HYDROCARBON CHARACTERIZATION
OF SEDIMENTS IN ROOKERY BAY, FLORIDA

A PROPOSAL

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September 24, 1984
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I. INTRODUCTION

Rookery Bay is an unspoiled estuarine preserve in coastal Collier County, Florida (Veri et al., 1973). Recently, however, areas in southwest Florida have become some of the fastest growing in the United States. A consequence of this growth has been extensive residential development leading to a drastic change in land use over a short time period. The growing concern of increased urbanization which may adversely impact the Rookery Bay area has been eased through efforts of the Collier County Conservancy and the National Audubon Society. These organizations purchased approximately 2,600 acres of land surrounding the 1,400 acre state owned waters of Rookery Bay; with this land they have formed the Rookery Bay Sanctuary. However, problems may still occur from runoff of upland developments if adequate management is not enforced.

Several inventories of Rookery Bay Sanctuary resources have been conducted (Conservation Foundation, 1968; Southwest Florida Water Management District, 1980; Yokel, 1975). The results indicate the Rookery Bay area supports and provides nursery grounds for a diverse assemblage of animals, many of which have a high sport and/or commercial value. Destruction of these natural resources from pollutant spills, including petroleum hydrocarbons, would be devastating.

Sources of petroleum hydrocarbons to the Rookery Bay system include the transport of petroleum products along the Intracoastal Waterway, sewage and land drainage from residential development, along with runoff from roads and highways. With increased interest in oil exploration and production off the Florida west coast, there exists the continued threat of oil affecting adjacent coastal zones from drilling and transportation accidents.

Since these threats of petroleum contamination exist, a baseline survey of hydrocarbons in the Rookery Bay area must be obtained to provide information for predicting continued impact from future development of the adjacent coastal zone and to establish the extent and duration of contamination from chronic or catastrophic oil spills.
A) Study Area

The Rookery Bay Sanctuary is located on the southwest Florida coast between 26° and 26°3' north latitude and 81°46' and 81°43' longitude. It is approximately five miles south of Naples, between the Gulf of Mexico and S.R. 951 (Figure 1). It occupies an area of 5,038 acres which include uplands, marshes, mangrove forests, tidal creeks and state owned open water areas. The area is generally low lying with more than 72% less than two feet in elevation, being constantly submerged or intertidal. Mangrove forest is the dominant habitat occupying 2368 acres, or 47.0% of the Sanctuary. Bays and tidal creeks cover 1,746 acres (35.1%), and tidal marsh areas occupy 688 acres (13.7%) (Yokel, 1975).

The Rookery Bay proper is shallow covering 1,034 acres with an average depth of 3.0 feet and an annual mean tidal range of 1.80 feet (Yokel, 1975). The primary freshwater input comes from Henderson Creek, which encompasses 308 acres with an average depth of 2.5 ft and a mean tidal range of 1.95 feet. The majority of the watershed area for Henderson Creek is outside the Sanctuary boundaries with input to the creek occurring as far as east of U.S. 41. Both the bay and the creek have reportedly good flushing rates; the mean renewal rate for Rookery Bay is estimated at 3.2 days and for Henderson Creek 2 days (Lee and Yokel, 1973).

During the late 60's and early to mid 70's a number of research projects were sponsored by the Conservation Foundation describing the biology, hydrography and water quality of the Rookery Bay area as well as formulating plans and concepts of land use.

B) Water Quality and Land Use

The Rookery Bay Sanctuary was created primarily because it represents a relatively intact and healthy portion of the southwest Florida ecosystem. After creation of the Sanctuary, the Conservation Foundation sponsored studies to obtain ecological information on Rookery Bay. These findings were summarized in a 1974 report (Clark, 1974).

Although overall water quality of the bay is assessed as "good", several problem areas were noted by the report. Both dissolved iron and copper concentrations were frequently recorded above EPA maximum acceptable limits. Turbidity was also observed to be a problem during periods of maximum...
Figure 1. Rookery Bay Sanctuary and surrounding areas.
runoff and is believed to be a limiting factor in seagrass abundance and
distribution within the bay. Elevated salinities in the bay caused by a
reduction of freshwater input during the dry season was also stated as a
management aspect for concern. Reductions of freshwater input as a result of
watershed alterations could possibly increase salinity levels to stressful or
toxic concentrations for the resident biota.

Although the current water quality of the bay may be considered "good",
all of the above mentioned areas of concern can be improved or further
degraded, depending on land use outside of the Sanctuary. The primary usage
of the lands inland of Rookery Bay has been agricultural, primarily unimproved
pasture and a limited amount of farming. The coastal urbanization of this
area was relatively slow (compared to other areas of Florida) until the 60's
but is now considered one of the fastest growing regions in the United States.
The area is being developed primarily as a retirement/recreational area with
associated service businesses. It is this type of coastal urbanization which
most threatens the integrity of Rookery Bay coastal area. There are no laws
or regulations prohibiting development of the Sanctuary's watershed areas, and
it is likely development will occur. Two development corporations alone have
permits pending for over 24,500 units of housing within the sphere of
influence of Rookery Bay (pers. comm., Collier County Regional Planning
Council), some of which are adjacent to the Sanctuary's boundaries. Several
areas, such as the Marco Island Development, have already been completed or
are under construction and have been the focal point of intensive controversy
due to excessive destruction of shoreline habitat.

Therefore, primary land use for the Rookery Bay region is for planned
urban housing and recreational developments.

C) Hydrocarbon Identification

The detection of hydrocarbons in the marine environment is complicated
by the fact that the analyst must distinguish among recently biosynthesized
(biogenic) hydrocarbons, hydrocarbons from fossil fuel combustion and forest
fires (pyrolitic), and petroleum (petrogenic) hydrocarbons. The type of
petroleum also must be discernible to ascertain the pollution source.
Much consideration has been given to the development of classification schemes to aid in hydrocarbon source identification. The basis for the most widely accepted identification scheme is separation of the hydrocarbons into aliphatic and aromatic/olefinic fractions. Analysis of these fractions by capillary GC-FID and GC/MS provides the qualitative and quantitative information necessary to establish source classification criteria (Farrington and Meyer, 1975; Boehm, 1978; Pierce et al., 1981).

