DAMES & MOORE

Funds for this project were provided by the Department of Environmental Regulation, Office of Coastal Management using funds made available through the National Oceanic and Atmospheric Administration under the Coastal Zone Management Act of 1972, as amended.

LAKE WORTH LAGOON

NATURAL RESOURCES INVENTORY -AND- RESOURCE ENHANCEMENT STUDY

DECEMBER 15, 1990

DAMES & MOORE

IN CONJUNCTION WITH
PALM BEACH COUNTY
DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

TABLE OF CONTENTS

8.0 APPENDIX

- 8.1 REFERENCES/LITERATURE DATABASE CONTENTS
- 8.2 SEDIMENT GRAIN SIZE DATA TABLES (A-F)
- 8.3 MUNYON ISLAND PLANT LIST

LIST OF TABLES AND FIGURES

TABLE

FIGURES

1.0 EXECUTIVE SUMMARY

Lake Worth Lagoon is recognized as one of Florida's important estuarine lagoon systems. Continually impacted by an expanding population since the late eighteen hundreds, Lake Worth Lagoon must be protected through implementation of a comprehensive management plan if its unique natural resources are to be preserved and maintained. The first step in the formulation of a management plan is the survey, inventory and analysis of existing natural resources, literature and data contained herein.

Over two hundred sources of literature and data on the natural resources of Lake Worth Lagoon have been identified and organized in a computerized database system. Information identified through the literature and data search has been further supplemented with field studies in order to produce a series of 14 maps which geographically illustrate the status of various natural resources and characteristics of Lake Worth Lagoon. This report includes tables, maps, and supporting information that describes the following:

1. **Dredged and Filled Areas:** Lake Worth Lagoon has been transformed from a freshwater lake to urban estuarine lagoon in the past 100 years by continual man-induced impacts associated with development of the area. Major alterations of Lake Worth Lagoon have been made by the filling of previously submerged lands and dredging of submerged lands to maintain channels and inlets.

2. **Governmental Jurisdictional Boundaries:** Portions of Lake Worth Lagoon are within the boundaries of unincorporated Palm Beach County, thirteen municipalities, a port authority, and an inlet district.

3. **Land Use:** Six zoning designations and major land uses are distributed along Lake Worth Lagoon; Residential (72.5%), Public (17.5%), Commercial (8.1%), Industrial/Utilities (1.0%), Water (0.8%) and Community Service (0.1%).

4. Bathymetry: Water depths within Lake Worth Lagoon are variable (<1.0'-30.0' NGVD). Numerous areas have been dredged for navigation. The Atlantic Intracoastal Waterway is maintained at -11.0'(NGVD), the Lake Worth Inlet and Port of Palm Beach are maintained at -35.0'(NGVD), and the South Palm Beach Inlet has design depth of -6.0'(NGVD).

5. Hydrologic and Hydraulic Characteristics: Lake Worth Lagoon receives freshwater input from rainfall, which averages 5.4'/year, and groundwater inflows estimated at 281-330 cfs. Drainage from 3 major canals (C-16, C-17, and C-51) contributes considerable amounts of freshwater into Lake Worth Lagoon. Salinity variations in the Lake correspond closely to the seasonal variations in the freshwater inflow. Major tidal influences occur via the Lake Worth and South Lake Worth Inlets. The West Palm Beach Canal (C-51) controls the flushing characteristics of the Lake more than tidal and wind driven forces; its flow direction is 75% northward and 25% southward. Lantana Bridge is the area where the tidal influence from the inlets is most reduced. The maximum residence time of the water body between the two inlets is about 28 tidal cycles (14 days).

6. Sediment Characteristics: Sediment grain sizes and types, along with occurrences of rock outcrops throughout the lagoon have been identified. Data from five sediment studies conducted from 1970 - 1989 are presented on a map and in tabular form.

7. Point and Nonpoint Source Outfalls: During the 1950's an estimated 10 million gallons per day (MGD), of raw sewage was discharged directly into Lake Worth Lagoon. By 1970, most sewage was treated to secondary standards, but the discharge had increased to 18.49 MGD. During the past twenty years discharges into Lake Worth Lagoon have been greatly reduced through the use of alternative effluent disposal methods. Concurrently stormwater discharge has increased over the years. A total of 381 stormwater outfalls and 4 point sources were documented in this survey.

8. Shoreline Characteristics: Lake Worth Lagoon's shoreline is approximately 70 linear miles (91.5 miles including canals), much of which has been altered through the years. 87% of the original shoreline mangroves have been eliminated resulting in mangroves along only 19% of the shoreline. Bulkheads comprise approximately 65% of the shoreline.

9. Submerged Natural Resources: Lake Worth Lagoon is host to valuable plant and animal communities such as seagrass beds (6 species), macroalgae (10 species), oyster habitat, corals and sponges. Seagrasses cover approximately 35% of the total submerged area of Lake Worth Lagoon. Three main areas of the lagoon support extensive seagrass beds. Of the total seagrass area of 2110 acres, the percentages of area dominated by various seagrass species are: *Halodule wrightii* (51%); *Halophila decipiens* and *Halophila johnsonii* (25%); and a mixed assemblage of all three species (19%). *Syringodium filiforme* (1%) is primarily found near the Lake Worth Inlet area and a major *Thalassia testudinum* bed (2%) is located east of Big Munyon Island. *Halophila johnsonii* has been designated by the Florida Natural Areas Inventory as a species of limited distribution and recommended for inclusion on the State list of threatened plant species.

10. Known Occurrences of Fish: 261 species of fish are known to occur in Lake Worth Lagoon and in the vicinity of the inlets. 195 species have been collected within Lake Worth Lagoon. The fish collection data from six studies conducted from 1962-1985 are presented on a map of the lagoon.

11. Endangered, Threatened and Rare Species and Species of Special Concern: 13 plant and 27 animal species known or likely to naturally inhabit Lake Worth Lagoon are recorded. All known protected plant species occur in either in John D. MacArthur State Recreation Area or Gemini Botanical Gardens.

12. Marinas and Docks: The survey indicates that Lake Worth Lagoon has storage/dock facilities for approximately five thousand boats (2558 marina slips and 2156 dry storage racks

and hundreds of private docks). The area currently accommodates 47 marinas, and 8 public boat ramps.

13. Water Quality: Water quality data has been collected in Lake Worth Lagoon since the late 1960's. Data indicates that the lagoon is a moderately polluted estuarine system. A trend analysis indicates water quality either remained fairly constant or slightly improved over a fifteen year period. Analysis of sediments for heavy metals and organic compounds indicate a system which chronically receives runoff from urban development.

14. Habitat Restoration and Enhancement: 20 habitats along Lake Worth Lagoon have been selected, identified and evaluated in order to establish a prioritized list of areas in need of restoration/enhancement. Five project types for habitat restoration and enhancement to be implemented are - Shoreline and Wetlands Creation, Artificial Reef Creation, Shoreline Stabilization (rip rap), Seagrass and Oyster Bed Creation and Public Information and Education.

Analysis of the available information regarding Lake Worth Lagoon indicates that water quality and habitat resources have been drastically impacted by urbanization of the area over the past one hundred years. Fish and wildlife habitat has declined due to dredging and filling activities. However, productive areas of seagrass beds, shoreline mangrove communities and other habitat components remain and are utilized by a great number of fish and wildlife species. These areas need to be protected and preserved, while other declining habitats need to be enhanced or restored to their natural state.

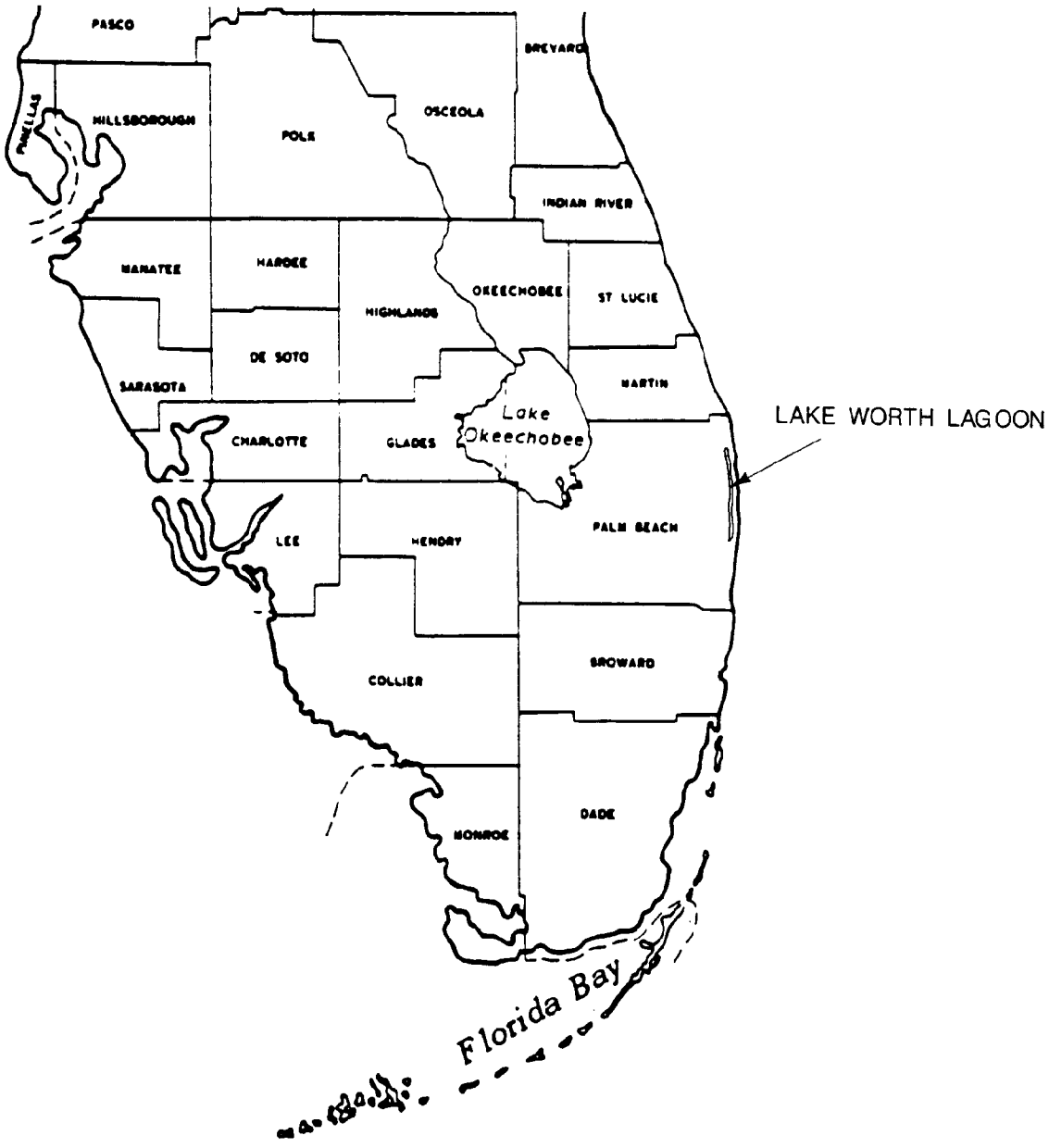
The information in this report is a valuable basis for development of a comprehensive management plan for Lake Worth Lagoon. The report provides an analysis of resource trends, as well as recommendations for habitat enhancement projects which will be undertaken by Palm Beach County's Department of Environmental Resources Management through use of County Vessel Registration Fee Ordinance revenues.

2.0 INTRODUCTION

The coastal lagoons and estuaries of Florida are extremely important resources which benefit all of us in many ways. As distinct geographic features they are the focal point of life along the coast. Our cities are built along their shores, and we utilize their waters for recreation and commerce. The fish and wildlife resources which make Florida unique also depend upon these natural systems for their existence. Seventy percent of our recreational and commercial fish species are dependent upon coastal estuaries at some point in their life cycle (Harris et. al., 1983).

Lake Worth Lagoon is located in Palm Beach County along the urbanized southeast coast of Florida (**Location Map**). Historically, Lake Worth Lagoon been one of the most abused and least protected coastal water bodies in Florida. Since the first settlers arrived in Palm Beach County in the late eighteen hundreds, Lake Worth Lagoon has been subjected to a constant onslaught of environmentally degrading activities including channel dredging, shoreline bulkhead construction and filling, causeway and bridge construction, dock and marina construction, industrial waste discharge, sewage disposal, stormwater runoff, canal development, port development, mosquito control, and power plant construction and operation. While the cumulative impact of these activities over the past one hundred years has significantly altered Lake Worth Lagoon from its previous character and diminished its value as a healthy estuarine ecosystem, significant regionally important natural resources remain. The fish and wildlife values, water quality, and recreational values which remain must be identified, evaluated, and protected to assure their future viability. Proper management of the Lake Worth Lagoon System will lead to protection and enhancement of this important coastal resource.

The Indian River Lagoon located to the north, and Biscayne Bay located to the south of Lake Worth Lagoon have been subject to numerous studies and management activities in recent years. However, Lake Worth Lagoon has received relatively little attention by



LOCATION MAP OF LAKE WORTH LAGOON

environmental agencies. For this reason, the Palm Beach County Department of Environmental Resources Management, (ERM) initiated this Natural Resources Inventory and Resource Enhancement Study of Lake Worth Lagoon.

This study was funded by a Federal Coastal Zone Management Grant administered by the Florida Department of Environmental Regulation, Office of Coastal Management. ERM was responsible for conducting the literature search, and field studies. Dames & Moore was contracted by ERM to organize and analyze data, produce maps, and generate the report.

The objectives of this project were to:

- Identify significant research, data and literature regarding the natural resources of Lake Worth Lagoon.
- Identify and map important environmental characteristics of Lake Worth Lagoon.
- Analyze the information and maps to determine environmental trends and conditions.
- Identify and evaluate habitat restoration and enhancement projects which can be undertaken by ERM.

The findings of this study will ultimately be utilized by ERM as the basis of a comprehensive Lake Worth Lagoon Management Plan designed to improve and protect Lake Worth Lagoon as an important coastal natural resource. The report will guide ERM in its selection of Lake Worth Lagoon habitat restoration or enhancement projects undertaken with revenues produced by the County Vessel Registration Fee Ordinance.

This study was completed through a four task approach:

1. Literature Search and Database Development
2. Field Studies and Mapping
3. Natural Resources Inventory and Analysis
4. Identification of Potential Habitat Restoration and Enhancement Projects.

3.0 LITERATURE/DATA SEARCH AND DATABASE DEVELOPMENT

A detailed literature and data search was conducted by ERM staff in an effort to locate information related to natural resources of Lake Worth Lagoon. Sources of literature investigated in the search include:

Area Planning Board of Palm Beach County
Florida Atlantic University
Florida Department of Environmental Regulation
Florida Department of Natural Resources
Municipal Comprehensive Plans
Palm Beach County Library
South Florida Water Management District
University of Miami
University of Florida

References were organized in a DBASE software program to provide a manageable and expandable database. Entries include title, author, reference number, date of publication, key words, location of publication, and abstract. The entries can be retrieved by author, reference number or key word. The database currently includes over two hundred citations, and is available for use through ERM. A complete list of references contained in the database is included in the appendix of this report **(Appendix 8.1)**.

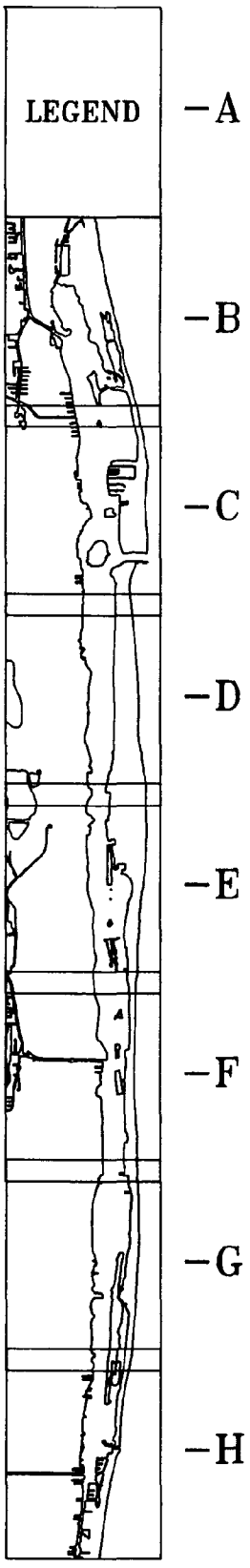
4.0 FIELD STUDIES AND MAPPING

Field studies were conducted during the spring and summer of 1990 by ERM. The studies were structured to produce resource baseline information that can be presented on map overlays of Lake Worth Lagoon. Field study methods are briefly discussed in the sections of the report which precede each map overlay.

The information produced through field studies and the literature/data search is presented as overlays to a base map developed from United States Geological Survey, (USGS) quadrangle maps scaled at 1 inch = 2000 feet. Overlays include:

Dredged and Filled Areas
Governmental Jurisdiction Boundaries
Land Use
Bathymetry
Hydrologic and Hydraulic Characteristics
Sediment Distribution
Point and Nonpoint Source Outfalls
Shoreline Characteristics
Submerged Natural Resources
Known Occurrences of Fish
Endangered, Threatened and Rare Species and Species of Special Concern
Marinas and Docks
Water Quality Stations
Habitat Restoration and Enhancement Project Areas

The maps were produced by AUTOCAD software, and are presented in match line format in this document (**Map Key**). Full size maps with color overlays are available for review at ERM.



NOTE:

THE NORTHERN BOUNDARY OF THE STUDY AREA IS LITTLE LAKE WORTH.

THE SOUTHERN BOUNDARY OF THE STUDY AREA IS THE OCEAN AVENUE BRIDGE, BOYNTON BEACH.

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* MAP KEY		D&M JOB NO. *20335-001-049*

5.0 NATURAL RESOURCES INVENTORY AND ANALYSIS

5.1 HISTORY OF LAKE WORTH LAGOON

Lake Worth Lagoon is a narrow elongated lagoon bordered on the west by the Atlantic Coastal Ridge and on the east by a barrier island or peninsula. The barrier island was formed as part of an offshore bar during the late Pleistocene (120,000 years B.P.) when sea level was elevated. As sea level dropped during the glacial age the offshore bar became partially lithified. During the last rise in sea level the present day barrier island and narrow lagoon was established. The sea reached its present level about 6000 years ago, and the Florida Peninsula emerged in approximately its present shape. Sea levels oscillated over the last 6000 years changing the shape of the shoreline. The closing or opening of inlets, followed by the creation of brackish or freshwater conditions are common events in narrow coastal lagoons like Lake Worth Lagoon. During modern times Lake Worth was first noted on an 1830 map as a freshwater lake with drainage from a swampy area along the western edge (Pierce, 1970).

Florida pioneers first came into contact with Lake Worth during the Seminole Indian wars of the mid-eighteen hundreds. In fact, Lake Worth is named after Brigadier General William Jenkins Worth, an important military figure of that era. The Seminole Indians which had settled in the area at that time called the lake "Hypoluxo", which meant "water all around, no get out". This was a fitting name, as Lake Worth at that time was a freshwater lake with no permanent connections to the ocean, and no significant outflows or surface water inflows.

The barrier island to the east (Palm Beach) separated Lake Worth from the Atlantic Ocean. Extreme high tides and waves, high lake water levels and storms occasionally caused the formation of small temporary inlets. To the west, a sand ridge separated the lake from the mainland, which at the time consisted mostly of sawgrass marsh. The lake was also isolated

from the Loxahatchee River to the North, and Hillsboro River to the south by sand ridges which connected the mainland to the barrier island at each end of the lake.

Historically, only three natural islands existed in Lake Worth. Big and Little Munyon Islands located in the northern part, and Hypoluxo Island located in the southern part of the lake. Vast freshwater marshes surrounded the lake, and freshwater grassbeds grew within the lake. The main sources of water for the lake were direct rainfall and groundwater inflow from the west.

The first settlers came to the shores of Lake Worth in the 1860's. They immediately began the changes known as progress that continue to this day. Several early attempts were made to create navigable inlets from the ocean, and in 1877 construction of a stable inlet was achieved. Immediately, the lake began to change to a saltwater lagoon system. During the 1890's the East Coast Canal Company completed dredging of a navigation canal from the north end of Lake Worth Lagoon to the Jupiter Inlet. This resulted in an increase in freshwater discharges to the north end of Lake Worth Lagoon via the Loxahatchee River. Also during this decade developers began filling the wetland edges of Lake Worth Lagoon, an activity that would continue into the 1970's.

In the early 1900's, the Intracoastal Waterway was completed from the south end of Lake Worth Lagoon to Biscayne Bay. By 1915 the Port of Palm Beach created a permanent inlet 4 feet deep at the north end of Lake Worth Lagoon. The inlet was deepened to 16 feet in 1925. The dredge spoils were deposited in Lake Worth Lagoon resulting in the creation of Peanut Island. In 1917 the South Lake Worth Inlet was created in a failed effort to improve tidal circulation and provide flushing to the south end of the lagoon. The completion of the West Palm Beach Canal and spillway in 1925 resulted in creation of a significant freshwater inflow to Lake Worth Lagoon. Its creation also provide the drainage necessary for development of the west shore of the lagoon.

By the 1940's the changes in hydrology along with the pollutants contributed by freshwater and sewage effluent inflows had resulted in unacceptable water quality in Lake Worth Lagoon. In an effort to improve this problem Palm Beach County dredged one half million yards of sediment from the mid portion of the lagoon and deposited it on the Atlantic beaches of the Town of Palm Beach. Fumes from the decomposition of this organic material along the beaches reportedly resulted in paint peeling from houses. By the early 1950's, water quality in Lake Worth Lagoon was at its worst as an estimated ten million gallons of raw sewage effluent were discharged daily. In response to the problem, a massive cleanup effort occurred in the 1960's and 1970's resulting in 70% of the population being served by secondary treatment sewage disposal systems.

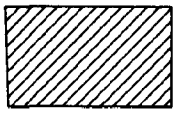
During this period, the assault on Lake Worth's shoreline reached its peak. Most of the shoreline was extended waterward by dredging and filling activities in the fringing wetlands. The newly created upland areas were contained by shoreline bulkheads. Large upland areas were created north of the Lake Worth Inlet in the area of Palm Beach Shores. In 1959, Munyon Island was enlarged by deposition of dredge spoil. Between 1940 and 1975 an estimated 87% loss in mangrove wetlands occurred through shoreline development. As of 1975, an estimated 275 acres of mangrove forest was all that remained (Harris et.al, 1983).

Today, Lake Worth Lagoon is connected to the Atlantic Ocean by two permanent inlets. The Lake Worth Inlet is 400 feet wide by 35 feet deep, and the South Lake Worth Inlet is 200 feet wide by 6 feet deep. The Atlantic Intracoastal Waterway channel runs the entire length of Lake Worth Lagoon. Eight causeways and bridges connect the mainland to the barrier island. Forty seven marinas and hundreds of private docks are scattered along the shoreline. Approximately 65% of the lagoon shoreline is bulkheaded. Only approximately 19% of the shoreline remains fringed by mangroves. Industrial activities include the Port of Palm Beach and the Riviera Beach Power Plant. Major freshwater inflows to Lake Worth include the Earman River (C-17), West Palm Beach Canal (C-51), and Boynton Beach Canal (C-16).

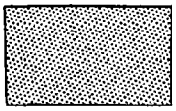
The information for the map of dredged and filled areas (**Figure 1**) was adapted from the W. Vines, 1970 report, Surface Waters, Submerged Lands, and Waterfront Lands for the Area Planning Board of Palm Beach County (Figure 7, Dredged and Filled Areas in Inland Waters). This map includes previously submerged lands which have been filled, and submerged lands which have been dredged. Major changes have not occurred in the past 20 years due to environmental regulations which limit dredging and filling activities.

This brief history illustrates that through man's activities, Lake Worth Lagoon has evolved over the past one hundred years from a freshwater lake system to an urban estuarine lagoon system in need of management.

LEGEND



SUBMERGED LANDS WHICH HAVE BEEN DREDGED

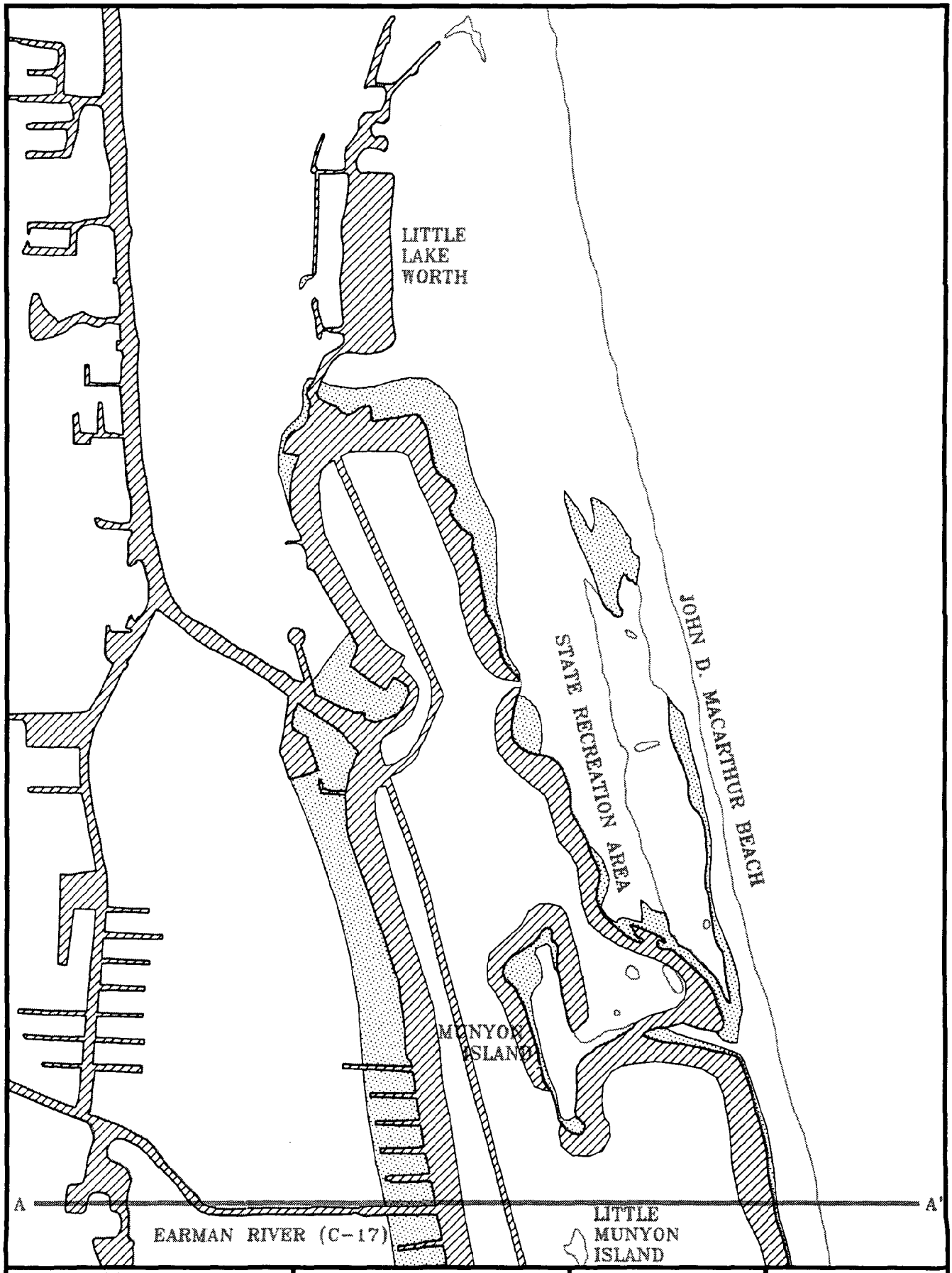


PREVIOUSLY SUBMERGED LANDS WHICH HAVE BEEN FILLED

NOTES

ADAPTED FROM VINES, W.R., 1970, ***SURFACE WATERS, SUBMERGED LANDS, AND WATERFRONT LANDS*** FOR AREA PLANNING BOARD OF PALM BEACH COUNTY, FLORIDA, FIGURE 7

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* DREDGED AND FILLED AREAS		D&M JOB NO. *20335-001-049* FIGURE *1-A*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

