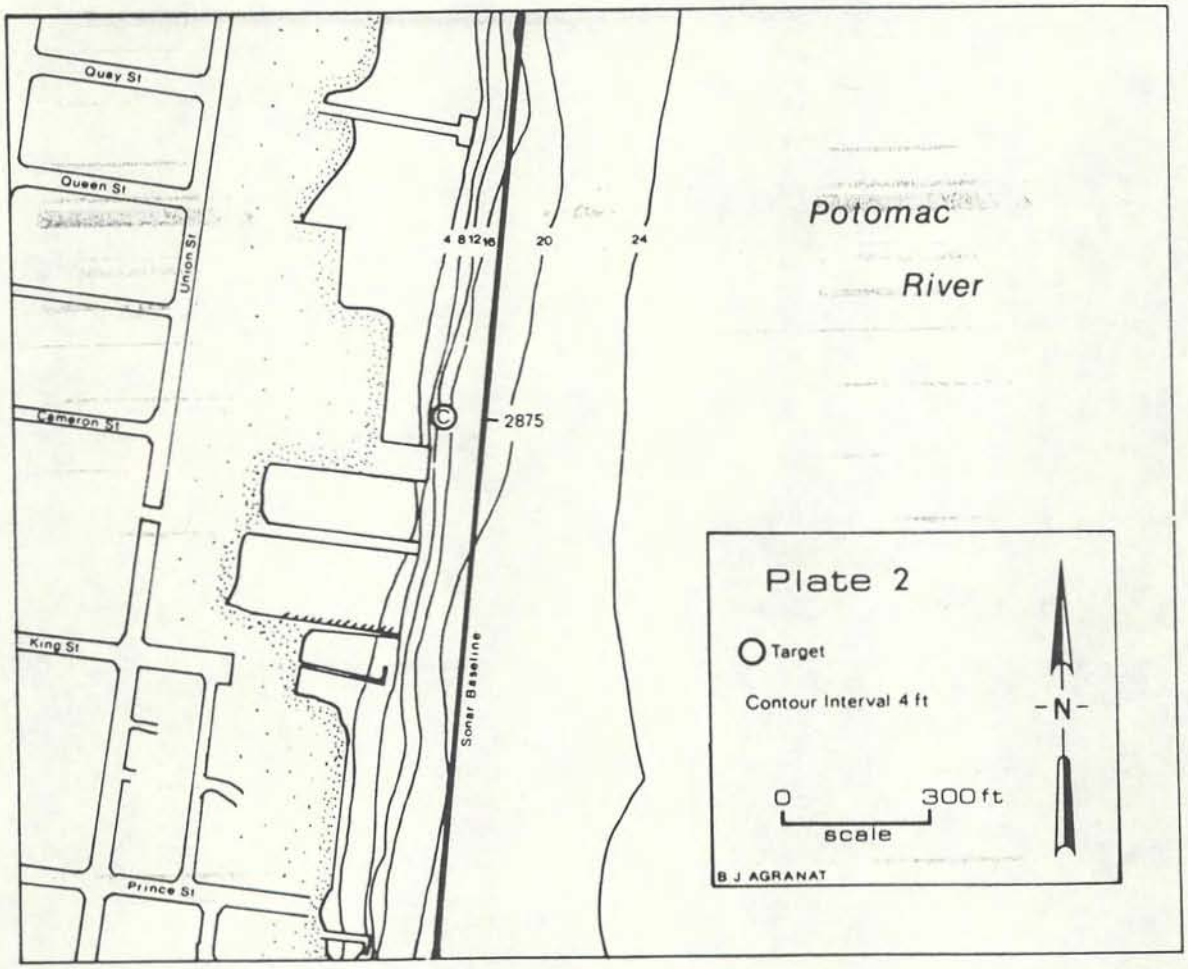



Figure 6. Target C-2875: Location Plate Number 2