A major distinction between biogenic and petrogenic hydrocarbons is that biogenic hydrocarbons exhibit sets of n-alkanes and alkenes, whereas petroleum contains the homologous series of n-alkanes, branched and cyclic alkanes and substituted polynuclear aromatic hydrocarbons. A predominance of specific compounds such as pristane (2, 6, 10, 14-tetramethylpentadecane), pentadecane (n-C_{15}), and heptadecane (n-C_{17}) are indicative of marine biogenic sources, while pristane in the presence of the isoprenoid, phytane, and a homologous series of n-alkanes, indicated petroleum hydrocarbons (Ehrhardt and Blumer, 1972; Blumer et al., 1971; Farrington, 1974). Hydrocarbons of terrigenous flora exhibit a strong odd/even carbon preference index (CPI) in the n-C_{23} through n-C_{31} n-alkane region (Boehm and Quinn, 1978; Farrington and Tripp, 1977).

Petroleum hydrocarbons are characterized by an unresolved complex mixture (UCM) of hydrocarbons in the aliphatic fraction, which is comprised primarily of branched and cyclic alkane hydrocarbons too numerous to be resolved by gas chromatographic techniques. Various petrogenic hydrocarbon sources include tanker washings, off-loading, outboard motors, sewage and land drainage. Classification may include refined or crude oil, recent or weathered oil, and pyrogenic sources. Classification of petrogenic hydrocarbon source is accomplished through specific diagnostic compounds in the aliphatic and aromatic-olefinic fractions.

Petroleum that has been recently introduced into the marine environment is indicated by a smooth alkane distribution (CPI = 1) over an UCM (Pierce et al., 1975; Farrington, 1974). Crude oil GC patterns are characteristic of geographical origin, but generally exhibit a wide boiling range of n-alkanes and UCM, sometimes with a bimodal UCM distribution. Refined petroleum distillates favor low boiling components, whereas residual oils show a
predominance of the higher boiling compounds (Butler et al., 1973; Thompson and Eglinton, 1978; Traxler and Pierce, 1974).

Interpretation of the aromatic-olefinic hydrocarbon distribution has recently been developed to help characterize hydrocarbon sources. Olefinic compounds are not abundant in petroleum, thus their predominance would indicate biogenic input (Farrington, 1974; Farrington and Trip, 1975; Boehm and Quinn, 1978; Keizer et al., 1978). Alkyl-substituted aromatic hydrocarbons are the major aromatic compounds in petroleum (Youngblood and Blumer, 1976; Laflemme and Hites, 1978), whereas a predominance of non-substituted polynuclear aromatics indicates pyrolytic sources (Lee et al., 1977; Bieri et al., 1978).
II. GOALS OF PROPOSED RESEARCH

The overall goal of this project is to establish a data base for hydrocarbons in the Rookery Bay system, with special emphasis on the identification of petroleum hydrocarbons. This information will be used to assess provable costs related to the impact of chronic and catastrophic petroleum contamination resulting from rapid residential, municipal and industrial development which may have influence on the Rookery Bay system. To accomplish this goal, the distribution of hydrocarbons in sediments will be correlated with historic land and water use patterns. In addition to the hydrocarbon survey, dye release studies will be performed to approximate areas which may be affected due to oil spills in the Gulf and surrounding tributaries or from chronic input of hydrocarbons resulting from increased urbanization.

Specific goals include:

1. Identify and quantify hydrocarbons in surficial sediments throughout Rookery Bay.
2. Provide information through dye release studies to aid in predicting areas that may be affected by petroleum hydrocarbons from chronic and acute inputs.
3. Correlate petrogenic versus biogenic hydrocarbons in sediment with land use patterns to establish sources and accumulation sites of petroleum contaminants.
III. PROPOSED RESEARCH

Surficial sediment samples will be the primary monitoring device to indicate a composite of recent petroleum influx. The samples will be collected in two phases: Phase I will represent the wet season (summer) and Phase II sampling will represent dry season (winter). The dye release study will provide information regarding potentially affected areas as a result of an oil spill.

In addition to hydrocarbon analysis, temperature (T°C) and salinity (S o/oo) will be determined for the water column at each sampling site.

A) Baseline Hydrocarbon Survey

1. Sample Collection

Surficial sediment (upper 5 cm of substrate, as defined by U.S. Bureau of Land Management, 1980) will be collected from ten (10) sites throughout the Rookery Bay study area during sampling Phase I (Figure 2). The sites have been selected in conjunction with knowledge of watershed, tidal influence and land and water use, to provide information regarding the impact of present developments and to establish baseline data in nondeveloped areas for monitoring the impact of continued development.

Sample collection for Phase I will begin in the summer (wet season). The first sampling will include surficial sediment from ten sites along with the dye release study in the Gulf. The second sampling (Phase II) will be approximately six months later, including surficial sediment from ten sites, again coincident with the dye study.

Sediment will be collected from each site as a composite of at least three grabs with a petite ponar grab sampler, to provide 500 g wet weight of relatively undisturbed sediment. Each sediment grab will be placed in a stainless steel scoop and placed in a precleaned glass jar with aluminum lined caps according to the procedure established by Pierce et al. (1981). Jars will be placed on ice for transport and stored frozen until analyzed.
Figure 2. Location of proposed hydrocarbon sampling stations.
2. Sample Sites

Phase I sampling sites include ten (10) stations corresponding with specific watershed, land use and tidal influence areas to enhance site description and data interpretation. Phase II sampling sites will be determined after the analysis of Phase I samples are completed so sites may be selected to either complement or supplement information obtained from Phase I. Phase I sampling sites are as follows (Figure 2).

(1) Gulf of Mexico -- 0.5 mile west of Little Marco Pass. This station will serve as a control station nearshore in the Gulf of Mexico and will establish marine sediment end-member conditions.

(2) Intracoastal Waterway (ICW) Marker R "34" -- north end of Little Marco Island. Items of specific concern include the transport of petroleum products along the ICW, as well as material transported in through Little Marco Pass.

(3) ICW Marker R "48". Items of specific concern include the transport of petroleum products along the ICW.

(4) ICW Marker R "20". Items of specific concern include the transport of petroleum products along the ICW, and the industrial/municipal development input from Johnson Bay.

(5) South Central Rookery Bay. This site includes input from the ICW and Johnson Bay from the west as well as from Henderson Creek from the east.

(6) Central Rookery Bay. This site provides background information of all inputs on Rookery Bay proper.

(7) North Central Rookery Bay. This site includes input from the ICW and from Stopper Creek.

(8) Stopper Creek Drainage. Items of specific concern would include materials transported into Stopper Creek from urbanization and roadways.

(9) Mouth of Henderson Creek. This site provides information of the input into Rookery Bay from Henderson Creek.