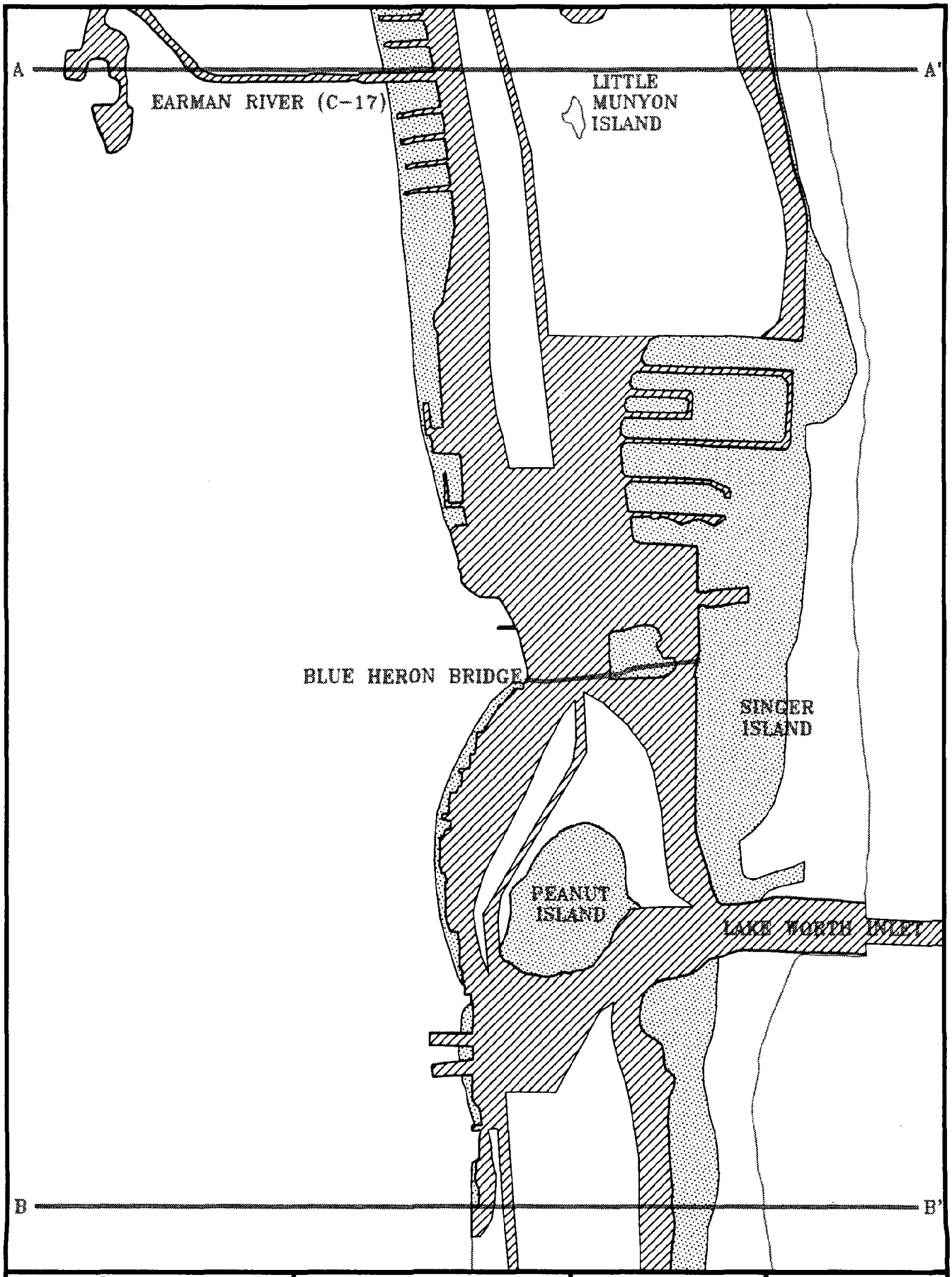
LAKE WORTH LAGOON

DREDGED AND FILLED
AREAS

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
1-B



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

DREDGED AND FILLED AREAS

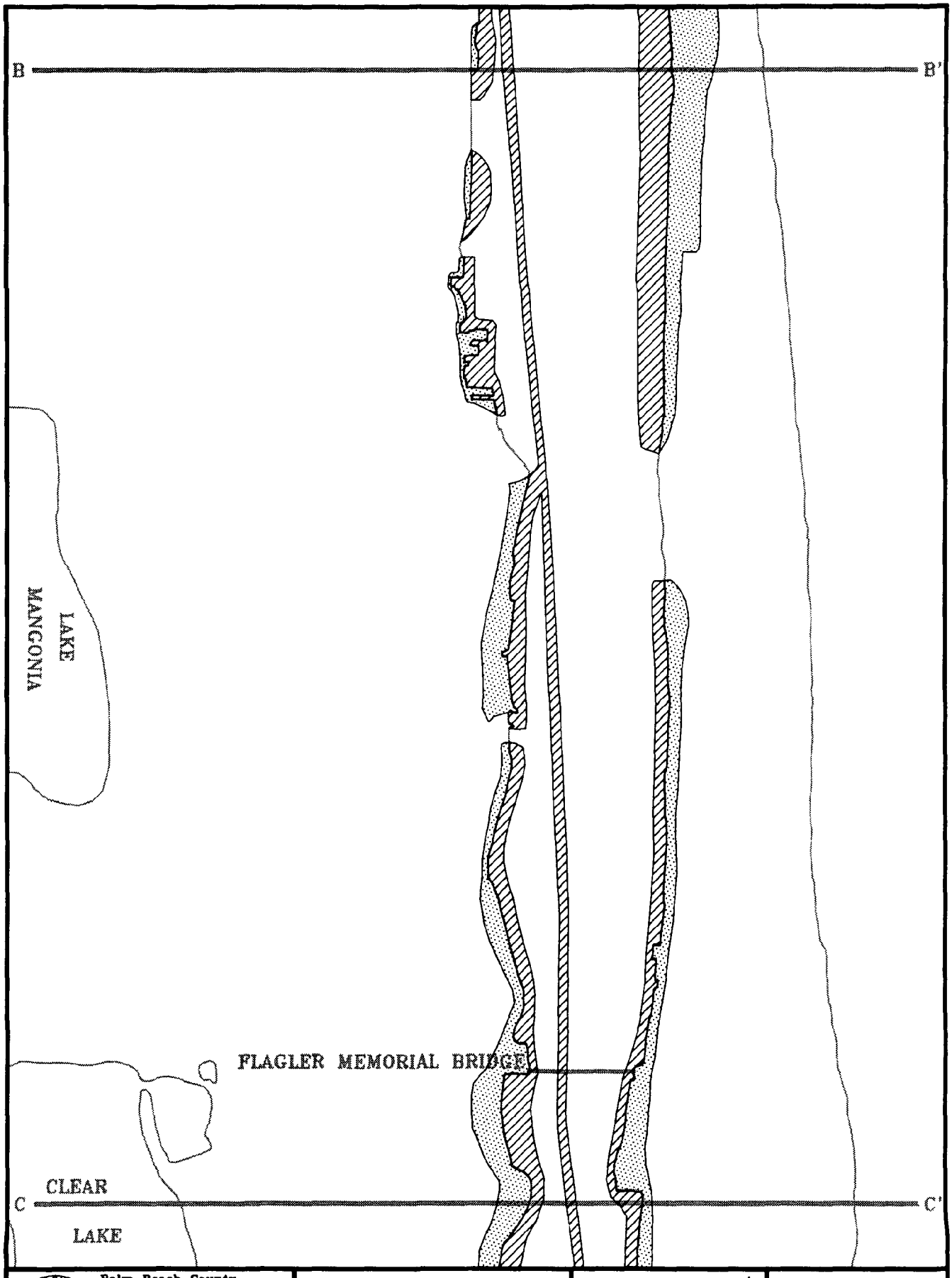
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *1-C*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

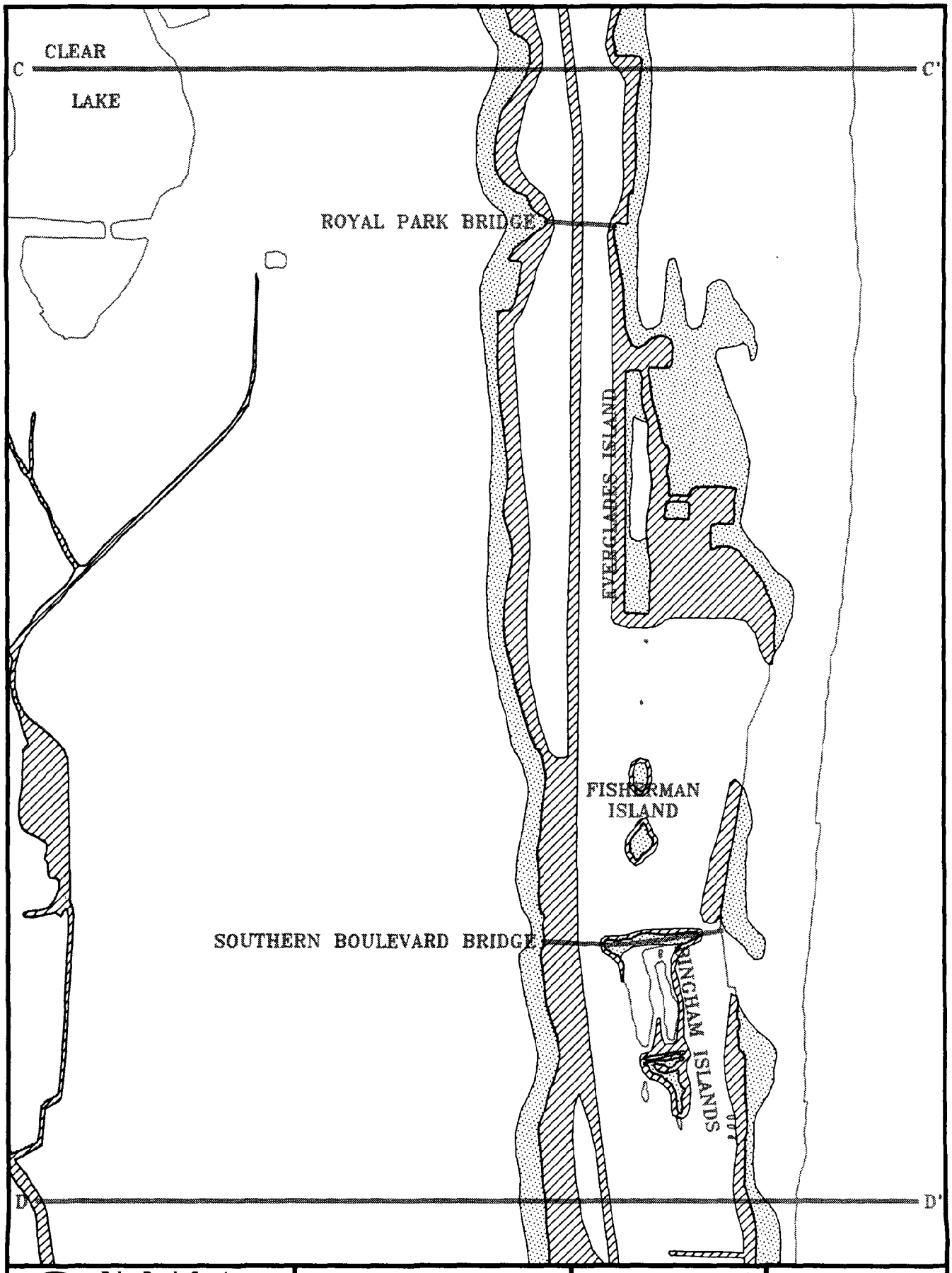
DREDGED AND FILLED
AREAS

0 1000 2000
SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
1-D



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

DREDGED AND FILLED AREAS

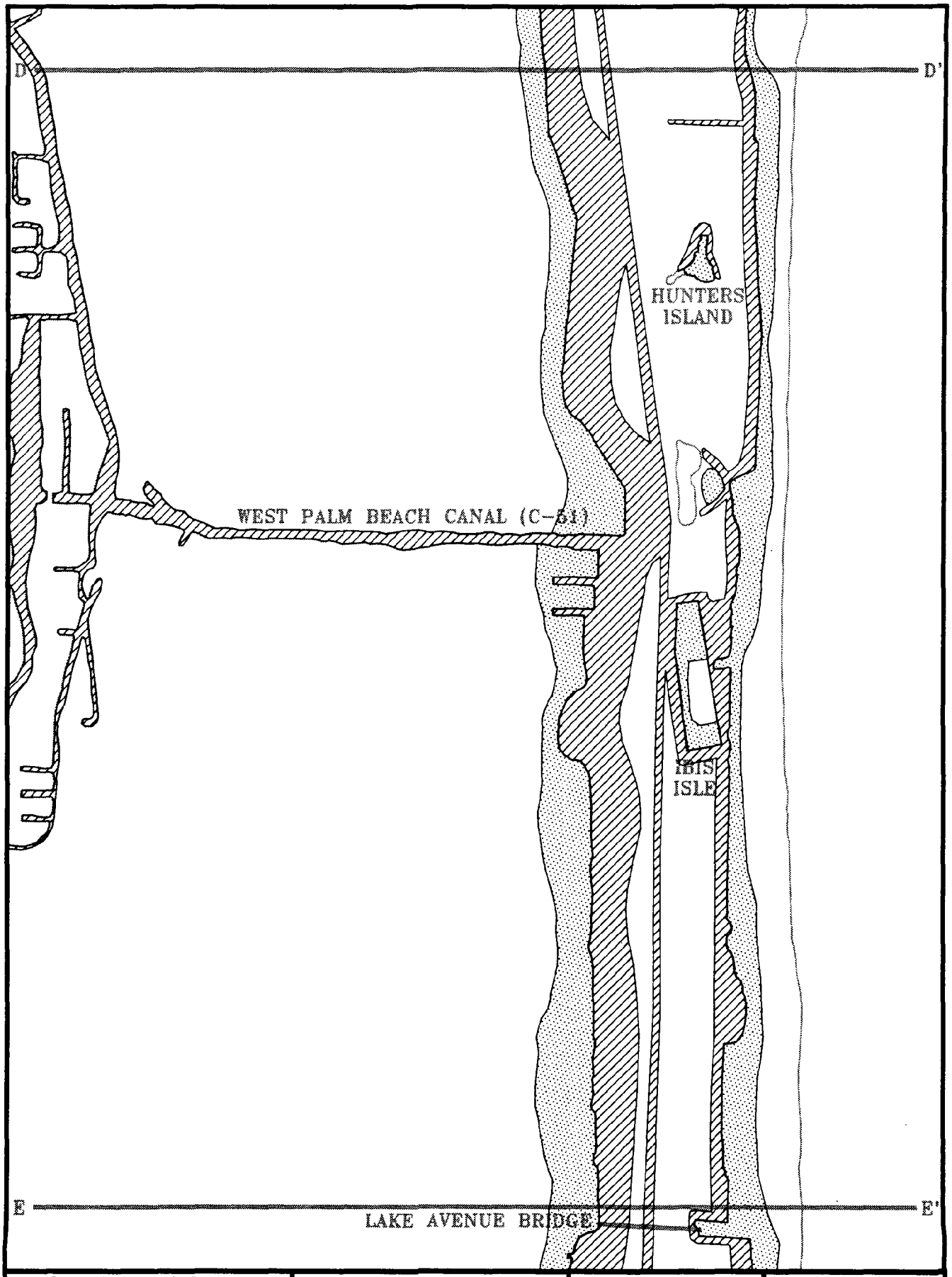
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *1-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

DREDGED AND FILLED AREAS

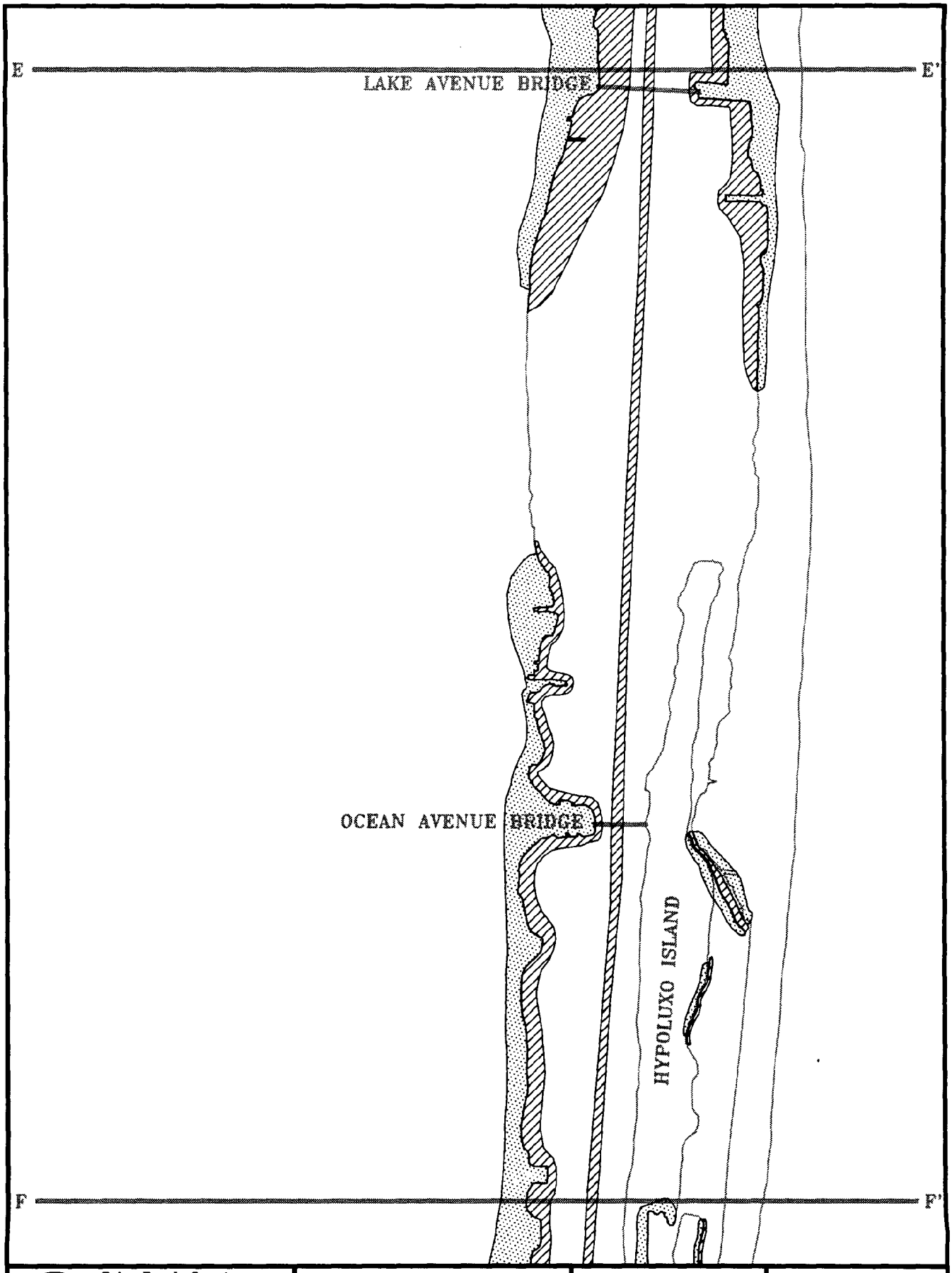
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *1-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

DREDGED AND FILLED AREAS

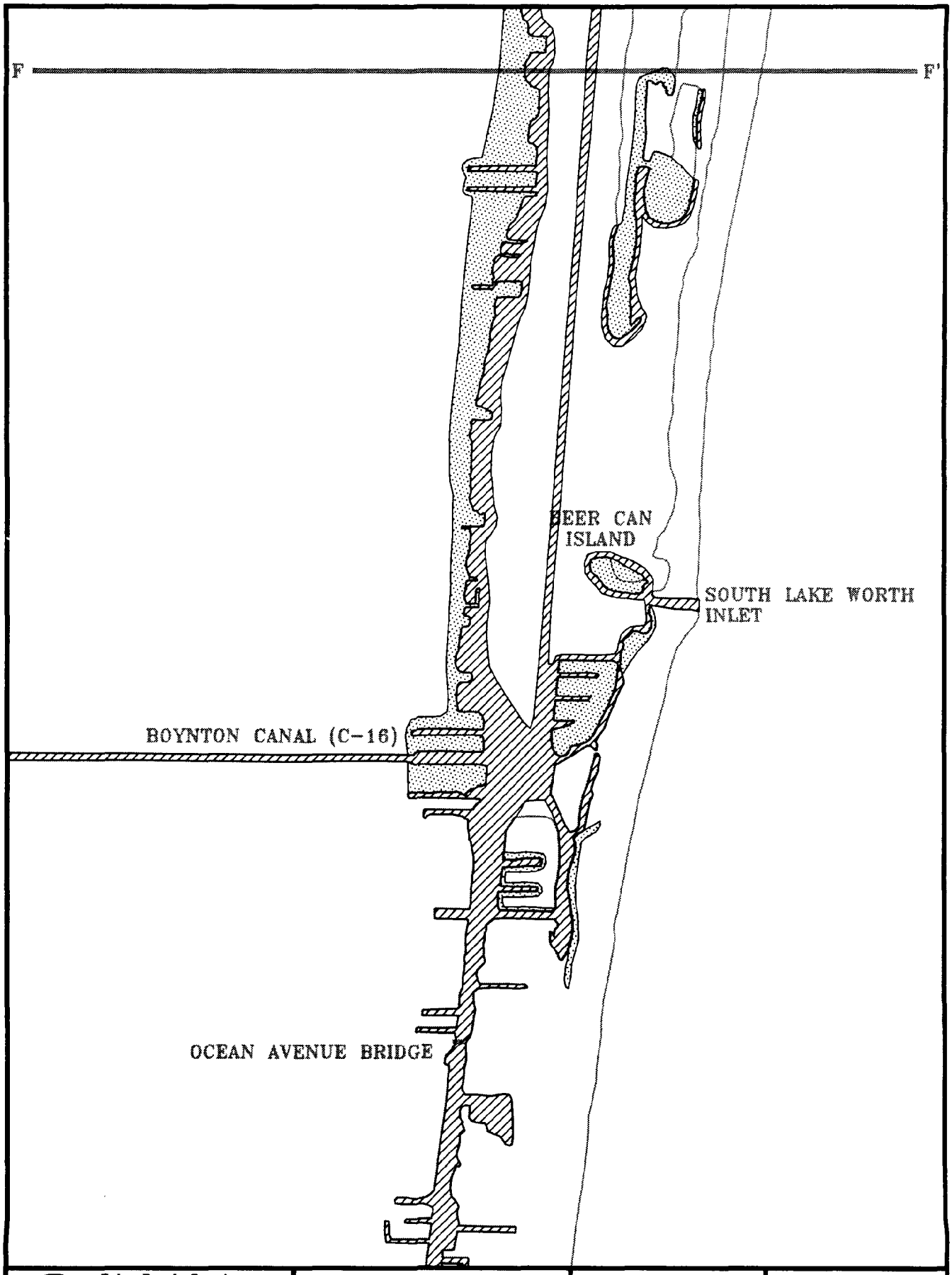
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *1-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

DREDGED AND FILLED AREAS

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *1-H*

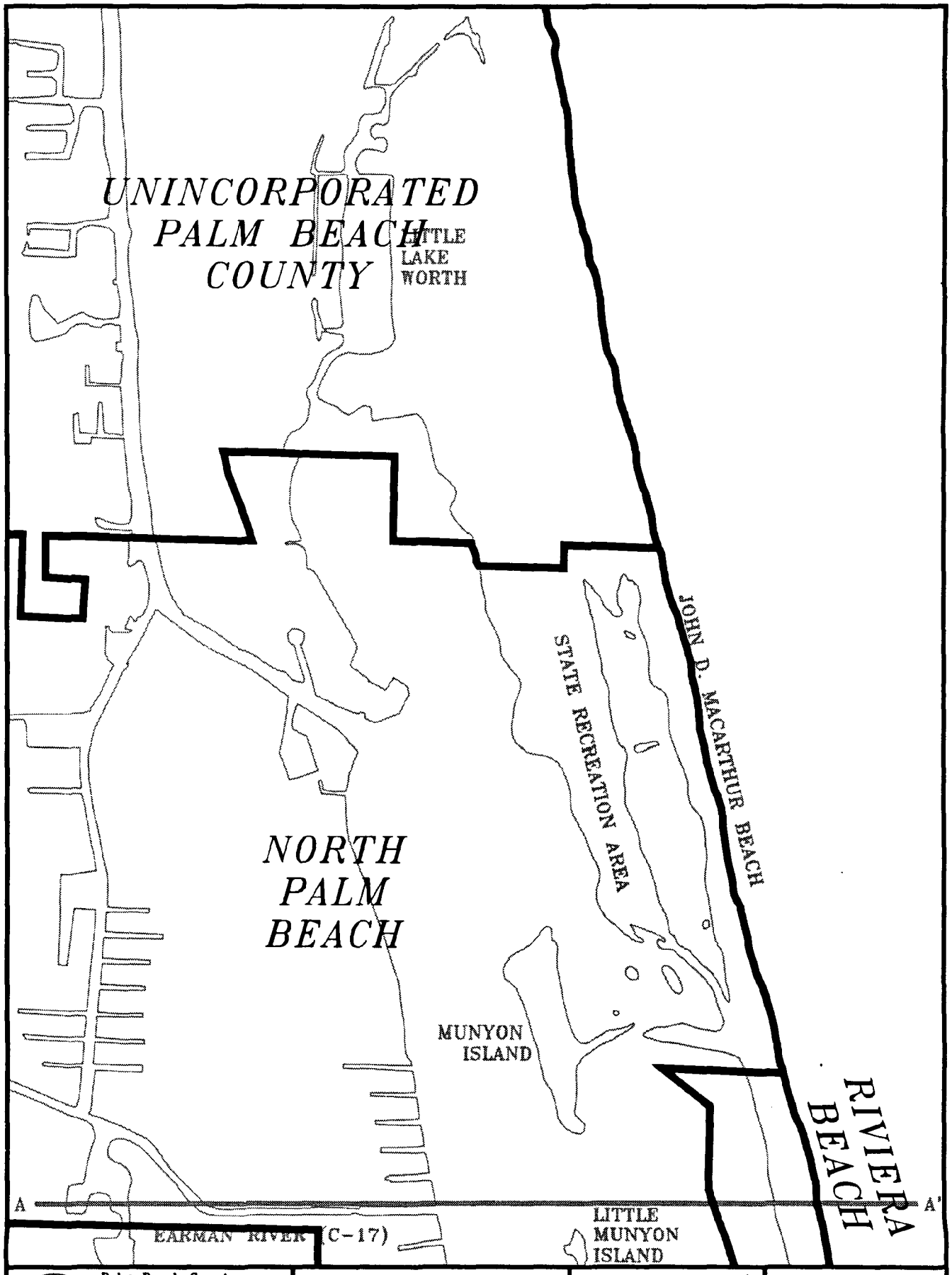
5.2 GOVERNMENTAL JURISDICTION BOUNDARIES

The submerged area and shoreline of Lake Worth Lagoon is divided between the geographical jurisdiction of many governmental units. The extreme north section, including Little Lake Worth is in unincorporated Palm Beach County. The Port of Palm Beach Authority controls the northern inlet area. The southern inlet area is controlled by the South Lake Worth Inlet District. The following thirteen municipalities also include portions of Lake Worth Lagoon:

North Palm Beach
Lake Park
Riviera Beach
Palm Beach Shores
West Palm Beach
Palm Beach
Lake Worth
Lantana
South Palm Beach
Hypoluxo
Manalapan
Boynton Beach
Ocean Ridge

Figure 2 depicts the current jurisdictional boundaries of each governmental unit. The boundaries were determined by review of USGS quadrangle maps, and a map depicting municipal boundaries as recognized by the Palm Beach County Tax Appraisers Office.

Note: The figure begins with Plate 2-B because there is no need for a legend.



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

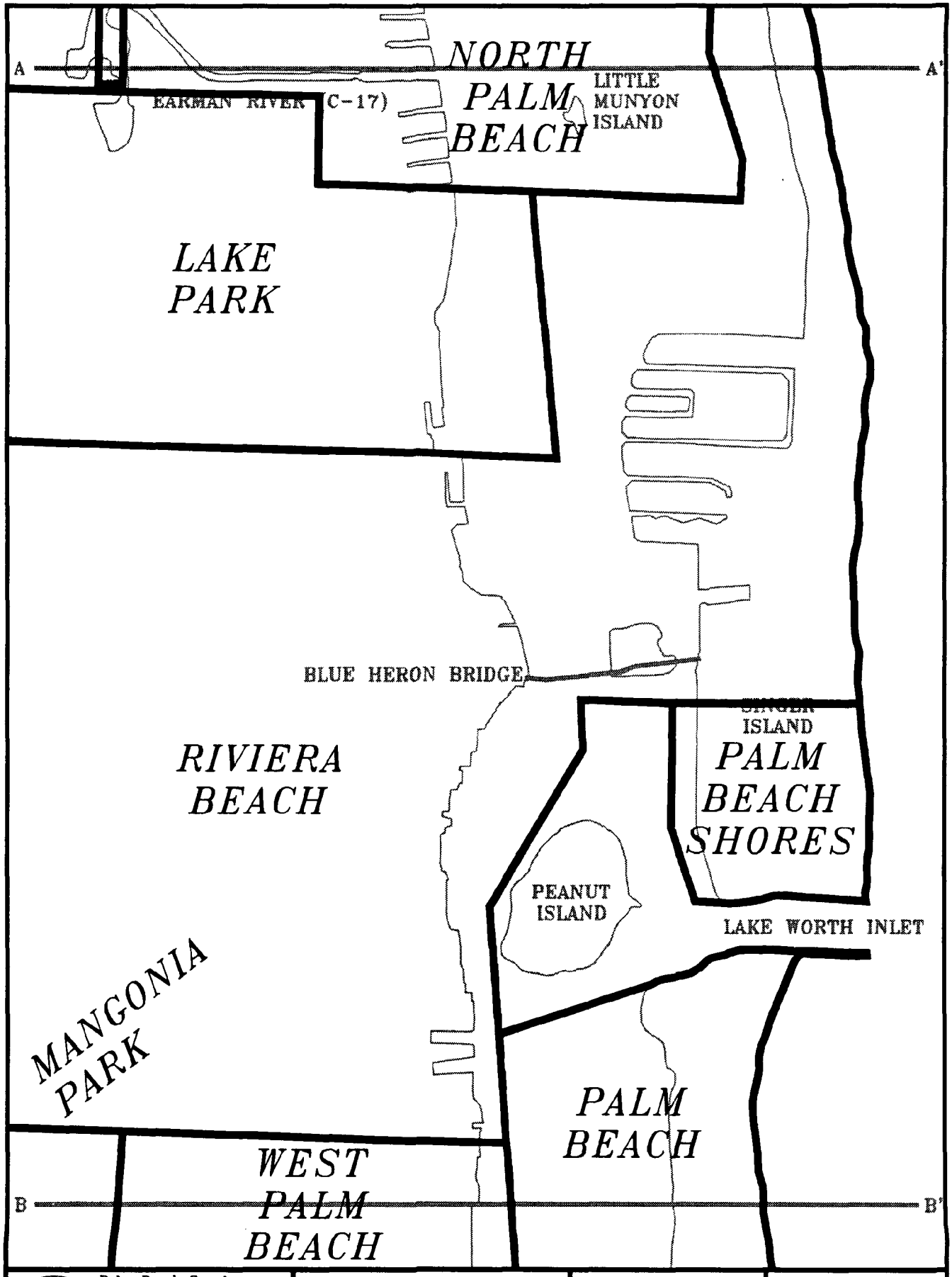
LAKE WORTH LAGOON

GOVERNMENTAL JURISDICTION
BOUNDARIES

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
2-B



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

GOVERNMENTAL JURISDICTION BOUNDARIES

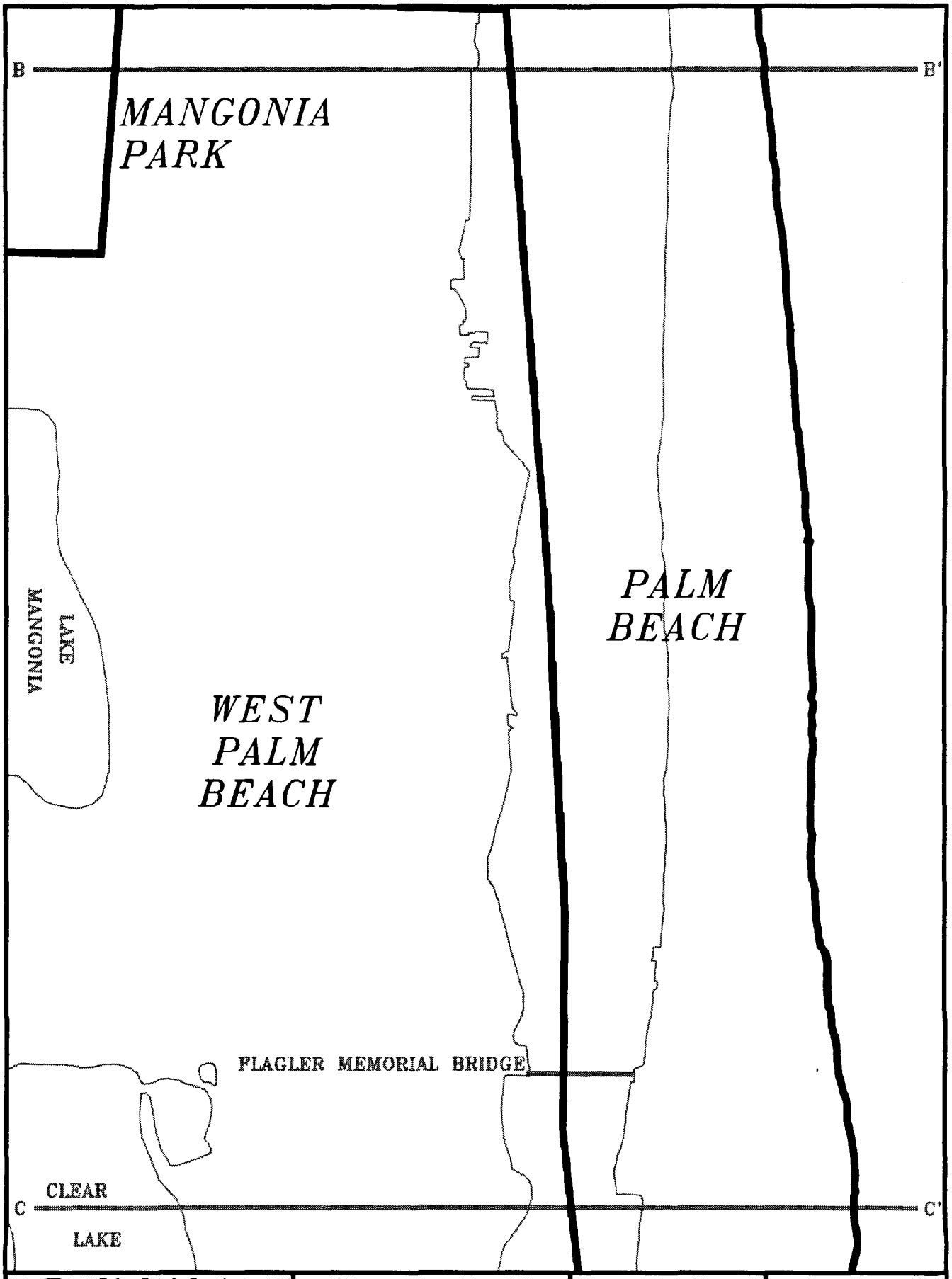
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *2-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