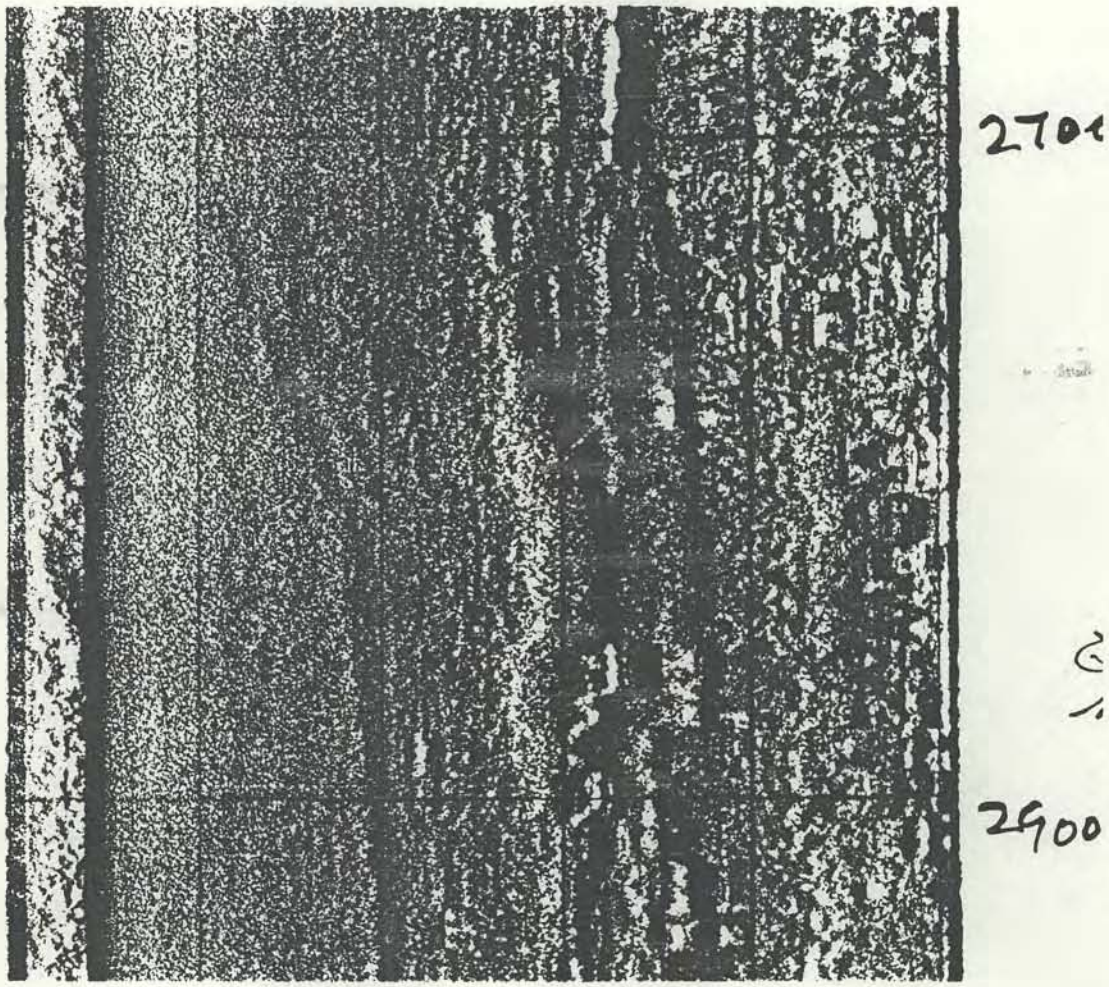



Figure 7. Target C-2875 Sonagram