(10) East-mid Henderson Creek. Items of specific concern would include materials transported into Henderson Creek from urbanization and roadways.
3. Sample Analysis

a. Saponification-Extraction.

Thawed sediment sampled will be mixed to provide a homogenous sample. Approximately 150 g wet weight will be placed in a Soxhlet extraction apparatus and saponified-extracted with benzene/0.5 N KOH-methanol (50/50) (ca. 250 ml total) for 24 hours, or until the extraction solution is clear. An internal standard consisting of ca. 50 ug each of 5 a-androstane and o-torphenyl will be added prior to extraction to provide assurance of extraction efficiency, separation of saturated and unsaturated fractions to provide a standard reference for the gas chromatographic data system. Methylstearate (the methyl ester of stearic acid) will be added to select samples to verify saponification efficiency.

b. Column Clean Up, Fractionization.

The saponification solution will be extracted with 3 x 50 ml hexane and the resulting hexane-benzene solution will be washed with distilled water to remove residual KOH-MeOH. The benzene-hexane will then be reduced to ca. 0.1 ml volume by rotary evaporation followed by purging with N₂ gas with repeated addition of hexane to replace benzene with hexane. A final sample volume of 1 ml hexane was added to a column of 2 g alumina (80/20 mesh) 2 g silica gel (100/200 mesh) and 1 g sodium sulfate (granular) for clear up and separation into aliphatic (saturated f₁) and aromatic/olefinic (unsaturated f₂) fractions. The f₁ fraction will be eluted with 3 bed volumes (bv) of hexane and the f₂ fraction will be eluted with 3 bv of hexane and benzene (50/50). Each fraction will then be reduced to 0.5 ml volume for gas chromatographic analysis.

c. Gas Chromatographic Analysis.

Gas chromatographic analysis will be performed with each fraction using a Varian Vista 6000 gas chromatography (GC) system coupled with a Vista 401 data system. A flame ionization detector will be used and the sample will be separated on a glass capillary column, 30 m x 0.25 mm with WCOT SE-30, temperature programmed at 100-280°C for 8°C/min which allows observation of the n-alkane series from n-C₁₃ through n-C₃₂. The injector is operated in the splitless mode with septum purge after 30 sec. The carrier and make-up gas is N₂.

As a check for purity of solvents, reagents and handling procedures, procedural blanks will be run with each set of ten samples analyzed. Verification of the extraction and analysis scheme will be accomplished by carrying samples spiked with known amounts of standard petroleum through the entire analytical scheme. Analytical precision will be established by triplicate analyses of samples spiked with a standard hydrocarbon mix.

Qualitative analysis will be established by comparison of retention times for known standards with the sample peaks. Quantitative analysis will be provided by establishing the approximate relative response of the FID for sample hydrocarbons to that of internal standard hydrocarbons added to each sample prior to saponification and extraction. The Vista chromatography data system identifies each sample peak according to a programmed retention time window and converts the response area to concentration units. Daily checks will be run to verify relative response factors and retention times.

All precautions will be taken to guard against contamination from boats and collection apparatus. Sampling blanks consisting of empty containers exposed to the sampling environment will be provided for each sample set collected. Also, samples of shipboard contaminants (outboard motor oil and gasoline) will be collected and analyzed for comparison with hydrocarbons found in the environmental samples.

Sample custody will be established by each Co-Principal Investigator for his designated task by marking each sample with an identification number and logging the number in the research notebook as each sample is collected in the field. The samples will be transported by the Co-P.I.'s and stored appropriately at the laboratory until analysis. At the time for analysis, each sample number will be written in the lab notebook for samples analyzed per a certain day. For the hydrocarbons, a label with the I.D. number and lab notebook page number will accompany the sample throughout the extraction and each fraction will remain clearly labeled. All hard copy chromatograms and stored data will be identified by the I.D. number plus the lab notebook page number for cross reference of results with analytical methodologies. The amount of nonanalyzed samples remaining will be clearly marked, logged and archived in the freezer for future reference if needed.
As each set of samples is analyzed, the results will be compiled and summarized in the lab notebook. Data will be analyzed from each set of samples prior to completion of the next set. Adherence to this policy will help avoid a backlog of data and will provide a more perceptive interpretation of the data as new sample results are obtained.

5. Data Interpretation

Hydrocarbons from each sediment sample will be divided into aliphatic and aromatic-olefinic compounds with qualitative and quantitative analysis obtained for each fraction. The Varian Vista-401 chromatography system will be used to identify each major resolved peak by Kovats retention index, relative to known internal standards (i.e., eicosene and phenanthrene). Quantitative analysis will be determined by detector response (area of each peak) relative to the response for each internal standard hydrocarbon.

Based on the above information, hydrocarbons in each sample will be characterized as biogenic vs. petrogenic or a combination of both, according to procedures devised by Boehm, 1978 and Pierce et al., 1981.

The hydrocarbon patterns for samples showing no evidence of petroleum hydrocarbons (i.e., biogenic hydrocarbons only) will be recorded to assess the impact of petroleum contamination. Characterization of the biogenic hydrocarbons by source (marine vs. terrigenous, animal vs. plant) will be provided based on location, major flora and fauna and comparison of characteristic hydrocarbon fingerprint patterns. Specific source identification, however, would be handled most appropriately in a future study, utilizing the baseline data gathered here in comparison with hydrocarbon patterns from dominant fauna and flora in each sampling area.

Samples containing petroleum hydrocarbons will be identified as areas receiving petroleum pollution. The petroleum will be characterized (i.e., gasoline, fuel oil, residual oil, weathered crude oil) and each site correlated with potential land and water use activities that could produce the type of petroleum found.

The primary monitoring tool will be the surficial sediment samples which provide a composite of input to the benthic environment covering a period of several weeks to months. The hydrocarbon distribution patterns observed in this study will be used to establish natural background type and
quantity in areas exhibiting only biogenic compounds. The presence of petroleum hydrocarbons will help discern sources of contamination based upon present land use practices. This information will be essential in predicting the impact of certain land use activities, thus providing input for planning future development. Also, these data provide background information to help assess provable costs related to the discharge of hydrocarbon pollutants.

B) Dye Release Study

The specific purpose of the dye release program is to simulate contamination of the waters adjacent to the Rookery Bay Sanctuary by: 1) an offshore oil spill in the Gulf of Mexico, hypothesized to come ashore in the vicinity of Hurricane Pass; and 2) a large scale contamination of the Henderson Creek drainage basin as the result of a highway spill, or industrial or residential accident. This portion would also aid in the possible tracking of low level chronic contamination as the result of increased urbanization in areas adjacent to Rookery Bay.

