STUDY OF SEDIMENTATION POLLUTION IN GULF COAST ESTUARIES

A Proposal by The

GULF UNIVERSITIES RESEARCH CORPORATION
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to the

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

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I. OBJECTIVES

This proposal outlines an investigation which has been planned to achieve the following objectives:

A. Identify and further develop experimental techniques suitable for studying sedimentation in estuaries. Many experimental methods have been used in past investigations, but some of these need to be adapted and modified to fit different situations in various estuaries and to provide more detailed information than has been obtained in past studies. Some further development is also needed to provide better analytical methods for evaluating sediment deposits. As a result of this work, suitable methods will be provided that can be used in any estuary where sedimentation is considered to be a problem or a potential problem.

B. Define the character of recent sediments in five Gulf Coast estuaries (Corpus Christi Bay, Galveston Bay, Lake Pontchartrain, Mobile Bay, and Tampa Bay - Figure 1). "Character" in this instance includes thickness, stratification, composition, and vertical and horizontal distribution. Primary emphasis will be on sediment which has been deposited in the last 100 years. This information then will become a baseline for the purpose of measuring future changes in sediment deposits in these estuaries.

C. Identify man-made changes which have occurred in the last 100 years. This will provide an inventory of sediment now present in these estuaries, together with an indication of the future effects of this sediment on water quality. These changes include increases and redistribution of sediment, together with physical, chemical, and biological changes which reflect the pollution problems in each estuary.

II. INTRODUCTION

Among the many impurities which affect water quality and beneficial uses of various estuaries, the general class of impurities included under the term "sediment" is perhaps the most prevalent and includes the greatest variety of different materials. Since an estuary by definition is a mixing zone between the fresh water from inland rivers and the salt water

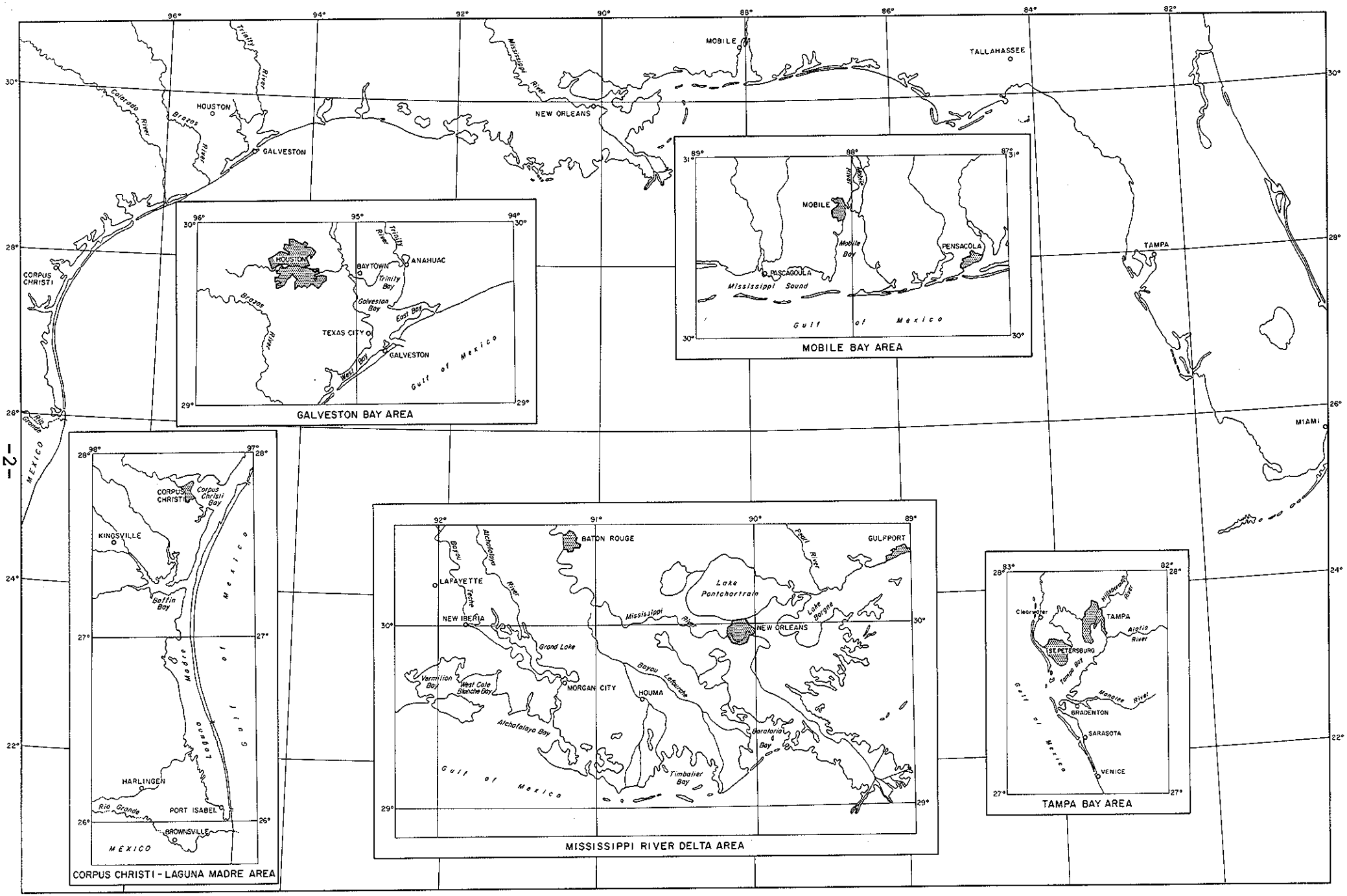

Figure 1. Index Map of Gulf of Mexico Estuaries — GURC Sedimentation Pollution Proposal

of the ocean, sediment can enter an estuary from either direction and can also be created by shore erosion or other processes in the estuary. Therefore, it can vary greatly in nature and composition.

From the practical standpoint of evaluating pollution problems, the most important difference between sediment and other contaminants dissolved in the water is that sediment tends to settle to the bottom where it may remain indefinitely. Dissolved contaminants are subject to transport and dilution, and eventually reach the ocean where an almost infinite volume of water is available for further dilution below the point at which detrimental effects are likely to occur. However, deposits of sediment in an estuary remain indefinitely unless removed by changes in the hydraulic character of the estuary, by natural chemical or biological processes, by man's activities such as dredging, or by some usual event such as a hurricane. Therefore, existing pollution from sediment may be more difficult to control than pollution from dissolved matter.

The dissolved contaminants now present in estuaries can be eliminated in a relatively short time by merely removing contaminants from the effluent streams entering the estuary and its tributaries. Even if all waste treatment processes were operated at high efficiency, however, sediment deposits already on the bottom of many estuaries would remain for many years or decades and would have an adverse effect on water quality. For example, anaerobic reactions frequently occur over a period of time in sediment deposits, and release tremendous quantities of sulfides and other contaminants into the waters above. In this way, a chemically contaminated sediment deposit may act as a "pollution bank" which would continue to have adverse effects on water quality until the deposited material had completely reacted. Therefore, an adequate evaluation of pollution which results from sedimentation must of necessity take into account the long-range character of the problem and the future effects of sediment already present.

Sediment may affect an estuary in many ways. It may even be beneficial, as when sediments act to introduce nutrients into the marine environment which have a beneficial effect on marine life and increase the growth of shrimp, fish, and other desirable marine organisms. More often, however, the effects turn out to be detrimental. Marine organisms have evolved throughout the centuries in estuaries relatively uncontaminated by man's activities, and any radical change in the estuarine

environment is likely to be detrimental. Since most of man's activities which influence the occurrence of sediment result in an increase rather than a decrease, problems of dredging and maintenance of navigation channels become more serious rather than less serious. From an aesthetic standpoint, an increase in the amount of sediment present destroys the scenic beauty of a body of water. Thus, most of the effects of sediments are likely to be detrimental rather than beneficial.

The mechanism by which sediment exerts detrimental actions involves several factors. By its mere physical presence, sediment deposits can change the hydraulic nature of a body of water in such a manner as to increase siltation and aggravate other water quality problems. In addition, the chemical nature of the sediment may cause important adverse effects, especially if the sediment includes sludge from domestic or industrial waste which decomposes slowly and depletes the oxygen content of the water. Sediment can also include living microorganisms or their by-products which exert detrimental effects through decay and other changes, and thus the biological character may also be a matter of major importance.

The Gulf Universities Research Corporation has recently completed for the Federal Water Pollution Control Administration a "State of Knowledge" report*, to evaluate available information concerning sedimentation in four Gulf Coast estuaries and to identify the most glaring deficiencies in the present knowledge. If these deficiencies could be eliminated by additional research efforts, better control methods could then be developed to limit future damage due to sedimentation, and thus contribute to man's overall efforts to manage and control the estuarine environment.

The above report presented detailed information on four Gulf Coast estuaries. This will not be repeated in detail here, except to point out that these four estuaries provide a wide variety of environments with respect to size, physical characteristics, depth, water quality, salinity, types of sediment, and other characteristics. Thus, the development of new methods and techniques in the proposed investigation should be valuable to evaluate pollution problems caused by sediment in any estuary.

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*"Case Studies of Estuarine Sedimentation and Its Relation to Pollution of the Estuarine Environment." Gulf Universities Research Corporation, Contract No. 14-12-445, March, 1969.

conservation, etc. While some of these have served to reduce sediment pollution, an evaluation of these estuaries indicates that more rigorous control measures will be needed in the future. This is especially true in Galveston Bay where the greatest rate of increase in population is expected for the next few decades.

The "State of Knowledge" survey also identified a considerable lack of knowledge with respect to the nature and extent of sediment deposits which now exist in these four estuaries. This proposal outlines an experimental program to obtain this much needed knowledge, so that logical planning can be initiated to develop appropriate control measures and thereby provide the necessary future safeguards for the various beneficial uses of these and other estuaries.

III. INTERESTS OF OTHER GOVERNMENTAL AGENCIES

The proposed program is aimed primarily at evaluating sediment as a water pollutant and in providing basic information to reduce the degree of pollution which exists. Therefore, it is directed to the Federal Water Pollution Control Administration as the primary governmental agency with responsibilities in this area. However, sediment is important in many other ways in addition to the direct adverse effects on water quality. Therefore, the proposed study is also of some interest to other governmental agencies. These are tabulated below to indicate the wide variety of interest which exists and to indicate the potential value of the proposed study in meeting several future requirements for corrective action to reduce the adverse effects of sediment in estuaries. The information to be obtained is significant in regard to evaluation of mineral resources (sand, gravel, and shell deposits), disposal of spoil from dredging operations, foundation characteristics, hydrology (circulation), rate of sediment accumulation and erosion, and nature of nutrients which affect the growth of marine organisms.

A. Corps of Engineers

The Corps of Engineers is responsible for the construction and maintenance of channels and other navigation facilities in estuaries, and therefore is vitally concerned with the movement of sediment and various factors which affect such movement.

The proposed study would provide information of value in identifying various sources of sediment, in determining the amounts present in the various estuaries under study, and in identifying the mechanism of movement throughout the various bays and estuaries. Where construction activities are in progress or contemplated, the bottom and subbottom profile data would also be helpful in preliminary planning for such construction. However, to be of maximum benefit here, profiling would have to be performed in the exact locations of interest. This could be done for future projects which have already been identified, and this possibility will be considered in detailed planning for profile runs in the proposed study.

B. U. S. Geological Survey

This agency has a major responsibility for collecting and analyzing water quality data in Gulf Coast bays and estuaries, and also data related to mineral resources including ground water, sand and gravel, phosphate, and metals. The proposed study of sedimentation in estuaries should assist in this work through providing background information on deposits of sediments and on their nature. One of the objectives of the USGS is to establish a total inventory or budget of sediment transfer from estuaries into the ocean and the proposed study would provide valuable background information for this purpose.

C. Bureau of Commercial Fisheries

The primary value of the proposed study to this agency would be in providing background information on the historical development of water pollution problems in the various estuaries being studied. While this may be related only indirectly to the growth of marine organisms, the information may be useful in indicating possible future problems which changes in sediment transport may bring about. To the extent that changes in marine life in different estuaries have been identified, the historical record of pollution to be obtained by this study might help to both explain and forecast some of these changes in marine life. If man-made influences have had a major effect on marine life when these influences were superimposed on the different natural environments, then further data to be derived from the proposed sediment study may help in understanding these effects.

D. U. S. Coast and Geodetic Survey

This agency is interested in tides and tidal currents and the flushing action of bays and estuaries, and also bathymetry. This work presently involves both suspended and deposited sediment. Therefore, the proposed study would be of interest in that present deposits of sediment give some indirect indication of the past history of changes in suspended sediment, and also of changes which might occur in the future due to hurricanes, changes in flow conditions as a result of construction of reservoirs, and other factors. This agency is also responsible for mapping of shorelines and for identifying changes in the mean low water line due to erosion, deposition of sediment, or construction activities of any kind.

E. Texas Water Quality Board

The Texas Water Quality Board is responsible for controlling effluent discharges in order to limit water pollution in all of the waters of the state of Texas. Major problems exist in the Galveston Bay area which have been the subject of continuing study for many years. At the present time, a comprehensive study of the entire Galveston Bay system is in progress to more fully evaluate the problems which exist and to provide information for water quality management for the entire system. This study includes a small amount of coring in the Houston Ship Channel as well as studies of reaction rates and other characteristics of bottom sediments in Galveston Bay itself.

While complete details of this work have not been determined, it will include studies of the organic content of bottom sludge and the relationship between such sludge and water quality in Galveston Bay. This work will be performed with sediment obtained from the bottom of the bay with dredges, but no actual coring will be done. In the ship channel, cores will be obtained to a depth of two to four feet at selected locations, and various analytical tests will be conducted to determine the physical and chemical characteristics of the sediment. However, both of these experiments will provide information only on conditions at or just below the mud-water interface, and will reveal very little of the character of the underlying layers below a depth of a few inches in Galveston Bay or four feet in the ship channel. Since some sludge deposits are suspected of exceeding ten feet in depth in portions of the ship channel, it is obvious that much more extensive coring would be required to obtain a complete inventory of the sediment now present.

The investigation outlined in this proposal would not in any way duplicate the work presently planned under the Galveston Bay Study. Rather, it would contribute additional information of value through providing a detailed inventory of the sediment now present in various portions of the Galveston Bay system. The analytical data would also be valuable to measure such detrimental components as pesticides, heavy metals, organic residues, etc. In this way, the proposed investigation should be valuable in making it possible to obtain a more accurate estimate of the effects of sediment deposits on future water quality in Galveston Bay.

A better understanding of the historical development of water pollution problems in Galveston Bay, as revealed by the analysis of cores, might also assist indirectly in estimating the effects of future population increases and growth in industrial activity on water quality in Galveston Bay.

Because of the fact that the Galveston Bay study is now in progress, maximum benefit would result from the investigation outlined in this proposal if the work outlined for Galveston Bay could be completed at an early date.

F. Other State Agencies

While the Galveston Bay Study represents the most extensive effort in these estuaries to develop a comprehensive management plan, other state agencies in the Gulf Coast states also have various responsibilities in these estuaries. These include the following:

1. Safeguarding of marine life such as fish, shrimp, oysters, etc., to protect both commercial and recreational values.

2. Evaluating mineral deposits to establish severance taxes and other policy matters relating to the removal of sand, gravel, oyster shell, petroleum, and other mineral resources.

3. Maintenance of navigation channels (jointly with federal agencies) to enhance commercial interests, and planning and construction of new facilities.

Water quality management, including the limitation of siltation, is a major factor in all of the Gulf Coast estuaries. Therefore, all of the state agencies concerned with these estuaries would benefit from the information to be obtained in the proposed investigation.

IV. PROPOSED RESEARCH PROGRAM

An experimental program is proposed, to obtain basic information on sedimentation in Gulf Coast estuaries to meet the objectives enumerated previously. As discussed in the "State of Knowledge" report submitted to the Federal Water Pollution Control Administration by Gulf Universities Research Corporation, the most important requirement at this time is to obtain information on the existing sediment deposits as a basis for evaluation of natural versus man-made (pollution) changes in sediment. This proposal outlines a detailed program to meet that requirement.

Overall coordination and management of the program will be carried out by the Gulf Universities Research Corporation, while the detailed investigations will be conducted by various GURC member institutions. Detailed profiling and obtaining of cores will be conducted by Southwest Research Institute on a subcontract basis. University scientists with previous experience in the Gulf Coast estuaries to be studied will be responsible for coordination in each estuary and for evaluation and interpretation of results. The same university scientists, assisted by others where appropriate, will then use the basic information obtained in this study to plan and undertake additional fundamental studies of sediment characteristics and other aspects of pollution sedimentation in Gulf Coast estuaries. In this way, the proposed investigation will serve as a foundation and will provide background information for a long-range study which should produce substantial benefit for many years to come.

This method of organization and administration is advantageous in this case since a comprehensive study of this nature requires the participation of senior scientists with many diverse backgrounds in such fields as geology, hydrology, chemistry, biology, and many others. A study of this nature is beyond the capability of a single institution or organization. By combining the talents and capabilities of several organizations through the Gulf Universities Research Corporation, however, a method is provided by which a project team can be

assembled and their efforts coordinated for a broad comprehensive study of this nature. Thus, the objectives of the Federal Water Pollution Control Administration can be achieved within a reasonable time limit and at minimum cost, and the Gulf Universities Research Corporation can achieve its basic objective of providing a mechanism for cooperative action by the participating universities and other institutions.

The first step in the proposed program will consist of bottom and subbottom profiling to determine the nature and extent of sediment deposits. The next step will be the evaluation of cores obtained at selected locations to determine the physical, chemical, and biological characteristics of these deposits. This work will provide the basic information for planning more detailed analytical studies, and core material will also be available for further studies at a future date.