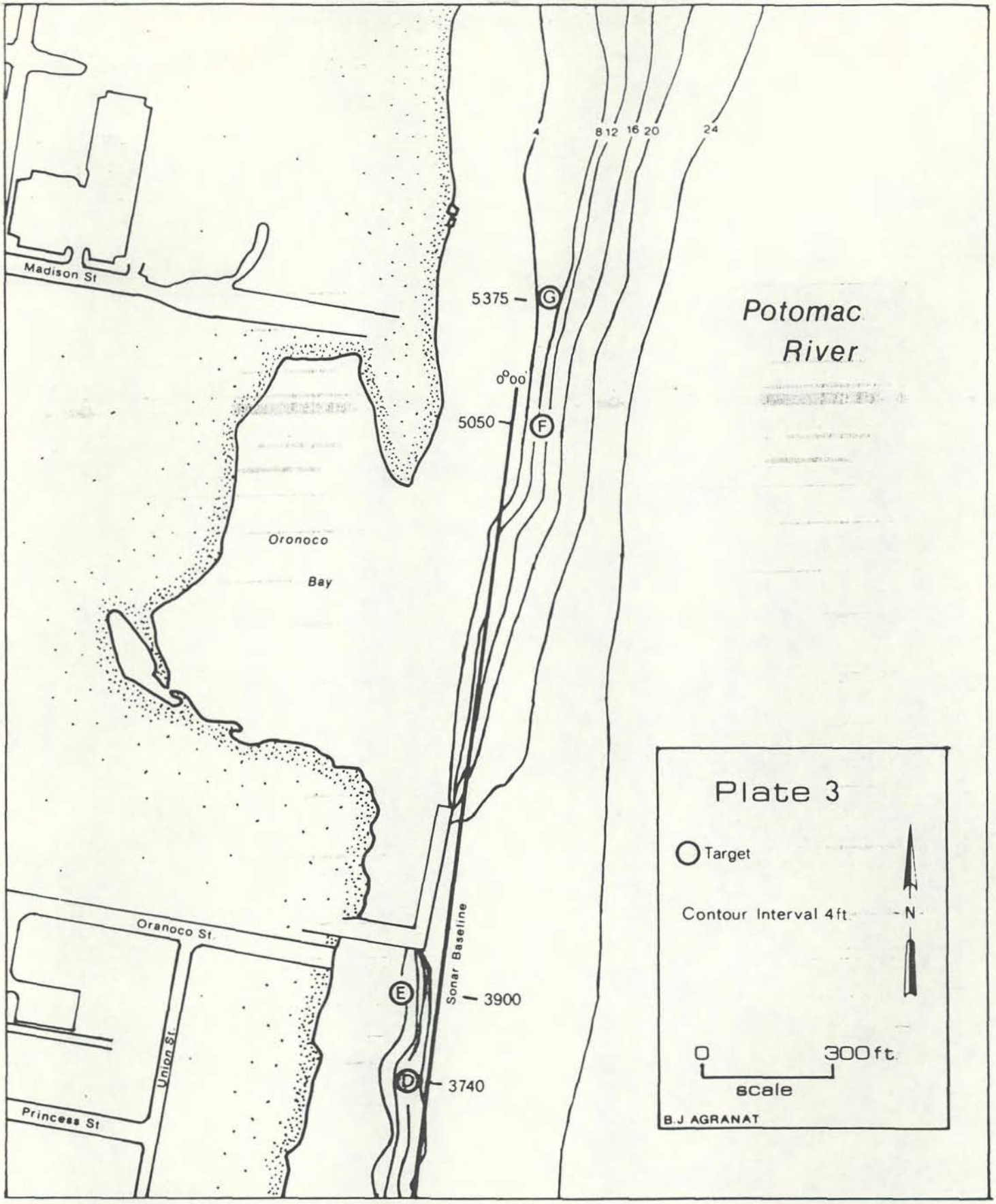
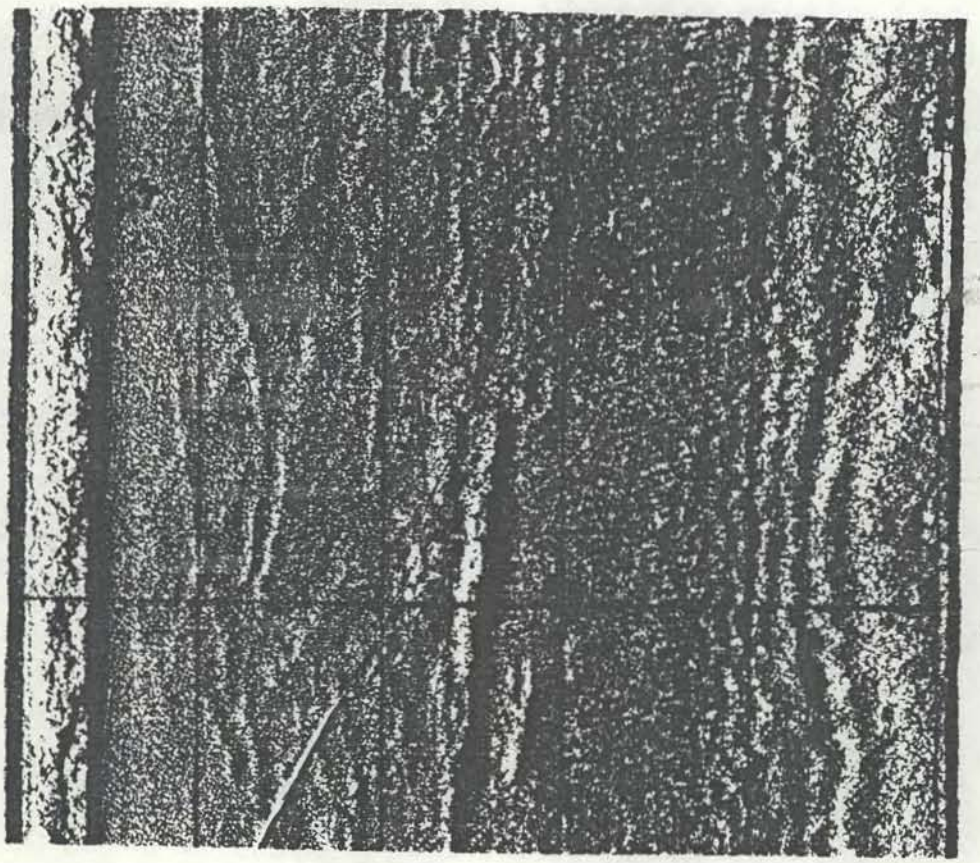