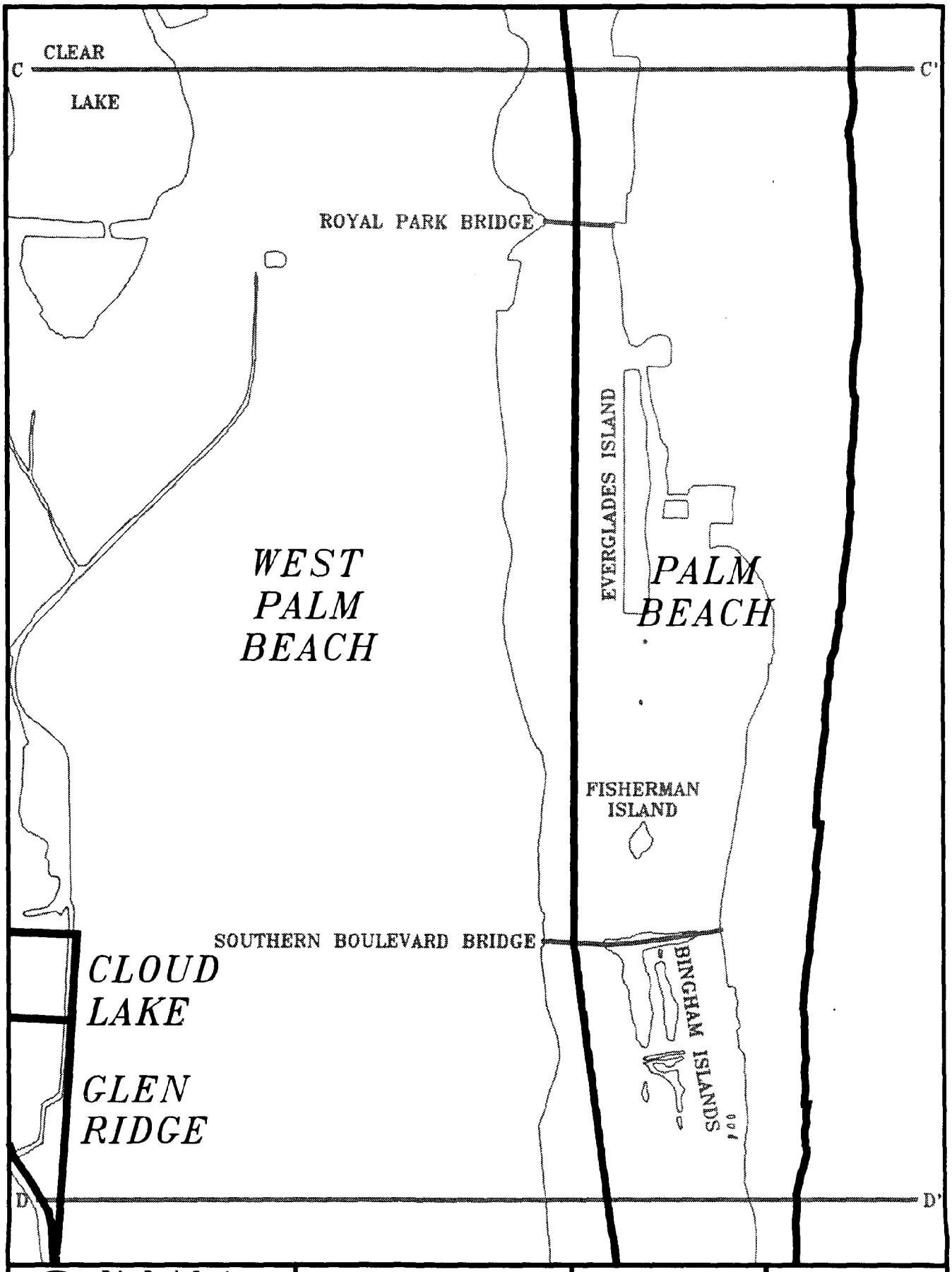
GOVERNMENTAL JURISDICTION BOUNDARIES

0 1000 2000

SCALE (FEET)

D&M JOB NO. *20335-001-049*

FIGURE *2-D*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

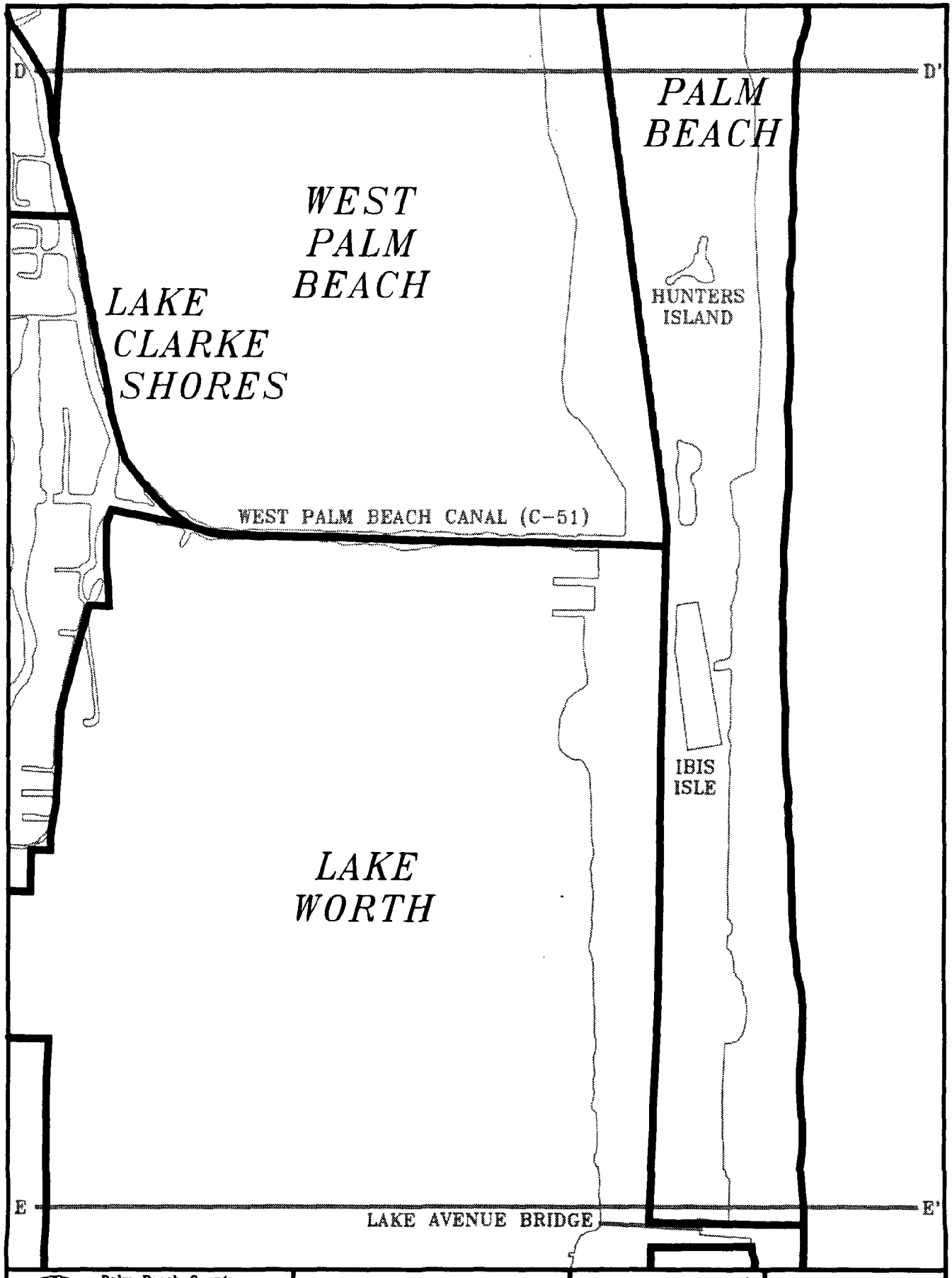
GOVERNMENTAL JURISDICTION
BOUNDARIES

0 1000 2000
SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
2-E



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

GOVERNMENTAL JURISDICTION BOUNDARIES

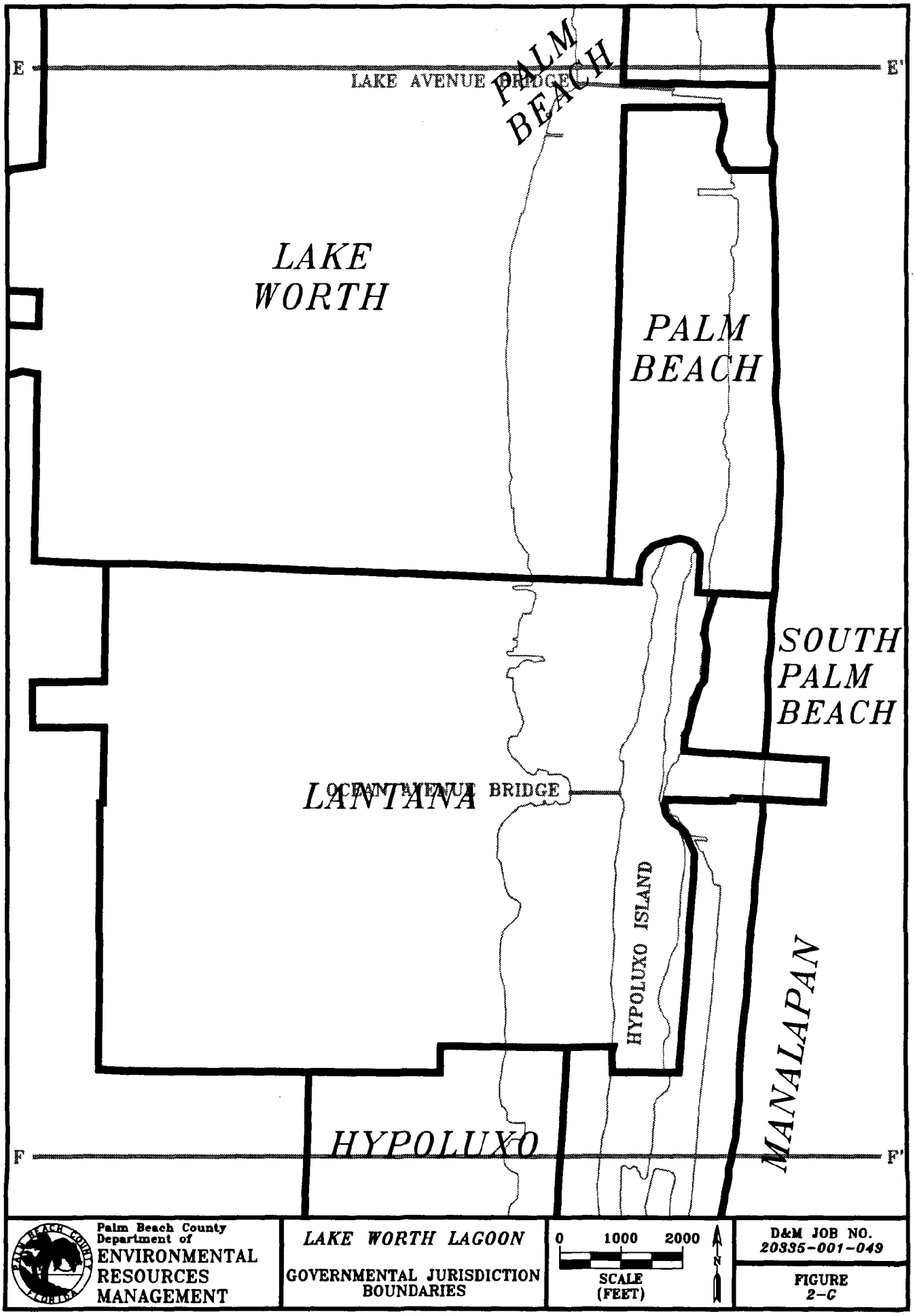
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *2-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

GOVERNMENTAL JURISDICTION BOUNDARIES

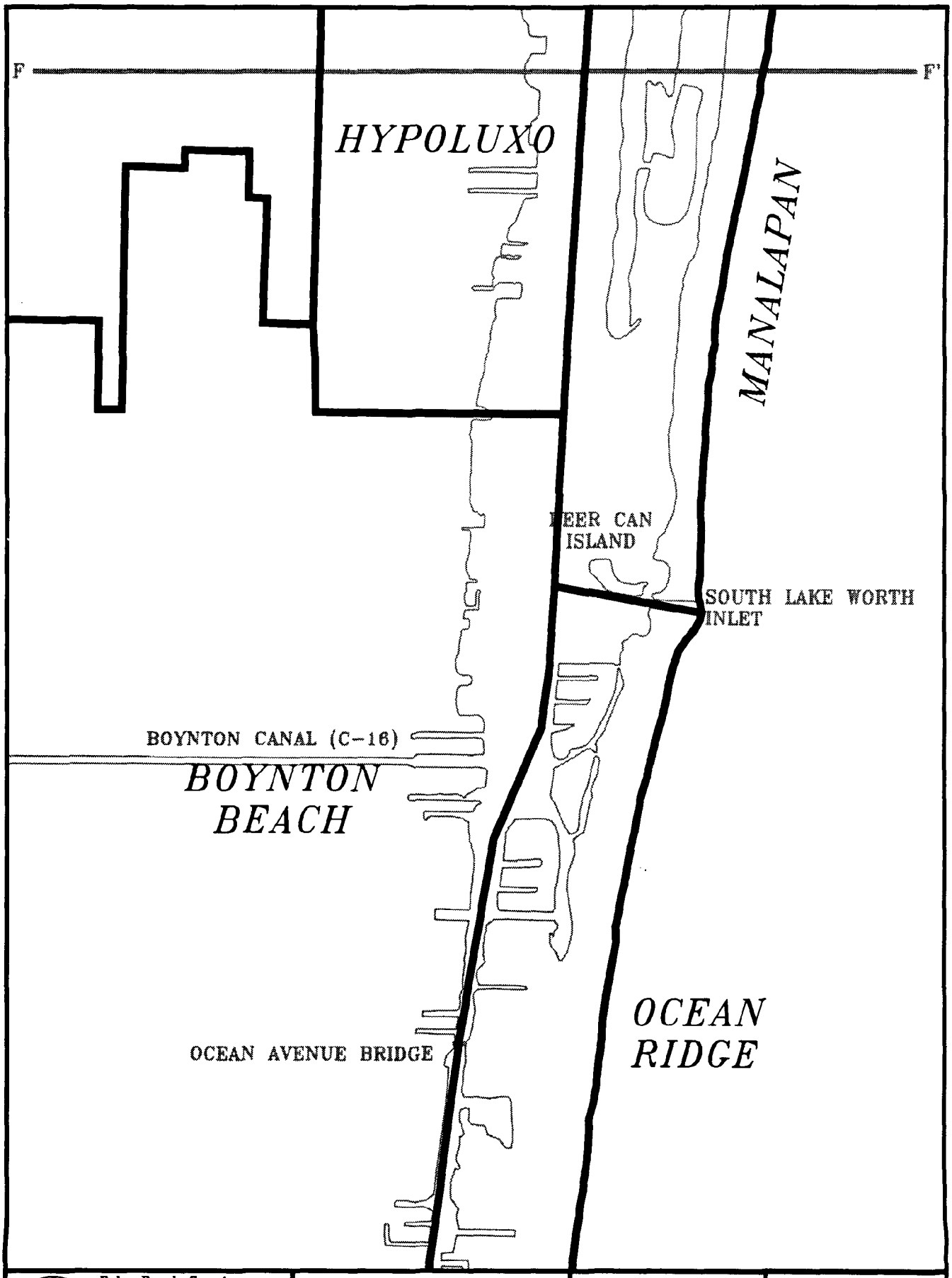
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *2-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

GOVERNMENTAL JURISDICTION BOUNDARIES

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *2-H*

5.3 LAND USE

The majority of land adjacent to Lake Worth Lagoon has been intensively developed for waterfront commercial and residential purposes. Single-family homes and multi-unit condominiums with waterfront or canal based marina facilities are very common. Major industrial areas are concentrated near the Port of Palm Beach. Commercial areas are limited and consist mostly of waterfront offices, restaurants and marina facilities. Open spaces are limited to public parks and road right-of-ways. The approximate percentages of shoreline area designated for various land uses are presented in **Table 1.**

TABLE 1

LAND USE

LAND USE DESIGNATION	*LINEAR MILES	PERCENT OF SHORELINE
Residential Areas	50.75	72.5%
Public Ownership/Public Districts	12.25	17.5%
Commercial Districts	5.67	8.1%
Industrial/Utilities District	0.70	1.0%
Community Services District	0.07	0.1%
Water Area/Open Space	0.56	0.8%

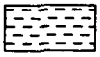
* The total length of the Lake Worth Lagoon shoreline excluding canals is approximately 70 miles.

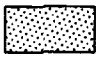
While not located within the area of this study, it should be noted that the drainage basins surrounding the C-16, C-17, and C-51 canals contain a significant amount of undeveloped lands. The manner in which these lands are developed could have a significant impact on Lake Worth Lagoon, the receiving water for runoff from these canal basins.

Land uses along the shoreline of Lake Worth Lagoon are depicted on **Figure 3.** Zoning designations and land uses have been combined into six categories; public use or ownership, residential, commercial, industrial, special use, and open water areas. Shoreline areas have been classified into these categories based upon zoning designations found on the 1989 Redi Map aerial photographs. Submerged land deed area designations were obtained from the Palm Beach County Property Appraisers Office.

LEGEND


RESIDENTIAL AREAS


PUBLIC OWNERSHIP, PUBLIC DISTRICTS, PUBLIC RECREATION AND OPEN SPACE, PUBLIC/SEMI-PUBLIC PLANNED UNIT DEVELOPMENT, RECRECATION, RECREATIONAL OPEN SPACE, PRESERVATION/ CONSERVATION AREAS, COMMUNITY FACILITY DISTRICT

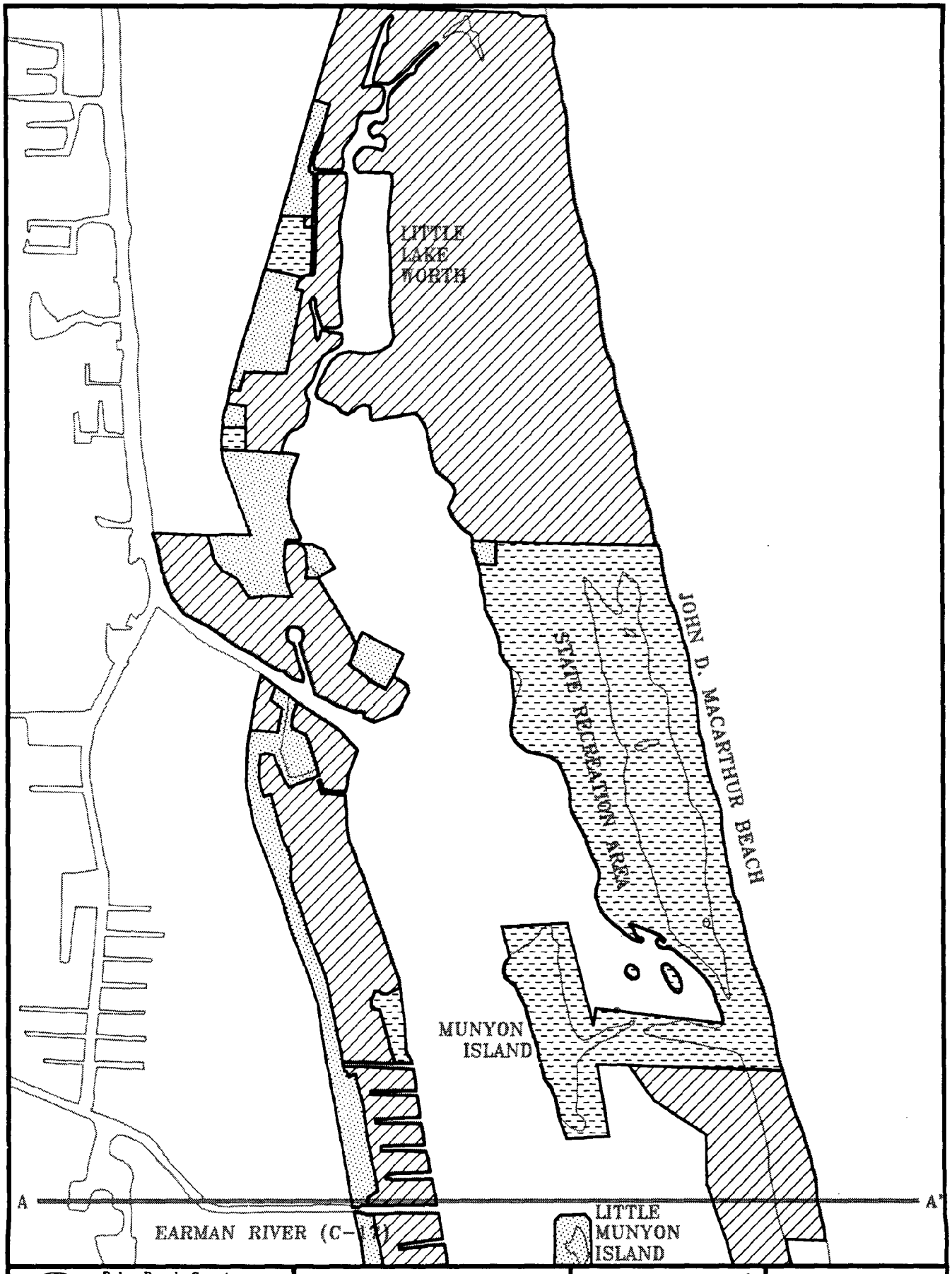

COMMERCIAL DISTRICTS (GENERAL, MARINE, OFFICE, NEIGHBORHOOD, BUSINESS), HOTELS, OFFICE PROFESSIONAL DISTRICT, LAKE FRONT DISTRICT, WEST PALM BEACH LAKE FRONT DISTRICT, WEST PALM BEACH LAKE FRONT CORE DISTRICT, WEST PALM BEACH DOWNTOWN PLANNED UNIT DEVELOPMENT


GENERAL INDUSTRIAL DISTRICT, UTILITIES DISTRICT


COMMUNITY SERVICE DISTRICT INCLUDING U.S. COAST GUARD STATION


WATER AREA/OPEN SPACE

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* LAND USE		D&M JOB NO. *20335-001-049* FIGURE *3-A*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

LAND USE

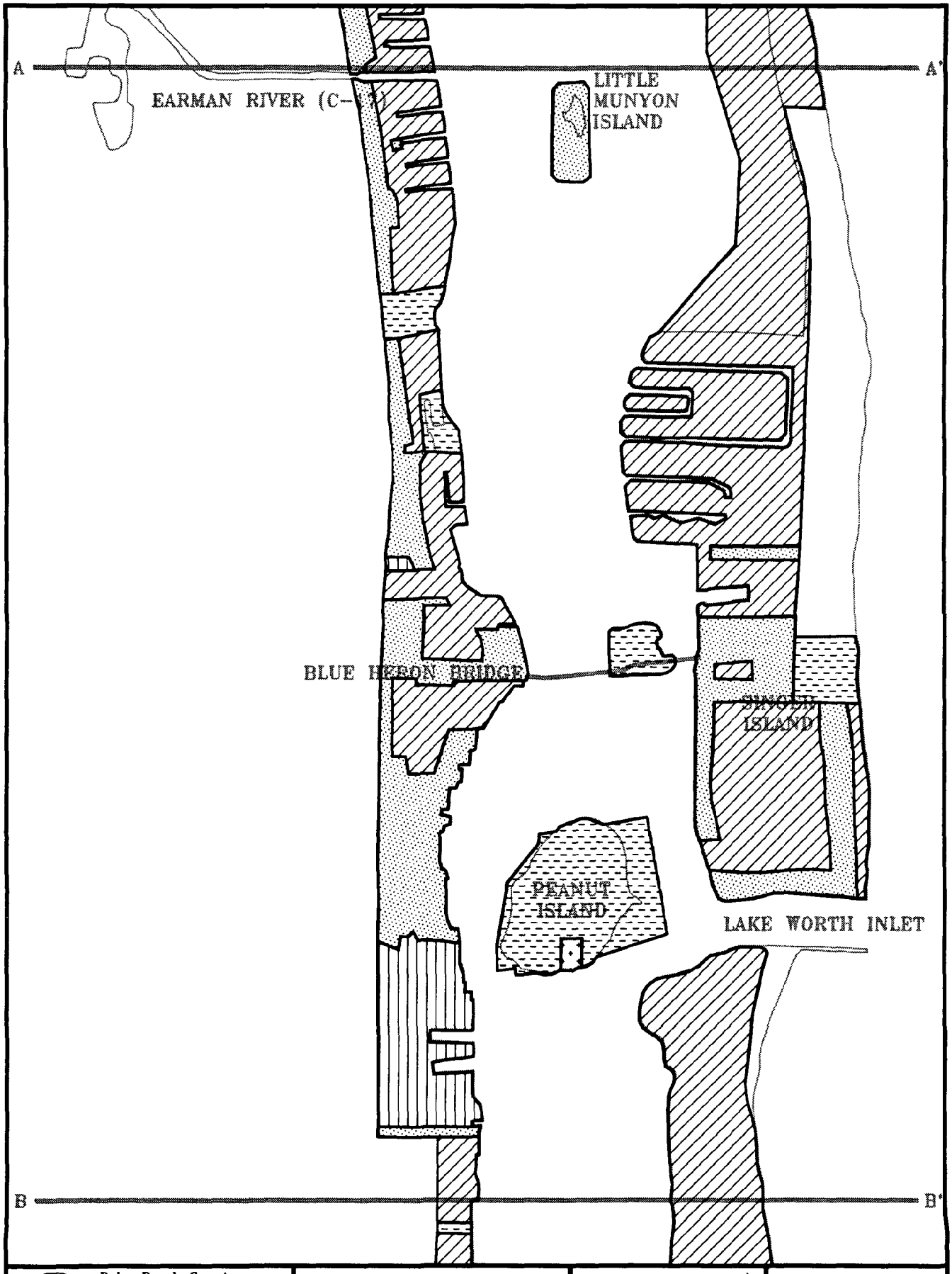
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *3-B*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

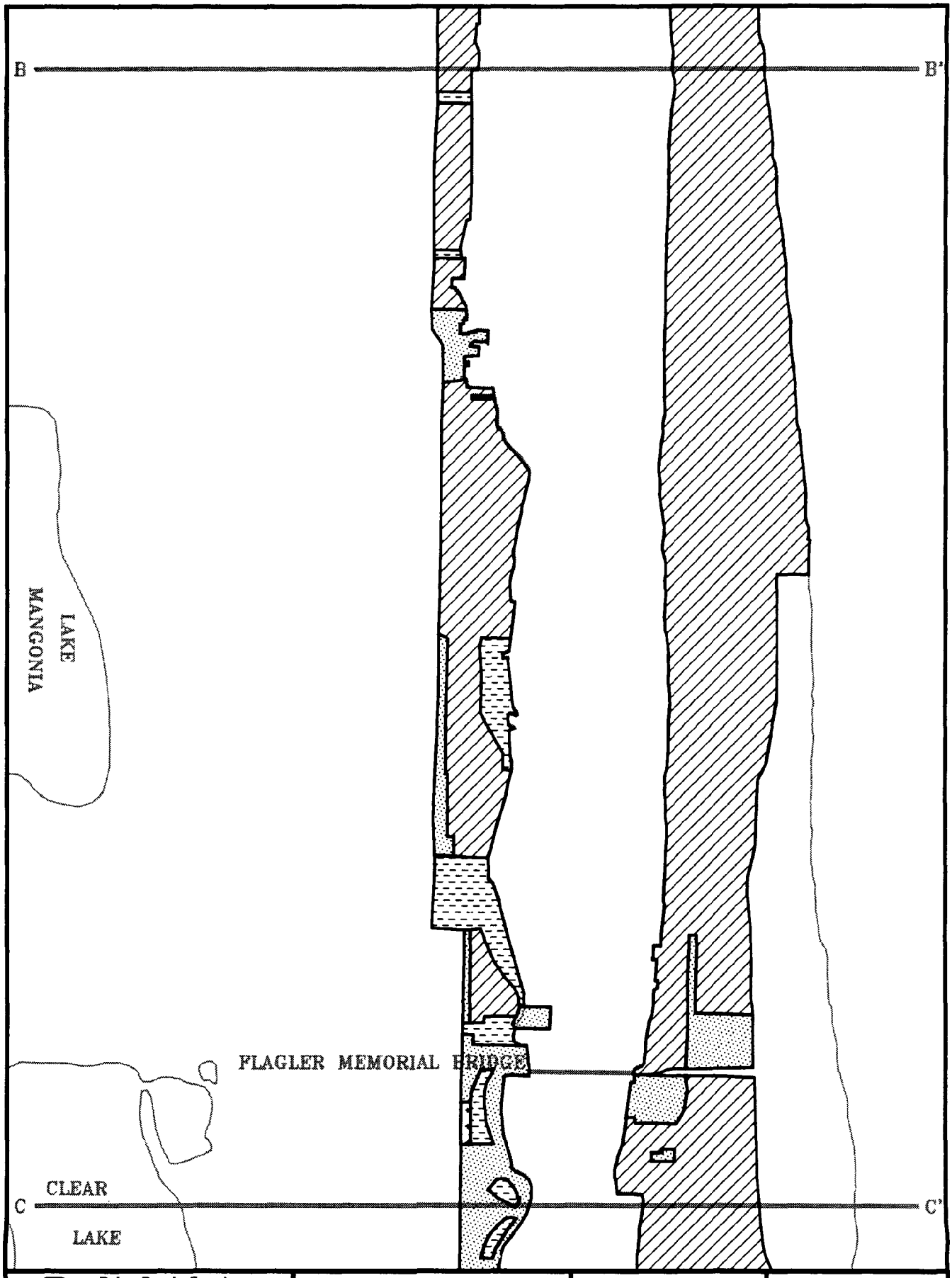
LAND USE

0 1000 2000

SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
3-C



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

LAND USE

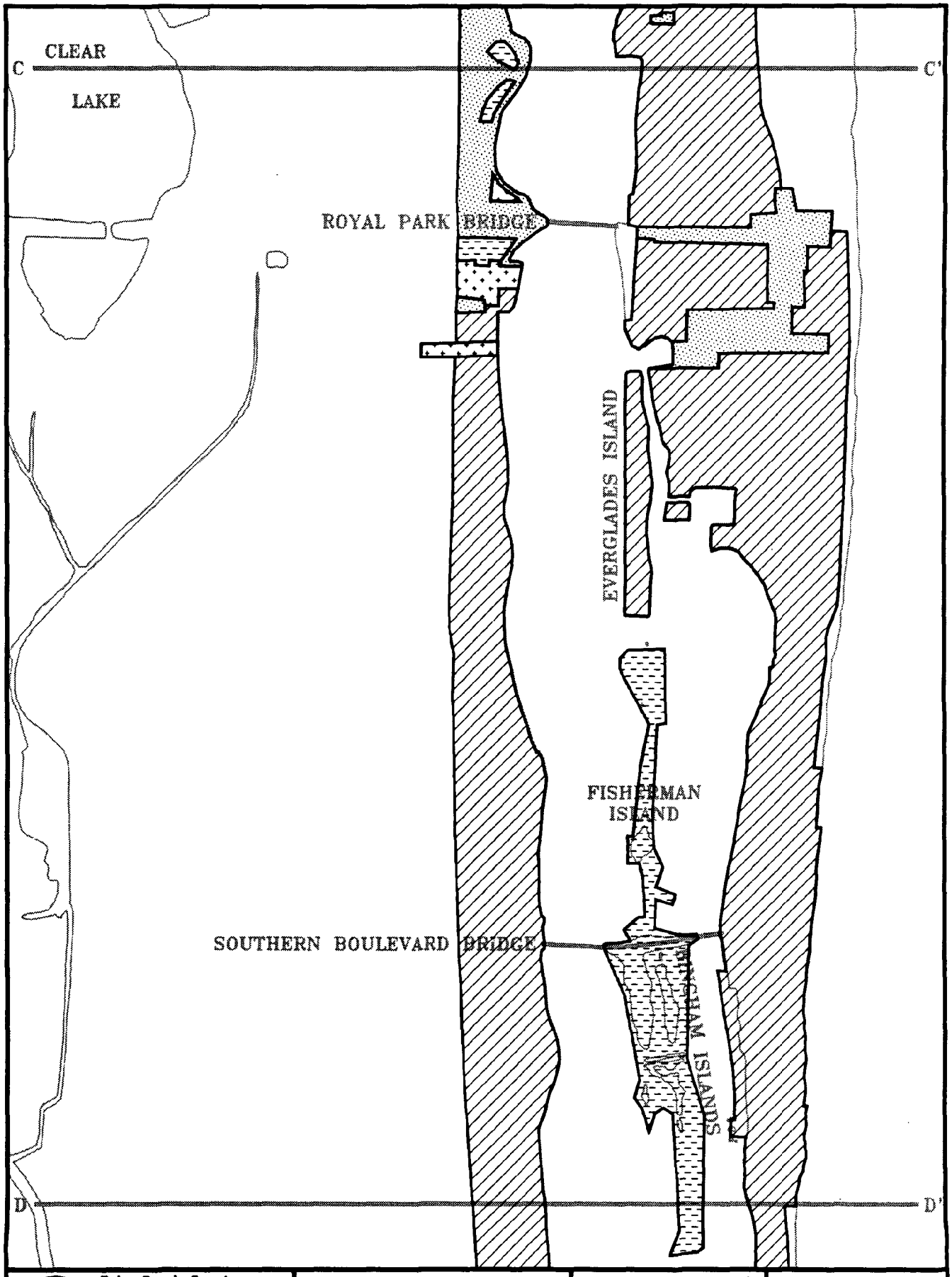
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *3-D*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