One of the major limitations of previous sediment studies is that accurate navigation was not provided, and therefore there is no way to return to the same locations subsequently for additional studies and comparative measurements. Therefore, changes in sediment deposits over a period of time cannot be accurately measured. To avoid this difficulty in the proposed investigation, all profiling and coring will be accomplished with the aid of Hi-Fix navigation so that all data will be accurately located. This will make it possible to provide an accurate baseline for comparison with conditions at any future time. The supplement to this proposal describes the experimental techniques to be used, and contains a description of the Hi-Fix navigation equipment and its method of operation. Past experience has shown that this equipment is capable of indicating the horizontal location of the vessel at all times to within a few feet. Thus, both the profile data and the core locations will be accurately determined for subsequent comparative tests at any future time.

Details of the program are discussed under the following major headings:

A. Bottom and Subbottom Profiling
B. Obtaining Cores
C. Evaluation of Cores
D. Presentation of Data

General information concerning these tasks is discussed below and is applicable to all estuaries to be studied. While the various tasks will overlap, they are discussed separately for ease of presentation. The time schedule for conducting this work in the various estuaries is presented subsequently.

A. Bottom and Subbottom Profiling

The first major task to perform in each estuary is to obtain a record of bottom and subbottom profiles. Accomplishing this in an entire estuary on a high density basis (one-mile rectangular grid or less) would be rather expensive, and need not be undertaken unless an actual requirement exists for this information. Therefore, it is planned to conduct the profiling on a less dense grid and to supplement this with a high-density grid in a few selected areas. Since all profiling will be done with accurate navigation, additional work can be performed in the future to obtain more data in other areas if the information obtained in the first profiling indicates a need for more detailed data.

The density of profiling and other experimental details will likely need to be modified as the work progresses. To illustrate the concepts involved and to provide a reasonable basis for cost estimation, tentative plans were prepared based on a four-mile rectangular grid in the five Gulf Coast estuaries, to be supplemented with a one-mile grid in a few selected areas. Figure 2 shows one way in which this could be accomplished in Lake Pontchartrain, showing a four-mile grid as a first phase profiling plan. If later work requires additional profile data, a second phase profile could then be obtained, also on a four-mile spacing but rotated at 45 degrees to the first phase pattern. In estimating costs, the first phase four-mile grid was assumed for the five Gulf Coast estuaries, eliminating portions of the estuary near the shore where water depth is less than five feet. This procedure is thought to be adequate for planning purposes, and likely will not need to be changed to a substantial degree as the work progresses.

The supplement to this proposal contains a detailed description of equipment which has been used for this purpose in the past and includes representative charts to illustrate the degree of detail available. By using techniques such as this, extensive information can be obtained on the bottom profile and on the various layers of sediment which have accumulated.

A major problem in conducting bottom and subbottom profiling is that of determining water depth or otherwise locating the measurements in the vertical plane. Since the profiles must provide a baseline for comparison with later conditions, accurate determination of vertical locations is a necessity. Water depth is variable and cannot always be measured due to the combined effects of wind, tide, and other factors. Where possible, existing tide gauges will be used as a means of measuring changes in water depth.

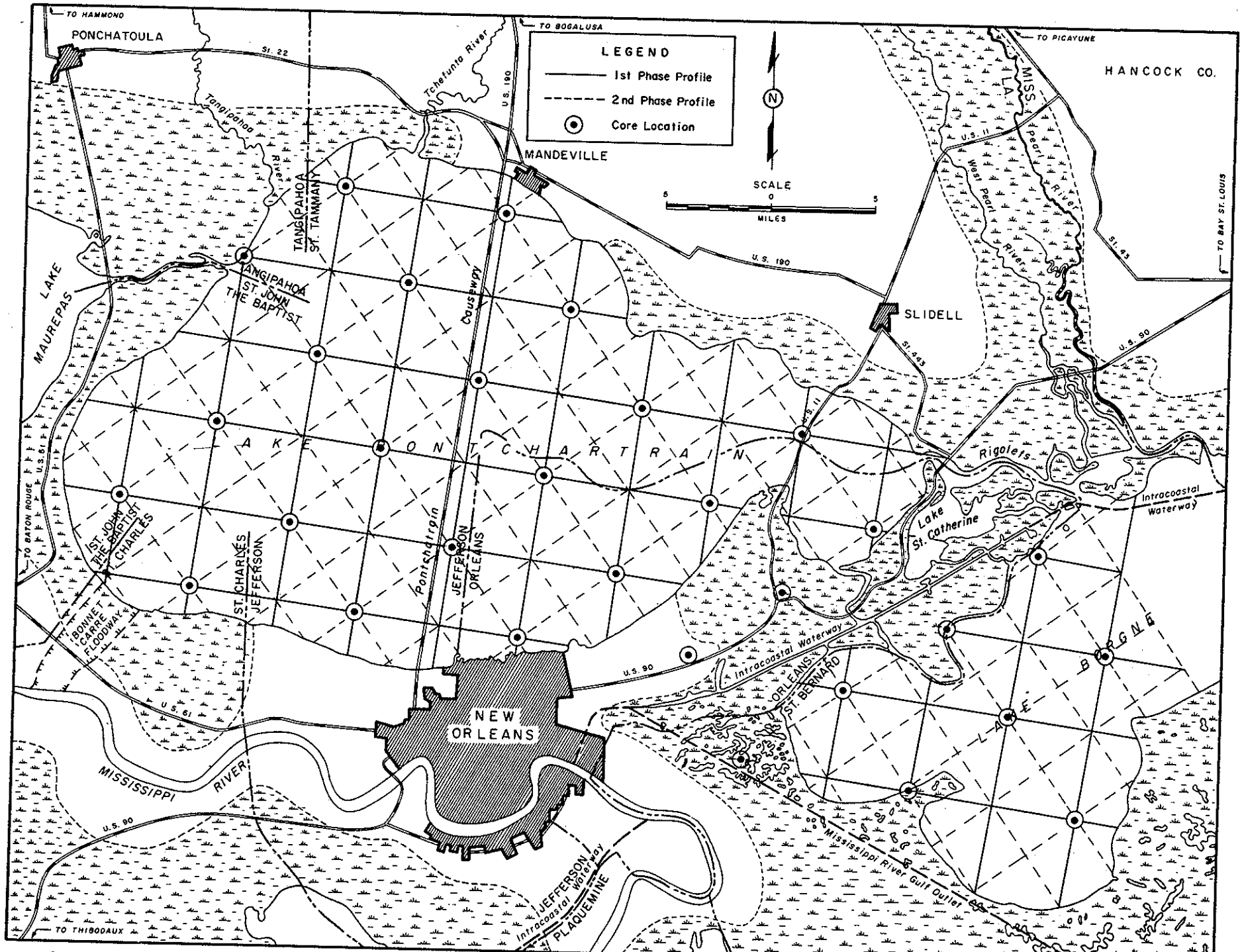

Figure 2. Recommended estuarine acoustical profiling - coring program.

As discussed subsequently under "Obtaining Cores," at least some cores will be obtained down to the top of the Pleistocene or other preRecent layer, thus providing a readily identifiable baseline beneath the layers of sediment being studied. Thus, a baseline will be available which is independent of variations in water level and can be used as a future reference point. Additional stratigraphic horizons in the Holocene sediments may also be used as reference points. By comparing the bottom level with both the top of the water and a recognizable stratigraphic horizon, it is expected that some estimate can be made of the effects of wind and other factors which affect water level. In this way, a means of interpolation between tide gauges can likely be provided, especially in areas where wind may cause unexpected changes in water level close to a shoreline. While some development of techniques will be required here, the available information indicates that a combination of these various methods will make it possible to provide adequate information to determine the exact vertical location of sediment layers identified by profiling.

Profile records will be identified as to location, and coordinates or exact survey points will be marked on each record. Duplicate copies will be made, including reference marks and survey identification, for distribution to the participating university scientists, and the original copies will be filed for future use.

From these profile records and core data, maps will be prepared to indicate the location and types of sediment in the areas covered. These maps will then be used for further evaluation of sediment and for selection of additional coring locations and planning other work to follow.

These maps will include the following basic types:

1. PreRecent topographic maps, to show the elevation of identifiable preRecent surfaces.
2. Recent isopach maps, to show the thickness of recent sediments.
3. Stratigraphic-lithologic cross-sections, to show the distribution of sediment types at different elevations below the bottom.
4. Lithofacies maps of stratigraphic units, to show the distribution of significant identifiable bodies of sediment such as mud, shell, sand, and gravel.

B. Obtaining Cores

The profile data will aid in indicating where coring will be most significant. Information available from other agencies will also be used when available, to indicate areas in which the most serious sedimentation problems have occurred in recent years so that coring can be performed in the most appropriate locations. These locations will be selected both with respect to known sedimentation patterns and with respect to geologic and topographic features such as submerged river channels, sand bars, areas of previous oyster shell dredging, and other factors expected to influence the patterns of sedimentation.

If possible, coring will be extended to sufficient depth to be sure that at least a 50 - to 100-year record of sedimentation is obtained. Present information indicates that this will require cores through only a few inches or a few feet of sediment, except where sediment has accumulated in areas dredged previously to recover oyster shell or construct navigation channels. Where definite information is not available to determine appropriate depth, cores will be taken to a depth of 30 feet.

Another reason for extending cores to 30-foot depths, even though pollution-related sediment may only exist for the first few feet, is that in many locations in Gulf Coast estuaries this depth makes it possible to reach the top of the Pleistocene or other preRecent layer. This will be important in at least some cores as a means of providing a baseline for vertical measurement. As discussed previously, this will assist in providing a fixed baseline to aid in resolving whatever uncertainty may exist because of unmeasured variations in water level. A few cores may be extended to a maximum of 100 feet for this purpose.

C. Evaluation of Cores

Preliminary data will be obtained on cores in order to indicate the general nature and extent of the various sediment deposits. These data and additional core sample material will then be supplied to the participating university scientists for more detailed study.

A general description of each core will be prepared and the following steps will be completed in preliminary processing:

1. Photographs, both black and white and color, will be secured by splitting each core lengthwise and obtaining detailed photographs of each section which shows a major change in physical appearance.

2. For the top ten feet, a two-inch sample will be taken every six inches for chemical analysis. The remaining four inches of each six-inch segment will be dried and stored in plastic bags for future use and additional analytical purposes.

3. Below ten feet, a two-inch sample will be taken every 12 inches for chemical analysis, and the remaining material will be dried and stored for future use.

To evaluate the pollution characteristics of sediment deposits, a limited amount of analytical work will be performed. Much of this will be concentrated on samples from the upper layers, with only limited confirmatory tests from the portions of the cores below the point at which pollution became an important factor in sediment deposition. While the exact sample schedule will need to be altered based on experience, the following tests are contemplated on a considerable number of samples from each estuary:

1. C14 will be measured to identify Pleistocene or other preRecent strata as a means of establishing a vertical baseline.

2. Grain size analysis will be completed to identify major sediment types such as gravel, clay, silt, and sand.

3. Vertical distribution of phosphate will be measured to obtain data on the occurrence of detergent by-products and other phosphate-containing pollutants.

4. A semi-quantitative spectrographic analysis for metallic constituents will be performed. While this technique is not highly accurate when a complex mixture of metals is present, it provides an excellent screening technique to identify the major metallic constituents as an aid to planning further work.

5. Total organic content will be determined by extracting the sediment samples with carbon tetrachloride and determining the organic content of the extract by infrared analysis. This reveals no information on specific organic compounds but is an excellent screening technique to obtain an approximate measure of total organic content.

6. Since pesticides have become an important pollutant in recent years, a single analysis by gas chromatography using electron capture detection is anticipated. This method is capable of measuring several of the common chlorinated pesticide materials at the parts per billion level. Typically, a single analysis provides quantitative estimates for DDT, chlordane, eldrin, dieldrin, and possibly other chlorinated hydrocarbon pesticides.

This group of tests will provide preliminary information of use in evaluating the past history of pollution due to sediments and in providing an inventory of the sediment deposits now present. This will also make it possible to plan more detailed analytical work which is discussed subsequently.

D. Presentation of Data

As experimental data on each estuary are obtained, they will be presented in the following ways:

1. Acoustical profile and core data will be furnished to participating university scientists for synthesis, analysis, and evaluation. This evaluation will concern the Holocene sedimentary history of the various estuaries under study. Particular attention will be given to prominent subbottom datums that can be used for subsequent monitoring of surface sediment deposition and erosion. The sediments resulting from deposition during the past 100 years will be specifically evaluated in terms of pollutant characteristics.

2. Formal technical reports will be submitted by GURC to the sponsoring agency, outlining complete procedures, data, evaluation, and conclusions.

3. With the consent of the sponsoring agency, results will be published in scientific journals as appropriate.

Southwest Research Institute personnel will provide profile data, core samples, and analytical data of the various estuaries. The following University scientists will conduct additional evaluations and prepare technical reports on the various estuaries:

Corpus Christi Bay:	Dr. Alan J. Scott, et al, University of Texas
Galveston Bay:	Dr. Robert R. Lankford, et al, Rice University
Lake Pontchartrain:	Dr. A. E. Weidie, et al, Louisiana State University in New Orleans
Mobile Bay:	Dr. William F. Tanner, et al, Florida State University
Tampa Bay:	Dr. E. Alan Lohse, et al, University of Houston

V. FUTURE DETAILED ANALYTICAL STUDIES

As mentioned previously, a limited amount of analytical work will be performed on the cores to provide an indication of the chemical nature of the sediment now present. This information will make it possible to plan for more detailed analytical studies which will be undertaken following this investigation by the Gulf Universities Research Corporation and by the various participating university scientists. The following discussion is presented merely to indicate some of the possibilities which may warrant more detailed investigation in the future.

A. Identification of Organic Constituents

In areas where total organic content is significent, further work would be valuable to determine the source and nature of these contaminants. For this purpose, thin layer chromatography is useful for the preliminary separation of major types of organic constituents such as hydrocarbons and oxygenated compounds. Further analysis by gas chromatography and other methods can then be used to measure individual constituents or groups of related compounds. While detailed studies of this nature have not been reported on estuarine sediments, there is reason to believe that various hydrocarbon constituents can be measured as a means of determining the effects of petroleum refining and production, petrochemical manufacture, and other industrial operations on sediment pollution.

B. Identification of Sources of Organic Constituents

Further studies of the organic content with special emphasis on sulfur-and nitrogen-containing constituents might also be useful to evaluate the extent of pollution due to municipal sewage sludge. Various organic compounds in these categories are contained in many sludge deposits, and are also formed by anaerobic reactions in bottom sediment layers. In addition to direct toxic effects, these contaminants also are frequently involved in the complicated reaction patterns that influence dissolved oxygen in estuarine waters. While past studies have been rather superficial, there is reason to believe that it may be possible to identify specific organic constituents related to municipal sewage sludge, and thus provide additional information on the pattern of sediment pollution. By comparing samples from large industrial concentrations such as the Houston Ship Channel with areas known to be limited primarily to municipal sewage pollution such as the Clear Lake area of Galveston Bay, preliminary information could be obtained to determine whether or not a distinction can be made between industrial and municipal sources of pollution. If so, the information to be obtained in this way would be very valuable as an aid in future planning to develop adequate water quality control measures for estuaries situated near major metropolitan areas, especially where large industrial complexes are also a major factor.

C. Biological Studies

A biological evaluation would likely be valuable to identify changes in foraminiferal (protozoan "shells") content at various depths. This could be accomplished by a microscopic

inspection of samples from each one-foot segment of the cores. A study of this nature might reveal significant variations in the biological effects of sediment pollution over the past several years.

D. Analysis of Metal Content

If the preliminary spectrographic analyses indicate significant variations in metal content, detailed studies would be valuable to determine the exact nature and extent of heavy metal contamination. Such metals as arsenic, lead, chromium, tin, manganese, copper, and others are frequent by-products of our civilization and may have unexpected effects on water quality in estuaries.

It is interesting to note that various trace metals have been detected in estuarine waters in concentrations several orders of magnitude higher than in the rivers supplying the estuaries or in adjacent waters of the Gulf of Mexico. In many cases, both supply and removal of the major portions of some metals appears to occur within the bay system. Sources of supply might include municipal and industrial wastewaters, oil field brines, shipping and other activities, or special and unusual industrial facilities. (As one isolated example, the only tin smelter in North America is located at Texas City on Galveston Bay.) Removal has been shown to occur through incorporation of the metals into sediments and/or biological organisms. Accumualtion of metals in sediments might cause unexpected effects on growth and reproduction of marine organisms or through other detrimental effects.

E. Detailed Chemical Analysis

While a complete chemical analysis of all core samples might involve a considerable amount of needless duplication, a careful selection of samples for more complete analysis might reveal significant differences worthy of further study. A complete battery of chemical analytical tests could be set up, perhaps to include most or all of the following:

Carbonate
Bicarbonate
Bromide
Iodide
Chloride
Fluoride
Sulfate
Sulfide

Dissolved Carbon
Fixed Carbon
Total Phosphorus
Total Nitrogen
Ammonia Nitrogen
Nitrate Nitrogen

The potential value of this detailed analytical work is not known at the present time, but core sample material can be provided for this purpose if the preliminary results indicate that further work of this nature would be valuable.

F. Pesticide Degradation Products

The preliminary analytical work is expected to identify geographical areas where significant accumulations of pesticide residues exist in bottom sediments. In these areas, further work would be valuable to determine the nature and extent of pollution due to pesticide residues.

The first step would be a more detailed analysis of sediment samples to measure the different pesticides present: chlorinated hydrocarbons, arsenicals, organic phosphorus compounds, and others. Another important aspect is the pattern of degradation, since some pesticides are known to react and form degradation products more toxic than the original compound. The results of these studies could then be compared to the results obtained by the Bureau of Commercial Fisheries laboratory in analyzing oysters and other marine specimens to measure pesticide residues in marine organisms from different estuaries. Still other tests might be conducted to measure pesticide residues in bacteria, diatoms, algae, and other organisms in the food chain.