1. Release Stations

The dye study would be conducted in two phases. Phase I release would be conducted during the wet season (summer) and Phase II release would be conducted during the dry season (winter).

In order to assess the maximum effects, or "worst case", Phase I release (D1) would be conducted in Henderson Creek just east of the Sanctuary boundary (Figure 3). This would simulate a contaminant spill which could not be rapidly contained due to high levels of runoff during the rainy season. The high flow levels would also insure a maximum dispersion throughout the bay. The dye would be released just prior to the onset of ebb tide and tracked for a maximum of 24 hours or until levels of dye within the bay become undetectable.

Phase II dye release (D2) would be conducted at the Gulf side entrance of Hurricane Pass during the dry season, when conditions of low runoff insure maximum possible penetration of Gulf waters into the bay system. The dye will be released just prior to an above normal flood tide and tracked for a maximum of 24 hours or until levels of dye become too low to detect.
Figure 3. Location of dye release stations (D1, wet season; D2, dry season) and current meter locations, E.
Dye release programs will be conducted one day following hydrocarbon collections to insure efficient use of boats, equipment and field personnel.

2. Materials and Instrumentation

Rhodamine WT fluorescent dye (Crompton and Knowles, Inc., Reeding, PA) will be used for this study. The dye is non-toxic to organisms and does not readily adhere to organic particulates, making it an excellent tracer for water column movements. Exact amounts of dye used for the study will be determined after the initial reconnaissance phase.

A boat mounted Turner Model 111 Fluorometer equipped with a continuous flow door and chart recorder will be used to follow dye movement and record dye concentrations. Internal filters contained within the fluorometer consist of a 546 nm primary and a 590 nm secondary filter. A marine utility pump will be used to circulate water through the fluorometer. The fluorometer and pump will be run from power provided by a gasoline driven Honda generator (110V AC, 60 Hz).

The fluorometer will be calibrated in the laboratory prior to use in the field and again after completion of each 24 hour study. Serial dilutions ranging from 0.25 ppb to 50 ppb Rhodamine made from a stock solution of 10 ppm of 100% Rhodamine (i.e., 50 mg 20% Rhodamine/liter). Standards will then be read on each of the four sensitivity scales of the fluorometer and regression equations calculated for each scale so fluorometer readings can be converted to ppb Rhodamine.

Two Endeco digital magnetic tape recording in situ current meters will be used to record currents at the north and south passes to Rookery Bay during the duration of the dye study. The meters automatically record current speed, direction, water temperature and conductivity, and will be used to aid interpretation of the dye tracking data. The meters will be placed at the approximate locations used by Lee and Yokel (1973), to define currents in Rookery Bay.

Water temperature, conductivity and salinity will be measured with YSI SCT model 37 meters on each boat monitoring the dye plume.

For Phase I dye release the resultant plume will be monitored by 2 vessels. The first (primary vessel) will contain the recording fluorometer and will follow the plume, recording dye concentrations and tracking the leading edges of the plume. The secondary vessel will be used to sample more distant areas of the bay to yield information on rates of dispersion, as well as areas where the dye has already passed. Utilizing 250 ml plastic containers, crews aboard the secondary vessel will collect water samples, which will later be analyzed at the laboratory.

Phase II dye study will utilize two secondary boats, since the predicted path of the dye cannot be as accurately estimated. It is likely that dye will enter the bay by both the north and south passes. Additionally, a large portion of the plume will be diverted south into Johnson Bay. Therefore, the three vessels will be used in conjunction to track the plume. The secondary vessels will collect water samples as in Phase I.

All vessels will remain in radio contact with decisions on sampling strategies being made by the Co-Principal Investigator, who will be based on and continue data input from the primary vessel.

4. Data Interpretation.

Data on dye concentrations recorded and collected in the field will be used to calculate the relative proportions of dye dispersed to various parts of the bay system. This data will aid in the interpretation of hydrocarbon distributions and can be used to predict the fate of oil spills or other materials in the Gulf of Mexico or Henderson Creek watershed. Dye concentrations and currents will be mapped based on tide and time formats and presented in the final report.
I) PROJECTED TIME COMMITMENTS OF PRINCIPAL INVESTIGATORS

The projected time commitments for both Co-Principal Investigators covering the time period of the proposed project are presented in Table 1. Both Principal Investigators will have adequate time available to commit to the proposed study.
Table 1. Current and estimated time commitments of the two Co-Principal Investigators for the proposed study.

<table>
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<tr>
<th>Co-Principal Investigators</th>
<th>Projected % Commitment 1985</th>
<th>Project/Funded By</th>
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<tr>
<td>R. Brown</td>
<td>20%</td>
<td>Coprostanol analysis for a water quality study in Marathon Key, Florida/Florida Department of Environmental Regulation.</td>
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<td>25%</td>
<td>Toxic organic pollutants associated with Mississippi River suspended particulates and delta sediment/National Oceanic &amp; Atmospheric Administration.</td>
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<td>15%</td>
<td>Red Tide Research/State of Florida.</td>
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<tr>
<td></td>
<td>5%</td>
<td>Hydrocarbon Characterization-Intercalibration/University of South Florida.</td>
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<tr>
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<td>Hydrocarbon Characterization of Sediments in Rookery Bay, FL (proposed study)/National Oceanic &amp; Atmospheric Administration.</td>
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<tr>
<td>J. Culter</td>
<td>5%</td>
<td>Crystal River Ecological Studies/Florida Power Corporation.</td>
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<td>Baseline Survey of Benthic Communities at Big Bend, Tampa Bay/Tampa Electric Co.</td>
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<td>Southwest Florida Ecosystems Study/Minerals Management Service.</td>
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<td>Study of Select River Estuarine Systems on Florida West Coast/Southwest Florida Water Management District.</td>
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<td>5%</td>
<td>Midnight Pass Ecological Studies/Sarasota County.</td>
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<td>Hydrocarbon Characterization of Sediments in Rookery Bay, FL (proposed study)/National Oceanic &amp; Atmospheric Administration.</td>
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V. PROJECT MANAGEMENT/PERSONNEL

The proposed project management structure is shown in Figure 4. The Co-Principal Investigators, R.C. Brown and J.K. Culter, will be responsible for overall management of the project as well as liaison between Sanctuary Programs Division (SPD) and MML. They will establish the sampling and analytical procedures and will implement quality assurance procedures, interpret data and prepare reports. They also will aid the technicians with developing appropriate computer programs for data processing and during sample collection, extraction and analysis.