LAND USE

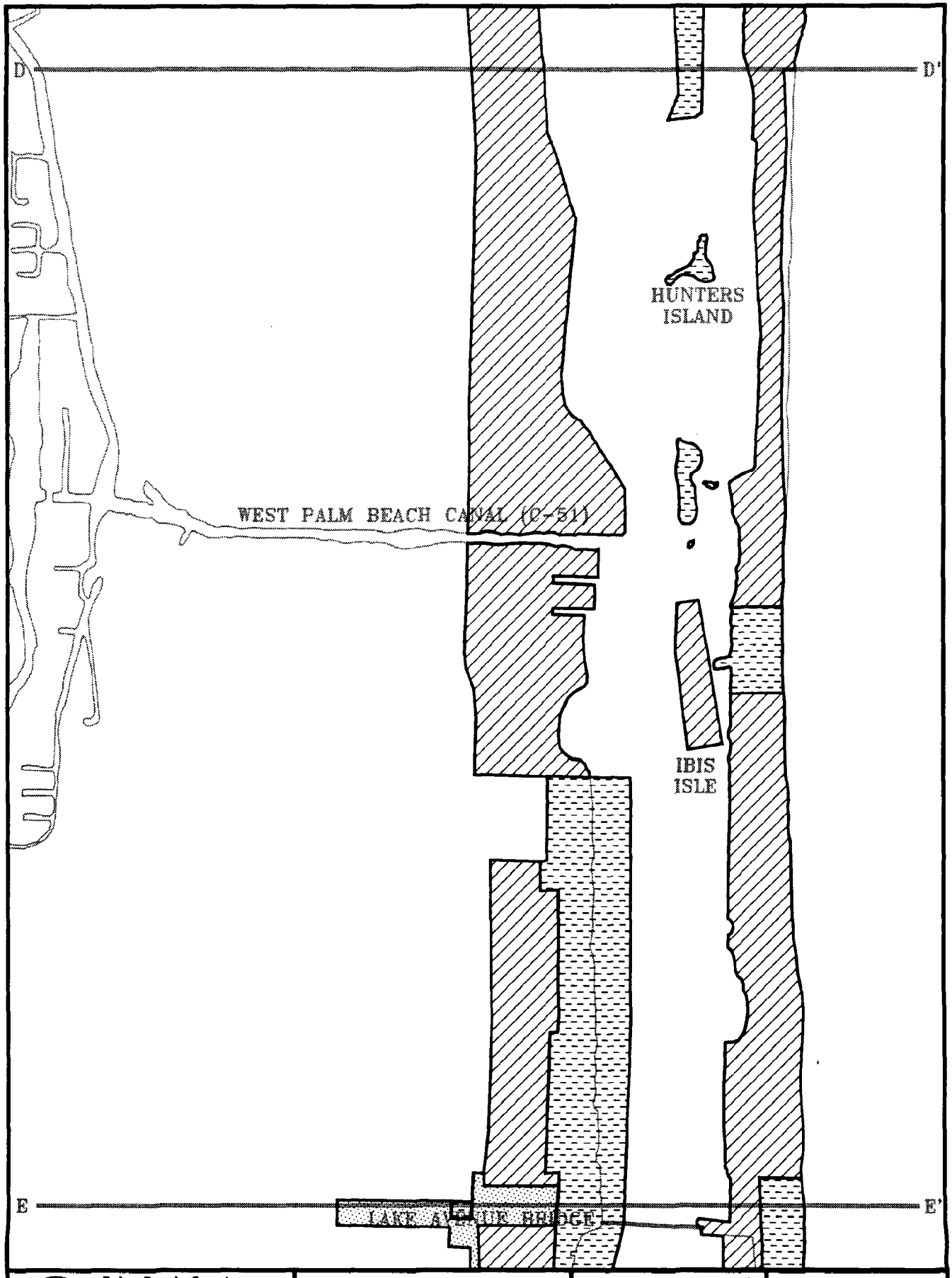
0 1000 2000

SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
3-E



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

LAND USE

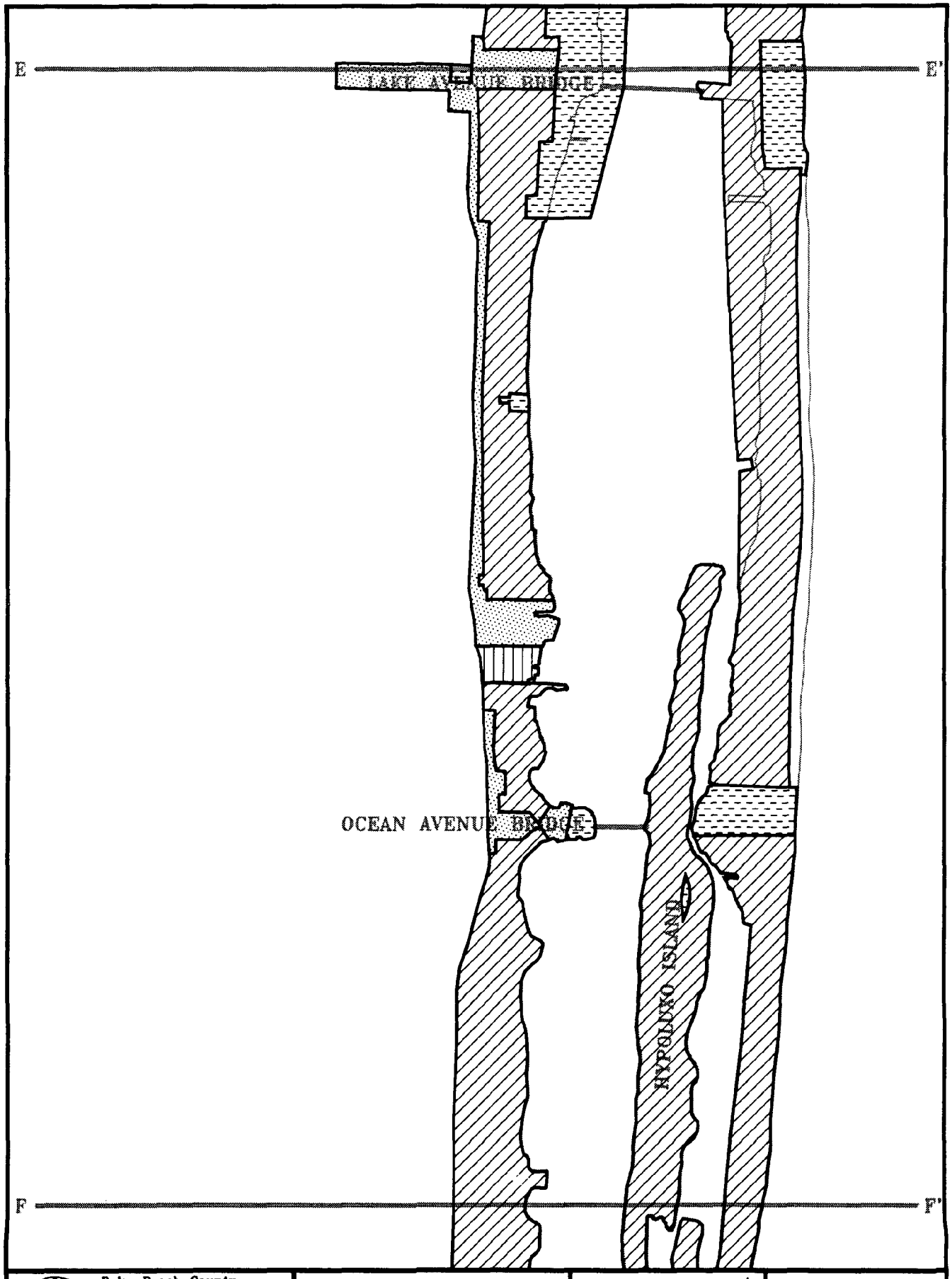
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *3-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

LAND USE

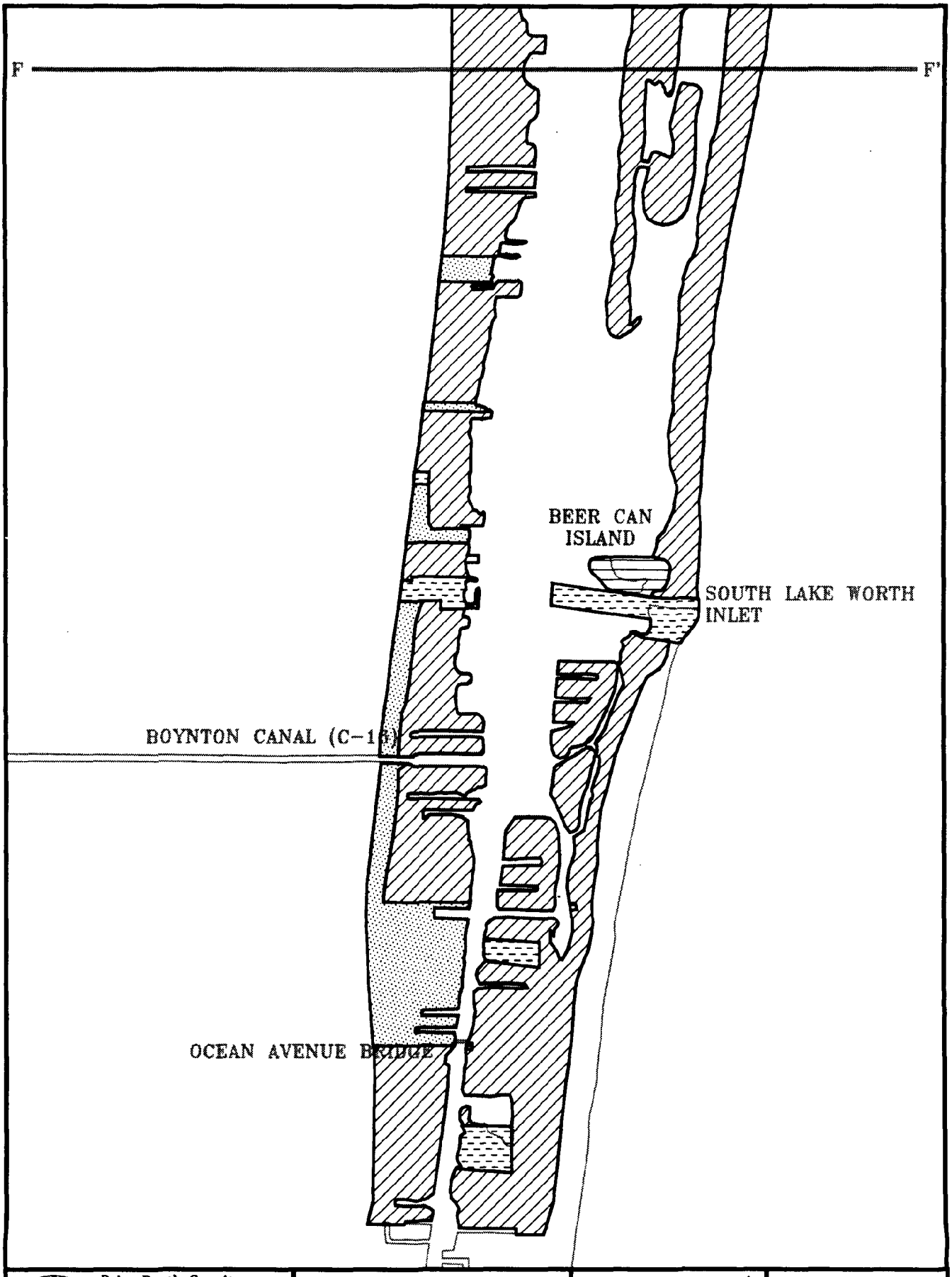
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *3-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

LAND USE

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *3-H*

5.4 BATHYMETRY

In the late 1800's, Lake Worth was a shallow water body with the majority of its area ranging in depth from <1 to 2 meters. Historical depths have been significantly altered by dredging and filling activities which have occurred over the past one hundred years. Lake Worth Lagoon currently ranges in depth from less than one foot to thirty five feet. Presently, the Atlantic Intracoastal Waterway is maintained at a design depth of -11 feet referenced to the National Geodetic Vertical Datum (NGVD) of 1929. The Lake Worth Inlet and Port of Palm Beach are maintained at -35 feet NGVD. South Lake Worth Inlet has a design depth of -6 feet NGVD. In addition, a number of basins, marinas, access channels and canals are maintained at various depths for navigation purposes. Dredged material from navigation projects has been deposited in areas of the lagoon resulting in spoil islands and shoals. Some areas were dredged as a source for fill material, resulting in isolated holes. (e.g.: Little Lake Worth has been dredged to a depth of 7 meters). For the most part, the areas of the lagoon which have not been dredged or converted to upland by fill activates remain at <1-2 meters in depth.

Bathymetric information for Lake Worth Lagoon is available from several sources. The USGS quadrangle maps include bathymetric contours at one meter intervals with supplemental 0.5 meter contours. The datum for the contours is mean low water. Navigation maps published by the National Oceanic and Atmospheric Administration (NOAA) indicated spot depths at mean low water.

The bathymetry map (**Figure 4**) has been created by digitizing the one-half meter contour lines found on the USGS quadrangle maps. Spot depths throughout the lagoon were established by field measurements taken by ERM. Major holes and shoal areas were also located in the field, and are depicted on the map.

LEGEND

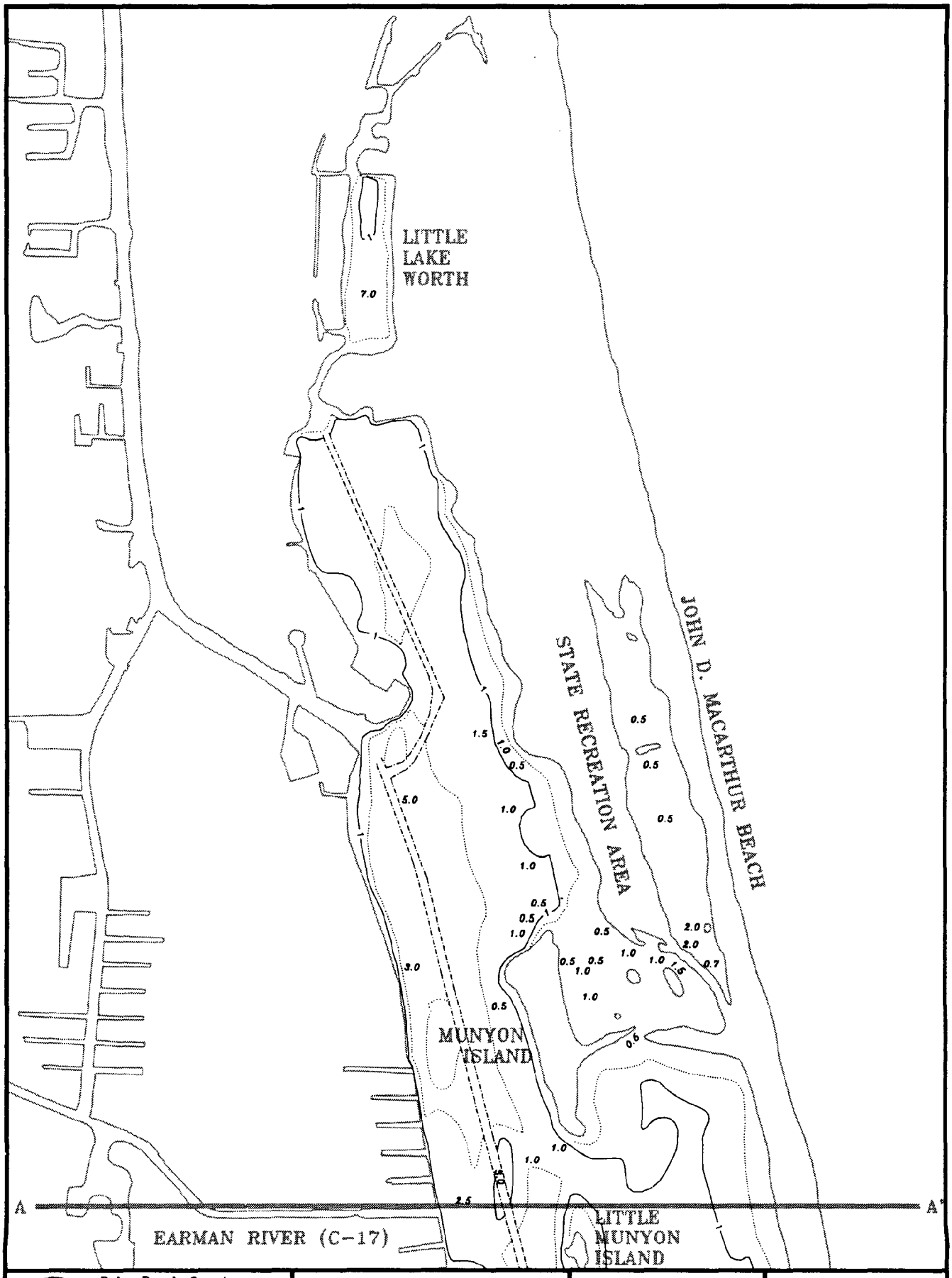
2.5 SPOT DEPTH IN METERS DETERMINED BY FIELD SURVEY (MLW)

NOTES

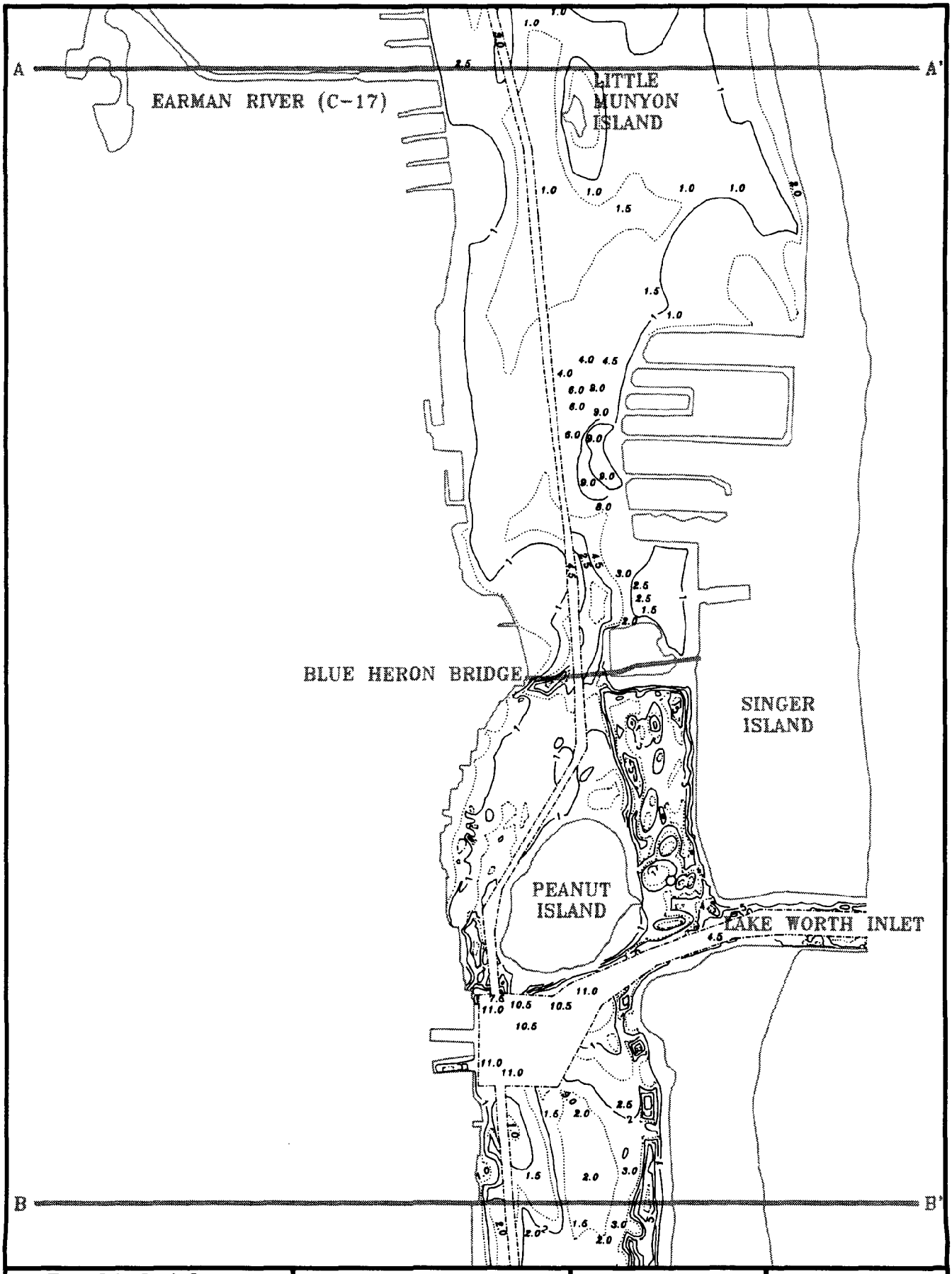
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS – DATUM IS MEAN LOW WATER

SOURCE: U. S. COAST AND GEODETIC SURVEY AND NATIONAL OCEAN SERVICE, 1986.

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* BATHYMETRY		D&M JOB NO. *20335-001-049* FIGURE *4-A*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* BATHYMETRY	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *4-B*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

BATHYMETRY

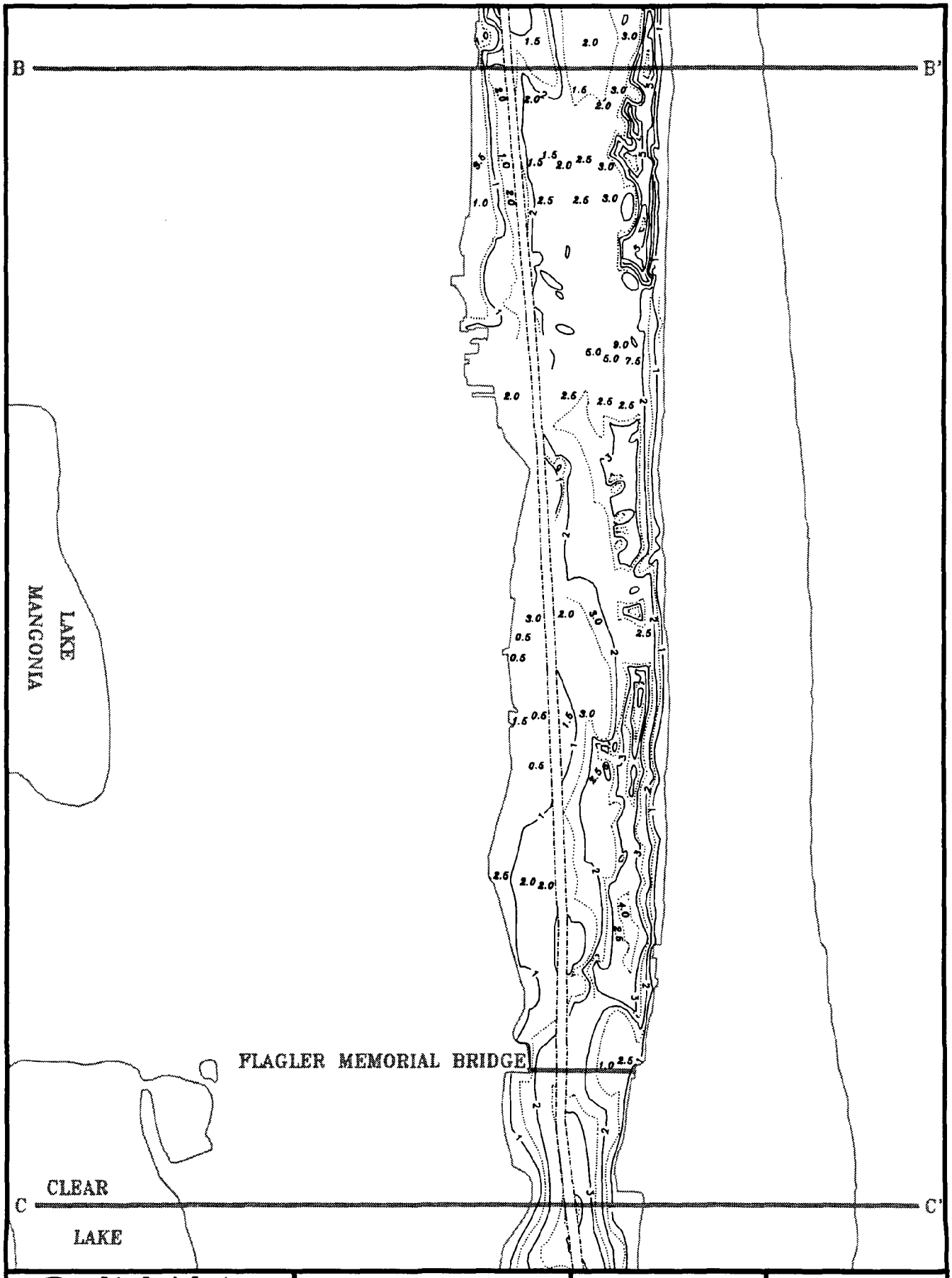
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *4-C*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