While little is known of the long-range accumulation, degradation, and biological effects of pesticide residues, this area is one which should receive increased attention in the years ahead. While many common pollutants decompose or disappear by dilution, the ability of marine organisms to accumulate and retain some pesticides almost indefinitely makes this entire subject one of great future importance.

In summary, these brief outlines illustrate some of the possibilities for future work which could profitably be undertaken after the program outlined in this proposal has furnished preliminary planning information and core material for analysis. Some of these suggestions have resulted from contacts with university scientists associated with Gulf Universities Research Corporation, and other staff members at the participating universities have expressed an interest in planning and conducting additional studies in the future. Therefore, it seems certain that the proposed investigation can form the basis for many other investigations, depending on the nature of the problems which are identified and the importance of these problems in safeguarding the beneficial uses of Gulf Coast estuaries.

The university scientists who will coordinate the proposed study in the various estuaries have expressed an interest in some of these additional studies, and in addition, the following persons have also expressed an interest in further studies and expect to participate in such studies at the appropriate time:

C. Everett Brett, University of Alabama
Louis G. Williams, University of Alabama
H. Nugent Myrick, University of Houston
J. Frank Slowey, Texas Christian University -
Robert H. Parker, Texas Christian University
R. T. van Aller, University of Southern Mississippi
John E. Ubelaker, Southern Methodist University

VI. UTILIZATION OF DATA OBTAINED

The basic data obtained by this experimental program will be useful in many ways. One of these, of course, is in demonstrating and identifying the various experimental techniques useful in evaluating pollution from sediment in any estuary. To this extent, the results will be applicable in further study of estuarine pollution which might be undertaken in any location.

In addition, many different agencies with responsibilities for the particular Gulf Coast estuaries being studied will be able to use the information. Some of these uses include the following:

A. Contribution of sediment to pollution problems, and degree of future control required. In particular, this study should aid in establishing or modifying water quality standards for Gulf Coast estuaries and their tributaries, so that control programs can be carried out to safeguard beneficial uses of the various estuaries. (Federal Water Pollution Control Administration, state and local pollution control agencies in the Gulf Coast area.)

B. Effects of sediment on navigation, especially in dredging of navigation channels and in the disposal of dredging spoil without creating additional pollution problems. (Corps of Engineers, County Navigation Districts, local Port Authorities.)

C. Conservation, and the effects of sediment on fish and other marine life, to the extent that sediment deposits represent

a portion of the pollution detrimental to marine life. (Bureau of Commercial Fisheries, Bureau of Sport Fisheries and Wild Life, state conservation agencies.)

D. Effects of sediment on shell dredging, recovery of sand and gravel, causeway and bridge construction, foundations for construction of facilities in or near estuaries. (Many industrial and business interests.)

E. Relationship of sediment to land utilization adjacent to estuaries, channel bulkheads, and other changes as a result of land development and urbanization. (Real estate interests, land developers, and governmental bodies concerned with these activities.)

VII. BUDGET

The overall program planning and management will be the responsibility of the Gulf Universities Research Corporation. Cost figures are presented below for each estuary, and cover the securing of basic information by profiling, coring, and analysis of cores. Scientists from GURC Member Universities will participate in the planning and evaluation of this work, in order to provide a basis for planning the future detailed analytical studies discussed previously. Proposals for these additional studies will be submitted at the appropriate times; such proposals will be based on experience and knowledge gained in this program, and will also make use of profile data and cores obtained during this investigation.

A. Corpus Christi Bay (total elapsed time - 8 months)

1. Field and laboratory work (125 miles of profiling, 300 feet of long cores, 24 short cores, 10 C^{14} determinations, 100 sediment fraction analyses, 50 total phosphate analyses, 50 metal analyses, 50 total hydrocarbon analyses, and 50 analyses for chlorinated pesticides, plus data correlation and evaluation).

Cost as outlined in attached SWRI proposal - $48,383.00

2. GURC Participation

a.	Personnel (GURC Executive Director - 1 week; GURC Program Coordinator - 1 month; secretarial assistance - 2 weeks. Costs include fringe benefits) -		$2,847.00
b.	Travel and per diem -		
	4 trips @ $50.00 ea.	$200.00	
	15 days @ $20.00 ea.	300.00	
			500.00
c.	Communications -		200.00
d.	Report preparation, drafting, and reproduction -		2,000.00
e.	Indirect Costs - 50% (est.) of salaries and wages -		1,424.00
	Subtotal		$6,971.00

3. GURC Member Universities Participation

a.	Personnel (Scott - 8 weeks; Lankford - 1 week; Lohse - 1 week; Weidie - 1 week; Tanner - 1 week) 3 mos. @ $1500/mo. -		$4,500.00
b.	Travel and per diem -		
	10 trips @ $100.00 ea.	$1,000.00	
	40 days @ $20.00 ea.	800.00	
			1,800.00
c.	Communications -		400.00
d.	Secretarial assistance - 4 weeks @ $116.00		464.00

e.	Report preparation -	1,000.00
f.	Indirect Costs - 50% (est.) of wages and salaries -	2,482.00
	Subtotal	$10,646.00
	Total for Corpus Christi Bay	$66,000.00

B. Galveston Bay

1. Field and laboratory work (costs as outlined in attached SWRI proposal)

a.	Setup charge -	$ 6,290.00
b.	Data acquisition and reduction	
i.	Profiling bottom and subbottom 200 miles @ $85.00/mi.	17,000.00
ii.	Coring - 15 cores ave. 30' 450 ft. @ $37.00/ft.	16,650.00
iii.	Short cores (10 ft. max.) 24 cores @ $140.00/core	3,360.00
iv.	Analysis of cores (see Corpus Christi Bay program)	10,000.00
v.	Preliminary synthesis, correlation and evaluation of all data	10,000.00
	Total SWRI Costs	$63,300.00

2. GURC Participation

a.	Personnel, including secretarial assistance -	$2,847.00
b.	Travel and per diem -	250.00
c.	Communications -	200.00
d.	Report preparation -	1,500.00
e.	Indirect Costs - 50% (est.) of wages and salaries -	1,424.00
	Subtotal	$6,221.00

3. University Participation

a. Personnel (Lankford, et al, including secretarial assistance)	$ 3,250.00
b. Travel and per diem	250.00
c. Communications	200.00
d. Report preparation	1,000.00
e. Indirect Costs - 50% (est.) of wages and salaries	1,625.00
Subtotal	$ 6,325.00
Total for Galveston Bay	$75,846.00

C. Lake Pontchartrain

1. Field and laboratory (costs as outlined in attached SWRI proposal)

a. Setup charge -	$ 15,510.00
b. Data acquisition and reduction	
i. Profiling bottom and subbottom 300 miles @ $87.00/mi.	26,100.00
ii. Coring - 1000 ft. @ $38.00/ft.	38,000.00
iii. Analysis of cores (see Corpus Christi Bay program)	10,000.00
iv. Preliminary synthesis, correlation and evaluation of all data	10,000.00
Total SWRI Costs	$ 99,610.00

2. GURC Participation

(Same as Galveston Bay Program) -	6,221.00

3. University Participation

Weidie, et al (same as Galveston Bay Program)	6,325.00
Total for Lake Pontchartrain	$112,156.00

D. Mobile Bay

1. Field and laboratory work (costs as outlined in attached SWRI proposal

a.	Setup charge	$ 12,885.00
b.	Data acquisition and reduction	
i.	Profiling bottom and subbottom 150 miles @ $88.00/mi.	13,200.00
ii.	Coring - 600 ft. @ $38.00/ft.	22,800.00
iii.	Analysis of cores (see Corpus Christi Bay program)	10,000.00
iv.	Preliminary synthesis, correlation and evaluation of all data	10,000.00
	Total SWRI Costs	$ 68,885.00

2. GURC Participation (same as Galveston Bay Program) $ 6,221.00

3. University Participation - Tanner, et al (same as Galveston Bay Program, plus $1,000.00 additional travel - per diem) $ 7,325.00

Total $ 82,431.00

E. Tampa Bay

1. Field and laboratory work (costs as outlined in attached SWRI proposal)

a.	Setup charge -	$ 16,830.00
b.	Data acquisition and reduction	
i.	Profiling bottom and subbottom 200 miles @ $91.00/mi.	18,200.00
ii.	Coring - 750 ft. @ $38.50/ft.	28,875.00
iii.	Analysis of cores (see Corpus Christi Bay program)	10,000.00
iv.	Preliminary synthesis, correlation and evaluation of all data	10,000.00
	Total SWRI Costs	$ 83,905.00

2.	GURC Participation (same as Galveston Bay Program)	$ 6,221.00
3.	University Participation - Lohse, et al (same as Galveston Bay Program, plus $1,200.00 travel and per diem)	7,525.00
	Total	$ 97,651.00

Summary:

Corpus Christi Bay -	$ 66,000.00
Galveston Bay -	75,846.00
Lake Pontchartrain -	112,156.00
Mobile Bay -	82,431.00
Tampa Bay -	97,651.00
	$434,084.00

Any number of the above listed estuaries could be combined into a single program, up to and including all five. The minimal program should consist of the Corpus Christi Bay program which involves joint participation of all the principal investigators in evaluation of operational procedures, data acquisition, quality control of data, data analysis and reduction. The study of the second estuary could be started two months after the initiation of work in Corpus Christi Bay.

VIII. BIOGRAPHICAL SUMMARIES

Summarized Biographies of Professionals Involved*

Dr. Dan E. Feray, B.S. University of Tulsa (1939), M.S. University of Illinois (1940), PhD., University of Wisconsin (1948), twenty-five years of professional experience (industry and universities) in geological research with major emphasis on depositional analysis of recent sediments in the Gulf of Mexico. Dr. Feray has served as Director of the sedimentation laboratory of Magnolia (now Mobil) Petroleum Company and as Chairman of the Geology Department, Texas Christian University. Dr. Feray is expected to be coordination and program manager for this activity.

Dr. Herbert C. McKee, (see personal data sheet in supplement appendix). Assistant Coordinator and program manager.

Dr. Robert R. Lankford, PhD., Scripps Institute of Oceanography (1962), approximately ten years of professional experience (Pan American Petroleum Corp. and Rice University) primarily in research dealing with processes and products of sedimentation (organic and inorganic) in the Gulf of Mexico, including Galveston Bay and other estuaries. Principal investigator of Galveston Bay study.

Dr. E. Alan Lohse, B.S., University of Houston, PhD., University of Texas (1952), twenty years of professional experience in geological research with major emphasis on depositional analysis of recent sediments in the coastal zone of the Gulf of Mexico. Principal investigator of Tampa Bay study.

Dr. Alan J. Scott, PhD., University of Illinois (1958), approximately fourteen years of professional experience (Illinois Geological Survey, University of Texas, and consultant in industry), primarily in research dealing with sedimentation in estuaries of the southwest Texas coast including the study of oyster shell deposits and the effect of hurricanes. Principal investigator of Corpus Christi Bay study.

Dr. William F. Tanner, B.A., Baylor University (1937), M.A., Texas Technological College (1939), PhD., University of Oklahoma, twenty-three years of professional experience in geological research with primary emphasis on the study of processes of sedimentation in the Gulf Coast. Dr. Tanner is Professor of Geology at Florida State University. Principal investigator of Mobil Bay study.

*More detailed biographies are available if required.

Dr. Alan E. Weidie, B.A., Vanderbilt University (1953), M.S. and PhD., Louisiana State University (1958, 1961), twelve years of professional experience in geological research with major emphasis on stratigraphy and sedimentation problems of the Gulf Coast. Dr. Weidie currently is Chairman of the Department of Geology, Louisiana State University at New Orleans. Principal investigator of Lake Pontchartrain study.

Proposal No. 18-6399
April 28, 1969

A PROPOSAL FOR

THE ACQUISITION AND REDUCTION OF BOTTOM AND SUBBOTTOM DATA FOR ESTUARINE SEDIMENT POLLUTION STUDIES

to

GULF UNIVERSITIES RESEARCH CORPORATION

to support a proposal to the Federal Water Pollution Control Administration on the Study of Sedimentation Pollution in Gulf Coast Estuaries

Submitted by: Philip Oetking, Director
Ocean Science and Engineering Laboratory

T. J. Lambertson
Manager of Operations, OSEL

Herbert C. McKee, Assistant Director
Department of Chemistry and Chemical Engineering

Approved:

Philip Oetking, Director
Ocean Science and Engineering Laboratory

SOUTHWEST RESEARCH INSTITUTE

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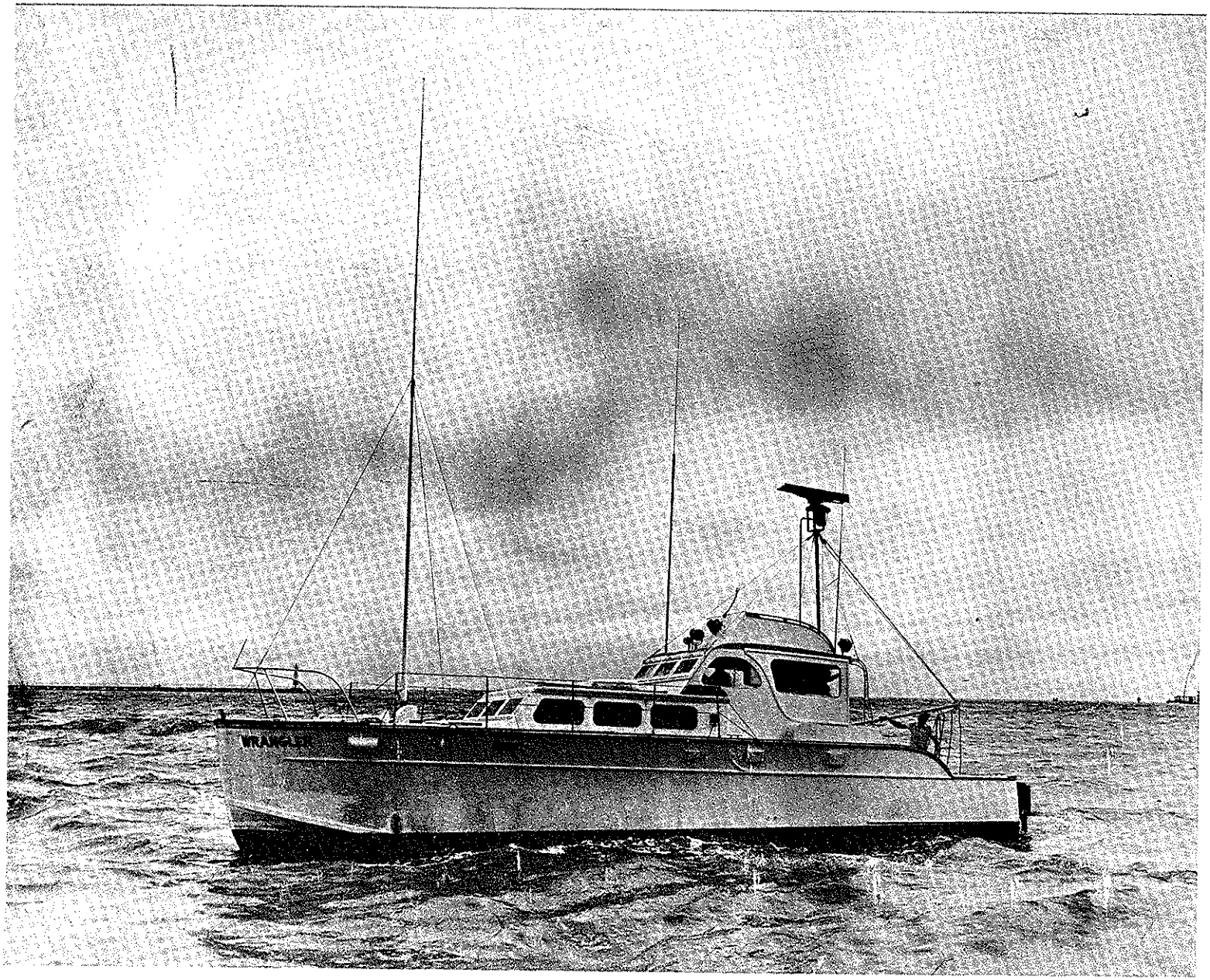

Frontispiece
The Ocean Science and Engineering Laboratory's
Research Vessel, "R/V Wrangler"

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I. OBJECTIVES

The objectives of the proposed program are (1) the acquisition and reduction of high resolution bottom and subbottom stratigraphic data and (2) the acquisition, preservation and partial chemical analysis of sediment cores and samples. These services are to be provided in support of a Gulf Universities Research Corporation (GURC) program concerned with the development of a methodology based on these data acquisition techniques and subsequent analysis and interpretation for the determination of sedimentary pollution processes in bays and estuaries as outlined in the accompanying GURC proposal.

II. SCOPE

The GURC program to be supported includes the evaluation of the proposed methodology using five major estuaries on the Gulf of Mexico as test areas (Corpus Christi Bay, Galveston Bay, Lake Pontchartrain, Mobile Bay and Tampa Bay). Investigations in each bay are defined as a separate phase of the program; any combination of phases considered to be most commensurate with current FWPCA requirements may be selected to comprise the overall scope of the program. An initial phase is proposed wherein Corpus Christi Bay will be used as a principal test area to evaluate equipment performance and, jointly with GURC scientists, to select final survey, sampling and interpretation procedures. In order to provide maximum flexibility in operational and financial planning, each phase is proposed in terms of a series of separate tasks.

The equipment which SwRI would provide in support of the proposed program is mounted in a research vessel with a four foot draft. The profiling and coring program is based on the acquisition of data in depths of five feet of water or more. Operational tasks in waters shallower than five feet in depth would require the acquisition of a shallow draft (not greater than two feet) craft and the transfer of SwRI profiling and navigational equipment to that vessel. This proposal does not include profiling or coring operations in less than five feet of water.