The Co-P.I., Robert Brown, will be responsible for overseeing use of the microprocessor-controlled gas chromatography system and the computerized data system for the hydrocarbon analysis. He will be involved with collection, processing and analysis of the samples and will work with the technician to ensure proper utilization of standards and blanks for proper software manipulation of the data. He has authored many reports and publications regarding petroleum contamination in the marine environment. Mr. Brown's resume is provided in Appendix A.

The Co-P.I., James Culter, will be responsible for coordinating the dye release/tracking portion of the study. He will conduct the field release of dye and be responsible for the tracking and laboratory data analyses. Mr. Culter has over seven years experience in estuarine ecology programs. He has participated in dye studies in the Gulf of Mexico, off Pinellas County; and in Hillsborough Bay. He was responsible for a dye study program in lower Tampa Bay as a portion of a large scale ecological baseline survey conducted for Tampa Electric Company. Mr. Culter will also be responsible for the data analysis and report preparation for the dye release program. Mr. Culter's resume is presented in Appendix A.

A Quality Assurance Committee consisting of senior scientists at MML would provide project-independent checks on QA procedures. The committee would regularly audit the project's QA procedures and report to the President of MML. If corrective measures are necessary, the Co-Principal Investigators would be briefed by the Division Director.
Figure 4. Proposed Project Management Structure.
Drs. E.D. Estevez and C.A. Luer will be the QA Officers in charge of monitoring MML's QA program. Dr. Estevez's areas of expertise are estuarine, coastal and wetlands ecology. He has managed numerous multidisciplinary projects on the west coast of Florida. Dr. Estevez will accompany the field crews on the first dye release to offer technical advice, and will review the technical reports prior to submission to SPD. Dr. Luer's areas of expertise include biochemistry of marine organisms, specifically reproduction, endocrinology, physiology and marine toxicology. Dr. Luer has not only served on, but has also chaired, several QA programs at MML during the past five years. Dr. Estevez's and Dr. Luer's resumes are included in Appendix A.

Dr. R.H. Pierce, the Division Director, will provide overall administrative and technical supervision for the project. Dr. Pierce's areas of expertise include the input and fate of toxic organics in the marine environment; he is an experienced consultant. Dr. Pierce will offer technical advice and will review reports prior to submission to SPD. Dr. Pierce's resume is provided in Appendix A.
VI. MML QUALITY ASSURANCE

MML maintains stringent quality assurance procedures on all its projects on a routine basis. A Quality Assurance Committee oversees QA procedures by conducting regular data audits and periodic operations checks. The QA committee is independent of the project team. A project-specific written QA manual would be prepared prior to initiation of the project. After review and approval by the QA committee and MML President, the manual serves as the primary guide for all QA procedures. The Principal Investigator implements QA procedures and is authorized to audit and impose corrective measures as necessary. Specific highlights of MML's QA program are:

- Spotchecks and audits by QA committee;
- Written QA manual;
- Individual and project (calibration, maintenance) logs;
- Regular meetings of the Principal Investigator and project personnel, to discuss and implement QA procedures, problems, and other necessary actions;
- Data records and log duplication with archiving to ensure no loss of data;
- Duplicate analyses of at least 10% of all samples processed in the laboratory;
- Replicate tests and/or supervisor approval of all anomalous results or reports;
- Documentation to adequately establish data traceability from sample collection to final reporting;
- Adequate validation (checks by supervisor) of all data;
- Rechecking of at least 10% of all computer data entries;
- Specifications for data reduction and analysis, and for the presentation and evaluation of results.

Upon project completion, a Quality Assurance Compliance Report would be submitted to SPD. The report will summarize the contents of the QA Manual and include copies of all QA correspondence and memoranda. Also included will be the reports of the QA Committee to Dr. Pierce, MML's Director of Marine Sciences Division and his evaluation of QA compliance.
VII. PROJECT SCHEDULES/REPORTS

We propose that the project commence on June 1, 1985 and continue until February 1986. Progress reports will be submitted on a quarterly basis, each report outlining progress to date and detailed problems, if any, encountered during the reporting period. A final report will be submitted on or before February 28, 1986.

A) Schedule of Activities

Presented in Figure 5.

B) Report Format

1. Hydrocarbon Survey.

Gas chromatographic data will be reported in tabular form, including the concentration of ug/g dry weight sediment for each major peak and identification of each compound by name or by retention index, relative to known compounds.

Reports will include precision and percent recovery for the standard hydrocarbon mixture components, both from the solvent and spiked sample matrices. Interlaboratory calibration of the standard mixture with spiked and non-spiked samples will be reported. Reagent blanks will be reported for each set of sample analyses, and compounds suspected of being contaminants will be characterized from reagents and procedural blanks.

In the final report, hydrocarbons will be classified by source, supported by a tabulation of the following information for each sample:

a) Qualitative and quantitative identification of major chromatographic peaks;
b) Pristane/phytane ratio
c) Pristane/n-C_{17} ratio;
d) Phytane/n-C_{18} ratio;
e) Total alkanes, ug/g and boiling range of n-alkane homologous series;
f) Total aromatics-olefinics, ug/g
g) CPI within n-alkane homologous series;
h) Correlative relations of UCM/resolved components and specific compounds indicative of biogenic vs. petrogenic sources.
Figure 5. Schedule of proposed activities.

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PHASE I

PHASE II
These data will be correlated with land use activities for interpretation relative to petroleum contamination as discussed above in Section III, 5. Data Interpretation.


Data obtained from the dye release program will be tabulated by position and dye concentration. Contour lines of concentration will be mapped where sufficient data exists. The overall dye pathway and ultimate fate will also be charted.

Data obtained from the YSI and Endeco meters will be tabulated by location and time. Current pathways and relative dye concentrations will be used to aid interpretation of hydrocarbon distributions and predict pathways and ultimate fates of oil spills (or other contamination) from the adjacent Gulf of Mexico and Henderson Creek watershed.
Mote Marine Laboratory, a private nonprofit organization, has excellent facilities and the necessary equipment for conducting the hydrocarbon survey and the dye release study detailed in this proposal.

Laboratory facilities include a 200 sq.ft. extraction-preparation lab and a separate 200 sq.ft. instrument lab with additional backup facilities available for the proposed project. Support services such as boats, sample freezers, accounting, secretarial, library, photolab, duplicating and copying, and computer services are all available in house.