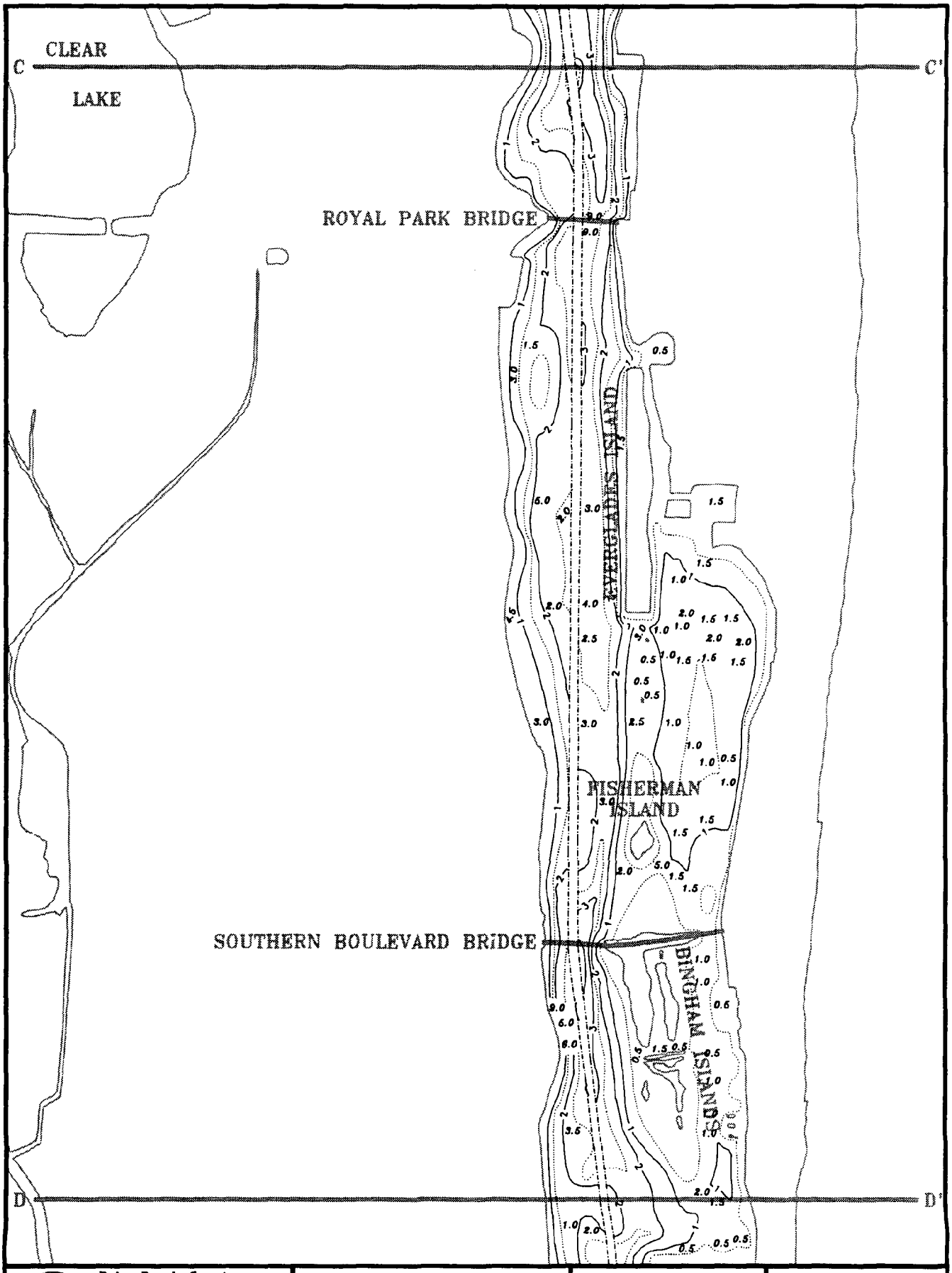
LAKE WORTH LAGOON

BATHYMETRY

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
4-D



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

BATHYMETRY

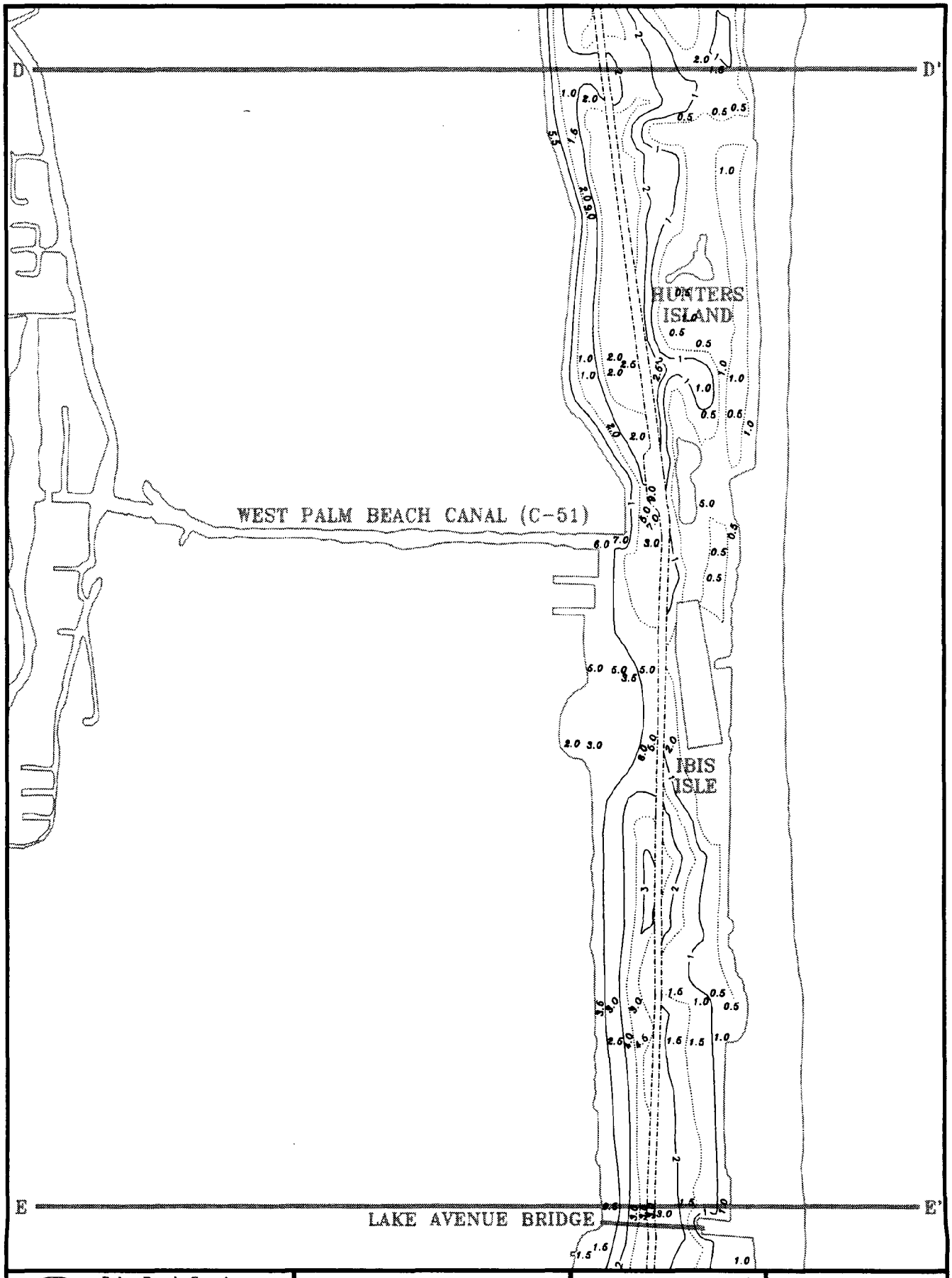
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *4-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

BATHYMETRY

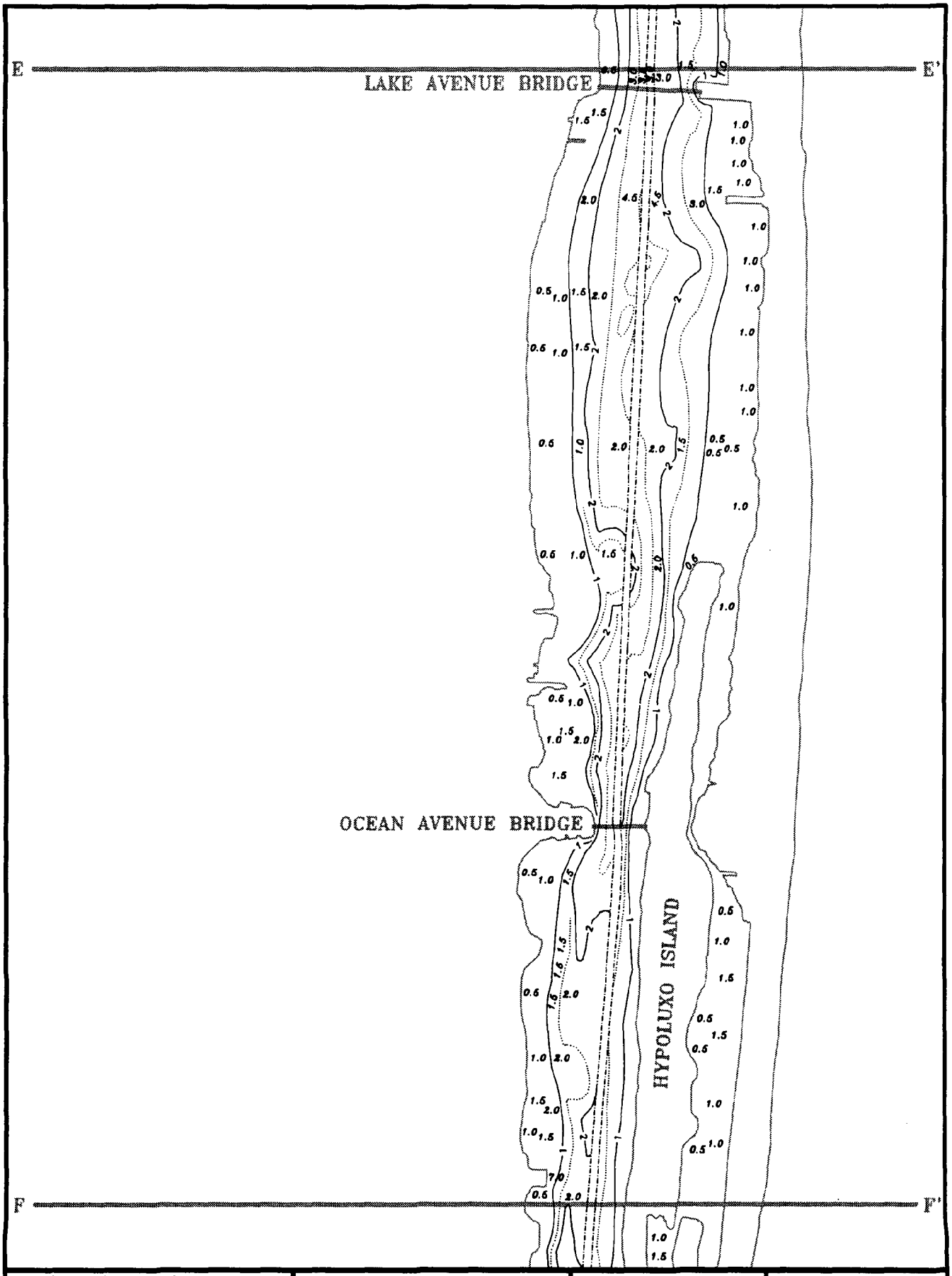
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *4-F*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

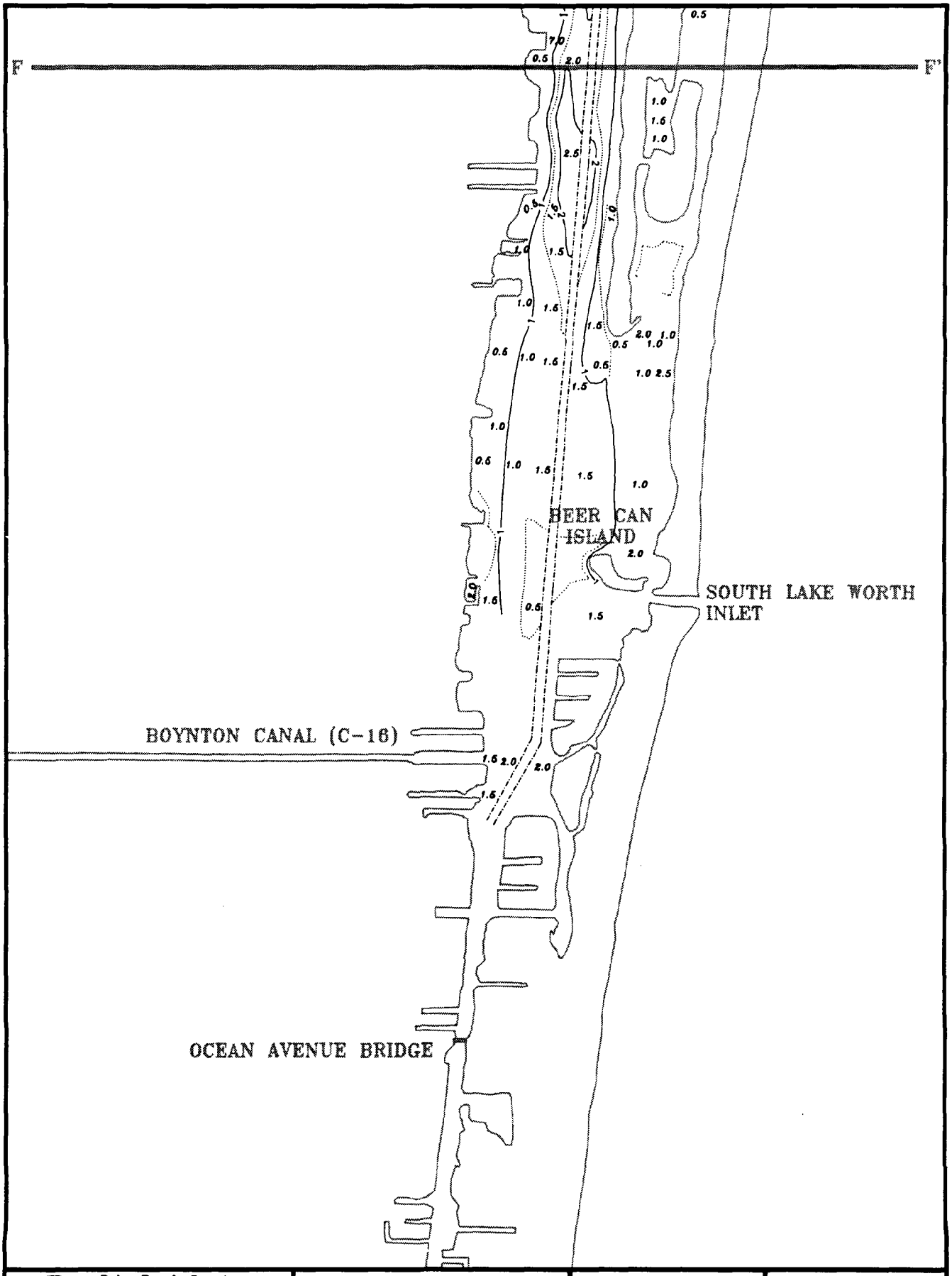
BATHYMETRY

0 1000 2000
SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
4-C



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

BATHYMETRY

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *4-H*

5.5 HYDROLOGIC AND HYDRAULIC CHARACTERISTICS

The hydrologic and hydraulic characteristics of Lake Worth Lagoon have been greatly altered from historic conditions by changes in tidal influence and freshwater inflows.

Tidal influence occurs at Lake Worth Inlet, South Lake Worth Inlet, and the Intracoastal Waterway entrances located at the north and south ends of Lake Worth Lagoon. Mean tide ranges are 2.6 feet at Palm Beach, 2.5 feet at Boynton Beach, and 2.8 feet at North Palm Beach, (van de Kreeke and Wang, 1976).

Freshwater inflows to Lake Worth Lagoon according to SFWMD, 1977 are:

West Palm Beach Canal (C-51)	49.7%
Earman River (C-17)	12.1%
Boynton Canal (C-16)	10.7%
West Palm Beach STP	1.3%*
Boynton Beach STP	.3%*
Surface Runoff	4.1%
Groundwater	22.3%

*The West Palm Beach and Boynton Beach wastewater treatment plant outfalls have subsequently been eliminated.

The C-51 canal is the largest inflow discharging an average of 356 million gallons per day. Seventy five percent of the discharge flows north and reaches the Lake Worth Inlet within five days. Twenty five percent flows south and reaches South Lake Worth Inlet within nine days (SFWMD, 1977). The maximum residence time of the water body between the two inlets is approximately 14 days (Chiu et.al, 1970). Miscellaneous hydrological and hydraulic facts for Lake Worth Lagoon are presented in **Table 2.**

TABLE 2

HYDROLOGICAL FACTS	
1.	Surface area of Lake Worth, including the bays is 2.64 X 10^8 $feet^2$.
2.	Surface area of Lake Worth between the two inlets is 1.96 X 10^8 $feet^2$.
3.	Volume of water below mean sea level, including the bays is 2.1 x 10^9 $feet^3$.
4.	Volume of water below mean sea level between the inlets is 1.73 x 10^9 $feet^3$.
5.	Average rainfall is 5.4 feet/year, a characteristic daily rainfall during the wet season is 1 inch/day.
6.	Typical evaporation rates are 0.05 inches/day during the winter, 0.22 inches/day during the summer (computed by Lee, 1975 for Card Sound, a lagoon on the Atlantic coast of Florida approximately 100 miles south of Lake Worth).
7.	An estimate of 281 cfs for the groundwater inflow was calculated for September 1974 and 1975 by J. van de Kreeke et al. 1976.
8.	The residence time of completely mixed pollutants - The time interval required to replace 50% of the resident water (half-life) is about two tidal cycles (or one day) and the pollutants are reduced to 10% of the original concentration in 6 to 8 tidal cycles (or 3 to 4 days).
9.	The residence time of stagnant pollutants - A particle was found to have a net drift of about 3000 feet per tidal cycle southward. A net inflow of about 2 X 10^4 feet per tidal cycle per foot width was found to be associated with this net drift. In this case, the maximum residence time of the water body between the two inlets would be about 14 days. (Chiu et al. 1970)
10.	Salinity variations in Lake Worth correspond closely to the seasonal variations in the fresh water inflow. The importance of groundwater inflow is illustrated by the salinity of 34 ppt during April, 1975 at Southern Boulevard Bridge compared to the ocean salinities of 36 ppt and higher when other freshwater sources were negligible. Salinity profiles along the length of Lake Worth (on 9/18/74) show a minimum of halfway between the two inlets. North of the West Palm Beach Canal, the salinity distribution oscillates over a distance approximately equal to the tidal excursion. Vertical salinity stratification is most pronounced south of the West Palm Beach Canal. (J. van de Kreek et al. 1976
11.	Friction factor (F) values in Lake Worth varied from 0.002 in the wider and deeper parts to 0.017 in the constrictions. The values of the friction factors are higher than the often recommend literature value F = 0.0025. A simplified one-dimensional analytical model yielded an overall friction factor of F = 0.017. The reason for these high values is the irregular bathymetry, in particular the constrictions, leading to a three-dimensional flow pattern (J. van de Kreeke et al. 1976).

Figure 5 presents a summary of Lake Worth Lagoon's hydrologic characteristics. Data presented on the map include: tidal amplitudes (feet) and tidal phases (hours) relative to the Lake Worth pier in the Atlantic Ocean; average tidal velocity for flood and ebb tides (feet/second); tidal flow or discharge flow ($feet^3$/second); volume of water ($feet^3$); salinity measurements of tidally averaged salinity and measured high and low tide salinities (parts per thousand); salinity measurements averaged for dry and wet seasons (parts per thousand); and friction factors as determined from a hydrological model of Lake Worth (Van de Kreeke et.al, 1976).

The sources used to compile this information are: Area Planning Board of Palm Beach County, 1979; Bishop, W. M. Consulting Engineers and Area Planning Board of Palm Beach County, 1974; Bruun, P., J. Battjes, T. Chiu, and J. Purpura, 1966; Chiu, T., J. van de Kreeke, and R. Dean, 1970; Florida Department of Environmental Regulation Southeast Florida District Branch Office, Port St. Lucie, Fla. Lake Worth Basin Water Quality Assessment for fiscal years 1985 and 1990. - water quality data; South Florida Water Management District, West Palm Beach, Florida -water flow data from 1985 - 1990 for the Earman River (C-17), West Palm Beach Canal (C-51), and the Boynton Canal (C-16); Schneider, J., 1973; University of Florida, 1971; van de Kreeke, J., J. Wang, R. Rehrer,and M. Roessler, 1976; van de Kreeke, J., and J. Wang, 1978.

A comprehensive circulation study of the entire Lake Worth Lagoon has not been done. Accordingly, flow directions, the extent of tidal flushing influences, and the quantities of water exchanged through the inlets have not been documented.

LEGEND

TIDAL AMPLITUDES AND PHASES

XX/ RELATIVE TIDAL AMPLITUDES = AMPLITUDE IN LAGOON/AMPLITUDE IN OCEAN (L.W. PIER)

/XX PHASE LAG = (HOURS) WITH RESPECT TO OCEAN TIDE AT L.W. PIER

AVERAGE TIDAL VELOCITY = FLOOD TIDE/EBB TIDE (FT./SEC.)

DIRECTION

TIDAL FLOW OR DISCHARGE FLOW IN CUBIC FEET PER SECOND (CFS)

A BASED ON DISCHARGE (WPB CANAL 948 CFS, BOYNTON CANAL 0 CFS, OCEAN TIDE RANGE 3.6 FT.)

B BASED ON DISCHARGE (WPB CANAL 1170 CFS, BOYNTON CANAL 24 CFS, OCEAN TIDE RANGE 3.4 FT.)

C BASED ON DISCHARGE (WPB CANAL 228 CFS, BOYNTON CANAL 200 CFS, OCEAN TIDE RANGE 2.1 FT.)

D NO FRESH WATER INFLOW

E F FRESH WATER INFLOW 1500 CFS FROM THE WPB CANAL (C-51)

G H I MEAN DISCHARGE BASED ON 1971-1976 FLOW, FROM AREA PLANNING BOARD OF PALM BEACH COUNTY, 1979 - PALM BEACH COUNTY 208 AREAWIDE WASTE TREATMENT MANAGEMENT PLAN

WATER VOLUME IN CUBIC FEET (CUF)

A D F NO FRESH WATER INFLOW

B C E G FRESH WATER INFLOW 1500 CFS FROM THE WPB CANAL (C-51)

H I FROM AREA PLANNING BOARD OF PALM BEACH COUNTY, 1979 - PALM BEACH COUNTY 208 AREAWIDE WASTE TREATMENT MANAGEMENT PLAN

SALINITY IN PARTS PER THOUSAND (PPT)

A TIDALLY AVERAGED SALINITY/MEASURED HIGH TIDE SALINITY/MEASURED LOW TIDE SALINITY, MEASURED ON 9/18/74, FROM J. VAN DE KREEKE AND OTHERS, 1976, FIG. E2, PAGE 36

B AVERAGE DRY SEASON/AVERAGE WET SEASON FROM THE FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION - PORT ST. LUCIE OFFICE, LAKE WORTH BASIN ASSESSMENT SURVEYS 1985 AND 1990. AVERAGE SALINITIES WERE CALCULATED FROM MIDDEPTH SAMPLES COLLECTED DURING AN OUTGOING TIDE ON 11/5/84, 2/4/85, 5/1&2/85, 8/12/85, 12/13/89, 3/22/90 AND 6/4/90.

* THE FLOW DIRECTION VALUES ARE BASED ON 852 FEET^3 /SECOND FLOW FROM THE WPB CANAL (C-51).

** THE RESIDENCE TIME IS THE TIME TAKEN TO REMOVE THE ACCUMULATED VOLUME OF FRESH WATER FROM THE LAGOON.

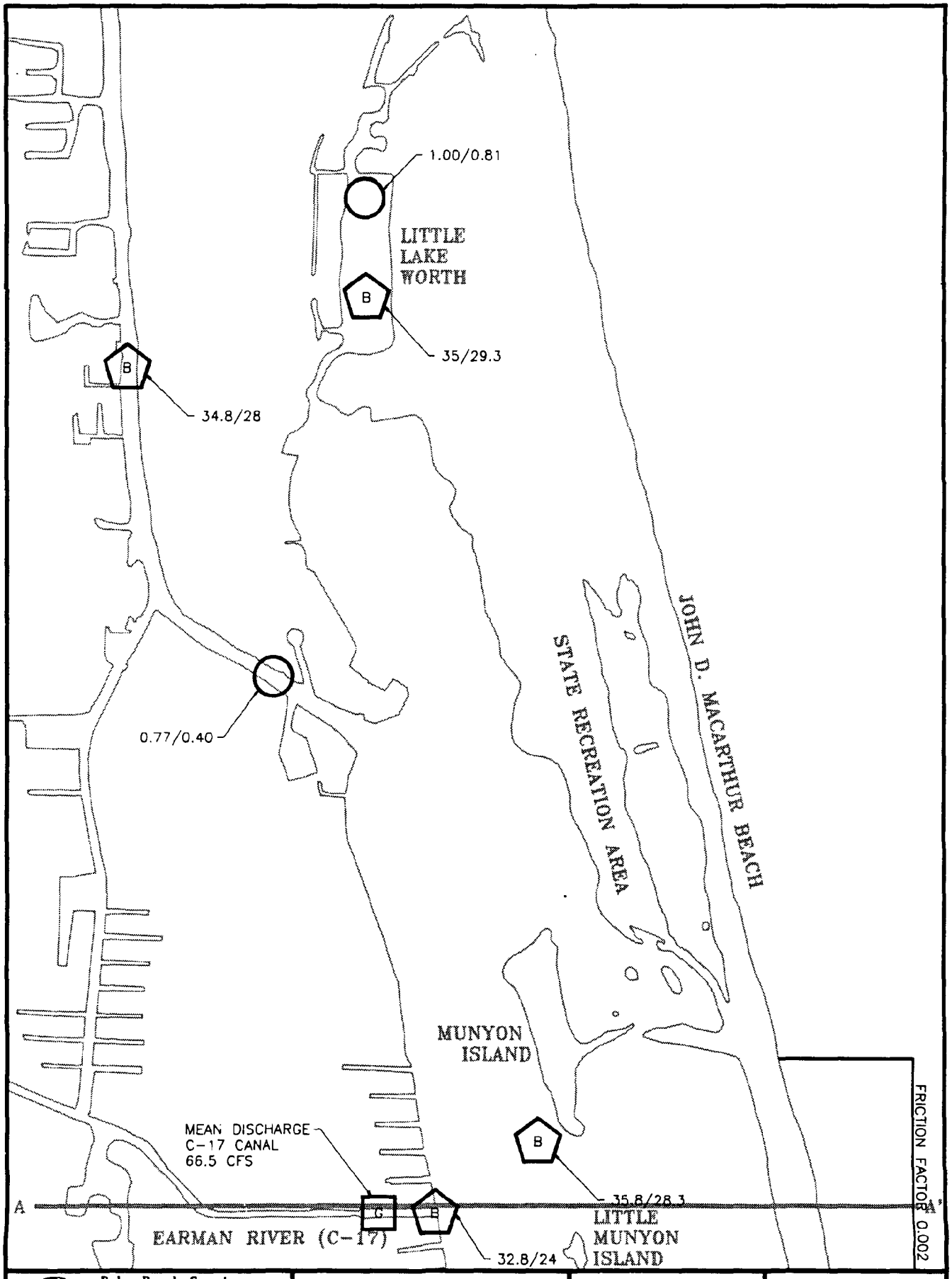
*** THIS IS THE AREA OF MINIMUM CURRENT ACTIVITY AND MINIMUM MIXING WHERE THE TIDES PROPAGATING THROUGH THE TWO INLETS MEET AT THE TIDAL DIVISION LINE.

**** TIDAL DATA SHOWS THAT THERE IS A CONSIDERABLE OVERLAPPING BETWEEN THE TWO INLETS AND THAT THE LAKE WORTH INLET INFLUENCES THE WATER LEVELS IN THE LAKE TO A GREAT EXTENT.

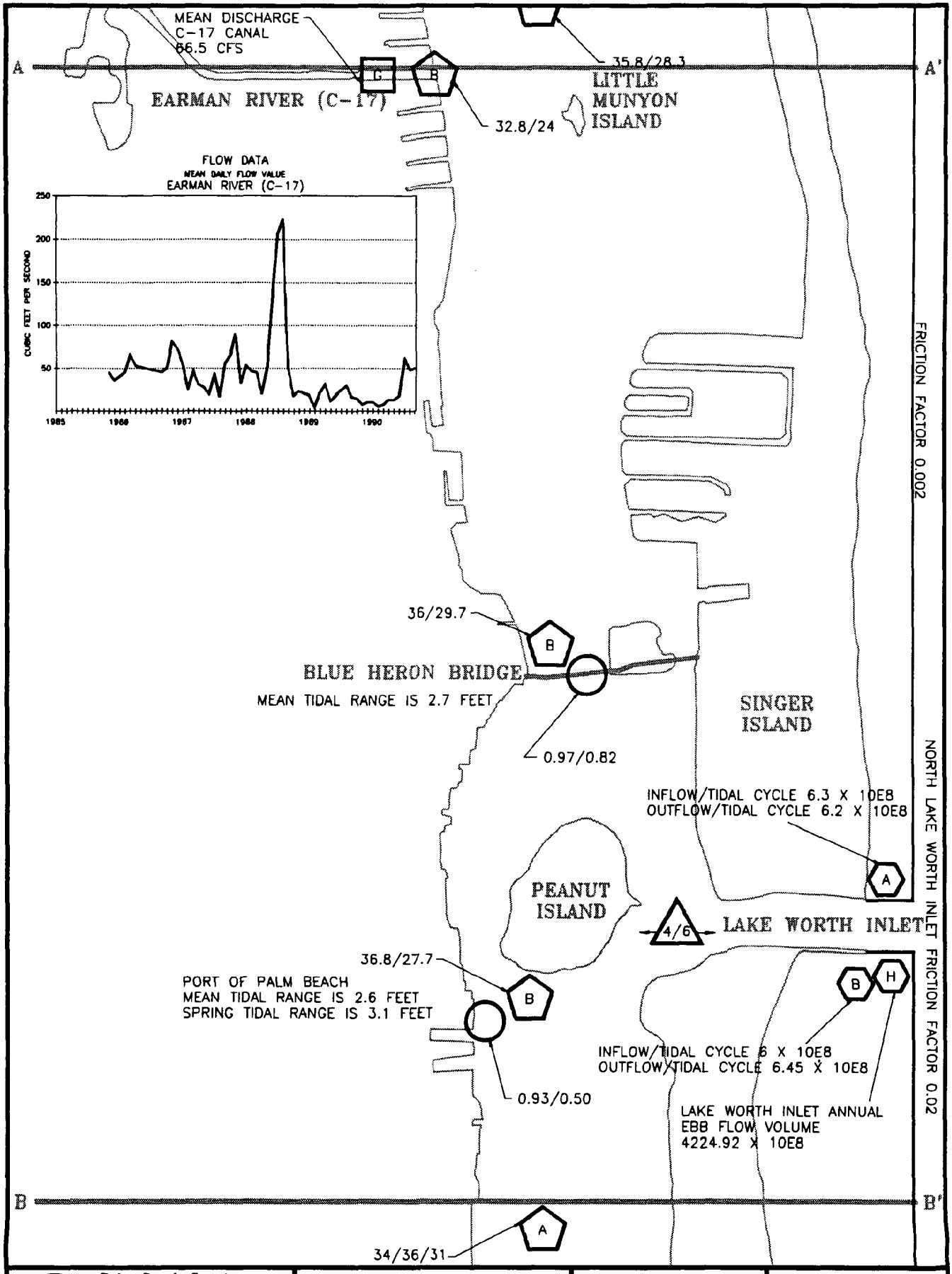
***** BASED ON WEEKLY SURFACE WATER SAMPLES AT HIGH AND LOW WATER FROM 1/75 - 12/75.