Figure 8. Targets D-3740, E-3900, F-5050, G-5375
Location Plate Number 3



3700'

Figure 9. Target D-3740 Sonagram

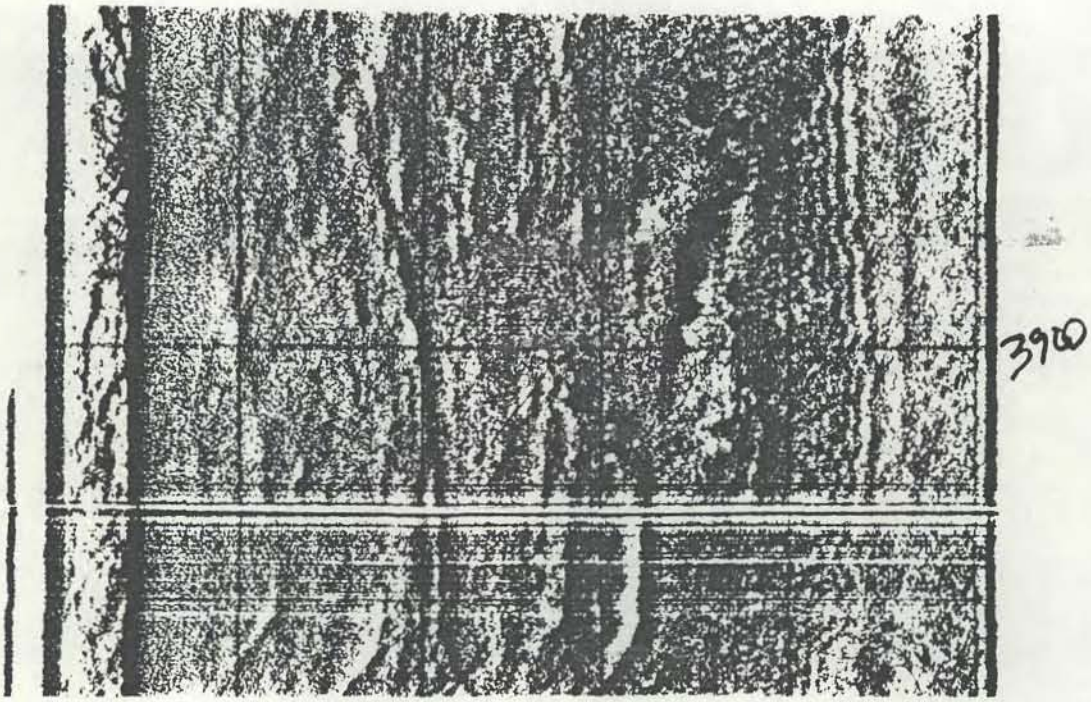



Figure 10. Target E-3900 Sonagram

material. Probing of the sediment produced no indication of subbottom structure.

Target E-3900

Target E-3900 was located 3900 feet north of the transit station on the Ford Plant Dock in four to 12 feet of water (Figure 8). Analysis of the target signature suggested that the return was generated by a bottom scour or exposed lens of sand or clay in the channel shoulder profile (Figure 10). An examination of the bottom confirmed that the signature had been produced by natural scouring. Examination of the bottom surface and probing of the bottom sediments in the vicintiy of the scour also identified the remains of a dead tree and 55-gallon drum. No evidence of cultural material, other than the drum, was found.

Target F-5050

Target F-5050 was located 5050 feet north of the transit station on the Ford Plant Dock in twelve to sixteen feet of water (Figure 8). Analysis of the target signature suggested that the return was generated by exposed material on the bottom surface (Figure 11). An examination of the bottom surface in the vicinity of the target confirmed that the signature had been returned by the remains of a modern dock structure. A ten-foot-long creosote impregnated piling and associated planking were found protruding from the channel shoulder near the remains of a pump station west of the entrance to Oronoco Bay. No additional cultural material was found at the site and probing of the bottom sediments produced no evidence of subbottom material in the vicinity of the dock structure.