Specific equipment necessary for the project, including a Varian Vista-600 Glass Capillary Gas Chromatography System (with a Varian 6500 backup GC) coupled with a Vista-401 data system, Perkin-Elmer 6503 Spectrofluorometer, Turner Fluorometer Model 100, Varian 5000 HPLC with UV-fluorescence detector, sediment samplers, ovens, balances, freezers, muffle furnaces, field water quality monitors, etc., are all available in house.

A general statement of the facilities and equipment available at MML is presented in Appendix B.
IX. LITERATURE CITED


APPENDIX B

Facilities and Equipment Statement
Mote Marine Laboratory (MML) is located on City Island in Sarasota, Florida on a six acre site fronting on both Sarasota Bay and New Pass to the Gulf of Mexico. (A field station is manned and operated at Crystal River, Florida for projects in west-central Florida. The facilities and equipment at that station are described in a subsequent section.) The Sarasota research facility of 21,700 square feet houses: a library of 2,750 volumes, 200 serials and 16,000 reprints; water chemistry, pesticide residue, bioacoustic, bioassay and environmental ecology laboratories; five resident and one visiting scientist laboratories; collection room; five controlled environment rooms; five administrative offices; a drafting room; an archives room; and a large conference-seminar hall. A separate 1,200 square foot building at dockside serves as the ship and boat maintenance facility, machine shop and carpentry shop. In addition, two well equipped air conditioned trailer laboratories house biomedical, microbiological, bioassay and toxic organic substance research programs, and two constant temperature rooms. Experimental tanks, all supplied with filtered seawater drawn from New Pass, include eight water tables (six environmentally controlled) and two 16 foot diameter circular pools. A tidally fed lagoon is used to maintain large experimental animals. A variety of boats and ships (total of 12) are available, ranging in size from 12 to 45 feet.

A. Laboratory Space

Staff Scientists occupy office-laboratory suites with an average combined floor space of 300 sq.ft. Technical support is provided by laboratories with an average area of 250 sq.ft. All rooms are equipped with laboratory grade counters, plumbing, wiring and facilities. Ventilated hoods are present in six laboratories and safety equipment (flame proof cabinets, first aid stations, emergency showers, etc.) are located near all areas of hazardous activity.
Ample space is available in Sarasota for the administration and execution of large and multidisciplinary projects. The space for each major project is set aside from other laboratory operations to provide added control of project-related activities. In addition, MML operates five field mobile laboratories (trailers: 60' x 12' and 48' x 12'), one of which houses a complete bioassay facility. These trailers are outfitted with general purpose wet labs, offices, analytical facilities and a once through seawater system (for bioassays, algal assays, and larval survival studies).

B. Administrative Facilities and Abilities

MML is staffed with adequate administrative personnel to ensure proper accounting and financial management of projects. As evidenced by the Laboratory's research record (see Standard Form 254) and current projects, MML is familiar with federal accounting, procurement, quality assurance and reporting procedures. Typing, word processing, photocopier, duplicating and binding equipment are also available. Administrative and financial data are managed using Heath, IBM PC and Apple II Plus Computers, Apple III Hard Disc Computers, TeleCom long distance telephone logging, and other automatic systems. The existing administrative configuration is capable of managing a staff of 150 persons and the operation of approximately 75 grants and contracts. Independent audits of MML records are conducted each year and are available for inspection.

C. Information Services

Library. MML's library is well equipped to handle the literature requirements of projects. A full-time librarian supervises all circulating, research, and archival materials, transmits interlibrary loan requests, and manages all information procurement. Computerized literature searches are conducted with the Laboratory's T.I. Silent 700 portable data terminal which accesses the Lockheed Dialog Information System. The library is also equipped with a 3-M Model Microfiche reader and printer. The MML Librarian is an active member of the International Marine Laboratory Library Association.
Data Processing MML owns a Heath H-8 computer with disc systems, video terminal and IDS 560 printer; two Apple III Computers, each with two floppy disc drives, high resolution terminals and two printers; three Apple II Plus Computers, with two floppy disc drives, high resolution terminals, and three printers; an Apple Versawriter; two IBM PC computers with twin disc drives and printers; two Zenith data and word processing systems; two Apple III Hard Disc computers with Apple Image writers; a NEC Astra 200 microcomputer with dual 8" floppy disc drives and a printer; a Wang 300 Programmable Calculator; a Varian Vista 401 Chromatography Data System with CRT and disc drive for manipulation and storage of chromatographic analyses; and access to the computer facilities of the University of South Florida (IBM 370), and the University of Florida (IBM 3033). The Apple computers are available for transmission of data (binary or report formats); text (reports or direct communications); and graphics (Versawriter Graphics Tablet) via either 300 or 1200 baud modems. Commercial and custom hardware software is available, including QUADLINK, color graphics cards, NBI word processing and Northwest Analytical's STATPAK.

Reporting MML publishes a quarterly newsletter, Contributed Papers, an Estuarine Studies Series, and a Review Series. MML Staff also report findings in professional journals and in other communications. Examples are provided in the Resume section. MML has recently sponsored scientific conferences and workshops on bioacoustics, manatees, sea turtles, radionuclide standards, and the Tampa Bay Area Scientific Information Symposium.

D. General Facilities

Shop: A machine shop is available to fabricate and repair or modify equipment.

Photographic Laboratory: A well equipped photographic laboratory is maintained. A variety of video tape recording equipment is available in house, as well as general and special purpose 35 mm cameras.

Drafting and Artwork: A draftsman and artists, a new 280 sq.ft. drafting room, and adequate facilities are available for graphic needs of projects.
Storage Space  Secure, locked storage facilities are available for sample storage at ambient, 25°C, 4°C and -20°C, as preservation techniques require. Additional areas are used as equipment storage and staging areas.

Taxonomic Reference Collection: A reference collection of algae (ca. 450 species), macroinvertebrates (ca. 1,200 species), zooplankton (ca. 80 species), and fishes (ca. 275 species) is available at MML.