10EX = 10^X

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* HYDROLOGIC AND HYDRAULIC CHARACTERISTICS		D&M JOB NO. *20335-001-049* FIGURE *5-A*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* HYDROLOGIC AND HYDRAULIC CHARACTERISTICS	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *5-B*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

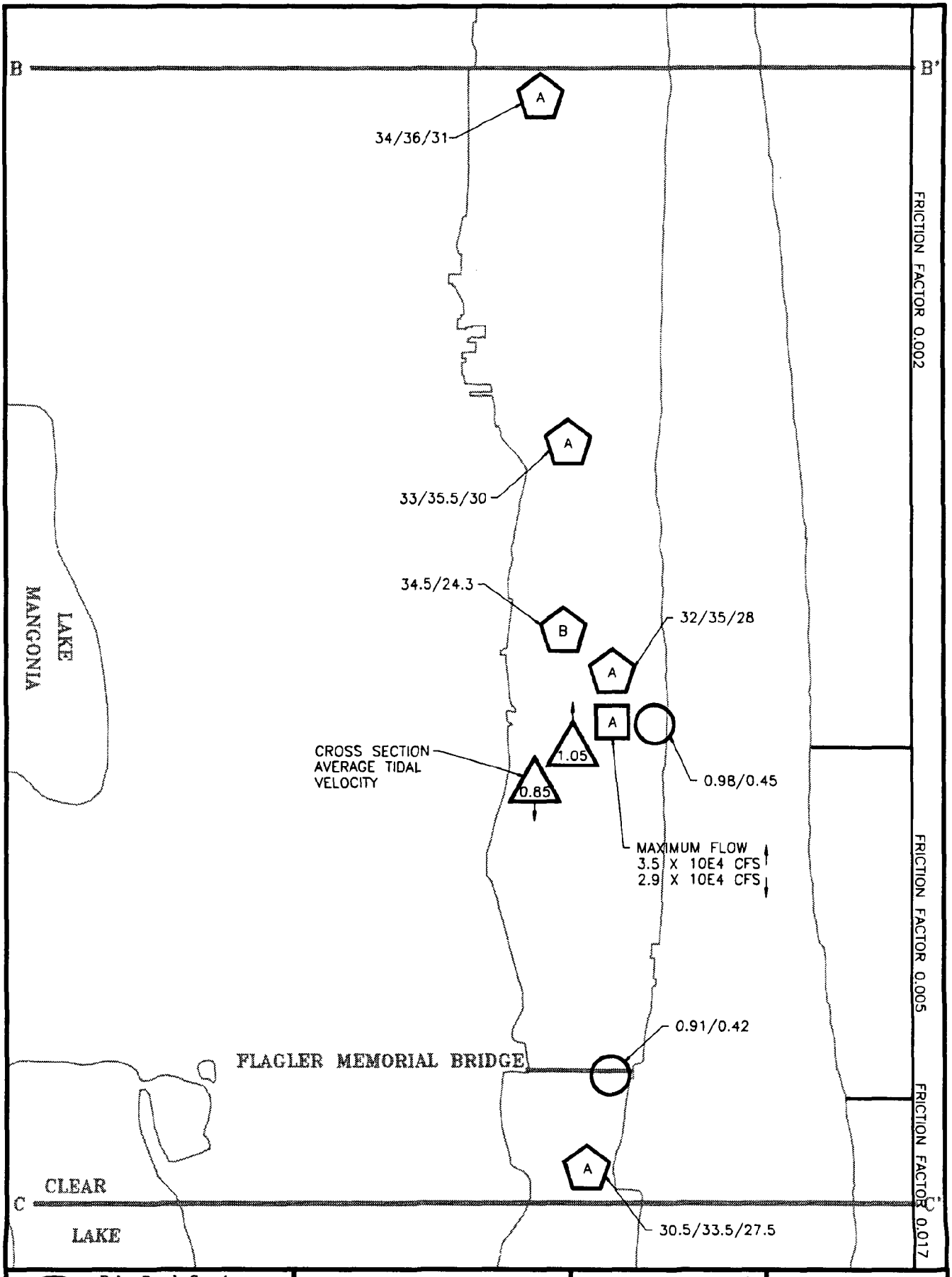
LAKE WORTH LAGOON

HYDROLOGIC AND HYDRAULIC
CHARACTERISTICS

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
5-C



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

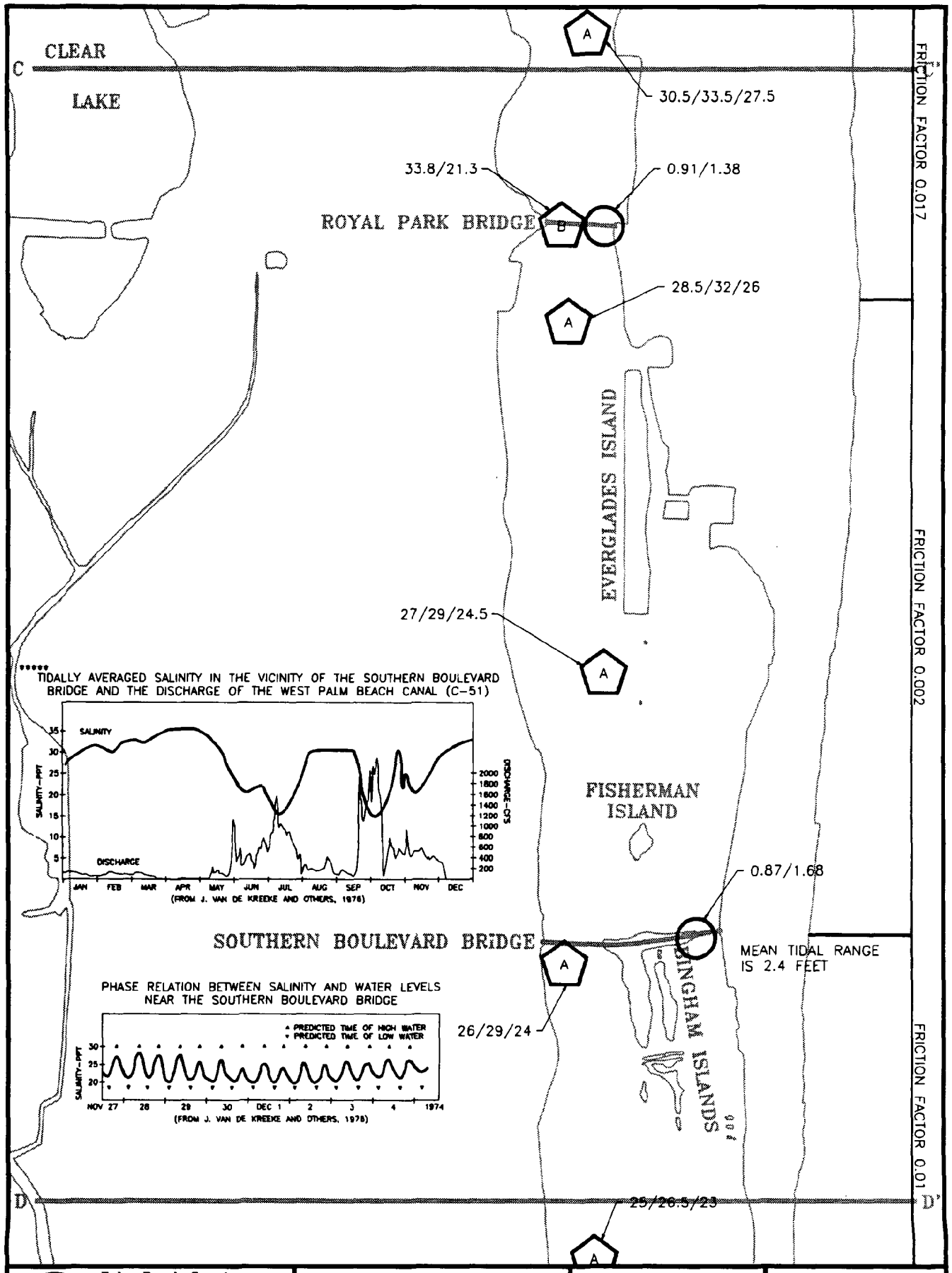
HYDROLOGIC AND HYDRAULIC CHARACTERISTICS

0 1000 2000

SCALE (FEET)

D&M JOB NO. *20335-001-049*

FIGURE *5-D*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

HYDROLOGIC AND HYDRAULIC CHARACTERISTICS

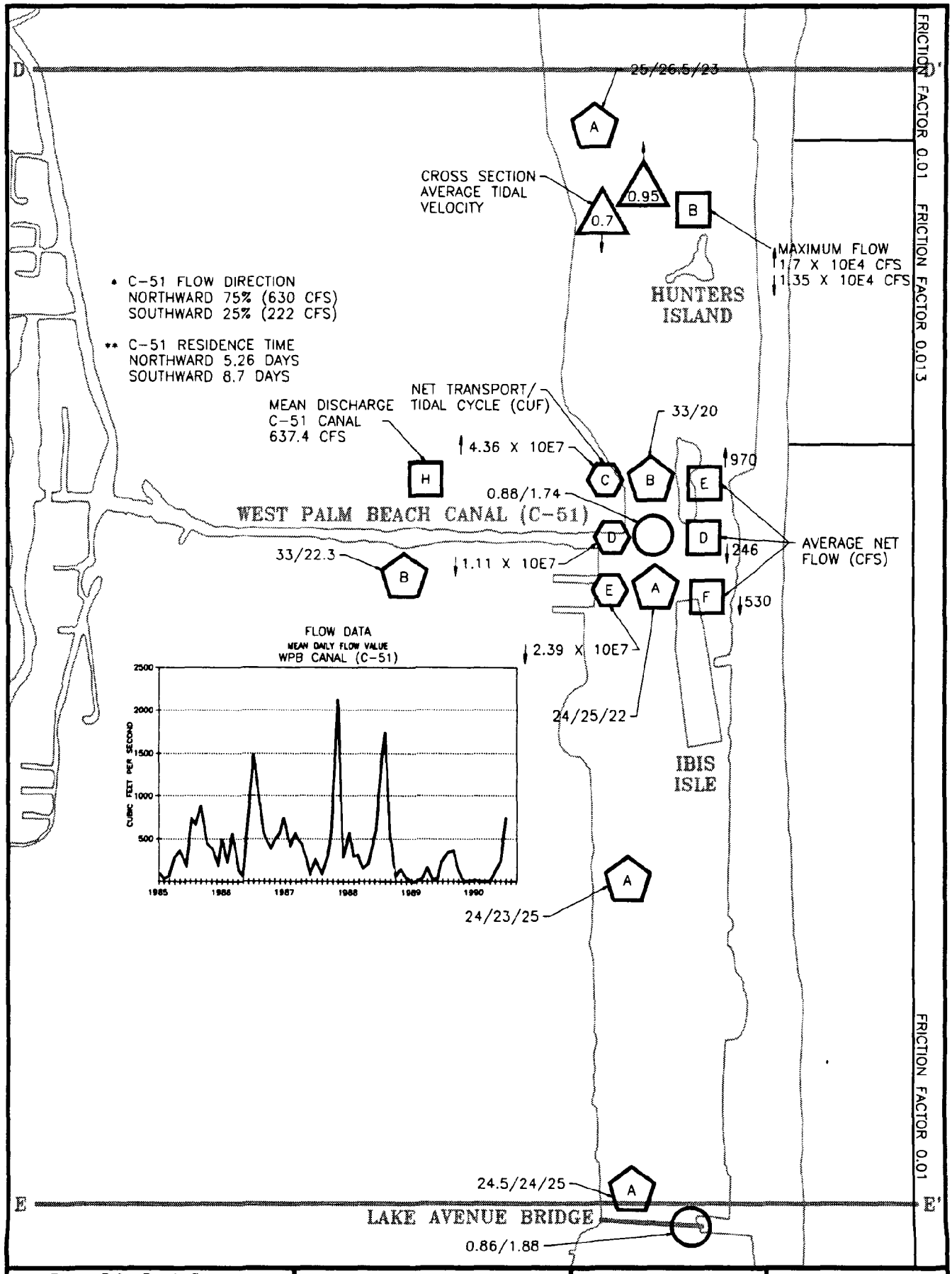
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *5-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

HYDROLOGIC AND HYDRAULIC CHARACTERISTICS

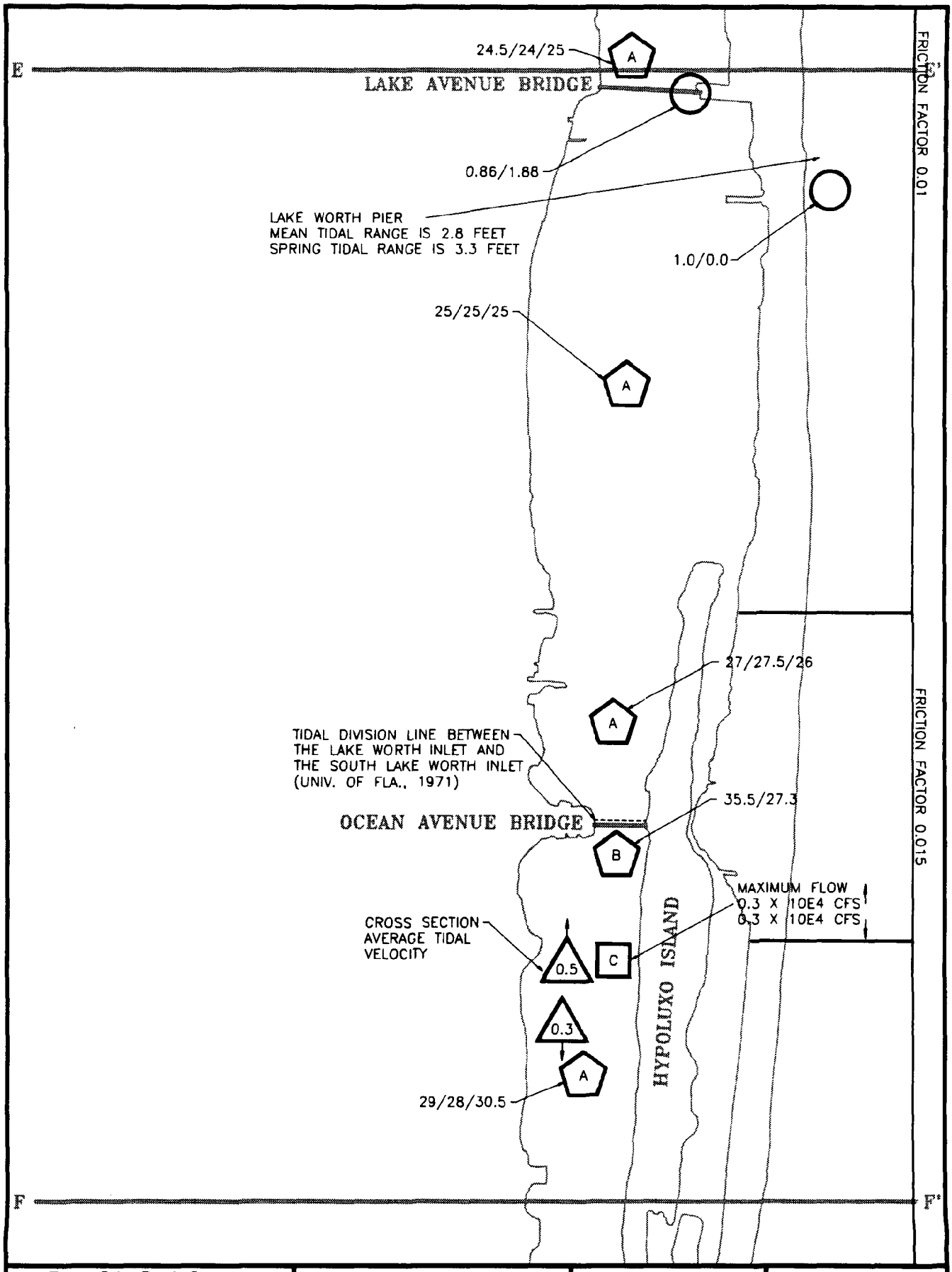
0 1000 2000

SCALE (FEET)

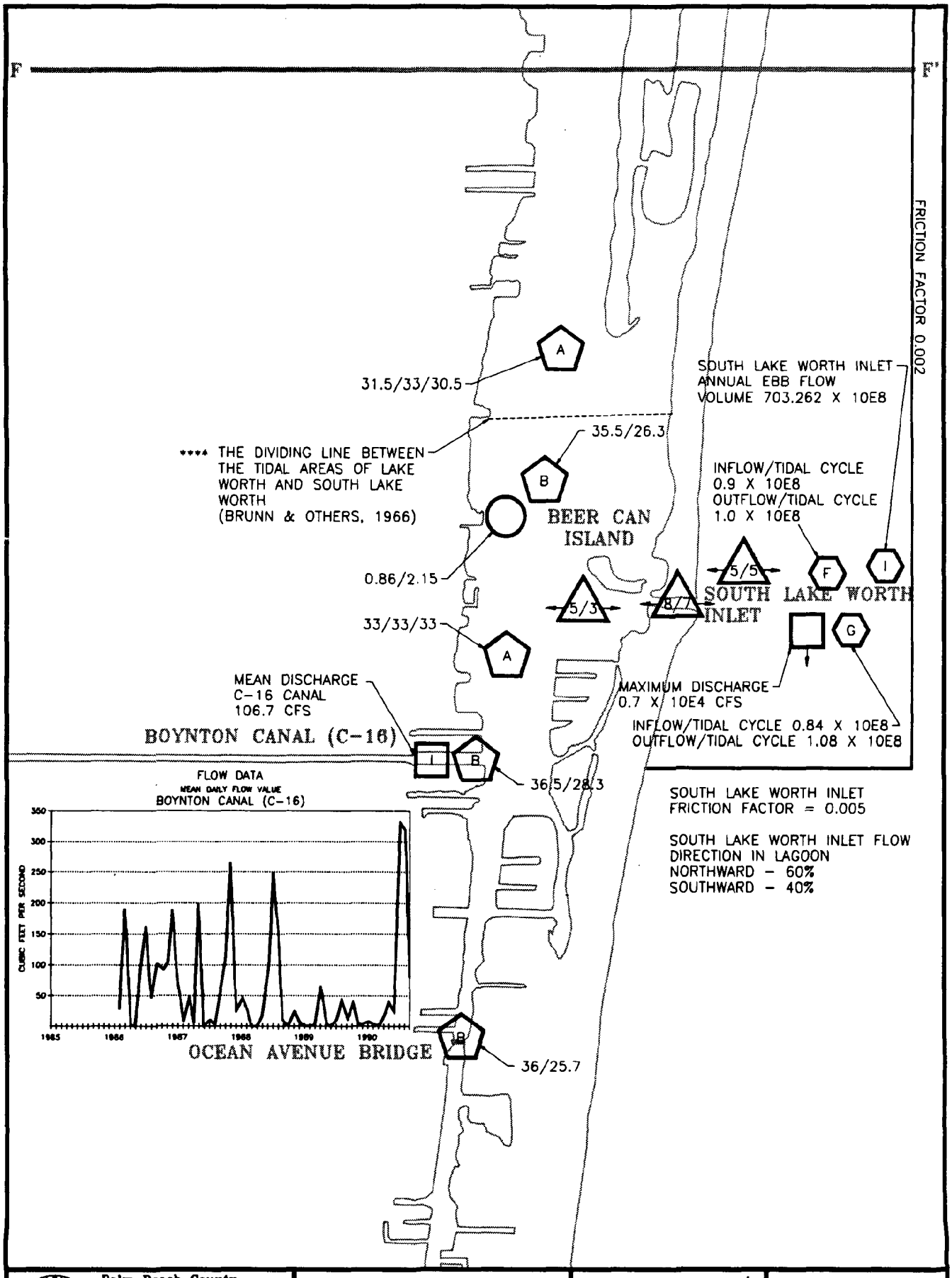
N

D&M JOB NO. *20335-001-049*

FIGURE *5-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* HYDROLOGIC AND HYDRAULIC CHARACTERISTICS	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *5-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

HYDROLOGIC AND HYDRAULIC CHARACTERISTICS

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *5-H*

5.6 SEDIMENT CHARACTERISTICS

The sediments of Lake Worth Lagoon have been the subject of several studies over the past fifteen years. Sediment samples have been highly variable in the percentages of various grain sizes. Fine to medium sands appear to be the predominant type of sediment in Lake Worth Lagoon.

Grain size characteristics, category definitions and grain size data for Lake Worth Lagoon sediments were compiled from the literature and put in tabular form (**Appendix 8.2**). The grain size data was divided into descriptive categories. The categories are: shell material or gravel, pebble or cobble size particles; shelly sand; sand; silty sand; sandy silt; and silt.

Figure 6 depicts the locations of sampling stations utilized in sediment studies and the grain size category of the sample collected at each station. Field observations were used to determine the location of peat deposits or rock outcrops depicted on the map. The studies used to compile data for the map are: Reed, J.K., 1975; Rogers, R. 1970; Rudolph, H., 1989; Schropp, S., and F. Calder, 1989; Tropical Ecosystems Inc., 1983.

Distinct geographical distribution of various sediment categories is not indicated by analysis of existing data. Shell or gravel sized particles were found only at two locations in the central part of the lagoon that have been heavily altered by dredge and fill activities. Silt sized particles were found only at the northern end of the study area in Little Lake Worth which has been dredged to 7 meters in depth resulting in a siltation basin. Shelly sand, sands, and sandy silt are distributed throughout the study area with greater occurrence of the larger sized particles near and north of the inlets, and greater occurrence of the smaller particles near the C-17 inflow and from the C-51 inflow south to the vicinity of Lake Avenue Bridge. These observations can be logically supported by several hydrological facts: greater tidal energy and flushing near the inlets prevents deposition of fine materials; canal inflows contain large amounts of suspended particles which settle out in the lagoon; tidal influence

is most reduced in Lake Worth Lagoon south of the C-51 inflow near Lantana Bridge allowing maximum settlement of suspended particles . Peat deposits occur south of Blue Heron Bridge and south of Hypoluxo Island. Limestone outcrops occur in the vicinity of Lake Worth Inlet, near the islands that are located west of the Town of Palm Beach, and North of Hypoluxo Island.

LEGEND

(XX) **SHELL MATERIAL, OR GRAVEL, PEBBLE OR COBBLE SIZE PARTICLES** > 2mm (−1 phi UNITS)

△XX△ **SHELLY SAND**
GREATER THAN 10% SHELL MATERIAL OR PARTICLES > 2mm (−1 phi) AND GREATER THAN 10% SAND SIZE PARTICLES

[XX] **SAND**
PREDOMINANTLY PARTICLES SMALLER THAN A GRANULE AND LARGER THAN A COARSE SILT GRAIN, HAVING A DIAMETER IN THE RANGE OF 0.062mm − 2mm (4 TO −1 phi UNITS) WITH LESS THAN 10% OF PARTICLES LARGER THAN 2mm AND 10% PARTICLES LESS THAN 0.062mm

⟨XX⟩ **SILTY SAND**
AN UNCONSOLIDATED SEDIMENT CONTAINING MORE PARTICLES OF SAND SIZE THAN OF SILT SIZE, MORE THAN 10% SILT AND LESS THAN 10% OF OTHER SIZES

⟨XX⟩ **SANDY SILT**
AN UNCONSOLIDATED SEDIMENT CONTAINING MORE PARTICLES OF SILT SIZE THAN OF SAND SIZE, MORE THAN 10% OF SILT AND LESS THAN 10% OF ALL OTHER SIZES

[XX] **SILT**
AN UNCONSOLIDATED SEDIMENT CONTAINING MORE THAN 80% SILT SIZE PARTICLES, LESS THAN 12% CLAY AND LESS THAN 20% SAND

• **PEAT**
AN UNCONSOLIDATED DEPOSIT OF SEMICARBONIZED PLANT REMAINS

- **ROCK**
A LIMESTONE OUTCROP SOMETIMES UNDERLYING A THIN LAYER OF SEDIMENT

xx STATION DESIGNATIONS

REFERENCES

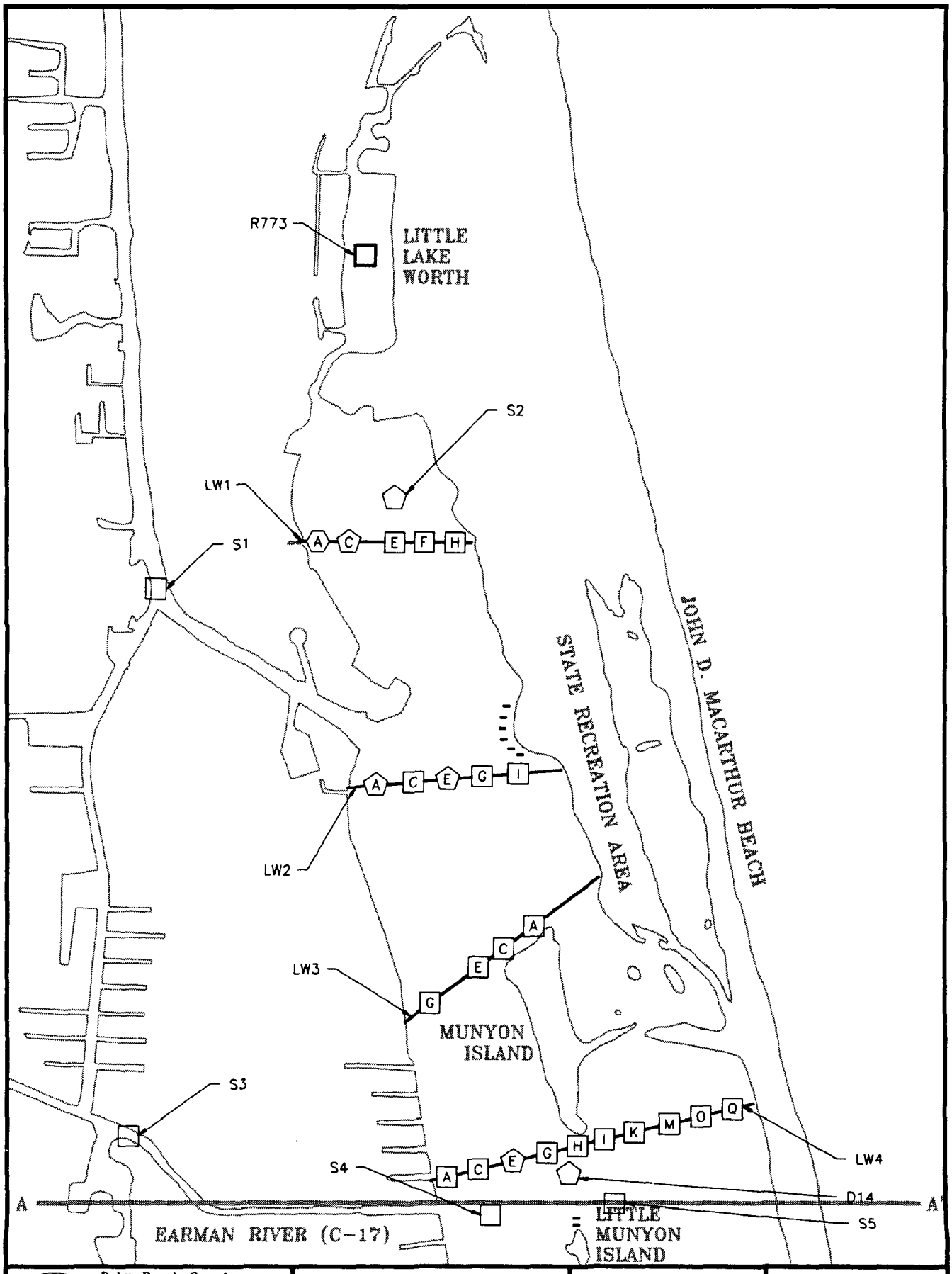
D# DEIS, D., R. WALESKY, H. RUDOLPH, 1983. FOR PALM BEACH COUNTY AREA PLANNING BOARD − UNPUBLISHED REPORT BY TROPICAL ECOSYSTEMS, INC.

LW# RODGERS, R., 1970. U.S.E.P.A. − UNPUBLISHED STUDY OF LAKE WORTH

R# RUDOLPH, H., 1989. FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION, PORT ST. LUCIE OFFICE, BIOLOGY SECTION − UNPUBLISHED REPORT OF LAKE WORTH

S# SCHROPP, S. AND F. CALDER, 1989. FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION, TALLAHASSEE OFFICE, COASTAL ZONE MANAGEMENT SECTION − UNPUBLISHED STUDY ON LAKE WORTH

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* SEDIMENT CHARACTERISTICS		D&M JOB NO. *20335-001-049* FIGURE *6-A*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SEDIMENT CHARACTERISTICS

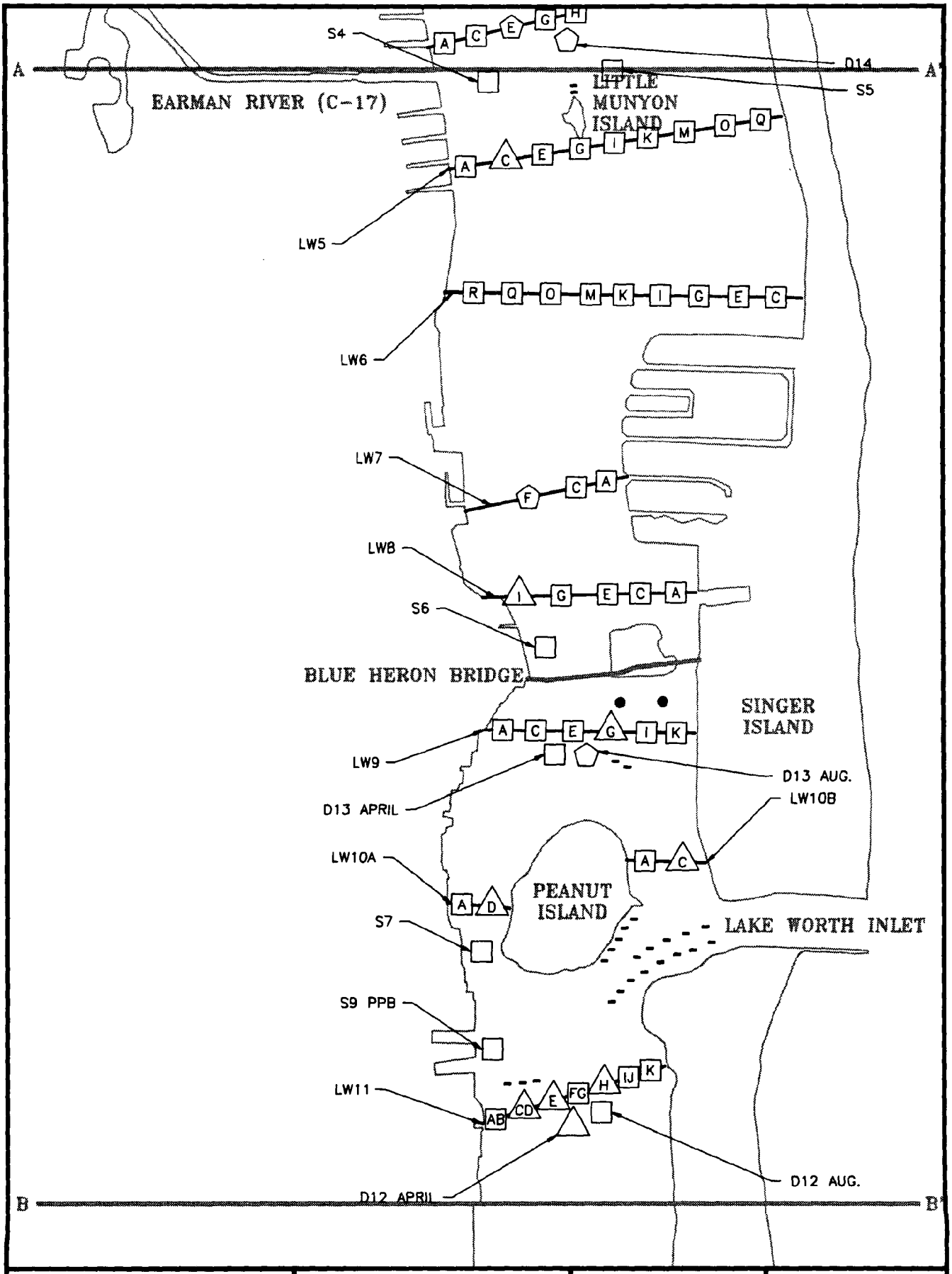
0 1000 2000

SCALE (FEET)