Target G-5375

Target G-5375 was located outside the survey area 5375 feet north of the transit station on the Ford Plant Dock in seven to twelve feet of water approximately 240 feet from shore (Figure 8). Analysis of the target signature suggested that the return was generated by exposed material on the bottom surface (Figure 12). Examination of the bottom in the vicinity of the target confirmed that the signature had been returned by the remains of a collapsed and completely submerged pump station dock structure. The remains of the dock contained pumps, valves, transfer hoses, and other equipment used to load or unload liquid cargos. Investigation of the surrounding bottom surface and probing of the bottom sediments failed to identify additional cultural material in the vicinity of the dock structure.

Oronoco Bay Magnetometer Survey

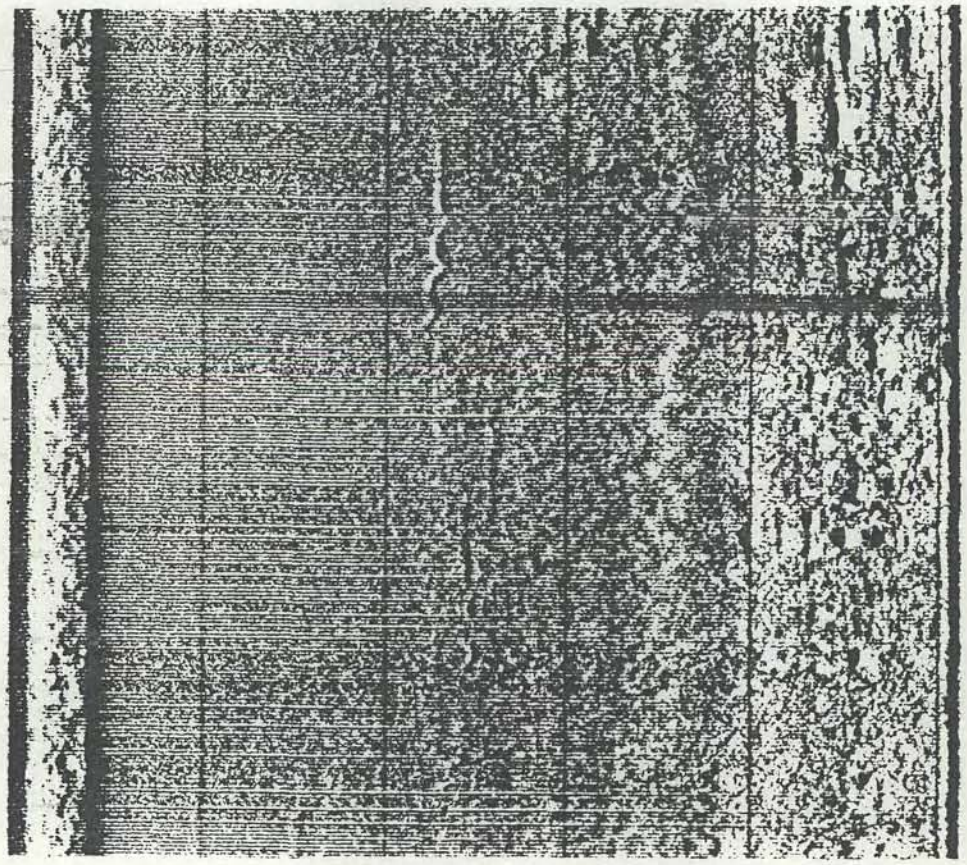
Analysis of the magnetic records generated by the Oronoco Bay survey confirmed that virtually all of the embayment was masked by modern fill material, pier structures, bulkheads, pipelines, storm drains, and a recently constructed dock. Along the south shoreline of Oronoco Bay an iron and concrete pier, steel sheet pile bulkhead, storm drain, and reinforced concrete rubble fill combine to generate an extensive magnetic disturbance. That disturbance masks much of the southern portion of the bay and makes identification of more subtle historically significant targets virtually impossible.

North of this disturbance natural magnetic background could be identified for a distance of approximately 200 feet in a band that was detectable from the Potomac River channel to the west shorline of Oronoco Bay. Within this area contour plotting of the data revealed two subtle anomalies that could be created by submerged cultural material. However, it is also possible that the signatures were created by the interaction of material creating the disturbance along the south shore and a second area of disturbance apparently created by pipelines connecting a pump station on the Potomac River channel with storage facilities located west of the bay in Alexandria.