E. Special Facilities

1. Bioassay Laboratory

Mote Marine Laboratory operates a complete bioassay facility including a constant temperature aquarium room (900 sq.ft.) and a 60 ft. trailer. The constant temperature aquarium room is provided with filtered seawater from the laboratory recirculating system, and is used for maintenance of stock animal cultures as well as for static bioassay experiments. The room is equipped with timer controlled fluorescent lighting and a continuous recording thermograph for documentation of temperature control. The 60' bioassay trailer is designed for flow-through culture and bioassay procedures and contains three seawater tables (48' long and divided into 8 sections) and one freshwater table (36' long divided into 8 sections). Temperature is maintained by two heavy duty air conditioning units. Bioassay organisms kept in continuous cultures include four polychaete species (Neanthes, Schizodorvillea, and two Ophryotrocha species), a mysid (Mysisidopsis) and a minnow (Cyprinodon). The fish, mysid and Neanthes are cultured at several different salinities to minimize acclimation time in preparation for experiments. Brine shrimp (Artemia) and phytoplankton (Chlorella, Dunaliella, Platymonas, Stephanoptera and Isochrysis) are cultured as food sources for bioassay animals.

2. Meteorology Station

MML operates a weather observatory that meets all National Weather Service specifications. Observers are trained and supervised by a Staff Meteorologist, and data are shared with both NWS and USGS (Water Resources Division). Data are collected twice daily for:

Temperature. National Weather Service (NWS) mini-max and current thermometers are in use in an NWS instrument shelter situated on the grounds, in compliance with federal standards.
**Rainfall** The MML rain gauge is fabricated to NWS specifications. It is a gauge consisting of four components: an eight inch brass collector and funnel; a copper overflow can; a brass inner measuring tube; and a laminated measuring stick. The gauge has a total rainfall capacity of 20 inches.

**Barometric Pressure.** A recording precision microbarograph of the double bellows type with a magnified scale made to NWS specifications records pressure tendency. Accuracy is improved by full temperature compensation between 32°F and 100°F. All barometric data are corrected for latitude and elevation. The instrument is calibrated weekly using a standard NWS mercurial barometer.

**Relative Humidity** is measured by a Sling Psychrometer consisting of two mercury thermometer tubes. Data from the Psychrometer are used in connection with a psychrometric calculator fabricated to NWS specifications. This calculator converts wet and dry bulb readings into relative humidity and dew point. It is for use at 30 inches of mercury average station pressure.

**Insolation.** An Eppley black and white pyranometer made to NWS specifications for the measurement of global, sun and sky radiation is in use. With precision ground WG7 optical glass transparent to wavelength of 280-2800 nm, sensitivity is approximately 11 microvolts per W/m².

**Wind Direction and Speed** is measured by a Climatronics anemometer mounted atop the MML City Island facility. Chart records of direction (580° potentiometer) and speed (0-50 and 0-100 mph) are produced on a continuous basis.

3. **Chemistry Laboratories**
   a. **Capability.**

MML can perform analyses in compliance with EPA and/or Standard Methods for alkalinity, acidity, color (visual, spectrophotometric), conductivity, residue (filterable, nonfilterable, total and volatile), salinity (conductivity, argentometric), turbidity (nephelometric, Jackson), chloride, chlorine (residual), fluoride (electrode), nitrogen (ammonia, nitrate, nitrite, total Kjeldahl, organic), dissolved oxygen, pH, phosphorous (ortho-, total, organic), silica (reactive), sulfate
(turbidimetric), sulfide, oil and grease (gravimetric), organic carbon, biochemical oxygen demand, chemical oxygen demand, surfactants (MBAS), chlorophyll a, b, c and pheophytin a, total and fecal coliform, metals (Cd, Cu, Cr, Fe, Pb, Mn, Hg, Ni, Zn, Sr, Ag), various pesticides, petroleum hydrocarbons and other priority pollutants including PCB's, dioxins, and dibenzofurans.

Mote Marine Laboratory was recently funded by the Environmental Protection Agency (EPA) to measure the impact of pesticides and heavy metals from point and nonpoint sources upon receiving waters (a 208 study); seventeen pesticides and six heavy metals were routinely measured. Recent participation in EPA Round Robin (WP-005) sampling indicated that 93% of MML's analyses met or exceeded the 99% confidence level established by EPA. MML routinely participates in the Florida Department of Environmental Regulation Statewide Chemistry Laboratory Quality Assurance Program for total Kjeldahl nitrogen, total phosphorus, BOD, NO₃, fluoride and chlorinated pesticides. In addition, EPA water supply performance evaluations (for NO₃ and fluoride) and EPA water pollution laboratory performance evaluation (for trace metals, minerals, nutrients and pesticides) are routinely performed at MML.

b. Instrumentation.

MML operates an extensive and well equipped chemistry laboratory with wet chemistry facilities, Varian Gas Chromatographs, Perkin-Elmer Double Beam (UV visible) Spectrophotometers, I-L 251 Atomic Absorption Spectrophotometer, Oceanography International Carbon Analyzer, Spinco Model L Preparative Ultracentrifuge, Technicon Model II AutoAnalyzer, Nuclear Chicago Twin-Channel Liquid Scintillation Spectrometer, International Universal Model UV Centrifuge, Coulter Particle Counter, Turbidimeters, Millipore Ultrafiltration Cells, Turner Fluorometer Model 110, Technicon Block Digester, laminar flow and flume hoods, glassware and chemical stores and a walk-in cold room.

Separate toxic organic and bioactive substances research laboratory and instrument rooms contain a Branson Sonicator; Soxhlet Multi unit Extraction Apparatus; Bucchi R10 Rotovaporatory; electronic digital balance; Varian model 6000 Capillary Gas Chromatograph equipped with dual
flame ionization detectors (FID) and a series 8,000 auto sampler; another
Varian Model 6500 Chromatograph equipped with an electron capture detector
ECD coupled with a Vista 401 Chromatography Data System interfaced with an
Apple II Plus minicomputer with dual floppy disc drive; Varian 5020 High
Pressure Liquid Chromatograph; a Varian Fluorichrome fluorescence detector;
a Varian UV 50 ultraviolet visible variable wavelength spectrophotometer; a
Turner Fluorometer (110); an International Micro-25 high speed refrigerated
centrifuge; a Varian DMS 80 UV-VIS recording spectrophotometer; a
Perkin-Elmer Model LC 650-10S recording spectrofluorometer, and a Labconco
Model 5 lyophilizer.

F. Special Field Equipment for Environmental Assessment

MML owns and operates the equipment listed by category below. Specifications are available upon request.

(i) Logistic Support

- 12 boats ranging in length from 12-45 ft; equipped with marine band, VHF
  radios, Loran C, and depth finders.
- Two Chevrolet Suburban, 4 wheel drive, all terrain truck.
- Two compact trucks, one Jeep and two automobiles.
- Two Apelco Marine VHF Radios.
- Sony Video Camera and Recorder.
- 1.5 KW Honda Portable Generator.
- Micronta Power Inverter.
- Canon AE-1 with databack, autowinder, and 3 lenses Yachica ME-1.
- 2 Polaroid One Step Cameras.
- 2 field tape recorders.