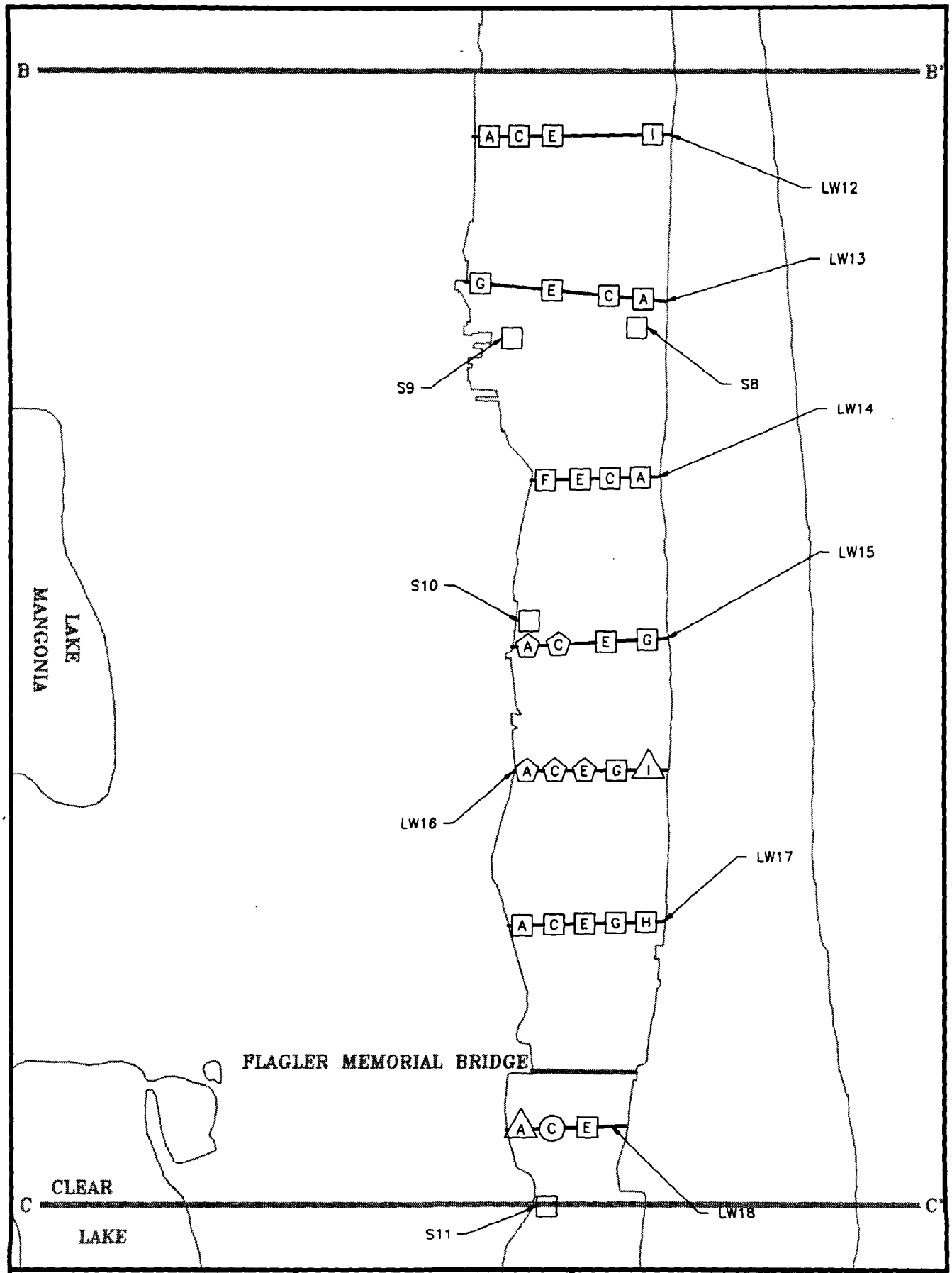
N

D&M JOB NO. *20335-001-049*

FIGURE *6-B*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* SEDIMENT CHARACTERISTICS	0 1000 2000 SCALE (FEET)	D&M JOB NO. *20335-001-049* FIGURE *6-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SEDIMENT CHARACTERISTICS

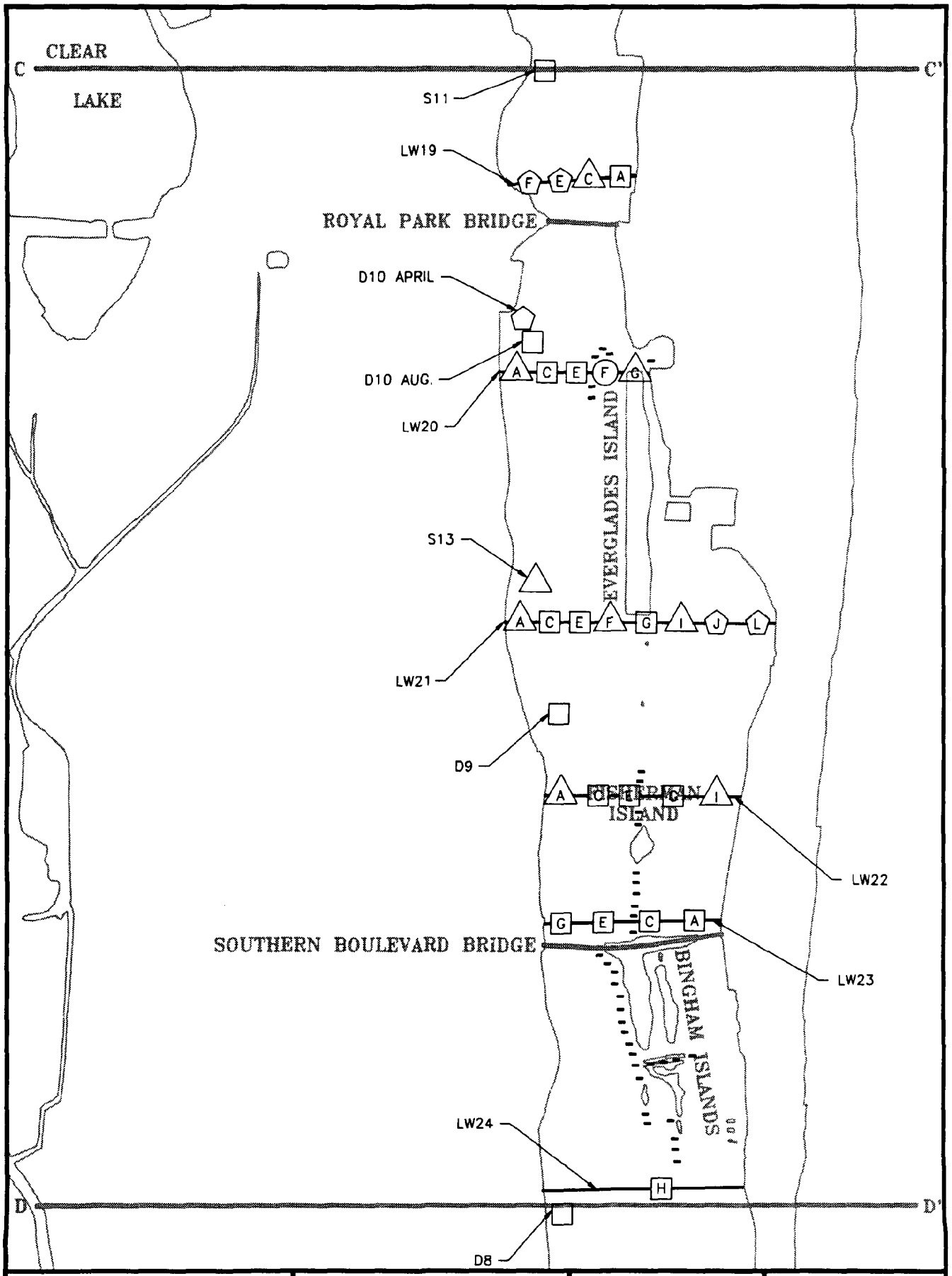
0 1000 2000

SCALE (FEET)

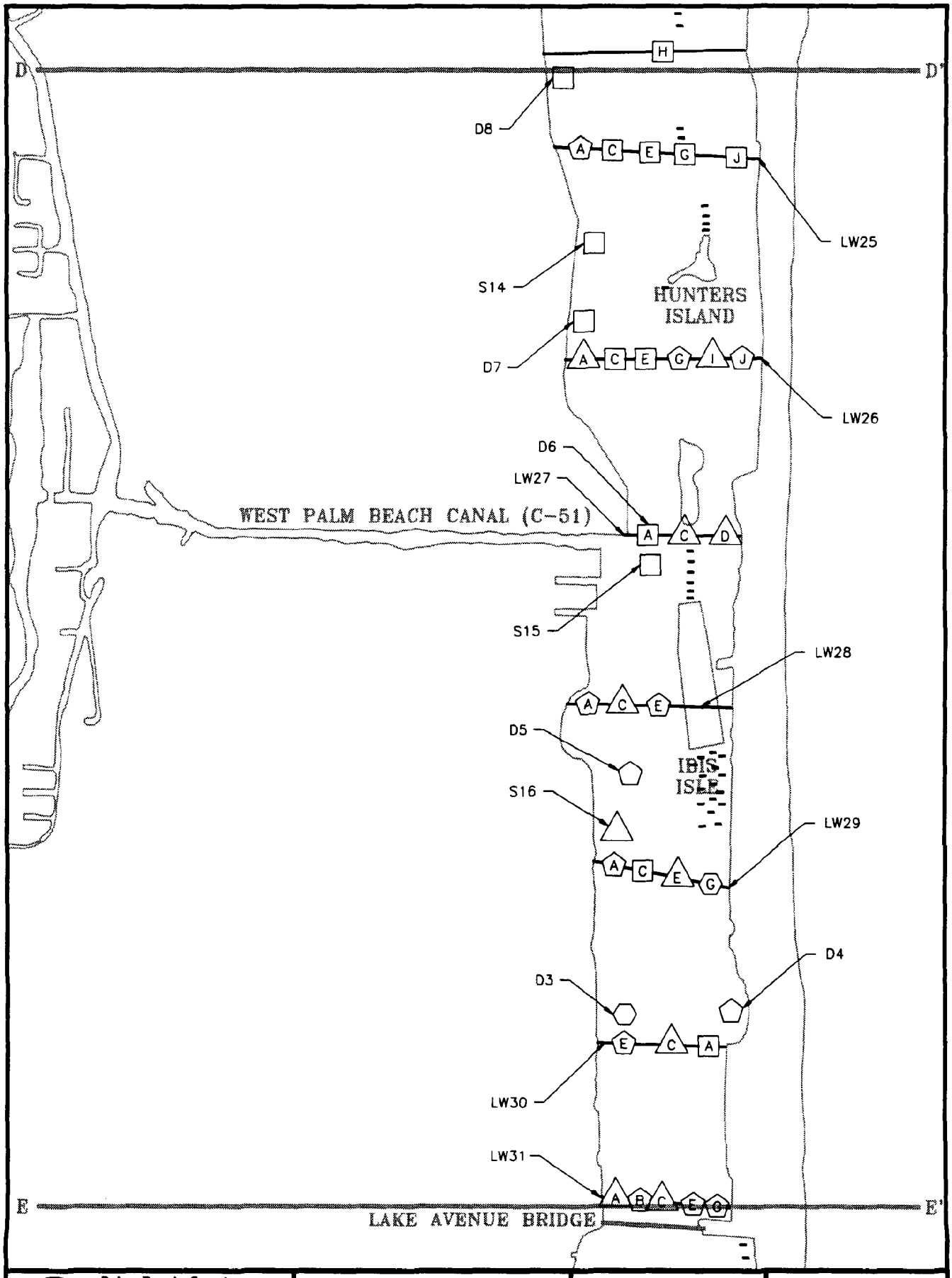
N

D&M JOB NO. *20335-001-049*

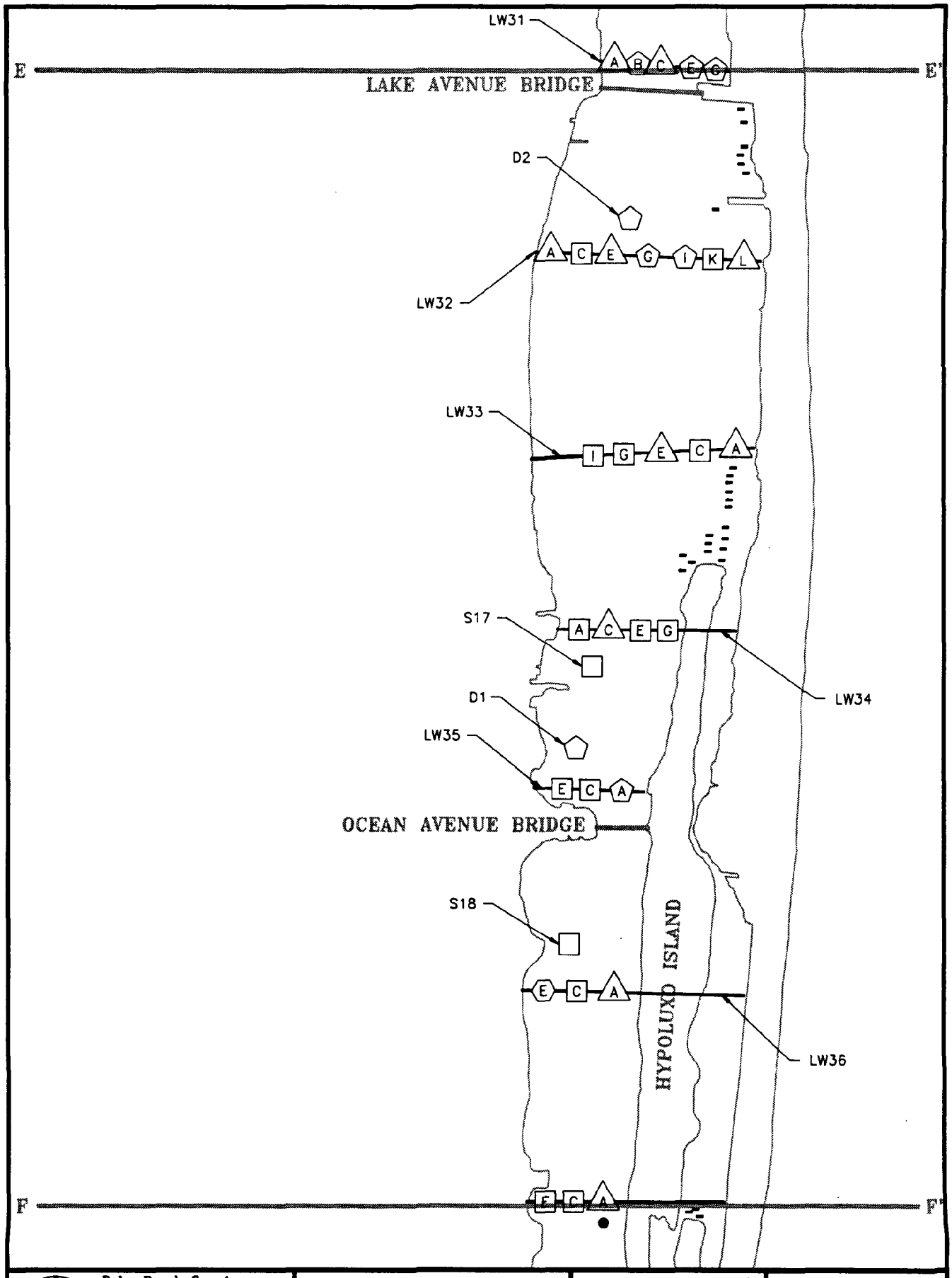
FIGURE *6-D*



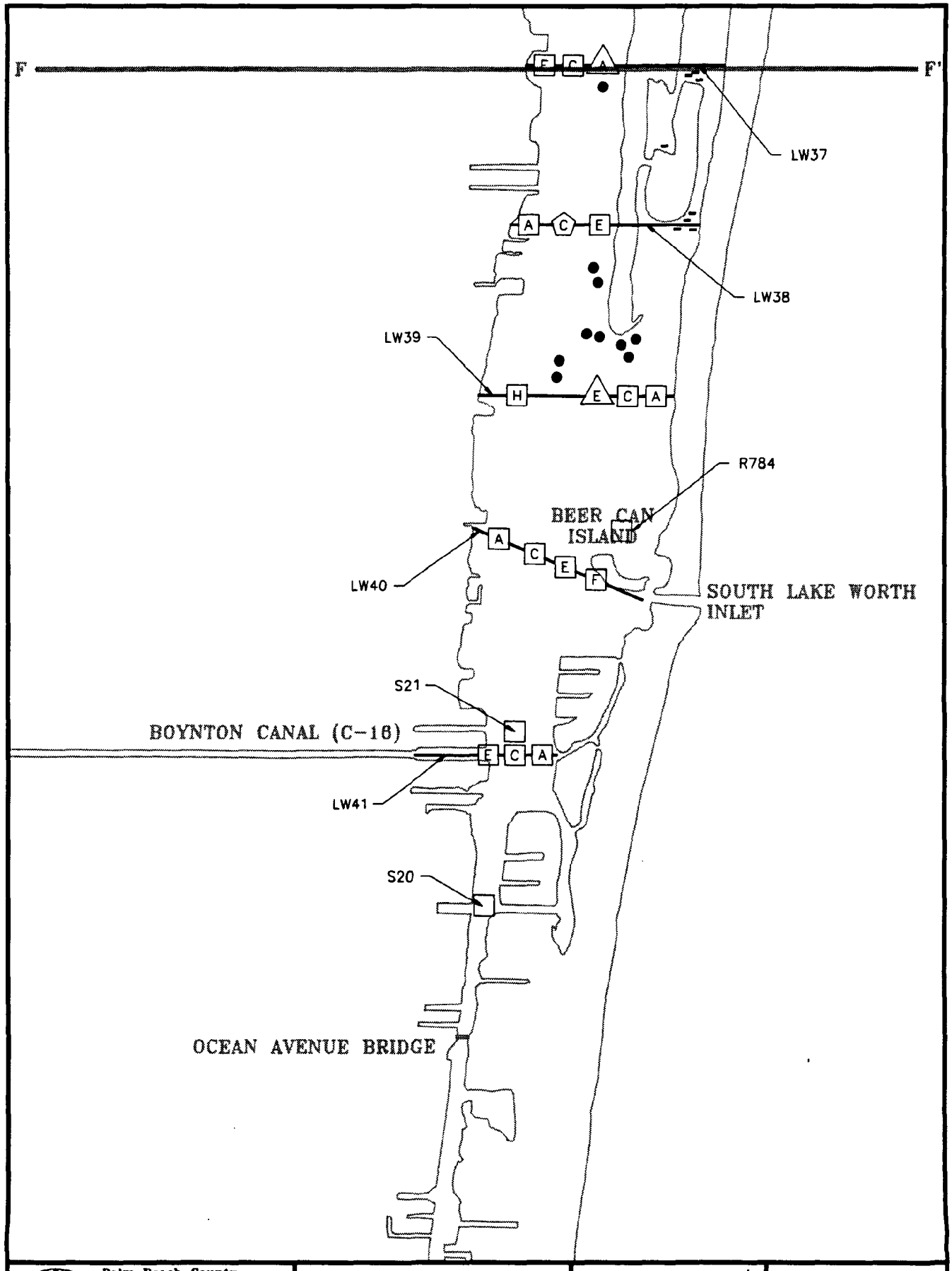
Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* SEDIMENT CHARACTERISTICS	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *6-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* SEDIMENT CHARACTERISTICS	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *6-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* SEDIMENT CHARACTERISTICS	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *6-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SEDIMENT CHARACTERISTICS

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *6-H*

5.7 POINT AND NON-POINT SOURCE OUTFALLS

Point source discharges to Lake Worth Lagoon have been greatly reduced in recent years. During the 1950's, an estimated ten million gallons per day (MGD) of raw sewage was discharged resulting in extensive bacterial and nutrient pollution. By 1970, seven major waste water treatment plants had been constructed, discharging 18.49 MGD of secondarily treated sewage effluent. The volume was reduced to 2.98 MGD by 1984, largely as a result of the National Pollution Discharge Elimination System (NPDES) program administered by the U.S. Environmental Protection Agency. According to the Florida Department of Environmental Regulation, three waste water treatment plants currently discharge a total of approximately 2.36 MGD of secondarily treated sewage effluent to the Lake Worth watershed (personal communication, DER, October, 1990).

The plants with discharge are as follows:

- Seacoast Utilities
  North Palm Beach Waste Water Treatment Plant
  design capacity - 4.85 MGD
  yearly average discharge (10/89 - 9/90) - 2.11 MGD
- Maisonettes South Inc.
  Condominium Waste Water Treatment Plant
  design capacity - 0.1 MGD
- Wellington Arms
  Condominium Waste Water Treatment Plant
  design capacity - 0.15 MGD

The Seacoast Utilities North Palm Beach Waste Water Treatment Plant is scheduled to take their discharge off line in December, 1990.

The Florida Power and Light Company's Riviera Beach Power Plant circulates 282 MGD of cooling water. The discharge into the lagoon is approximately ten degrees warmer than the ambient water temperature (Harris et.al, 1983).

Federal (NPDES) and state environmental regulations require removal of existing point sources or in some cases retrofit to meet established effluent limits. New point sources must apply "best technology" and meet stringent discharge standards in order to receive required federal and state permits. While new discharges are not categorically prohibited, the standards which must be met discourage them.

Non point source discharges to Lake Worth Lagoon represent a relatively small percentage of the total freshwater inflow but result in a major water quality influence. Most of the surrounding urban areas discharge stormwater runoff directly to the lagoon. A total of 381 stormwater discharge pipes along the Lake Worth Lagoon shoreline were identified in the course of this study. A summary of the outfall sizes is presented in **Table 3.**

TABLE 3	
Non-Point Source Outfalls	
Drainage Outfall Diameter	Number of Outfalls
small (<24")	57
medium (≥ 24" - 47")	28
large (≥ 48")	33
undetermined	263
Total	381

A great number of the drainage systems which discharge to Lake Worth Lagoon were constructed prior to the advent of regulations which require passive treatment components to be designed into the system prior to discharge. The impact of stormwater pollution on

water quality in Lake Worth is apparent in the overall Trophic State Index water quality rating at the lower end of the good range. Since point sources have been greatly reduced in recent years, it is reasonable to conclude that stormwater runoff is the major source of water quality pollution. Stormwater runoff from urban areas contains high levels of metals, nutrients, suspended solids, and oils and greases. Degraded water quality in turn increases biochemical oxygen demand and adversely impacts fish, wildlife and recreational resources.

State and local regulations require new stormwater drainage systems to be constructed and operated in accordance with design and performance standards which result in some treatment of drainage water prior to discharge. Existing outfalls however, are not required to retrofit. In recognition of the water quality impacts of stormwater discharges, the City of West Palm Beach has included a provision in its comprehensive plan to create a stormwater utility sometime during the 1990's when the city's population reaches 100,000. If the plan is implemented, stormwater runoff will be treated in a utility prior to discharge. Stormwater utilities, retrofit requirements, and improved design of stormwater treatment systems are initiatives which must be undertaken in order to reduce the water quality impacts of stormwater discharges.

The locations of major discharge points are indicated on **Figure 7**. Outfall locations were obtained from Municipal Comprehensive Plans, the Riviera Beach Development of Regional Impact Document and field observations. Outfall sizes were noted when the information was included in Comprehensive Plans. The sizes of the outfalls were designated as small (<24 inch diameter), medium (24 - 48 inch diameter), large (>48 inch diameter), unknown size, and point sources (waste water treatment plants and electric power plants).

LEGEND

OUTFALL SIZE

⊗ SMALL (< 24" DIAMETER)

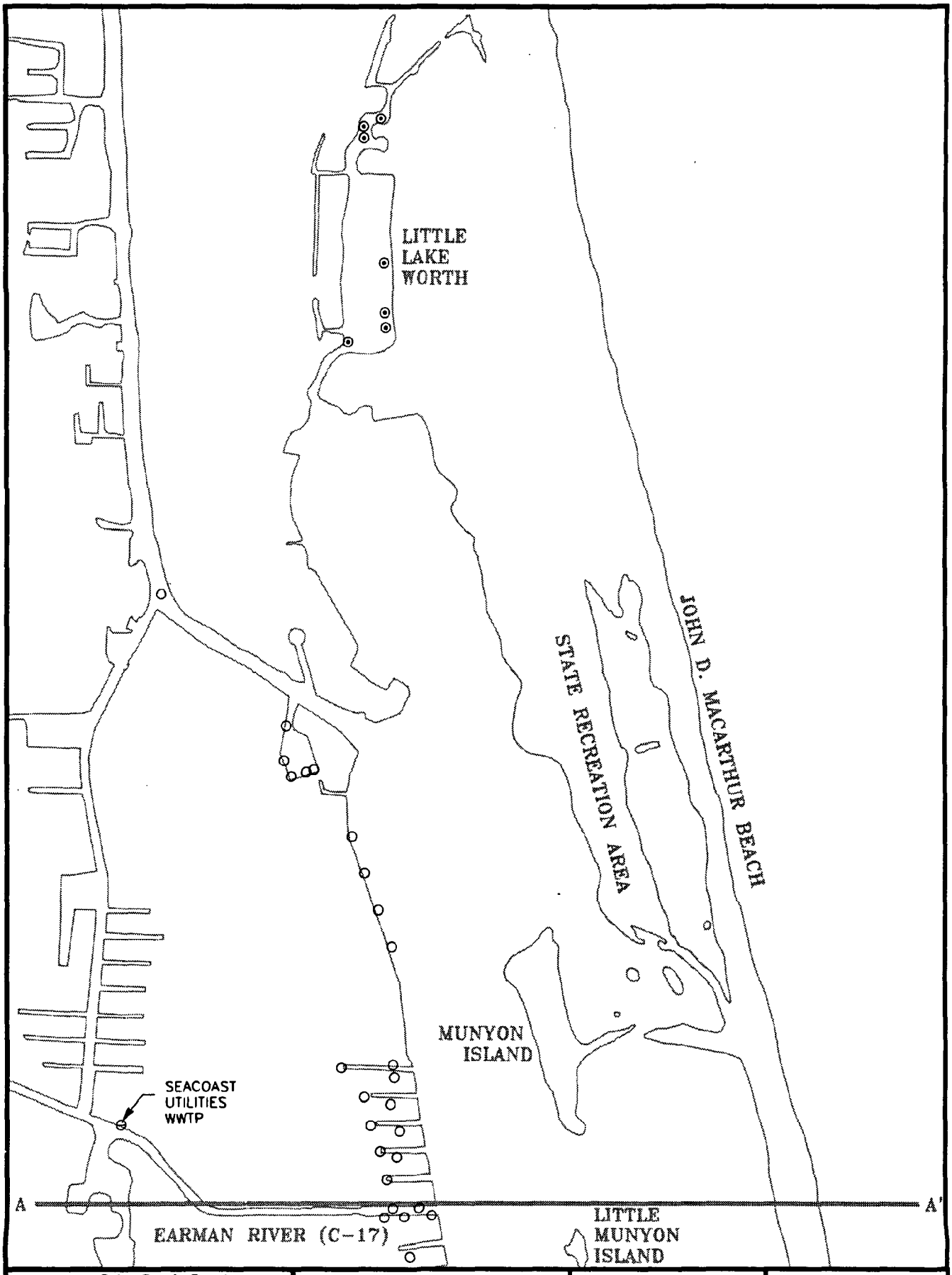
⊙ MEDIUM (≥ 24"–47" DIAMETER)

● LARGE (≥ 48" DIAMETER)

⊖ POINT SOURCE

○ UNDETERMINED DIAMETER

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* POINT AND NONPOINT SOURCE OUTFALLS		D&M JOB NO. *20335-001-049* FIGURE *7-A*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

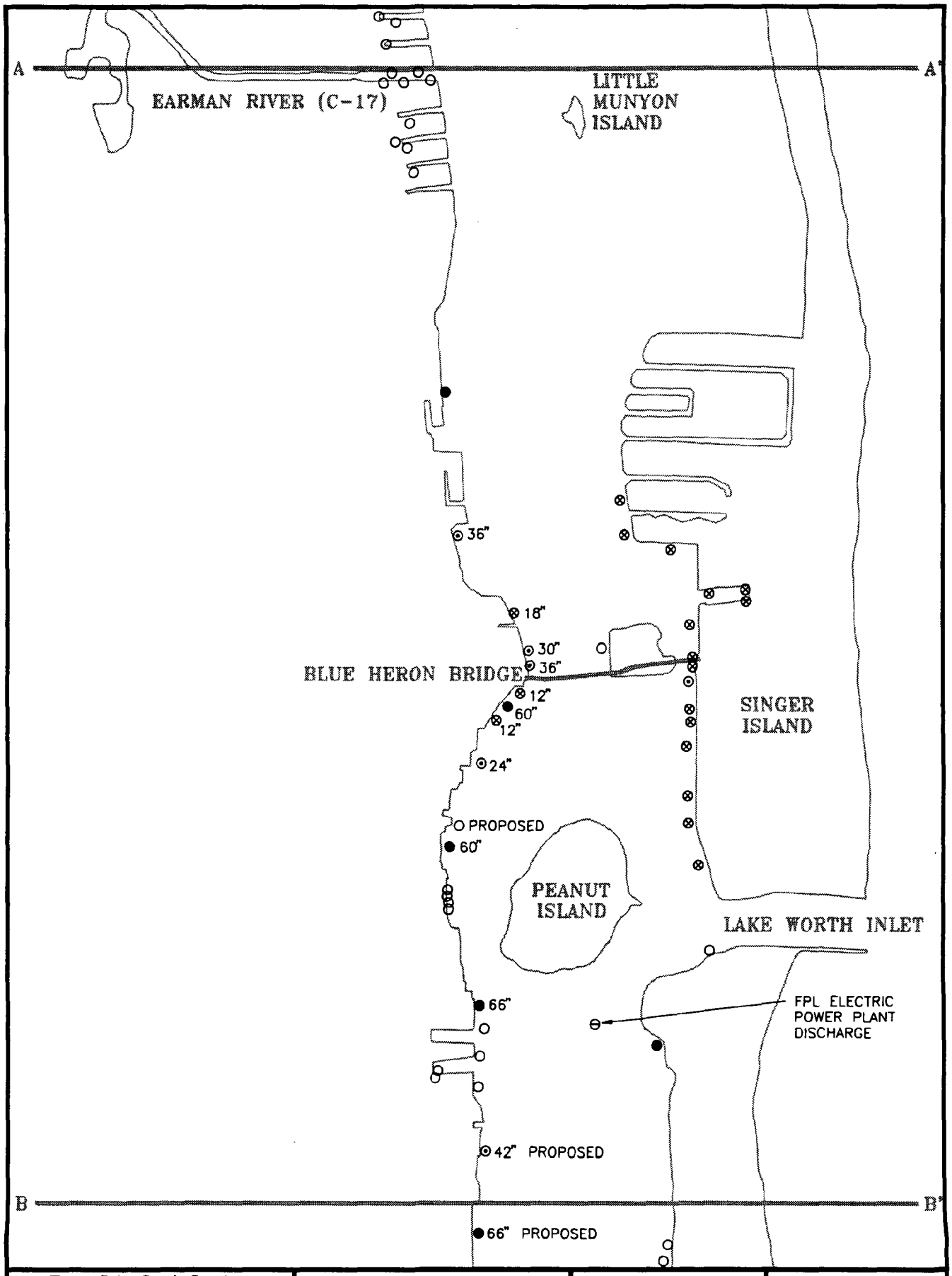
POINT AND NONPOINT
SOURCE OUTFALLS

0 1000 2000
SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
7-B



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

POINT AND NONPOINT SOURCE OUTFALLS

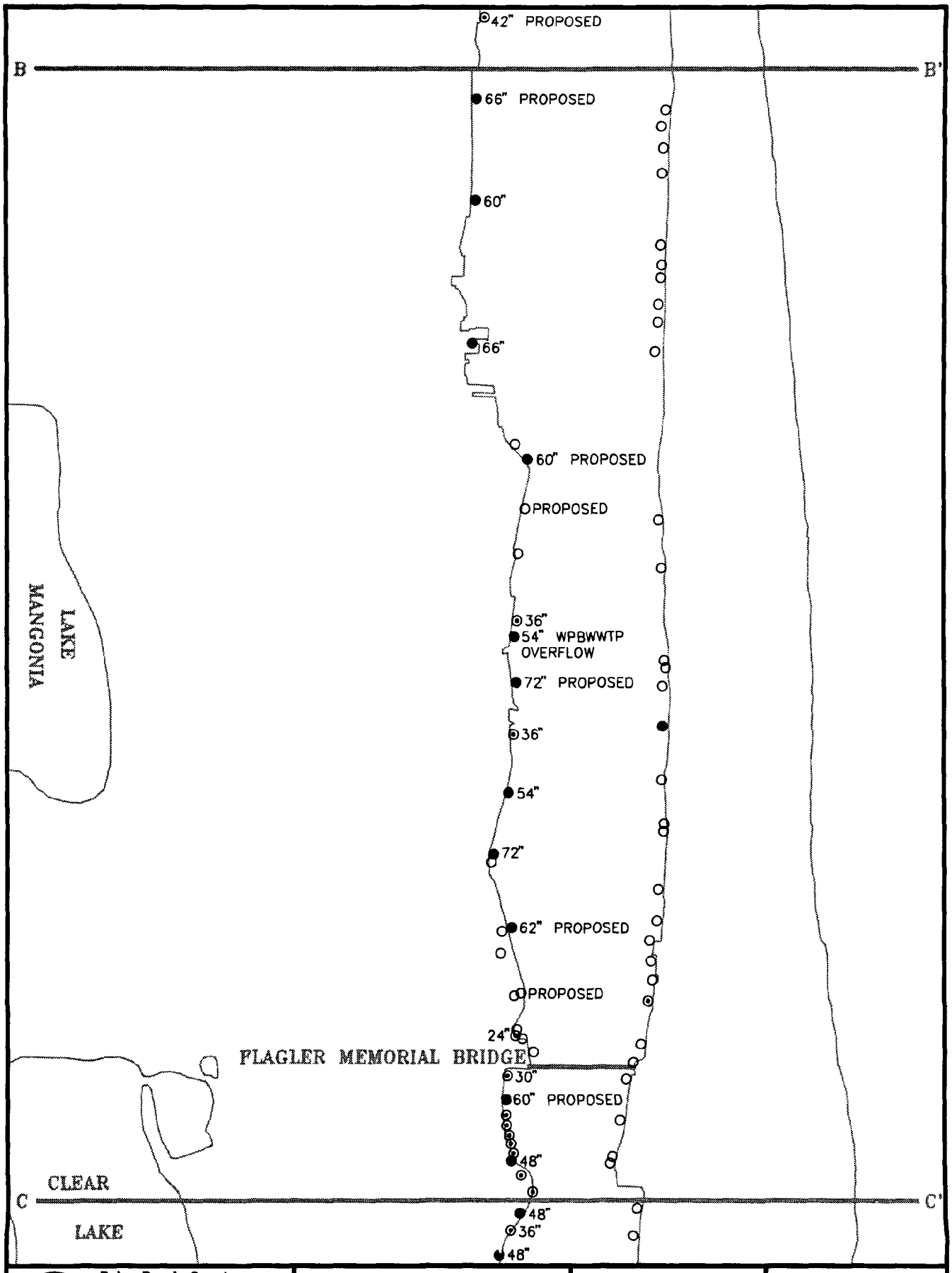
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *7-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