Long cores (average of 30 feet/core and ranging up to 100 feet) will be taken as a separate operation using a rented spud barge with SwRI coring equipment mounted aboard. Short push cores recovered with the Hanna core barrel and grab samples will be taken from the SwRI research vessel after completion of the profiling in each estuary.

The program permits selection by GURC and FWPCA of that combination of tasks which constitute the most effective data acquisition and reduction program for support of the GURC effort. The following tasks are proposed for each estuary:

A. Set up requirements

B. Data acquisition and reduction

1. Profiling, bottom and subbottom

2. Coring (long cores average 30 feet using coring machine on spud barge)

3. Coring (short cores 10 feet or less and grab sampling from R/V Wrangler)

C. Sample analysis

1. Carbon-14 dating measurement
2. Sediment fraction analysis
3. Phosphate analysis
4. Heavy metal analysis
5. Total hydrocarbon analysis
6. Chlorinated pesticide analysis

Cost estimates have been prepared on the individual tasks for each of the five major Gulf coast estuaries. These cost estimates are presented on a per unit basis (e.g., $/mile of profile); therefore, the proposed program is highly flexible.

III. DEFINITION OF TASKS

A. Set Up Requirements

Each estuary will have a specific set up requirement which will include: (1) all costs involved in transferring the research vessel, on-board and shore-based navigational and profiling equipment and instuments, and operational personnel; (2) surveying, protective fencing, negotiation and rental of navigation slave station sites, checking and calibrating site locations for navigational system, computer calculations and drafting requirements for tracker plotter charts; (3) electrical power and set up of equipment and maintenance requirements; (4) research vessel with crew for calibration of navigation and profiling systems; and (5) personnel subsistence during period of set up.

The differences in the set up charges for the various estuaries chiefly reflect the travel distances and the degree of complexity involved in the establishment of navigational slave station arrangement. Lake Pontchartrain requires several different locations of the shore-based slave stations to establish precise positioning of the profile grids and core locations. The configuration of the Lake Pontchartrain-Lake Borgne complex will necessitate locating three different station arrays for first order navigation. Lake Borgne was removed from precise positioning control to reduce that region's set ups to two for this preliminary survey program. Nevertheless, reconnaissance surveys may be made but the positioning accuracy will be less than first order. The set up charge for each estuary is a one time cost but is a prerequisite for all following program tasks proposed.

B. Data Acquisition and Reduction

All data collected will be positioned by the Decca Hi-Fix precision navigation system and corrected for tidal variations by use of existing recording tide gauges maintained in the estuaries by the U. S. Corps of Engineers and other navigational aid agencies. Wind direction and speed data as compiled by the U. S. Weather Bureau and measurements of the wind conditions taken periodically aboard the research vessel will be used to supplement compilations of the tide gauge readings, especially in remote areas of the estuaries. Whenever possible, established check points will be reoccupied to verify other means of determining water level variations. Sediment pollution changes due to erosion or deposition in subsequent years will be determinable by a comparison of future profiles

of the subbottom sedimentary layers with the key marker horizons delineated by the proposed program. Diagnostic units, recognizable in both present and future profiles, will provide a superior datum from which to evaluate sediment pollution problems and guide remedial action.

1. Bottom and Subbottom Profiling

A highly detailed record of water depth and the sedimentary sequence in the upper hundred feet or to the uppermost Pleistocene will be the specific objective of the profiling task. The ultimate goal in each estuary will be to obtain the maximum resolution of each sediment type encountered in this zone. In much of Corpus Christi Bay it has been found that significant penetration of the bottom sediments can be obtained with the precision depth recorder (PDR). When this penetration is possible, an extremely detailed profile of the uppermost sediment layers is obtained due to the high frequency and narrow beam-width characteristics of this instrument. Under these circumstances the water-bottom interface may be obscured due to the high gain used in which case the water depth will be obtained from another depth sounder.

In synchronization with the PDR a high resolution seismic reflection profiler will be recording continuous subbottom sediment information. This subbottom profiler was specifically designed to resolve small layers in the recent sediments and to operate effectively in shallow water. The combination of this information with that from the PDR will result in the required penetration and the maximum resolution of each sediment type under the wide variety of conditions that will be encountered.

Position information derived from the Hi-Fix will be systematically posted on the original records. Because of the shallowness of the estuaries, these records will be based on a constant sound velocity of 4800 feet/second and no attempt will be made to correct them for water temperature and salinity variations. The original records will be kept on file at OSEL and two continuous Xerox or comparable copies will be folded and filed in labeled protective envelopes until written authorization for their disposition is received. A minimum of one hundred miles of bottom and subbottom profiling was used in estimating the unit cost in each of the estuaries.

2. Coring and Sampling

Long cores averaging thirty feet in length and shorter push cores ranging up to ten feet in length will be retrieved at selected

locations along transects as determined by subbottom profiling information and consultation with GURC scientists. The long cores will penetrate to the top Pleistocene wherever practical. The push cores will be taken at intersections of subbottom profiles especially in the closely spaced profile section or in areas where the Pleistocene top is within ten feet of the bay bottom or where extensive mud sections are encountered. Close coordination with the GURC scientific staff will be required during the planning of the coring operations.

Where the bottom sediments are not receptive to the push core techniques, an 18-inch plastic lined drop coring device will be used and if core recovery still fails, a bottom sampler will be employed to gain bottom sediment information.

Long cores will be taken with the OSEL rotary coring rig mounted on a leased spud barge. All coring and sampling locations will be precisely established with the Hi-Fix navigational system. As time and space permits, sample preparation will begin on the barge and on the research vessel during coring operations. Completion of the extrusions, splitting, freezing, labeling, preliminary drying for photographing (black and white and color), visual description and final sample drying will be done in a temporary shore laboratory (rental building or trailer unit), or in the Institute's Corpus Christi or Houston laboratory, as appropriate.

Two inch sections from each 6 inch interval of the upper 10 feet of all cores and a two inch sample from every 12 inches below 10 feet will be placed in a plastic container and frozen in dry ice after splitting the cores longitudinally. Frozen samples will be subsequently transferred to OSEL freezer storage to await analysis. The remaining part of the samples will be air dried, plastic bagged, labeled and stored at the OSEL warehouse in Corpus Christi. Photographic negatives will be processed and individually labeled and filed, with two photographic contact prints of each black and white negative. Two color slides of each core section will be labeled and filed. A continuous depth measurement of each core section will be incorporated in each photograph.

No provision has been made in this proposal for costs involved in shipping above mentioned samples from the warehouse or for storage beyond a one year period of time.

3. Sample Analysis

The analytical study to evaluate the pollution characteristics of the sediments will be performed jointly by the Ocean Science and

Engineering Laboratory and the Department of Chemistry and Chemical Engineering. Carbon-14 age measurements on a select series of experimental samples, providing scheduling is favorable, will be run by Mobil Oil Corporation's Field Research Laboratory. However, if a large number of sample determinations are needed, a commercial geochronology laboratory such as Isotopes Incorporated will be utilized.

The sediment fraction analysis will identify the sediment types in terms of sand, silts and clays and plot the percentages by weight of each fraction by normal sediment laboratory methods. The phosphate distribution in the sedimentary sequence will be a measure of the occurrence of detergent by-products and other phosphate-containing pollutants. Where a separate water phase can be separated ASTM Method 37.1 will be used. Total phosphate by ASTM Method 37.2 will be run on solid material.

A semi-quantitative spectrographic analysis will be made for metallic constituents. Total hydrocarbon content will be determined by extracting the sediment samples and determining the organic content of the extract by infrared analysis. The gas chromatography method will be used to analyze the sediment samples for the chlorinated pesticides at the parts-per-billion level.

IV. SWRI/OSEL CAPABILITIES IN ESTUARINE STUDIES

The Ocean Science and Engineering Laboratory can furnish to the proposed program the unique combination of precise navigation, versatile high resolution subbottom profiling, synchronized bottom penetrating precision depth recording, the capability to obtain cores, and the experienced personnel to assure maximum effectiveness.

The Ocean Science and Engineering Laboratory is located on Corpus Christi Bay adjacent to the ship channel leading to Port Aransas and the Gulf of Mexico, and to the Intracoastal Waterway which provides ready access to bays, lagoons, and estuaries of the Gulf of Mexico. The shore facilities include laboratory, office, and warehouse space with equipment and instrumentation for chemical and geological analysis, mechanical and electronic calibration and repair of ocean research instrumentation, and storage of marine samples and data.

The Ocean Science and Engineering Laboratory is equipped to provide basic operational support for scientific test and engineering projects and, as a member of GURC, to furnish logistic support and experienced technical manpower to academic and institutional research activities. The OSEL resident staff is provided with the back-up expertise of a 1200-man scientific and engineering staff in SwRI-San Antonio and SwRI-Houston. The Institute is comprised of eighteen operating departments encompassing all areas of the physical sciences and engineering. The proposed program of sediment pollution in estuaries will heavily depend upon the knowledge and skills of the Department of Chemistry and Chemical Engineering.

Water pollution research and engineering services have been established at SwRI-Houston for seven years during which time this group has conducted both municipal and industrial surveys of chemical and thermal pollution, determined pollution sources, developed methods for treatment and control of pollution, and has established standards for monitoring industrial hygiene hazards. Much of this work was done in bays and estuaries. SwRI-San Antonio has developed methods for microchemical analysis for detection of pesticide residues and other pollutants, has developed methods for the gellation of hydrocarbons as a means of controlling petroleum pollution, and has developed biochemical and biological methods for waste treatment. This estuarine pollution research background will contribute valuable experience to the interpretation of the chemical analysis of the core samples.

The OSEL research vessel, the R/V Wrangler, is a 46-foot craft with a 200-mile range and a cruising speed of about 15 knots. Its size, range, and speed are well suited for research survey operations in the bays and estuaries of the Gulf as well as continental shelf areas. The vessel was equipped specifically for research in marine geology and physical oceanography in the shallow water of the coastal region. The primary capabilities of the R/V Wrangler for the proposed study include the following:

Navigation

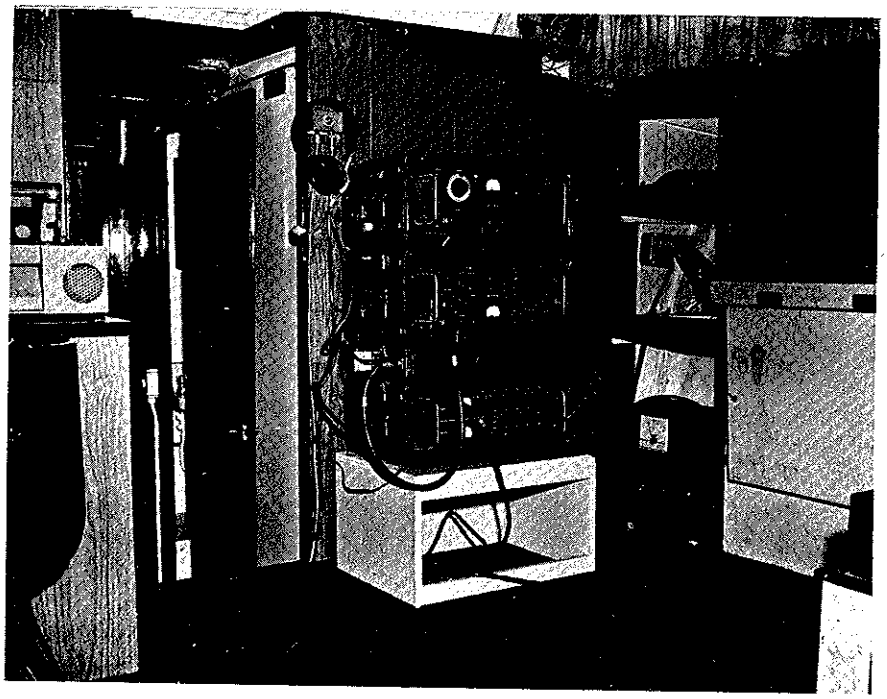
The precise navigational system is the Decca Hi-Fix. For the proposed estuarine study, the system will be used in the radial mode (i.e., with the transmitter located on the research vessel). The transponders, which OSEL has mounted in self-contained trailer units, can be easily transported to the most strategic locations for optimum utilization of the system's capabilities. (See illustrations, next two pages.)

The system was designed for an absolute accuracy of one meter at ranges as great as 70 miles from the base line. Experience in Corpus Christi Bay has demonstrated repeatability over extended periods of time that meet these specifications. A servo-driven track plotter has been installed as an accessory to the navigation system and provides a means of predetermination of a systematic study grid and provides a record of an actual path of where the bottom or subbottom profiles were made with a resolution of a few meters. Also, it furnishes a means of retracking the same profiling paths during any subsequent investigation. The Hi-Fix system will also be used to locate the core hole positions, thus assuring profile and core coincidence.

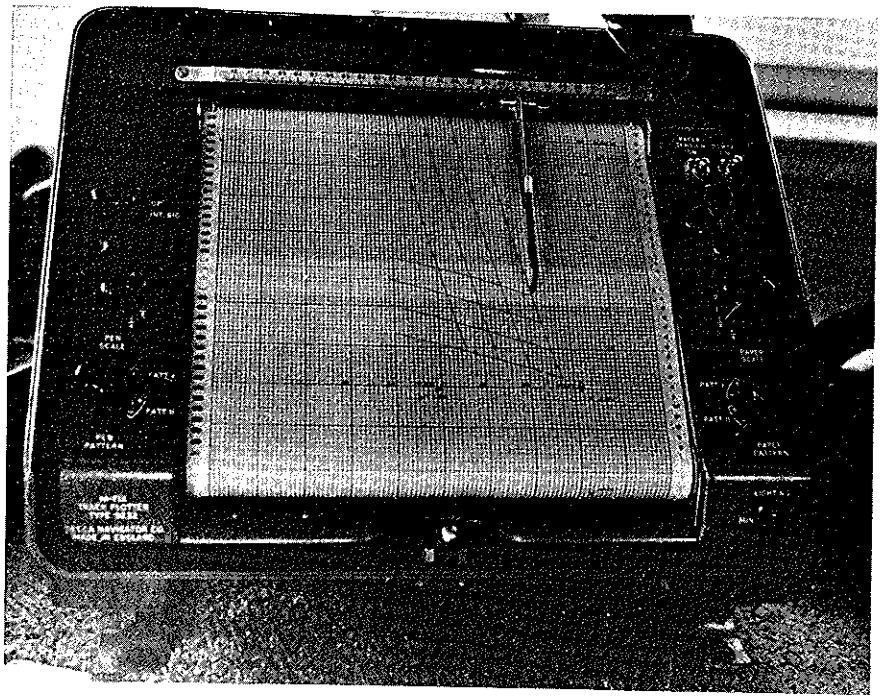
Subbottom Profiler

SwRI/OSEL has installed on the research vessel a continuous seismic profiling system which was designed with particular emphasis on the development of the most versatile high resolution system. The basic sound source is in an "arcer" which creates its acoustic energy through the release of a charge of electrical energy to the water in lieu of to another electrode. This particular system has the advantage of output frequency adjustment through electrode arrangement and a wide output power adjustment range of 180 to 5000 joules. (See illustrations.)

The receiving amplifier includes a 48-db/octave band pass filter (both edges continuously adjustable from 10Hz to 20KHz), 130-db gain, 100-db AGC (with individually adjustable attack and release) and a