North of the relatively undisturbed band extending roughly east to west across the bay the natural magnetic background was found to be extensively disturbed. This disturbance appears to have been created by the presensce of abandoned pipelines extending from a pump station on the west shoulder of the Potomac River channel to storage facilities that previously existed west of Oronoco Bay in Alexandria. The nature of the disturbance suggests that the pipelines may not extend across the entire width of the embayment.

The disturbance created by pipelines from the pump station was found to extend into additional disturbance created by reinforced concrete and other debris used to create a peninsula that extends into northeastern Oronoco Bay. The exact extent of the disturbance could not be determined as modern debris, silt, fill, and hydrilla made navigation in the northeast quadrant of Oronoco impossible.

West of the disturbance created by material used in building the peninsula and north of the area disturbed by the abandoned pipelines the natural magnetic background was identifiable. With the exception of a strong localized disturbance created by the remains of a small modern boiler the area was undisturbed all the way to the northwestern extremity of the bay. There fill material, modern debris, construction of a walk and pier structure created additional disturbance.



5050

Figure 11. Target T-5050 Sonagram

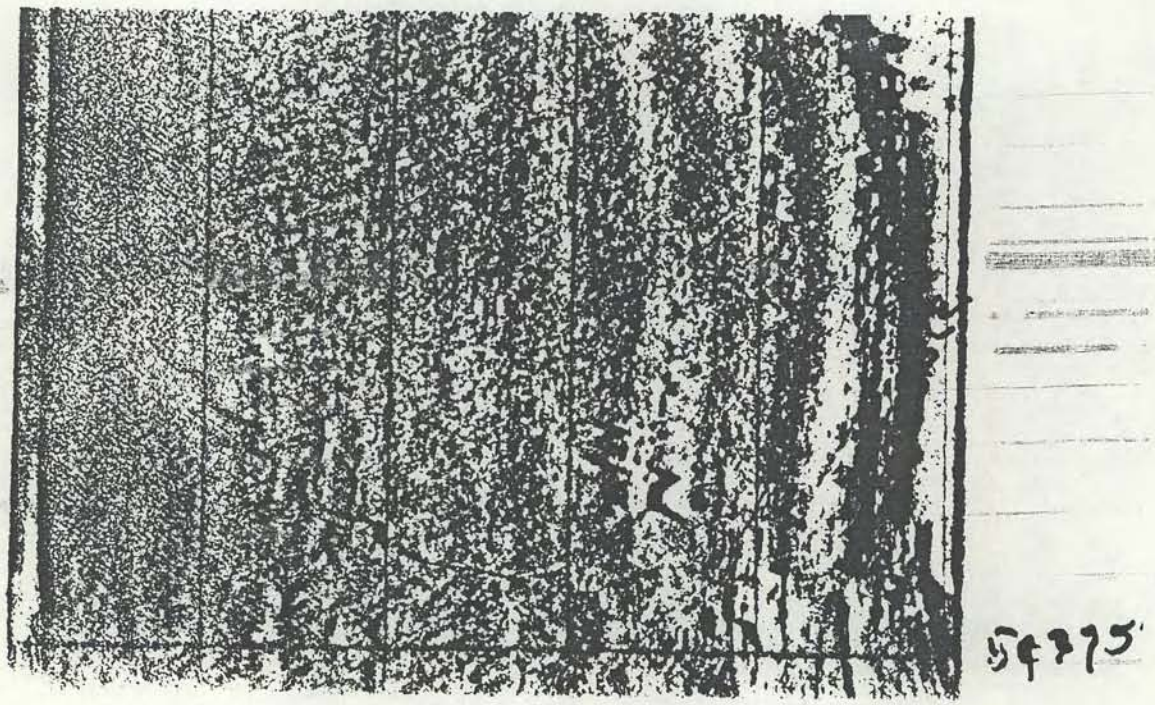



Figure 12. Target G-5375 Sonagram

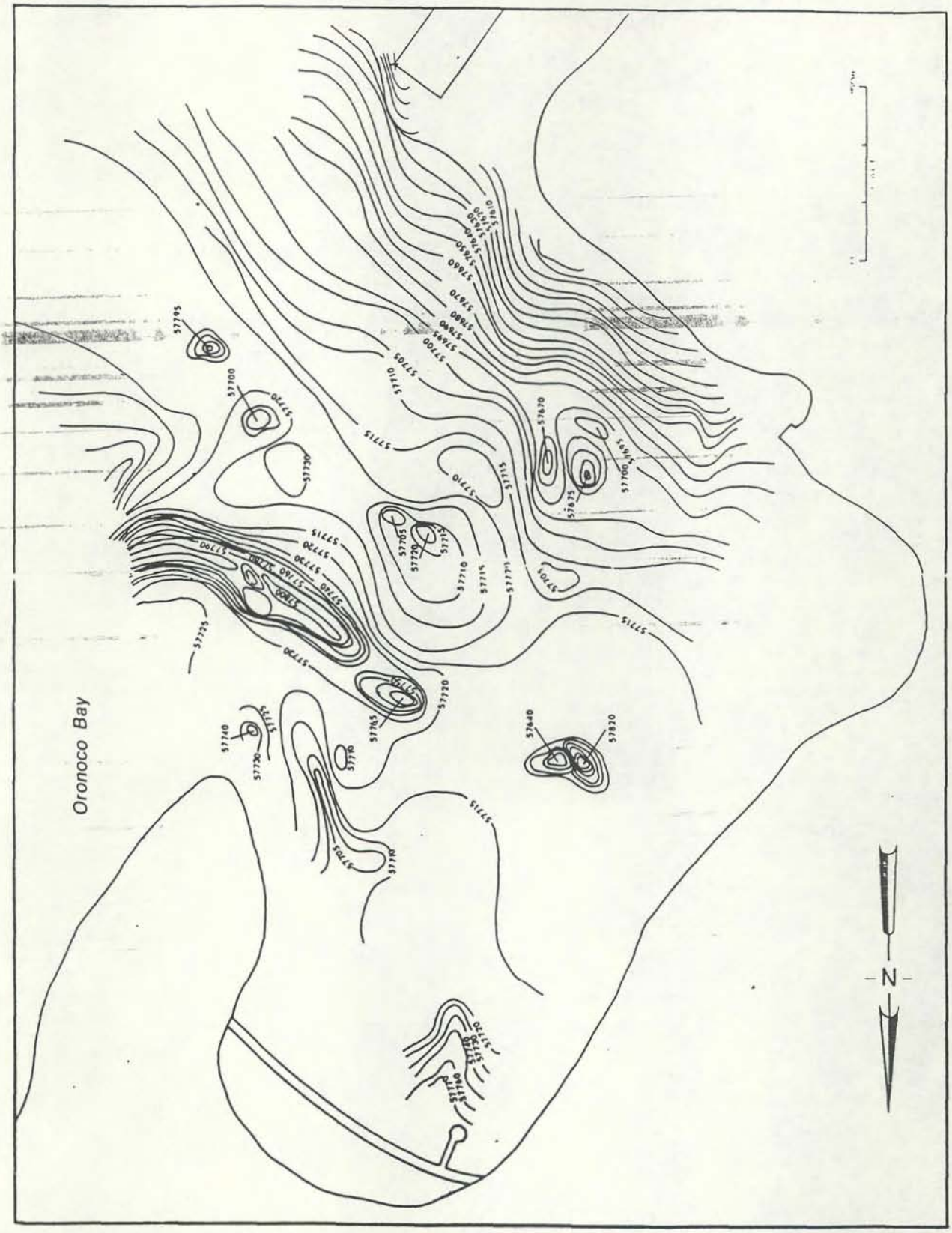



Figure 13. Oronoco Bay Magnetic Contour Chart

CONCLUSIONS

The side scan sonar survey of the Potomac River waterfront between Madison and Franklin streets identified a total of seven acoustic targets. Examination of the target sites confirmed that three of the signatures were returned by material exposed on the bottom surface. Two of the target signatures were returned by man made disturbance of the bottom sediments and one of the signatures was returned by natural bottom features. The final sonagram signature was returned by a natural bottom feature but, the site also contained modern cultural material. None of the side scan sonar targets identified during the survey were found to contain historically significant submerged cultural material. All of the cultural material associated with the Potomac River sonar signatures was found to be associated with modern activity.

The proton precession magnetometer survey of Oronoco Bay confirmed that modern debris, pump station transfer pipelines, and steel bulkheads and pier structures have created sufficient magnetic disturbances to mask much of the embayment. In the areas where the threshold of disturbance was low enough to permit identification of concentrations of historically significant cultural material, only one potential target was found. That target was extremely subtle and could have been created by the interaction of disturbances created by the abandoned pipelines and material along the south shore. An attempt to use side scan sonar in the shallow waters of the bay proved unsuccessful due to the high density of vegetation in the water column. In Oronoco bay only actual physical examination of the sub-bottom environment is likely to produce evidence of submerged cultural material.