(ii) Meteorology

- Davis Mark 3 Marine Sextant.
- 20 Anschutz 165-A mercury thermometers.
- 2 SA recording thermographs
- 1 Belfort recording pyranometer
- 8 Mini-max field thermometers.
o 3 Sims Model BT Anemometers.
o Airglide Anemometer.
o 2 Primco NOVA Barometers.
o 4 LiCor Sun and Sky Photometers and deck readouts.

(iii) Hydrology and Bathymetry
o 6 Stevens ADR Digital tide recorders.
o 3 Stevens Type F water level recorders.
o 1 Envirolabs paper tape reader.
o 2 Sitex HE356A depth recorders.
o 2 Nelco Autofix 700 Loran C.
o 1 Rangematic MK5-1000 range finder.
o 3 Ritchie hand bearing compasses.
o 3 Endeco 110 current meters.
o 1 Price AA current meter.
o 1 Price AA fiberoptic current meter.
o 2 Pygmy type Price stream current meters.
o 6 Sea Data TDR 2A submersible tide gauges (and tape reader)

(iv) Hydrography
o 5 Martek Mark VII multiparameter in situ water quality instruments.
o 5 Beckman RS-3 portable salinometers.
o 2 YSI SCT meters.
o Beckman TC16-B2 conductivity bridge.
o American Optical 10419 refractometer.
o 7 YSI 57 DO meters.
o 1 Beckman portable pH meter.
o 3 Orion digital pH meters.
o 6 Secchi discs.
o Hach 16800 portable nephelometric turbidimeter.
o Jackson Candle turbidimeter.
o 2 Turner fluorometers.
o 7 General Oceanics Niskin samplers.
o 4 Licor marine photometers and deck readouts.
(v) Biological Sampling

- 10 box sieves (0.5 mm mesh).
- 20 stainless steel bottom cores.
- 3 Petite Ponar benthic samplers.
- 4 64, 202 and 505 µm plankton nets (1 and 0.5 m).
- 8 General oceanics flowmeters.
- Plankton net with sled.
- 2 otter trawls and rigs.
- 150 ft 2 phase seine.
- 400 ft gill net.
- 400 ft trammel net.
- Marine mammal net (4" cord mesh).
- Walled lift net.

G. Specialized Laboratory Equipment for Environmental Assessment

In addition to the equipment contained in the Weather Station, Bioassay and Chemistry Laboratories, MML owns and operates equipment listed by category, below. Specifications are available upon request.

(i) Chemical Analyses

- 2 Precision low temperature incubators.
- 2 Blue M constant temperature baths.
- 1 Dunoff metabolic shaking incubator.
- Technicon BD-40 block digestor.
- Oceanography International 524-C TOC analyzer and ampule sealer.
- Martek Forge sterilmatic STME autoclave.
- 7 centrifuges (International; Spinco; Sorval; Dynac).
- 5 ovens (Fisher; Bickel; Thelco; Freas).
- 2 furnaces (Sybron; Blue M).
- Analytical balances (Mettler B5 and AE163).
- 3 American Scientific Products top loading balance.
- 5 spectrophotometers (Perkin-Elmer; Gilford).
- Varian SE330 spectrofluorometer.
- 3 laboratory pH meters (Corning; Beckman; Orion).
o Mechanical sieve shaker and sieve series (2).
  o Nuclear Chicago liquid scintillation counter.
  o Coulter Z particle counter.
  o 7 Polarographic dissolved oxygen meters and probes.
  o 6 vacuum pumps (Duo; Doerr; Fisher; Gast).
  o Corning mega pure glass still.
  o Circulating water bath/incubator.

(ii) Biological Analyses
  o 10 B&L stereo microscopes (6-30; 7-30 and 10-70X).
  o 30 Unitron ZSB stereozoom (7-45X) microscopes.
  o 1 Unitron ZST stereozoom (10-45X) microscope with Triocular head.
  o 2 Unitron 20-40X fixed focus microscopes.
  o 2 Unitron compound, triocular lead microscopes.
  o 1 Unitron inverted phase microscope.
  o 1 Zeiss compound microscope.
  o 2 AO compound microscopes.
  o 1 Nikon compound microscope.
  o 1 Olympus compound microscope.
  o 5 pairs, metric Vernier Calipers (+/- 0.05 mm).
  o Unitron and B&L ocular micrometers.
  o AO stage micrometers.
  o 35 illuminators.
  o 12 Fiber Optic illuminators.
  o 2 cameras lucida.
  o Photomicrographic equipment (Polaroid, Nikon, Yashica).
  o Laboratory counters.
  o 5 balances (Ohaus; Cenco; Roller-Smith).

(iii) Data Analysis
  o 2 IBM 254 K PC twin drive computers with CRT and printers.
  o 1 NEC 356 K microcomputer with twin drive and printer.
  o 5 Texas Instrument calculators.
  o 1 Wang 300 programmable calculator.
Facilities and Equipment at MML Crystal River Site

Twenty-two technicians, staff specialists, and project coordinators are assigned to the MML Crystal River MML site. Their facilities include a work area of 3 mobile laboratories/offices; covered bench space; storage areas; hot houses; and secured storage. Also included are two floating docks, eight boats, separate fuel storage facilities, and a boat repair shop with davits.

Specialized field equipment includes VHF remote radios and base station; 3 Sitex fathometers; 3 Loran C’s with latitude-longitude and intermediate course readouts; 5 LiCor twin sensor digital marine PAR photometers; 5 YSI dissolved oxygen meters; 5 Beckman RS5-3 SCT meters; 3 Martek VII pH/temperature/ORP meters; 2 Orion 201 pH meters; 16 Ryan recording bathythermographs; 12 Sea Data TDR recording submersible tide gages and 4 Endeco recording current meters, both with data readers; 16 microscopes and numerous forms of sampling gear. The facility also operated a Weathertronics automatic meteorology station which electronically measures and records wind velocity, insolation, temperature, rainfall, barometric pressure and relative humidity. Tape recorded data (Sea Data; Endeco; Weathertronics) are computerized by Apple II systems and are transmitted to other (archival and user) systems by modem and telephone.

These personnel and facilities will be available for general assignment during the summer of 1984.