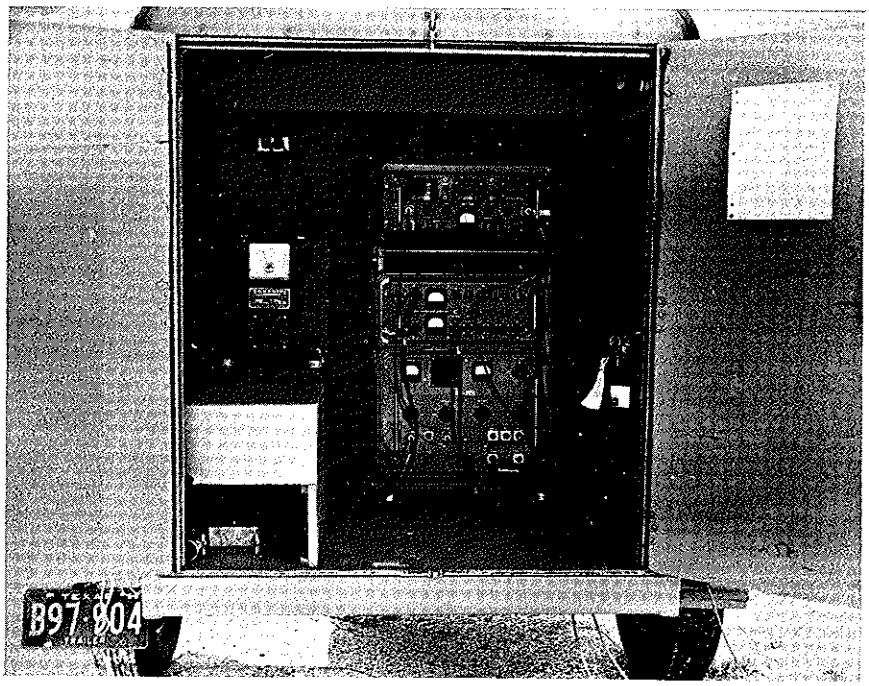


Transmitter Unit

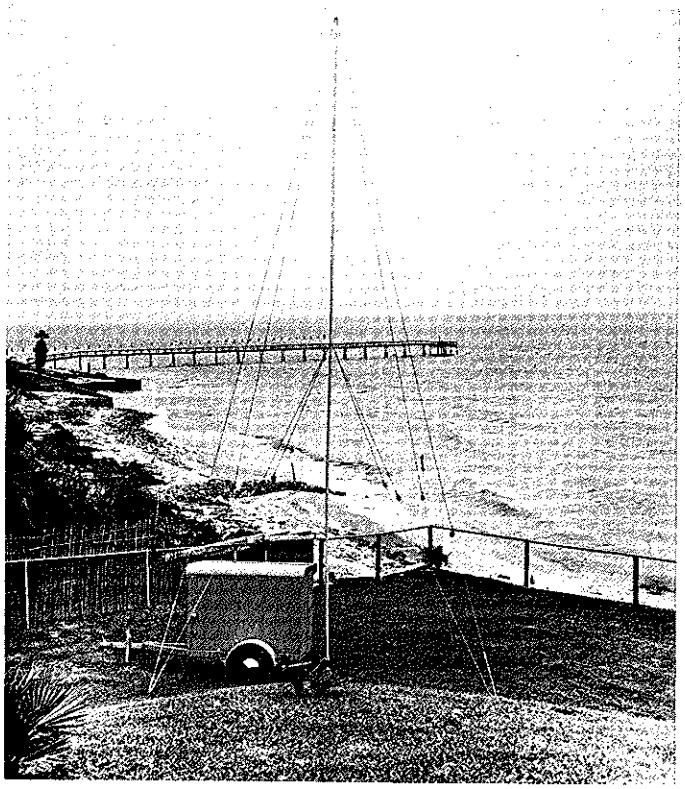


Automatic Position Plotter in Wheelhouse

Decca Hi-Fix Precision Navigation System
Components Aboard *R/V Wrangler*

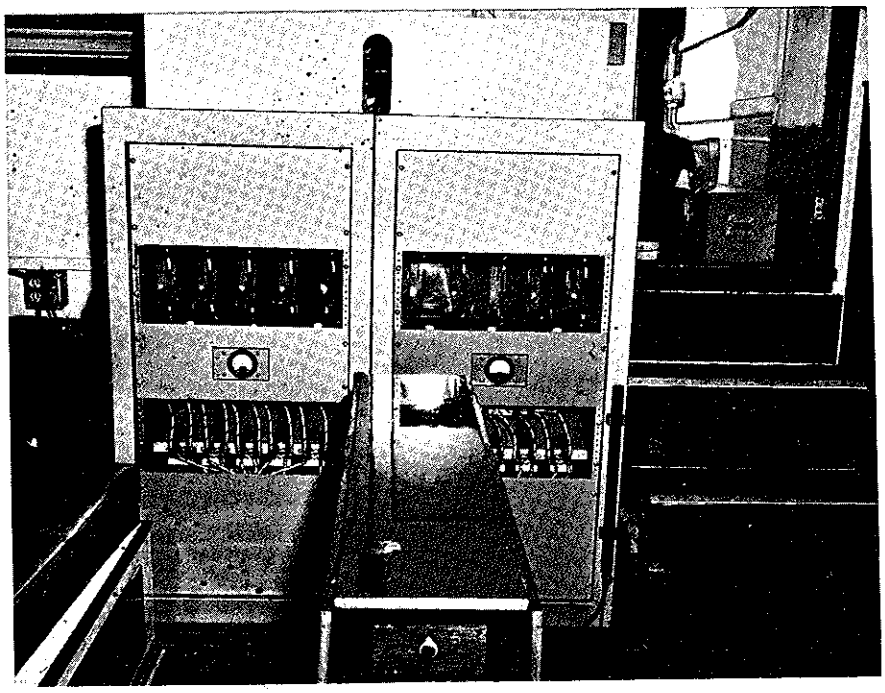


Trailer-Mounted Decca Hi-Fix Transponder Unit with
Self-Contained Power Generation Equipment

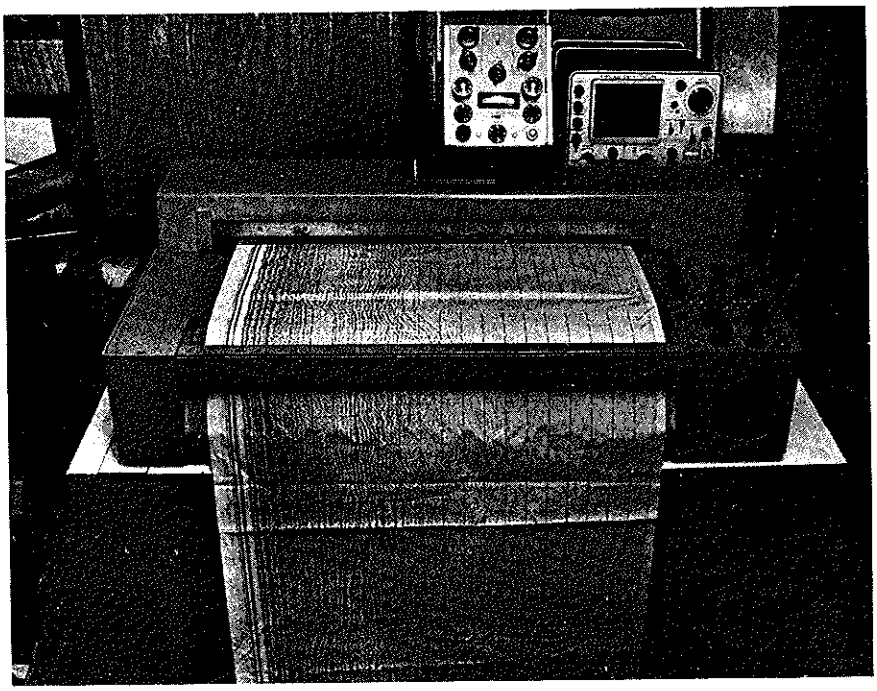


Transponder Unit in Operation

Decca Hi-Fix Precision Navigation System
Transponder Unit (Shore Station)



Arcer Control Unit



Arcer Profile Recorder

High Resolution Arcer Profiler Equipment
Aboard *R/V Wrangler*

black-gray biased output option. The hydrophone arrays have been specially designed for a high sensitivity and signal-to-noise ratio in shallow water.

Considerable experimental work has been done with this system in order to gain the experience necessary to insure optimum resolution over a variety of subbottom conditions. Presently, bed separation may be resolved to less than one foot. Excellent results have been obtained in Holocene and Pleistocene sediments in Corpus Christi Bay (see sample records). The output of the receiver is recorded on 19-inch chemically treated paper in a Gifft GDR-IC-19-T recorder which also furnishes synchronization to the system and selection of range and recording density.

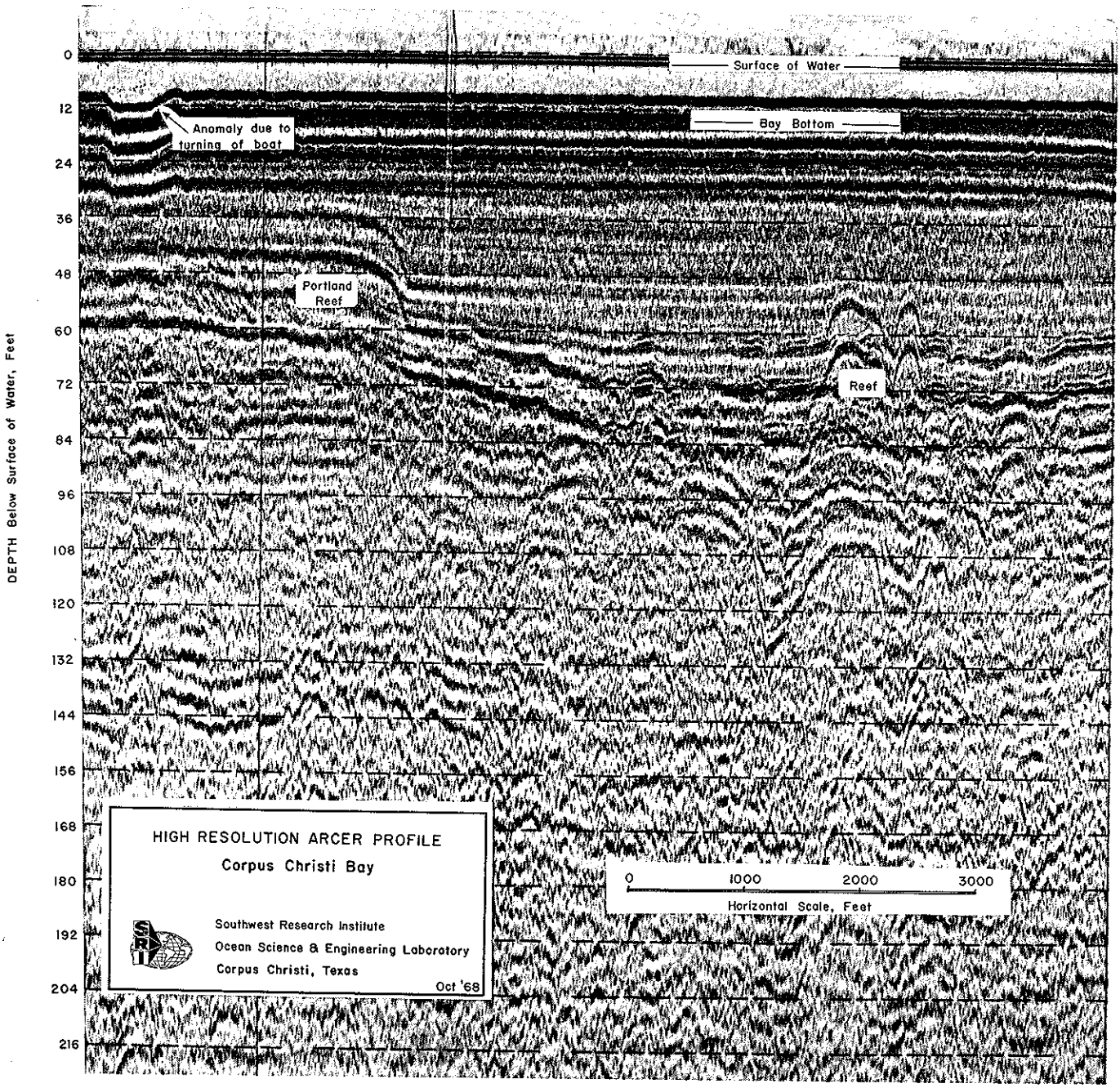
Precision Depth Recorder

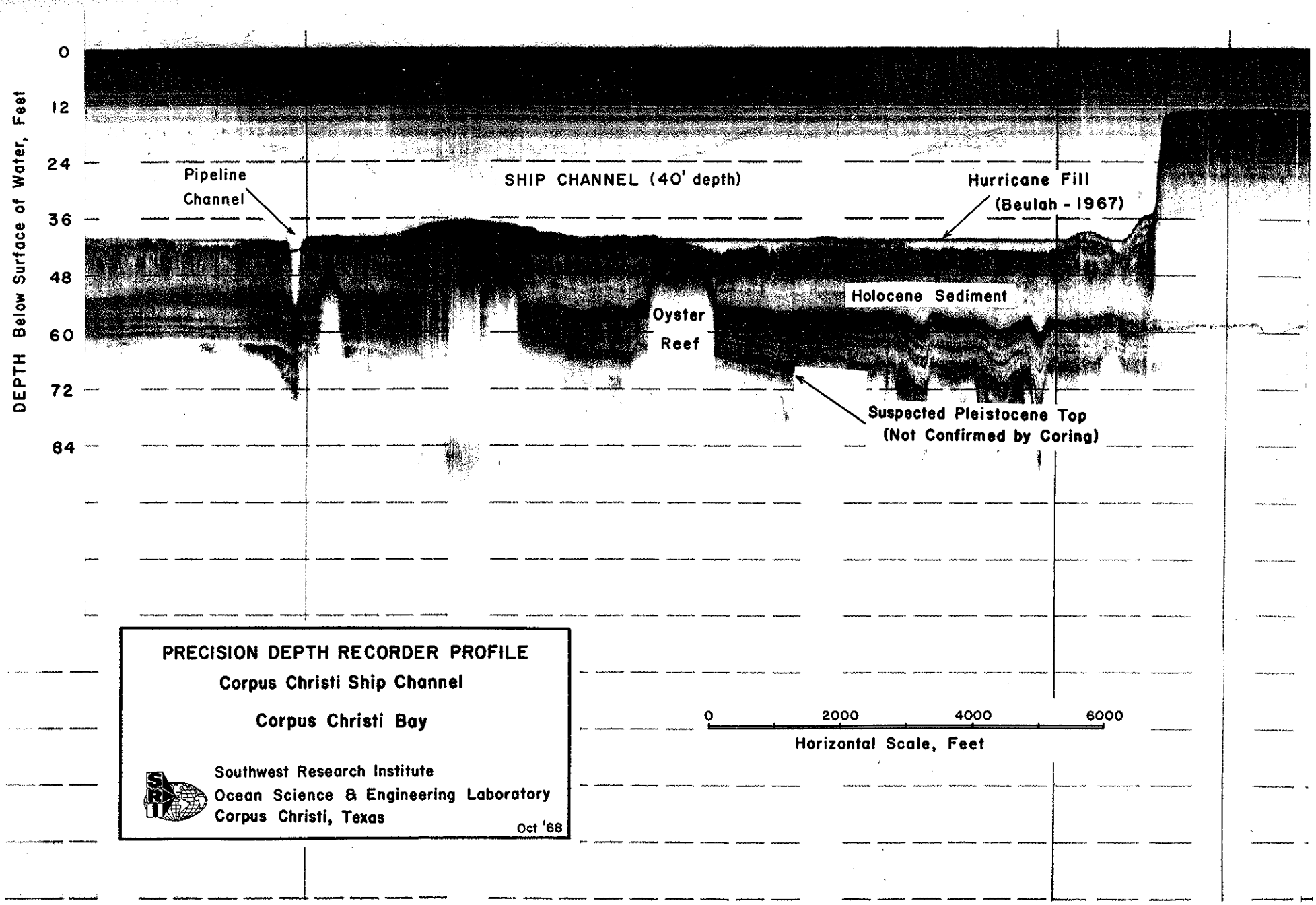
A precision depth recording system (PDR),including an Edo Western 353 transducer and a Gifft (GDR-IC-19-T) graphic recorder, has been installed in the R/V Wrangler. The Edo transducer is driven at 800 watts peak power at 12 KHz by the transmitter in the recorder. The recorder may be programmed to select the transmitted pulse width, paper speed, depth scale, and transceive cycle to achieve optimum data resolution. The identical model recorders of the subbottom profiler and the PDR may be programmed to produce the same vertical and horizontal scales.

In sonically transparent sediments as found in many Gulf Coast estuaries, a high gain setting produces appreciable subbottom penetration. Since this application may obscure the water-bottom interface, the Bendix Depth Sounder will record the water depth. In Corpus Christi Bay, for example, high resolution profile records are possible to a depth as great as 70 feet below water bottom. Under those conditions where this system records subbottom layers, the combination of the "arcer" profiler and the PDR produces the finest third dimension detail of the upper sedimentary section we have ever seen (see sample records). Hard layers such as sand banks or shell reefs halt the PDR penetration but not the subbottom profiler.

Coring Equipment

OSEL has a Sprague and Henwood Model 40-CL air-cooled gasoline engine driven core drilling machine with an oil operated hydraulic swivel-head and an auxiliary cathead. This is a highly efficient and versatile drill rig designed and engineered to furnish dependable service under the


DEPTH Below Surface of Water, Feet
0
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
192
204
216
Surface of Water
Bay Bottom
Anomaly due to turning of boat
Portland Reef
Reef
HIGH RESOLUTION ARCER PROFILE
Corpus Christi Bay
Southwest Research Institute
Ocean Science & Engineering Laboratory
Corpus Christi, Texas
Oct '68
0
1000
2000
3000
Horizontal Scale, Feet



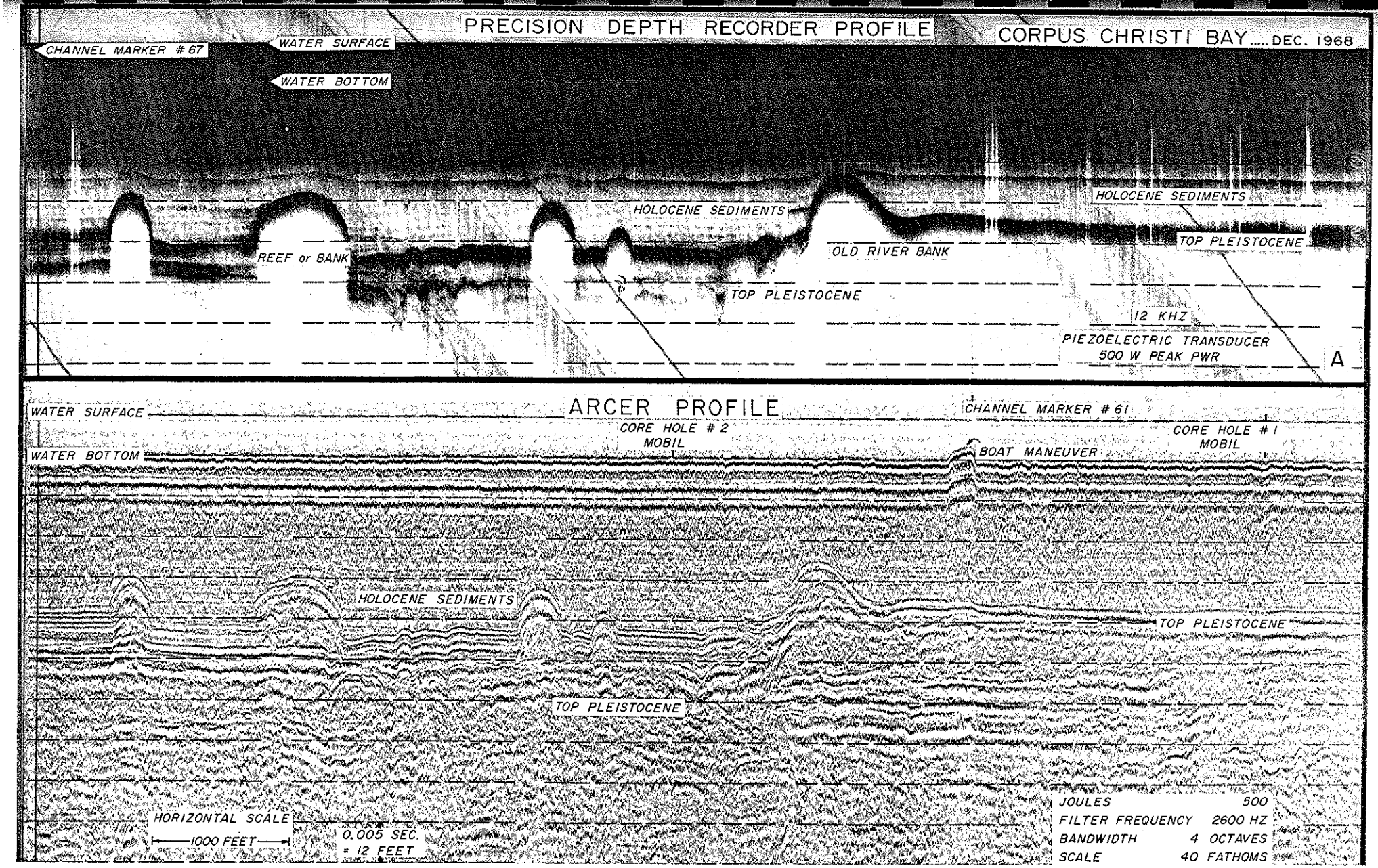
PRECISION DEPTH RECORDER PROFILE

Corpus Christi Ship Channel

Corpus Christi Bay

Southwest Research Institute
Ocean Science & Engineering Laboratory
Corpus Christi, Texas