These results confirm the findings of historical research carried out by Donald G. Shomette (Shomette, 1985). Along the Potomac River waterfront several well documented activities have no doubt contributed to the destruction of submerged cultural resources. First, during the first quarter of this century a major shipwreck removal project was undertaken to clear obstructions to navigation from the Potomac River off Alexandria. During this operation the remains of more than a dozen vessels were raised and removed. Second, the Potomac River channel off Alexandria and waterfront vessel slips and berths have been extensively dredged. This activity was initiated in the nineteenth century and continues today. Although dredging activity has declined since World War II, the demands of earlier navigation caused extensive destruction of the historic bottom.

A final consideration concerns the efforts of Alexandrians to extend their property at the expense of the Potomac. Shomette's historical research effectively documents efforts to reclaim the shallow bay that was a feature of the original waterfront. This suggests that the earliest lost or abandoned vessels and waterfront structures associated with Alexandria's development could be preserved beneath the city. This has been a well documented case in other American

ports. In New York (Reiss and Smith, 1983) and San Francisco valuable vessel remains have been discovered beneath reclaimed lands. In Oronoco Bay efforts to reclaim land are still underway. Historical evidence confirms that much of the original embayment has been filled to create new land. As abandoned vessels would likely have been moved into the shallowest water possible to prevent their refloating and becoming a threat to navigation, it is likely that Oronoco Bay vessel remains have already been buried. In addition it is also possible that vessels abandoned in the bay were completely destroyed to salvage valuable structural material and fastners.

## RECOMMENDATIONS

As no historically significant submerged cultural resources were identified during the remote sensing survey of the Alexandria central waterfront and Oronoco Bay, no additional investigation is recommended. However, to provide some assurance that unidentified material in Oronoco Bay would not be destroyed through bottom disturbing activity, consideration must be given to monitoring future activities such as dredging. This would insure that historically significant material could be salvaged if encountered during the operation. Although material in the bay area has generated sufficient magnetic disturbance to mask the more subtle signatures generated by historically significant material, that does not mean that underwater archaeological sites do not exist in the area. Likewise, silting along the Alexandria central waterfront has been extensive, and subbottom historic sites could well still exist; their remote sensing signatures undetectable amid the magnetic and acoustic disturbances caused by vessels and waterfront structures. To insure that such sites are not destroyed by disturbance of the river bottom, waterfront dredging and construction activities should be monitored by City of Alexandria or other qualified archaeologists.

BIBLIOGRAPHY

References Consulted

Burgess, Robert H.
1968 Chesapeake Sailing Craft: Part I. Cornell Maritime Press, Cambridge, Maryland.

Goldenberg, Joseph A.
1976 Shipbuilding in Colonial America. Published for the Mariners Museum by The University Press of Virginia, Charlottesville, Virginia.

Johnson, Michael F.
1981 A cultural resource management model for Fairfax County, Virginia. Fairfax County Archaeological Survey, Office of Comprehensive Planning. Fairfax, Virginia.

Kabler, Dorothy
1949 Alexandria: Port on the Potomac. Alexandria, Virginia.

Little, J. G. II and Harvard Ayres
n. d. Notes and Comments on the Archaeology of a Late Nineteenth and Early Twentieth Century Lighthouse on Jones Point, Alexandria, Virginia . Submitted to the National Park service by Catholic University, Washington, D. C.

Miller, T. Michael.
1983 "Charles Lee, Collector of Customs:Portrait of an Early Alexandrian on the Waterfront." The Alexandria Waterfront Forum: Birth and Rebirth 1730-1983. Alexandria Urban Archaeology Program, City of Alexandria.

Reiss, Warren, and Sheli O. Smith
1983 "The Ronson Ship: Made Into a Pier 240 Years Ago, Before South Street Existed." Sea History , No. 27, pp. 20-22.

Shomette, Donald G.
1985 Maritme Alexandria: An Evaluation of Submerged Cultural Resource Potentials at Alexandria, Virginia. , A report prepared for Alexandria Archaeology, Office of Historic Alexandria. City of Alexandria, Virginia.

_____ 1982 Shipwrecks on the Chesapeake: Maritime Disasters on Chesapeake Bay and Its Tributaries, 1608-1978 . Tidewater Publishers, Centerville, Maryland.