Oct '68



Comparison of Two Types of Profile Records

Ocean Science and Engineering Laboratory

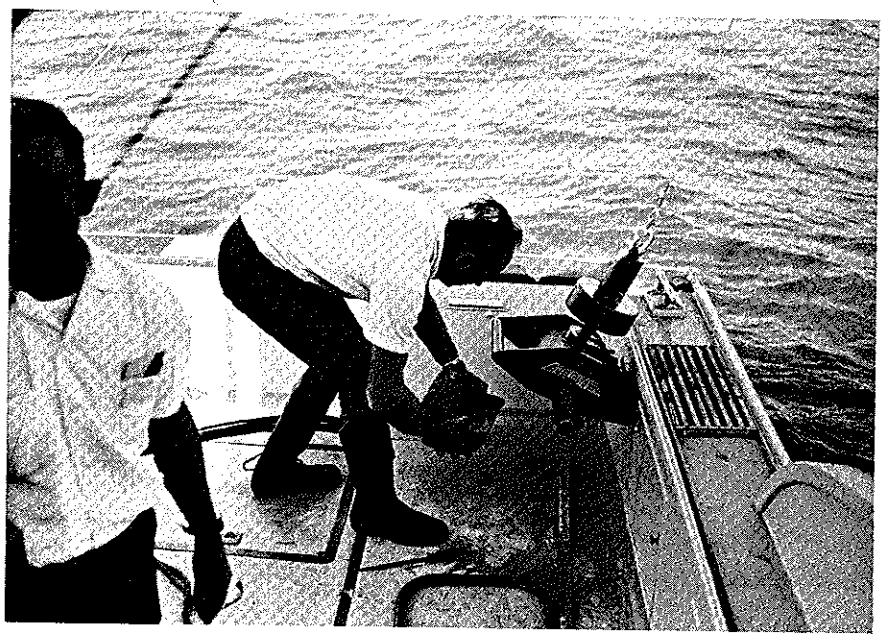
most difficult field conditions. The unit is skid mounted and uses a single pole derrick. The unit is a highly portable self-winching machine that can operate from its specially designed trailer, or from its skid mountings on land or barge surface. The power and transmission incorporated in this machine provide capacity to work to depths of 1000 feet with a core diameter of 2-1/8 inches under favorable operating conditions. A variety of core barrels and samplers is available to obtain the optimum core recovery from the unconsolidated sediments anticipated in the estuarine environment.

A Hanna type push coring apparatus is equipped with a five- or ten-foot core barrel. The core is retrieved in a 1-3/4-inch plastic liner. Coring success with this device is dependent upon sediment type and may have limited use in hard sands, silts, or shell. Full-barrel core recovery has been obtained in the Corpus Christi Bay area while operating from the R/V Wrangler in water depths as great as 13 feet.

A Phleger type gravity corer (Alpine Model 211) with an 18- or 36-inch core barrel and a Shipek sediment grab sampler will be held in reserve to gain samples when the push corer fails to provide a sediment core.

Beach Buggy and Coring Rig

Drop Coring Equipment



Shipek Bottom Sampler

Bottom Sediment Coring and Sampling Equipment Aboard the *R/V Wrangler*

V. COST ESTIMATES

A. Cost Per Unit Task

Each of the five Gulf Coast estuaries is treated as a separate phase consisting of a series of tasks. To facilitate operational and financial planning, the cost of each task has been estimated on a per unit basis with a minimum level of effort stipulated for each task. The cost estimates which follow are predicated on the tasks of each phase being sequential without interruption.

Phase I Corpus Christi Bay

1.	Set up charge		$3,455.00
2.	Data acquisition and reduction		
	a. Profiling bottom and subbottom	(100 miles min.)	66.00/mile
	b. Long cores (average 30 ft)	(min. 300 ft total)	28.50/foot
	c. Short cores (10 ft max.)	(24 cores min.)	122.00/core
3.	Sample analysis		
	a. Carbon-14	(no min.)	125.00/sample
	b. Sediment fraction	(100 sample min.)	12.50/sample
	c. Phosphates	(50 sample min.)	55.00/sample
	d. Heavy metals	(20 sample min.)	38.50/sample
	e. Total hydrocarbons	(1st 50 samples) (over 50 samples)	16.50/sample 11.00/sample
	f. Chlorinated pesticides	(1st 50 samples) (over 50 samples)	44.00/sample 38.50/sample

Phase II Galveston Bay

1.	Set up charge		$ 6,290.00
2.	Data acquisition and reduction		
	a. Profiling bottom and subbottom	(100 miles min.)	85.00/mile
	b. Long cores (average 30 ft)	(min. 300 ft total)	37.00/foot
	c. Short cores (10 ft max.)	(24 cores min.)	140.00/core
3.	Sample analysis		
	Same unit costs as in Phase I, Task 3		

Phase III Lake Pontchartrain

1.	Set up charge		$15,510.00
2.	Data acquisition and reduction		
	a. Profiling bottom and subbottom	(100 miles min.)	87.00/mile
	b. Long cores (average 30 ft)	(min. 300 ft total)	38.00/foot
	c. Short cores (10 ft max.)	(24 cores min.)	143.00/core
3.	Sample analysis		
	Same unit costs as in Phase I, Task 3		

Phase IV Mobile Bay

1.	Set up charge		$12,885.00
2.	Data acquisition and reduction		
	a. Profiling bottom and subbottom	(100 miles min.)	88.00/mile

b.	Long cores (average 30 ft)	(min. 300 ft total)	38.00/foot
c.	Short cores (10 ft max.)	(24 cores min.)	144.00/core

3. Sample analysis

   Same unit costs as in Phase I, Task 3

Phase V Tampa Bay

1. Set up charge — $16,830.00
2. Data acquisition and reduction

a.	Profiling bottom and subbottom	(100 miles min.)	91.00/mile
b.	Long cores (average 30 ft)	(min. 300 ft total)	38.50/foot
c.	Short cores (10 ft max.)	(24 cores min.)	148.00/core

3. Sample analysis

   Same unit costs as in Phase I, Task 3

These figures are presented as unit costs on a fixed price basis, to facilitate planning for various alternate combinations of phases. After such planning has been completed by GURC and FWPCA, it is anticipated that a cost-plus-fixed-fee contract will be negotiated, to cover the specific items required to complete the desired investigation. The attached Contractual Information Sheet outlines the method of cost calculation applicable to cost-plus-fixed-fee contracts and contains other information of a contractual nature.

B. Proposed Phase I Program and Cost Estimates

At the request of GURC, the Corpus Christi Bay phase is suggested as an all task minimum-effort experimental program which would permit examination and evaluation of the basic methodology for studying sediment pollution which is proposed for all five estuaries. The objective of this minimum program would be to evaluate equipment performance and, with

GURC scientists, to develop final procedures for surveying, sampling, analyzing, and interpreting the sedimentary pollution characteristics of estuaries.

Since the single phase, or minimum program, was defined as including all optional tasks, including interpreting the data acquired in the field and the results of the sediment analyses conducted in the laboratory, the following additional tasks are suggested:

Correlation, Evaluation, and Interpretation

1. Correlate subbottom profiles with cores and sediment analysis data

2. Prepare series of stratigraphic-lithologic cross-sections

3. Construct a Pre-Recent topographic map

4. Construct a Recent isopachous map

5. Prepare lithofacies maps of stratigraphic units

The minimum effort tasks recommended for the investigation include: initial set up ($3,455.00), 125 miles of bottom and subbottom profiling ($8,250.00), 300 feet of long cores ($8,550.00), 24 short cores ($2,928.00), 10 carbon-14 age determinations ($1,250.00), 100 sediment fraction analyses ($1,250.00), 50 total phosphate analyses ($2,750.00), 50 heavy metal analyses ($1,925.00), 50 total hydrocarbon analyses ($825.00), and 50 chlorinated pesticides analyses ($2,200.00).

The interpretation of the above information will involve 70 man-days of OSEL effort in addition to several weeks or more of consultation with GURC scientists. The cost of the interpretation, evaluation, and report preparation by SwRI personnel only, including travel, telephone, and reproduction costs, is $15,000.

Total cost of Corpus Christi Bay test project without provision for GURC and university personnel is $48,383.

This cost computation for the first phase to be conducted in Corpus Christi Bay is representative of the method of cost computation for the additional four phases.

VI. TIME SCHEDULE

The data acquisition in Corpus Christi Bay could be carried out over a period of three months. If the five phases were conducted as a single continuous program, it would be possible to complete the acquisition of all the data in a period of 15 months.

VII. REPORTS

A bimonthly informal letter progress report will be submitted for each phase of the program and a final report will be submitted at the completion of each phase. The final reports will include the results of all work performed in those phases. The preceding cost estimates provide for reproduction of 10 copies of each final report.

SOUTHWEST RESEARCH INSTITUTE
CONTRACTUAL INFORMATION
COST-PLUS-FIXED-FEE PROPOSAL

SwRI Proposal No. 18-6399
Purchase Request No. _____

Southwest Research Institute is a not-for-profit corporation organized in the public interest and existing under the laws of the State of Texas, with its general offices at 8500 Culebra Road, San Antonio, Texas 78228. Laboratories are maintained at San Antonio, 3600 Yoakum Boulevard, Houston, Texas 77006, and 1901 N. Shoreline Drive East, Corpus Christi, Texas 78403. The Institute presently employs approximately 1000 full-time scientists, engineers, technicians, and service personnel.

The Defense Supply Agency, Defense Contract Administration Services Office, 7071B San Pedro, San Antonio, Texas 78216 has been assigned responsibility for administration of Department of Defense contracts. The agency having cost cognizance on all Government contracts awarded this Contractor is the Defense Contract Audit Agency, San Antonio, 7077 San Pedro, San Antonio, Texas 78216.

Contractor's current financial statements are filed quarterly with the Defense Supply Agency, the audit agency, and the Directorate of Procurement, Headquarters, Air Force Systems Command, Andrews Air Force Base, Washington, D. C. 20331, who has been assigned cognizance under the program for the coordinated negotiation of overhead rates.

The accounting policies and procedures of the Institute and employee salary rates and ranges are reviewed and approved on a current basis as acceptable for Government cost-type contracts.

It is desired that a cost-plus-fixed-fee contract be provided with costs determined in accordance with the ~~Armed Services~~ Federal Procurement Regulations, ~~Section XV, Part 2~~. In accordance with current approved procedures, direct labor cost includes provision for vacation, holiday, and sickness costs at 12% of the cost of direct salaries and wages. A final negotiated overhead rate of 101.34% of regular staff direct labor cost has been established for fiscal year ended October 1, 1966 on the basis of actual cost by the cognizant audit agency. The overhead rate for fiscal year ended September 30, 1967 has not been established. The Government approved provisional overhead billing rate based on audit of current cost incurred and projections is 105% of direct labor cost. However, cost projections are made by the Institute on a periodic basis, and any expected variation from the approved provisional rate is reflected in the cost estimate.

Contractual Information - Continued

The approved policy of the Institute with regard to reimbursement for transportation and other travel expenses is limited to the actual cost incurred. Subsistence expenses are limited generally to $20.00 per calendar day per employee in travel status, and written justification of the traveler is required as a condition to reimbursement for any excess. Transportation by personal and/or Institute-owned automobiles is reimbursed at $.10 per mile as representing the actual cost of such transportation.

Government financing to the extent of current payments on account of allowable costs as provided in the clause entitled "Allowable Cost, Fee and Payment" in accordance with Paragraph 203.4 of Section VII of the Armed Services Procurement Regulations is requested.

The fixed fee, in the case of the Institute is paid not only for the "know-how", which it is in a position to furnish, but for the growth and expansion of the organization which has been set up primarily for the public good through scientific progress and as a specific service to the Government, industry and the public generally. The Institute, a not-for-profit organization, does not have the capital structure to provide for expansion outside of the fee received for work performed, and nominal contributions from interested individuals and organizations. Experience has proven that funds must be available to expand facilities, and also procure new and replace obsolete equipment, in order for the Institute to keep abreast with the latest in scientific development. The fixed fee proposed in this instance has been determined with due consideration given to factors set forth in ASPR, Section III, Par. 808.

This proposal shall remain in effect not longer than 120 days from date of presentation. This proposal constitutes an offer and, if accepted by a Notice of Award placed in the mail addressed to Southwest Research Institute, will form a binding contract on the terms covered by this proposal. It is agreed that any such Notice of Award will be replaced at a later date by a definitive contract bearing the same date as the Notice of Award and containing the details of the agreement between the parties.

Personnel to be contacted for any negotiations required on this procurement:

Contractual: Mr V. V. Krause, Contract Administrator, AC 512, OV 4-2000, Ext.503
Mr. D. D. Belto, Assistant Treasurer, Area Code 512, OV 4-2000, Ext. 231
Mr. A. C. Hulen, Treasurer, Area Code 512, OV 4-2000, Ext. 233

Technical: Dr. P. Oetking, Director, Ocean Sciences and Engineering Laboratory, Area Code 512, 883-2921

Contractual Information - continued

Contingent Fee Statement

Bidder represents: (a) That he has not employed or retained any company or person (other than a full-time bona fide employee working solely for the bidder) to solicit or secure this contract, and (b) that he has not paid or agreed to pay to any company or person (other than a full-time bona fide employee working solely for the bidder) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract, and agrees to furnish information relating to (a) and (b) above as requested by the Contracting Officer. (For interpretation of the representation, including the term "bona fide employee, " see Code of Federal Regulations, Title 41, subpart 1-1.5 (April 1966)(August 1967)

SOUTHWEST RESEARCH INSTITUTE

By D. D. Belto

D. D. Belto

Title Assistant Treasurer

Date: April 24, 1969

APPENDIX

PERSONNEL DATA SHEETS

PHILIP OETKING
Director
Ocean Science and Engineering Laboratory

Ph. B. in Geology, University of Wisconsin, 1946
M. S. in Geology, University of Wisconsin, 1948
Ph. D. in Geology with Minor in Mining Engineering,
University of Wisconsin, 1952

Dr. Oetking is a geologist with over 20 years professional experience as a researcher involved in petroleum and marine geology, mining and petroleum engineering, and lunar and planetary geology. In addition to publishing many technical reports and articles, he developed the concept and has directed the compilation and publication of the AAPG U. S. Geological Highway Map series.

His experience includes 5 years as a teaching assistant at the University of Wisconsin; 6 years as a research geologist with the Sun Oil Company in both domestic and foreign geological problems; 5 years as a consultant in marine, petroleum, and mining geology; 1 year with Chance Vought Corporation as a lunar advisor; and 4 years with the Southwest Center for Advanced Studies in marine, lunar, and planetary research. His background also includes professional scuba diving as a geological and engineering inspector for offshore pipelines and towers, and he has had deep-submersible experience. During World War II, he was an Air Force pilot. He is a designer of sailing craft and has over 30 years experience in operating and maintaining both sailing and power craft.

PROFESSIONAL CHRONOLOGY: Teaching assistant, University of Wisconsin, 1943, 1946-50; field assistant, Jones Laughlin Steel Company, 1946 (summer); research geologist, Sun Oil Company Research Laboratory, 1951-7; geological and engineering consultant, Dallas, Texas, 1957-62; research scientist, Chance Vought Corporation, 1962-3; research scientist, Graduate Research Center of the Southwest, Southwest Center for Advanced Studies, 1963-7; Southwest Research Institute, 1967-(director, ocean science and engineering laboratory, Corpus Christi, Texas, 1967-).

Memberships: American Association for the Advancement of Science, American Association of Petroleum Geologists, American Astronautical Society, American Society for Oceanography, Corpus Christi Geological Society, Dallas Geological Society, Committee on Research Grants of the Texas Academy of Science, Corpus Christi Marina Board, Advisory Committee to Coastal Bend Planning Board on Environmental Pollution, AAPG Map Committee, AAPG representative on the Offshore Technology Conference, and chairman of the Facilities Committee of Gulf Universities Research Corporation.

TOMME J. LAMBERTSON
Manager of Operations
Ocean Science and Engineering Laboratory

Mechanical Engineering, University of Oklahoma, 1944-6, (no degree)
M.S. in Mechanical Engineering, U.S. Naval Postgraduate School, 1957

After two years in the Navy V-12 College Training Program, Mr. Lambertson was commissioned in the U.S. Navy in 1946 and in the subsequent years served in all shipboard head of department assignments, the majority of which were in submarines. He next attended the Naval Postgraduate School and received an M.S. degree in Mechanical Engineering (Nuclear Power Curriculum). His paper, "Performance Factors of a Periodic-Flow Heat Exchanger," based on his thesis, was published in the April 1958 Transactions of ASME. As Executive Officer of the submarine BAYA, he worked closely with the scientific staff of the Naval Electronics Lab in the efficient and safe use of that submersible research platform. He next served as Assistant Director of the Navy Nuclear Power School for two years during which time he also developed and taught advanced classes in nuclear reactor physics and engineering. His last naval assignment was command of a submarine for nearly three years.

At Southwest Research Institute, Mr. Lambertson has designed specialized electromechanical devices and packaging to transform concepts into advanced-development end-items. This effort has been particularly applied to radio direction finding antennas and systems for ground, airborne, shipboard and submarine environments. He has also participated in the development of space flight-qualified hardware for mass measurement and physiological ergometry to be used in the Apollo Applications Program. As Manager of Operations for the Ocean Science and Engineering Laboratory, he is responsible for planning, coordination, scheduling and supervision of afloat operations and supporting activities.

PROFESSIONAL CHRONOLOGY: U.S. Navy, 1944-64 (student, V-12 program, 1944-6; junior officer on various ships and submarines as head of all shipboard departments, 1946-54; student, U.S. Naval Postgraduate School, 1954-7; submarine executive officer, 1957-9; assistant director, Navy Nuclear Power School, 1959-61; submarine commanding officer, 1961-4); Southwest Research Institute, 1964-(senior research engineer, electromechanical group, division of electronics and electrical engineering, 1964-8; manager of operations, ocean science and engineering laboratory, 1968-).

Memberships: Society of Sigma Xi, American Society of Mechanical Engineers and Marine Technology Society.

ROY W. THOMPSON
Manager Electronics Systems
Ocean Science and Engineering Laboratory

BSEE, Texas A&M University, 1962
BBA, Texas A&M University, 1963
Graduate Studies at San Diego State College,
Trinity University and Texas A&I University

Mr. Thompson represents a broad background in electronics with special emphasis on digital and instrumentation systems. As an electronics engineer at General Dynamics/Astronautics, he was simultaneously engaged in system analysis and testing of instrumentation, telemetry, range safety, various adapter subsystems, and the land based support equipment for the Atlas R&D weapons. At General Dynamics/Electronics, he served as Cognizant Design Engineer for the timing system aboard the T-AGM-19 class tracking ship from contract negotiations to delivery. He then served in the same capacity for the central data processing system during procurement and initial installation.

At Southwest Research Institute he has worked with RFI analysis and digital instrumentation. Since joining the Ocean Science and Engineering Laboratory, Mr. Thompson has been responsible for the design, specification, procurement, installation and maintenance of all electronic systems.

His major effort has been involved with improving the operational performance of the precision navigation and high resolution continuous seismic profiling equipment being used by OSEL in the bays, estuaries and continental shelf area of the Texas Gulf Coast.

PROFESSIONAL CHRONOLOGY

Electronics engineer, General Dynamics/Astronautics-Atlas Weapons Systems, 1963-64; electronics engineer, General Dynamics/Electronics-SDO-Apollo Ships 1964-66; Southwest Research Institute, 1966- , (research engineer, Department of Electronics Systems Research, 1966-67; manager electronics systems, Ocean Science and Engineering Laboratory, 1967-).

MEMBERSHIPS

Institute of Electrical and Electronics Engineers.

EDWARD L. BAKER
Marine Electronics Technician
Ocean Science and Engineering Laboratory

Mr. Baker has 9-1/2 years of electronics technician experience including more than three years as supervisor with the U.S. Navy in theory and maintenance of communication and navigation systems. With Boeing Aircraft Experimental Electronics Laboratory, he was involved with the electronic systems of the Minute Man missile development project.

At a forward BMEWS site in Greenland and as an employee of RCA, Mr. Baker was responsible for maintenance and repair of the control and switching systems.

In addition to Navy Electronics School, Boeing training courses in soldering techniques and photoetch processes, and RCA school on digital techniques, Mr. Baker also is enrolled in a correspondence course with the Capitol Radio Engineering Institute on Digital Computers.

He holds an advanced class amateur radio license and a first class commercial radio telephone license with radar endorsement.

During the time Mr. Baker has been with the Ocean Science and Engineering Laboratory, he has achieved comprehensive knowledge in the maintenance, operation and evaluation of marine electronics systems. In addition, he assists engineering in the fabrication and testing of OSEL developed electronics equipments. Related to this function, he is also responsible for the calibration of laboratory test equipment relative to standards maintained by OSEL.

Mr. Baker recently completed a factory course of study on the Decca Hi Fix navigation system and holds certificates of completion in Electronics Engineering Technology and Management from the Capitol Radio Engineering Institute.

JAMES M. SHARP
Vice President for Physical and Biological Sciences

B. S. in Physics, A&M College of Texas, 1940
M. S. in Physics, University of Texas, 1948
Ph. D. in Physics, University of Texas, 1950

With nineteen years of experience in contract research and development for government and industrial organizations, Dr. Sharp is a specialist in the organization, management and technical planning and evaluation of research and development activities. His fields of specialization include acoustics, mechanics, electromechanics and instrumentation, and he is the author of numerous publications in these general areas. For the past eight years, his work at SwRI has emphasized interdisciplinary areas of research wherein he has established and directed a variety of programs involving the combined approaches of several specialties in physics, chemistry and biology. For the past three years, Dr. Sharp has been responsible for the organization, technical direction and management of the Division of Physical and Biological Sciences which includes a broad range of both applied and basic research programs in these scientific disciplines. His general duties involve long range planning for the development of programs and facilities at SwRI, extending Institute capabilities into new areas of science and engineering, and the development of activities involving educational institutions in the region.

PROFESSIONAL CHRONOLOGY: Research scientist, physics department, University of Texas, 1947-50; division leader, electromechanical division, research directorate, Sandia Corporation, 1950-3; chief, engineering analysis branch, research directorate, Air Force Special Weapons Center, 1953-4; Southwest Research Institute, 1954-(manager, special projects section, department of physics, 1954-5; chairman, department of physics, 1955-9; technical vice president, 1959-64; vice president, 1964-).

Memberships: Sigma Xi, Sigma Pi Sigma, American Physical Society, Research Society of America, Society for Nondestructive Testing, Texas Atomic Energy Advisory Committee, Research & Development Committee of the Instrument Society of America, Marine Technology Society.

HERBERT C. McKEE
Assistant Director
Department of Chemistry and Chemical Engineering

B. S. in Chemistry and Mathematics, Muskingum College, 1942
M. S. in Chemical Engineering, Ohio State University, 1947
Ph. D. in Chemical Engineering, Ohio State University, 1949

A registered professional engineer in Ohio and Texas, Dr. McKee has extensive experience in the methods and management of industrial research, particularly in the fields of air and water pollution, precision analytical methods, process development, distillation, and corrosion. At the OSU Research Foundation, he conducted hygroscopicity studies of fertilizer materials and designed and operated pilot plants for manufacturing inorganic chemicals. Later as an industrial chemical engineer, he contributed to the development of processes for producing organic chemicals. Since joining the SwRI staff, he has planned and supervised several long-range programs in air and water pollution, biochemistry, and development of special analytical methods. He has directed several major projects including a large scale urban air pollution survey (Houston, Texas), evaluation of equipment for protection against airborne toxic and corrosion agents. development of synthetic lubricants, and the design of bench scale pilot plants. Dr. McKee is the author (co-author) of numerous technical papers in his specialities.

PROFESSIONAL CHRONOLOGY: Commissioned officer, USA Air Corps Armament Laboratory, Wright-Patterson, 1944-6; research associate, Ohio State University Research Foundation, 1948-50; chemical engineer, Austin Laboratories, Jefferson Chemical Company, 1950-3; Southwest Research Institute, 1953- (senior chemical engineer, 1953-7; manager, air pollution research; manager, industrial pollution and analytical research, 1958-61; (assistant director, department of chemistry and chemical engineering, 1961-; assigned to SwRI-Houston, 1962-).

Memberships: American Chemical Society, American Institute of Chemical Engineers, Air Pollution Control Association, Scientific Research Society of America, and American Industrial Hygiene Association (Gulf Coast Section).

DONALD E. JOHNSON
Manager, Analytical & Biochemistry Section
Department of Chemistry and Chemical Engineering

B.S. in Agriculture, Texas A&M University, 1957
M.S. in Biochemistry, Texas A&M University, 1959
Ph.D. in Biochemistry, Tufts University School of Medicine, 1962

Trained in both medical and agricultural biochemistry, Dr. Johnson is experienced in the analysis of amino acids in physiological fluids by ion-exchange and gas chromatography. In collaboration with Dr. Alton Meister of the Tufts University School of Medicine, Dr. Johnson developed a method for the analysis of amino acids as their N-acetyl-n-amyl esters. Dr. Johnson was a National Institutes of Health Predoctoral Research Fellow and participated in an NIH symposium on Developments in Research Methods. Since joining SwRI, Dr. Johnson has been leader of a project on the metabolism and gas chromatographic analysis of psycho-active drugs. He has developed methods for the isolation of chlorpromazine and many of its metabolites from body fluids and their separation by gas chromatography. During this program, at least eleven chlorpromazine metabolites have been detected, many of which have not been reported on previously. He is also directing a comprehensive program to study the metabolism of antimalarial drugs. Dr. Johnson has continued his studies on analysis of amino acids and is the project manager of a program to develop a nitrogen detector for use in this area. Dr. Johnson has initiated studies on alkylating agents and free radicals in tobacco smoke and the effects of irradiation on the electron transport system of mice.

PROFESSIONAL CHRONOLOGY: Department of biochemistry, Texas A&M University, 1958-9; department of biochemistry, Tufts University School of Medicine, 1959-62; Southwest Research Institute, 1962-(associate biochemist, 1962-3; senior biochemist, department of chemistry and chemical engineering, 1963-4; manager, analytical and biochemistry section, department of physical and biological sciences, 1964-8; manager, analytical and biochemistry section, department of chemistry and chemical engineering, 1968-).

Memberships: American Chemical Society.

LELAND L. HISER
Manager, Air and Water Pollution Research
Department of Chemistry and Chemical Engineering

B.S. in Mining Engineering, University of Arizona, 1949
M.S. in Field of Environmental Engineering, Department of Chemical Engineering, Rice University, 1963

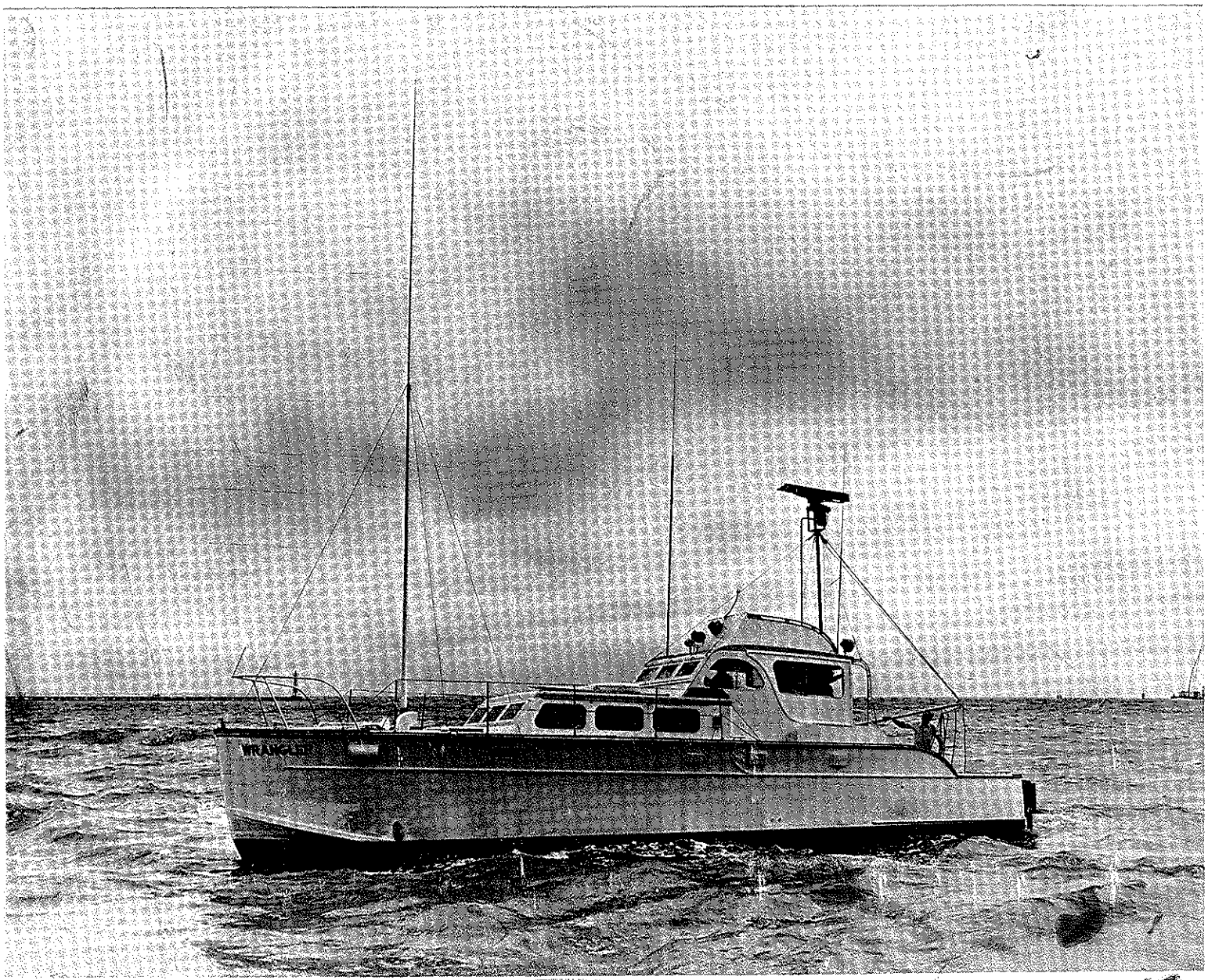
Mr. Hiser has had extensive experience in the theory and design of water and wastewater treatment methods and equipment. As regional sales representative for Infilco Inc., he was responsible for all industrial and municipal equipment sales and service for the southern half of the state of Texas. In this capacity, he was concerned with the solution of water and waste treatment process problems of a wide variety of industries and municipalities.

Since joining Southwest Research Institute, Mr. Hiser has supervised the design, construction and equipping of two wet chemistry laboratories and a mobile laboratory. As manager of the air and water pollution research group he has planned and supervised the research and authored the final reports on many projects including: (1) the evaluation of area-wide air and water pollution problems; (2) development of process design criteria for treatment of industrial wastewaters from petroleum refineries, petrochemical plants, rubber manufacturing plants, pulp and paper mills, etc.; (3) application of a specialized gas chromatographic method for determination of the source of fish taste and odor problems; (4) investigation of means and mechanisms for sulfur dioxide removal from stack gases; (5) development of an improved design and monitoring techniques for use of the Total Carbon Analyzer to study the kinetics of biological systems; and (6) investigation of several methods for the removal of color from paper mill wastes.

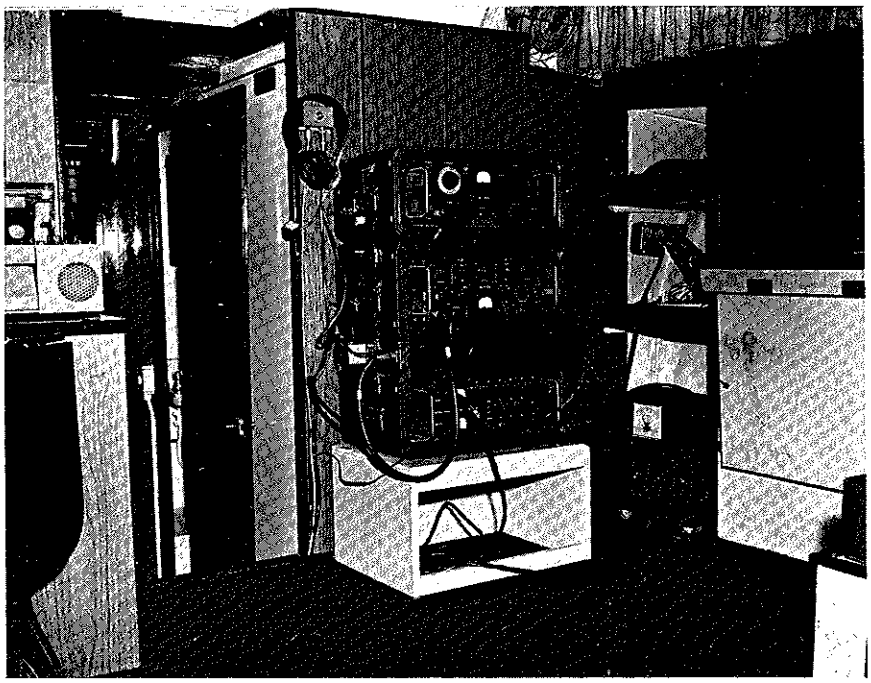
Mr. Hiser is the author and coauthor of several technical papers in his field.

PROFESSIONAL CHRONOLOGY: Engineer, Kennecott Copper Corporation, Ray Mines Division, 1949-50; design engineer, Infilco Inc., 1950-55; field sales engineer, Texas Gulf Coast, Infilco Inc., 1956-62; graduate student, Rice University, 1962-63; Southwest Research Institute, 1963-(senior research engineer, 1963-65; manager, air and water pollution research, Department of Chemistry and Chemical Engineering, 1965-).

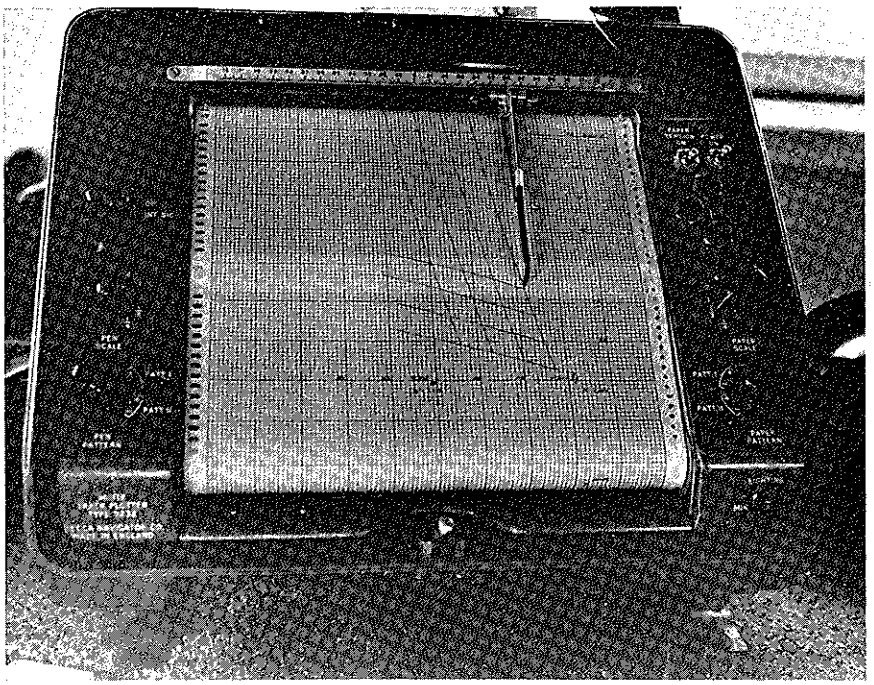
Memberships: Water Pollution Control Federation, American Institute of Chemical Engineers, Institute of Environmental Sciences, Sigma Xi, Tau Beta Pi, registered professional engineer (Texas).



Frontispiece
The Ocean Science and Engineering Laboratory's
Research Vessel, "R/V Wrangler"

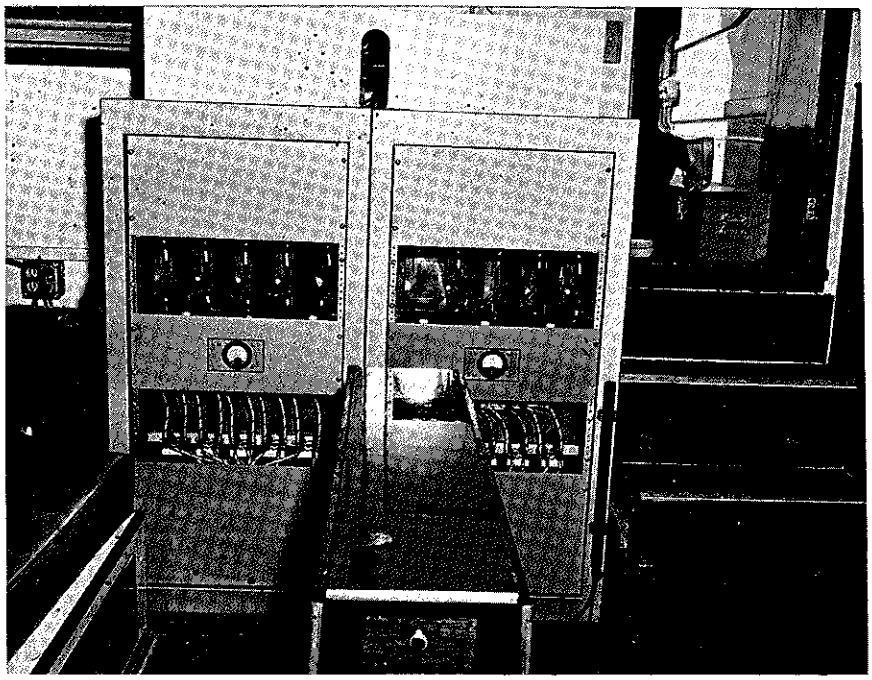


Transmitter Unit

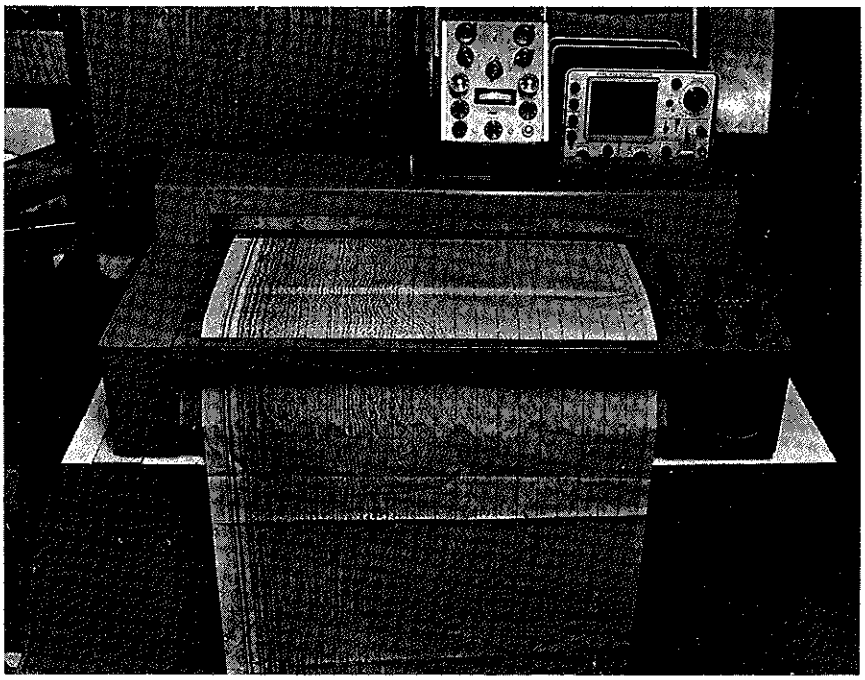


Automatic Position Plotter in Wheelhouse

Decca Hi-Fix Precision Navigation System
Components Aboard *R/V Wrangler*



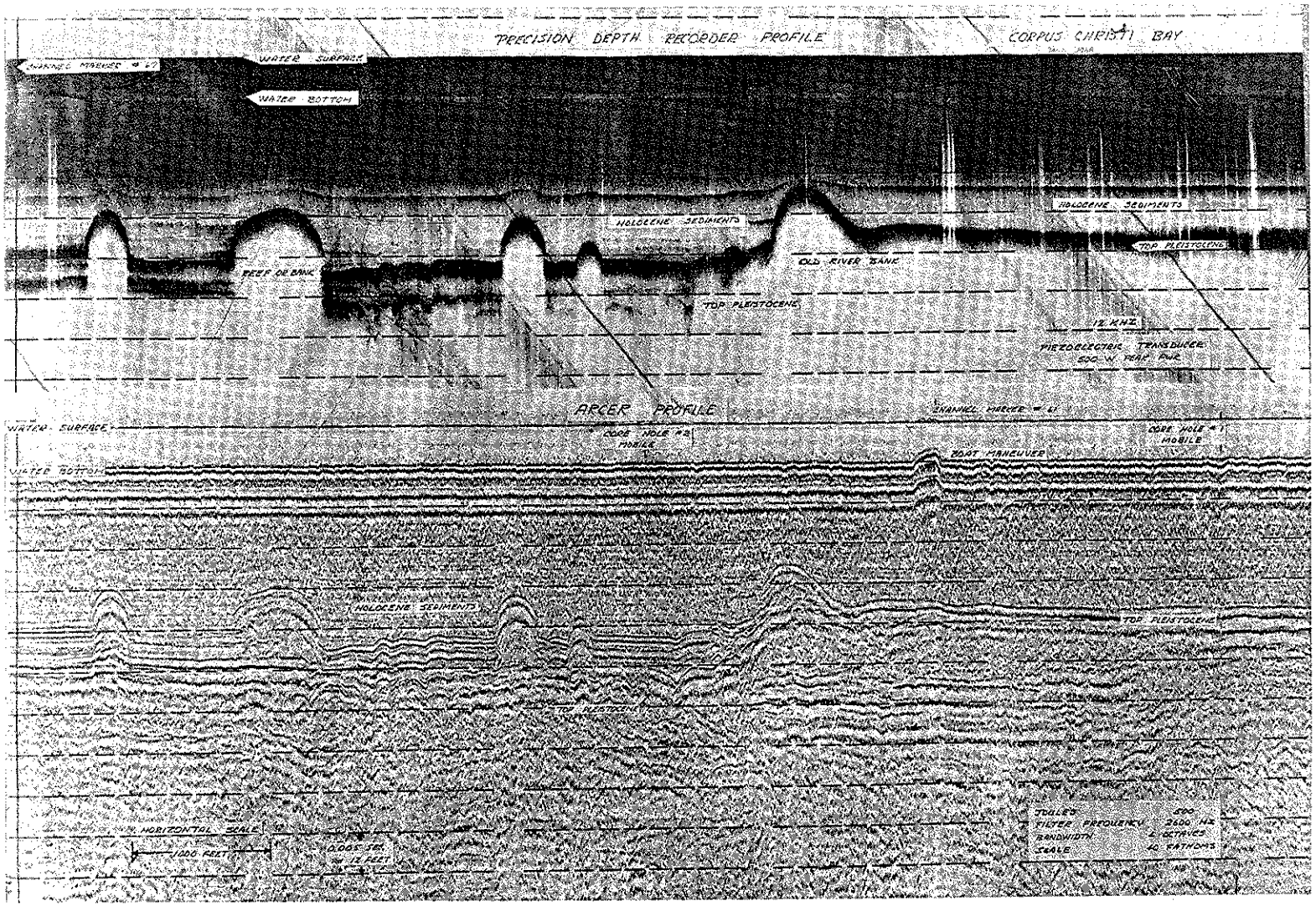
Arcer Control Unit



Arcer Profile Recorder

High Resolution Arcer Profiler Equipment
Aboard *R/V Wrangler*

~~Ocean Science and Engineering Laboratory's~~
Beach Buggy and Coring Rig



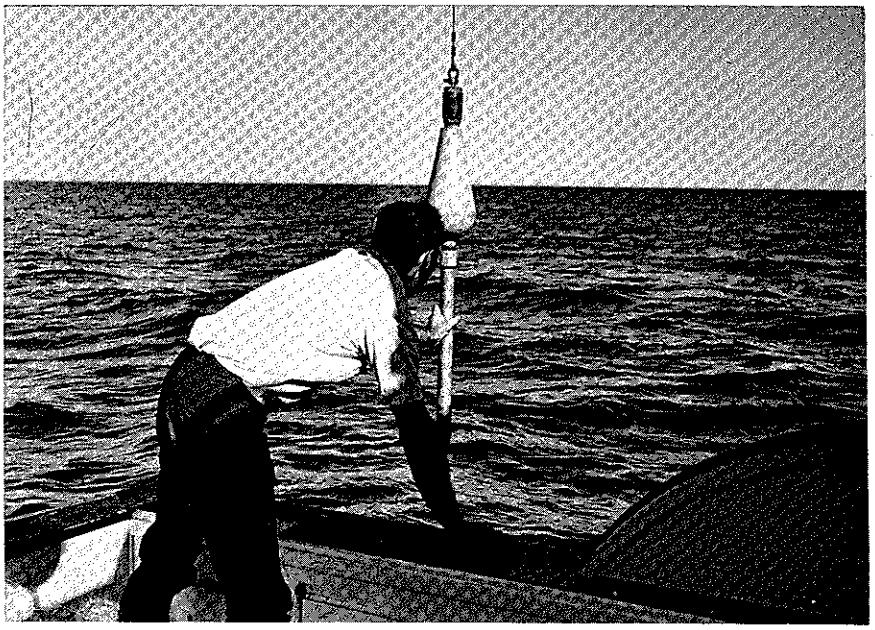
~~High Resolution Subbottom Profiles of Sediment Stratigraphy~~

two types of profile records.

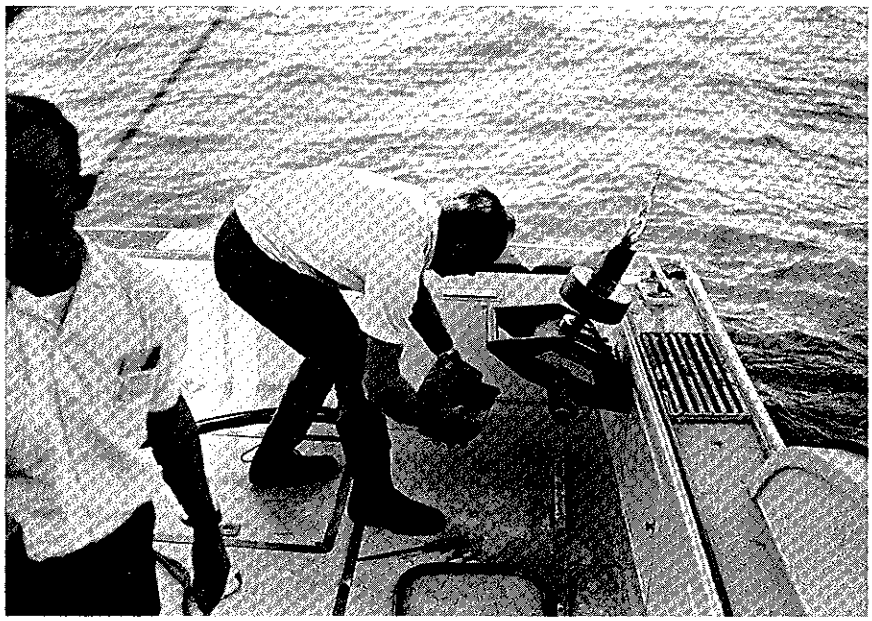
Comparison of ~~Precision Depth Recorder profile~~ and ~~High Resolution Arcer profile for same area in Corpus Christi Bay~~

(Ocean Science and Engineering Laboratory)

16.

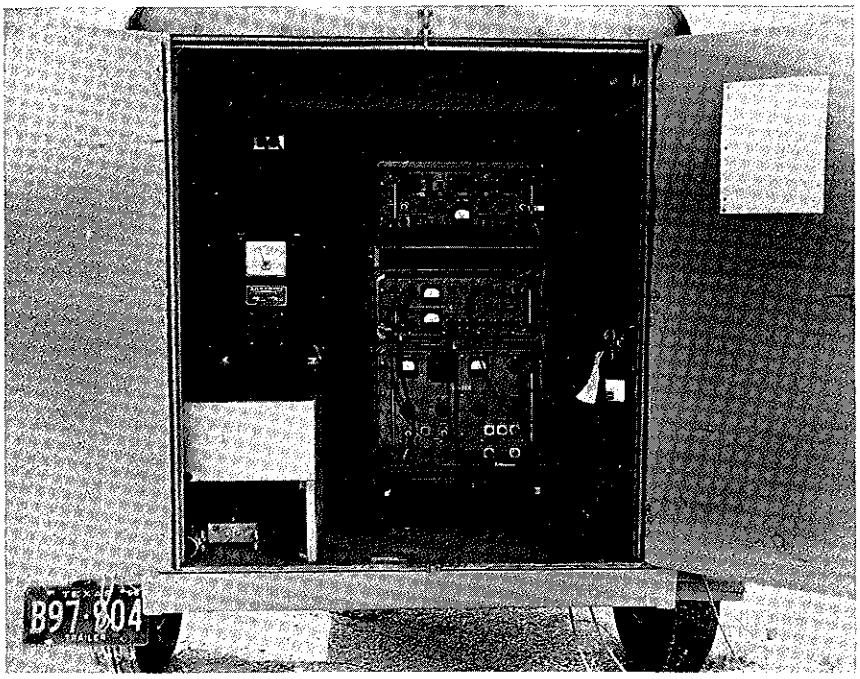


Drop Coring Equipment

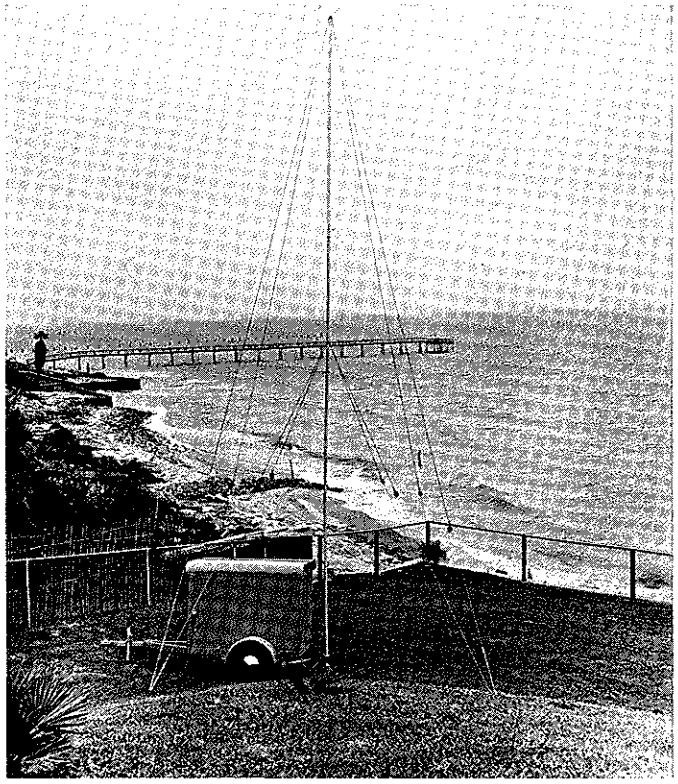


Shipek Bottom Sampler

Bottom Sediment Coring and Sampling Equipment Aboard the *R/V Wrangler*



Trailer-Mounted Decca Hi-Fix Transponder Unit with Self-Contained Power Generation Equipment



Transponder Unit in Operation

Decca Hi-Fix Precision Navigation System Transponder Unit (Shore Station)