POINT AND NONPOINT SOURCE OUTFALLS

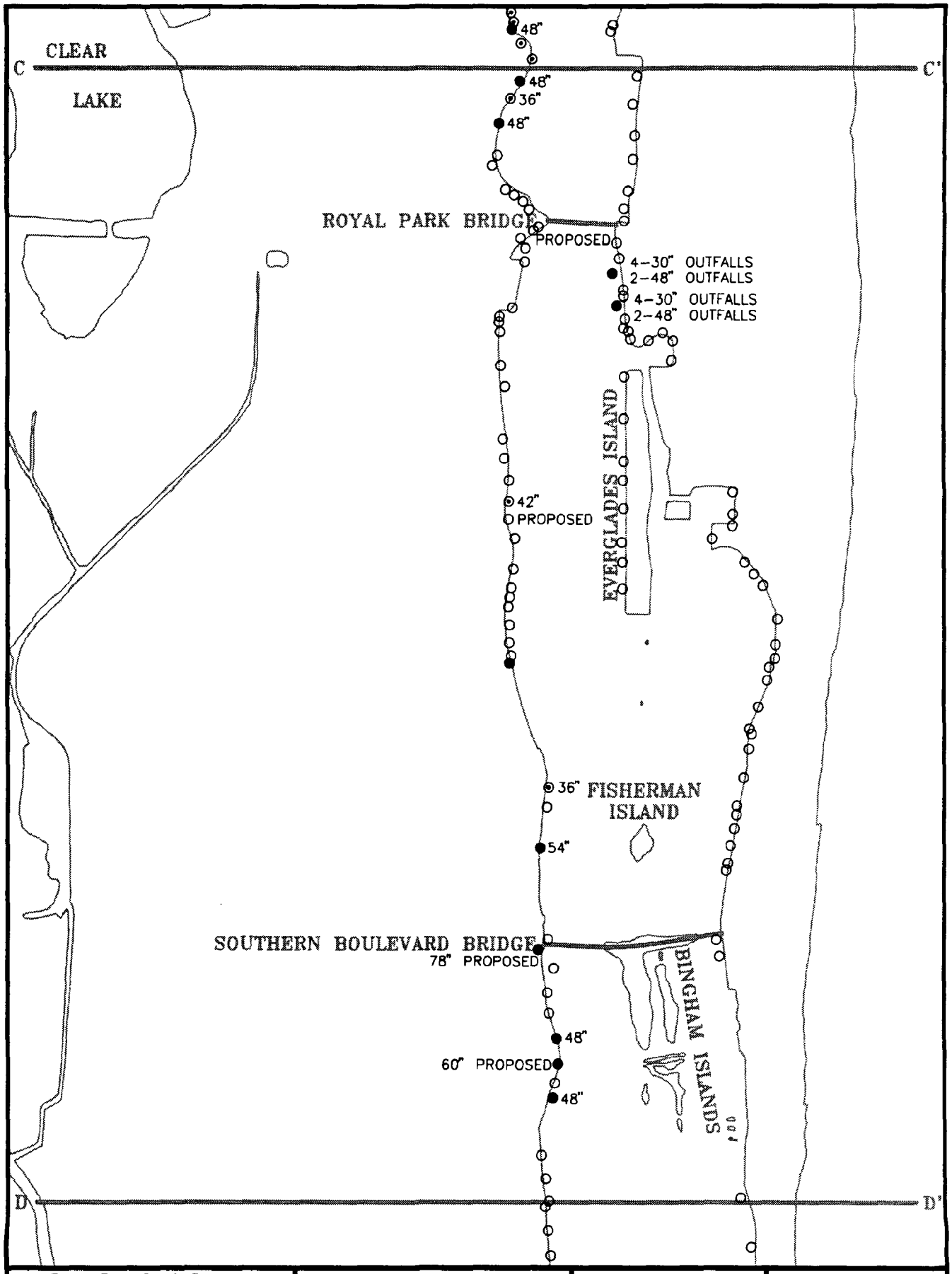
0 1000 2000

SCALE (FEET)

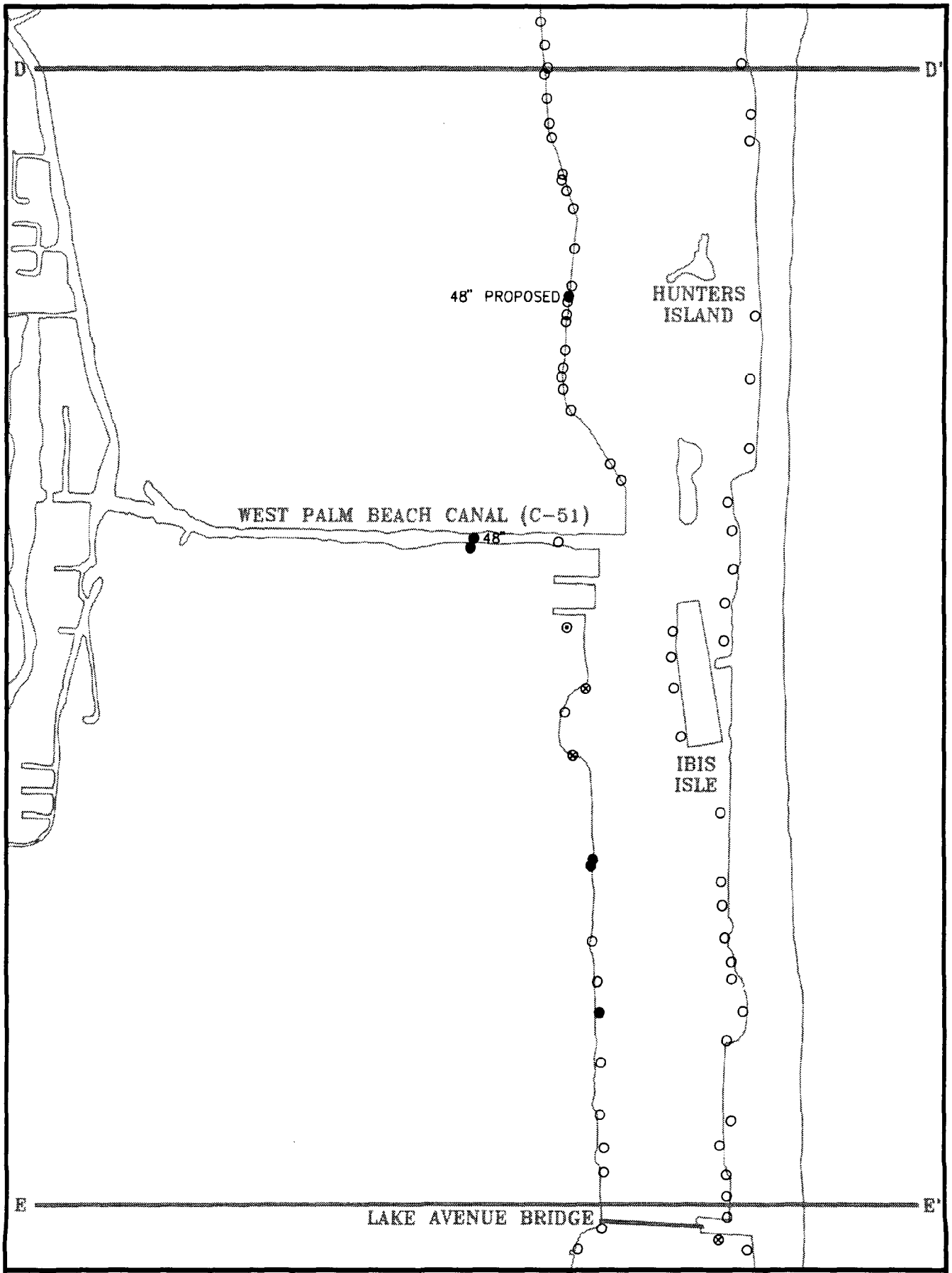
N

D&M JOB NO. *20335-001-049*

FIGURE *7-D*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* POINT AND NONPOINT SOURCE OUTFALLS	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *7-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

POINT AND NONPOINT SOURCE OUTFALLS

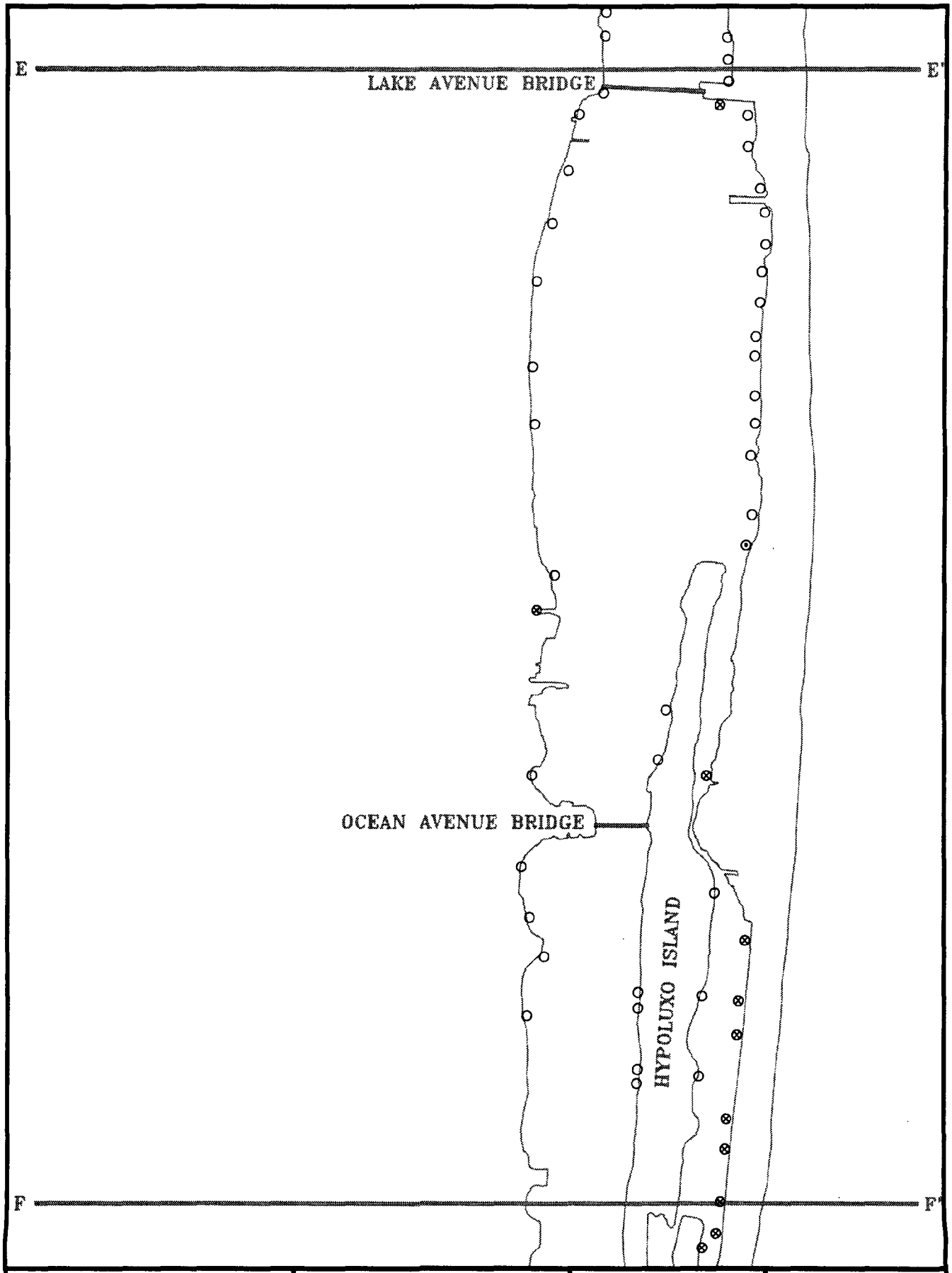
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *7-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

POINT AND NONPOINT SOURCE OUTFALLS

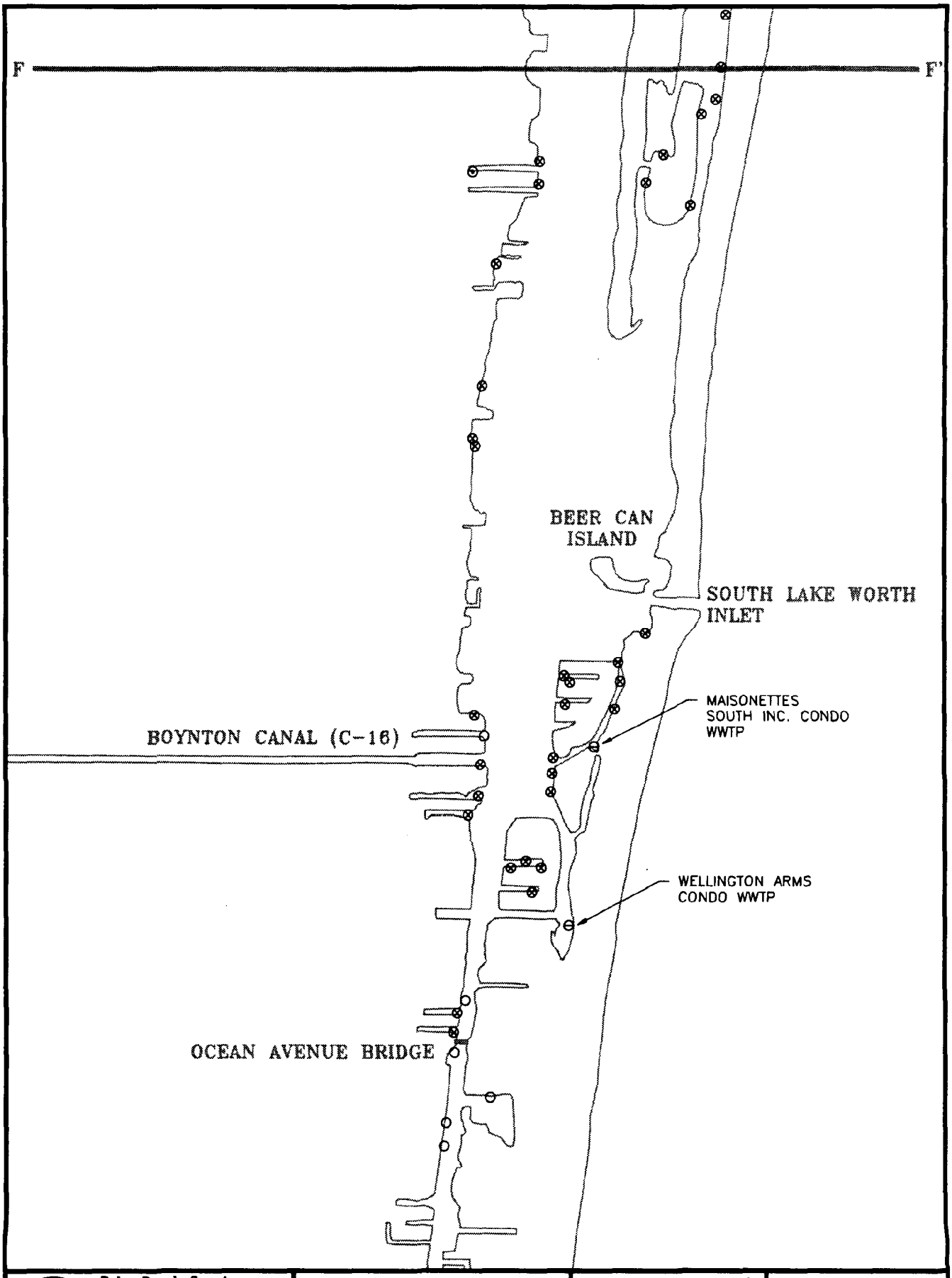
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *7-G*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

POINT AND NONPOINT SOURCE OUTFALLS

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *7-H*

5.8 SHORELINE CHARACTERISTICS

Most of the Lake Worth Lagoon shoreline has been altered by dredging, filling, and bulkhead construction (see Figure 1). Between 1940 and 1975, an estimated 87% of shoreline mangroves were eliminated by shoreline development (Harris et.al, 1983). The ecological value of mangrove communities has been well documented in the scientific literature. Mangrove communities provide habitat for marine organisms, protect shorelines from erosion, and enhance water quality by acting as natural filters. Detrital material produced by mangroves is the basis of the food chain for South Florida's marine and estuarine ecosystems. Currently only about 19% of the shoreline (including islands) has fringing mangroves. Bulkheads have been constructed on approximately 65% of the shoreline (including canals). The linear extent of major shoreline types is presented on **Table 4.**

TABLE 4

SHORELINE CHARACTERISTICS

SHORELINE TYPE	LINEAR MILES	PERCENTAGE OF SHORELINE
Bulkhead	55.3	60
Bulkhead with Rip-Rap Revetment	4.1	4.5
Natural Shoreline (Unvegetated)	8.2	9
Rock	0.6	.5
Rip Rap Revetment	3.5	4
Exotic Vegetation	2.5	3
Mangrove	17.3	19
TOTAL	91.5	100

*Includes connected canals.

Shoreline characteristics are depicted on **Figure 8.** The shoreline was divided into six categories; seawall revetment, rip-rap revetment, natural unvegetated shoreline, rock, mangrove vegetation, and exotic vegetation. The initial map was plotted from 1989 "Redi" aerial photographs. Field observations were used to ground truth the aerial photographs and plot shoreline characteristics.

LEGEND

ooooo BULKHEAD

ΔΔΔΔΔ NATURAL SHORE

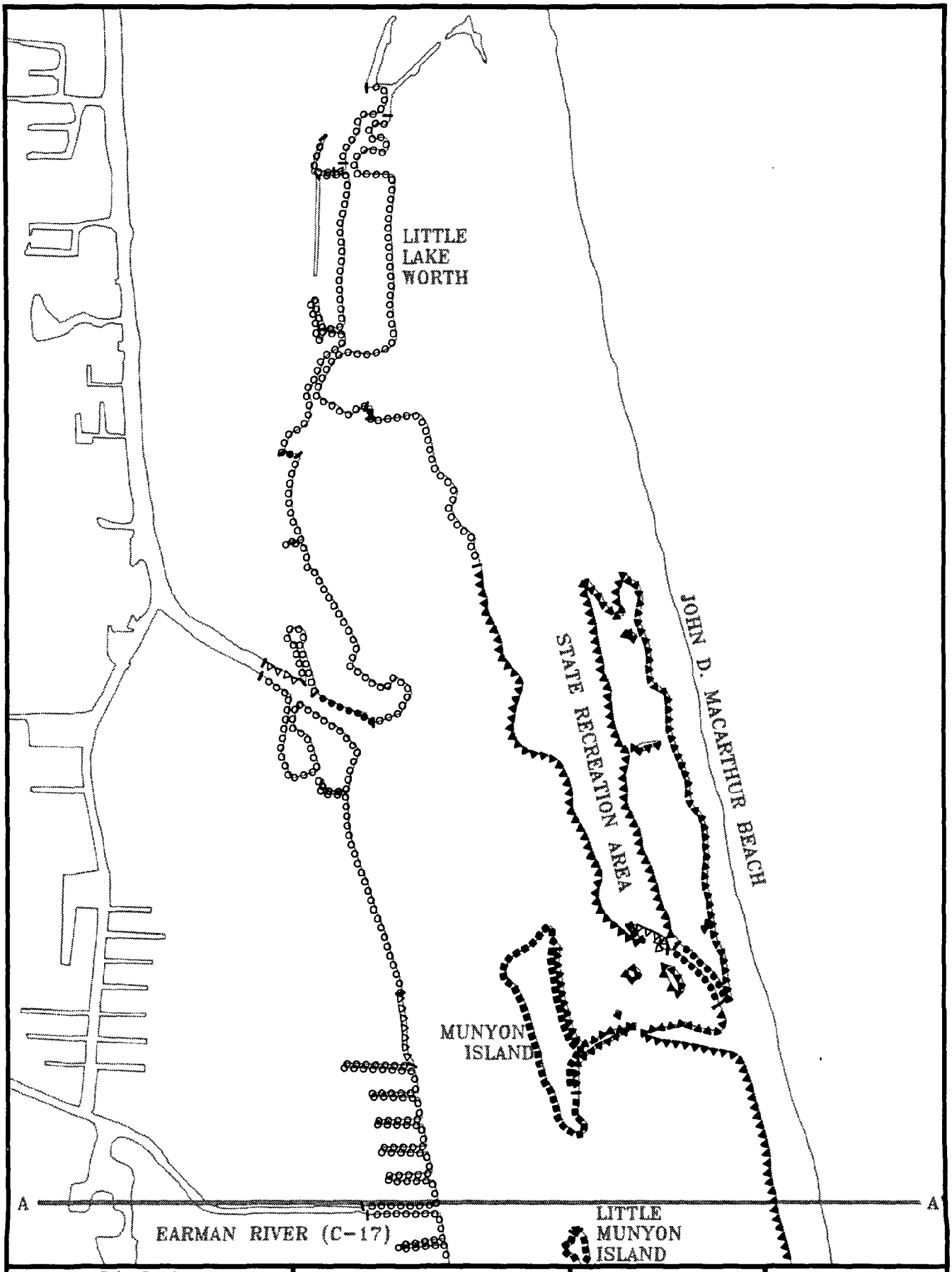
□□□□□ ROCK

●●●●● RIP–RAP REVETMENT

▲▲▲▲▲ MANGROVES (Rhizophora mangle – RED MANGROVE, Avicennia germinans – BLACK MANGROVE, Laguncularia racemosa – WHITE MANGROVE)

■■■■■ EXOTIC VEGETATION (Casuarina equistifolia – AUSTRALIAN PINE, Schinus terebinthifolius – BRAZILIAN PEPPER, Thespesia populnea – CORK TREE)

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* SHORELINE CHARACTERISTICS		D&M JOB NO. *20335-001-049* FIGURE *8-A*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

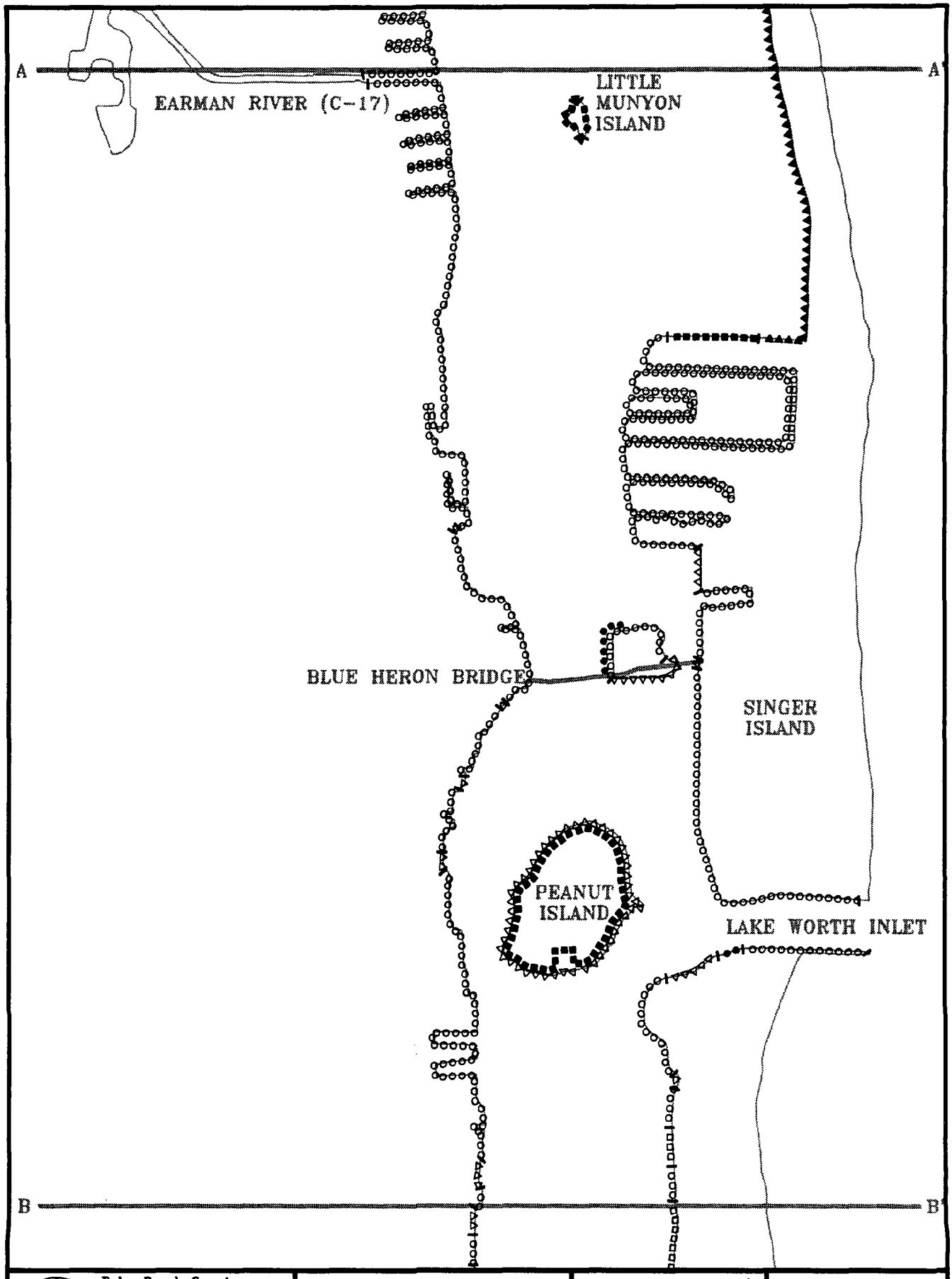
SHORELINE
CHARACTERISTICS

0 1000 2000
SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
8-B



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SHORELINE CHARACTERISTICS

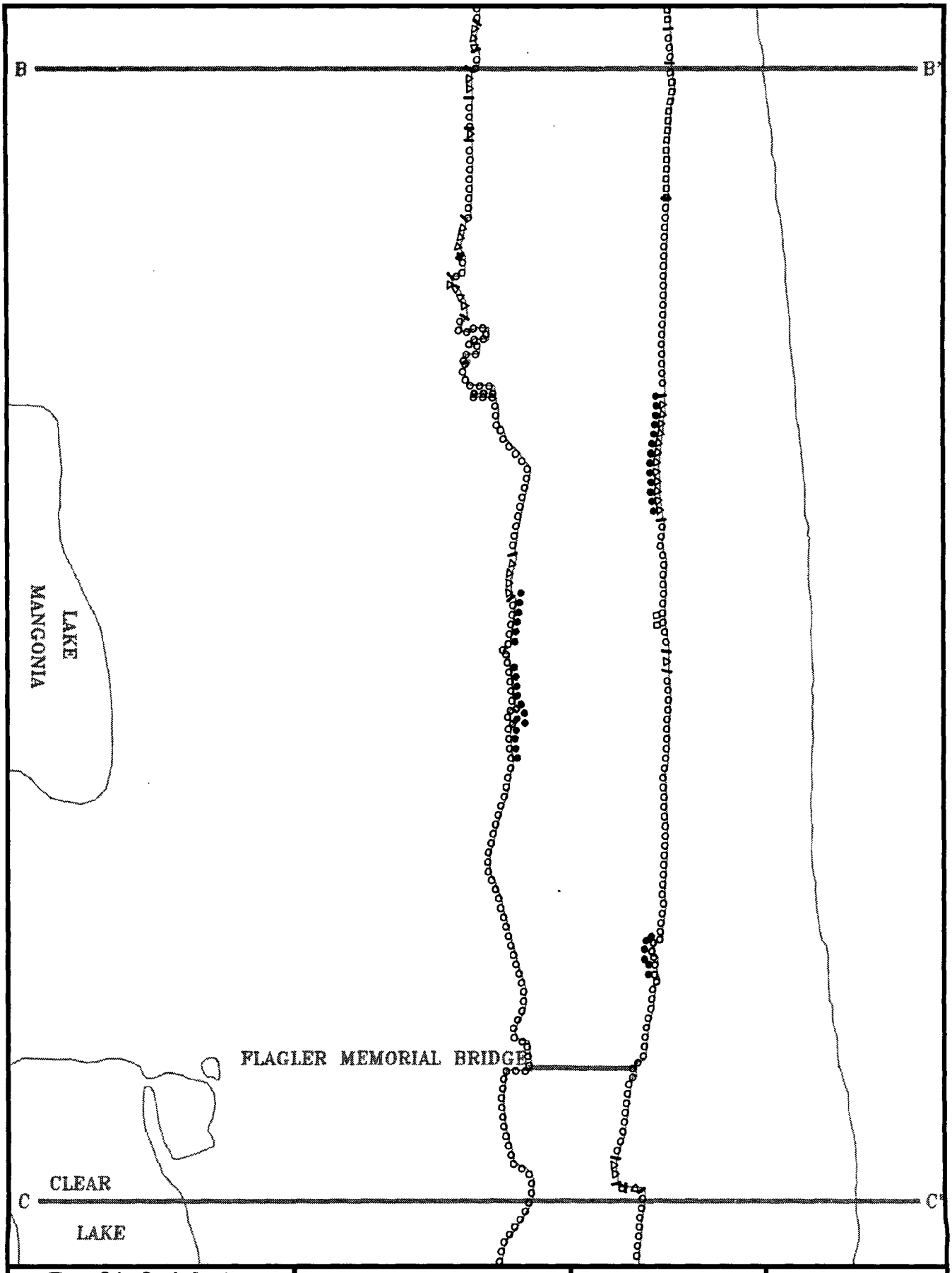
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *8-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SHORELINE CHARACTERISTICS

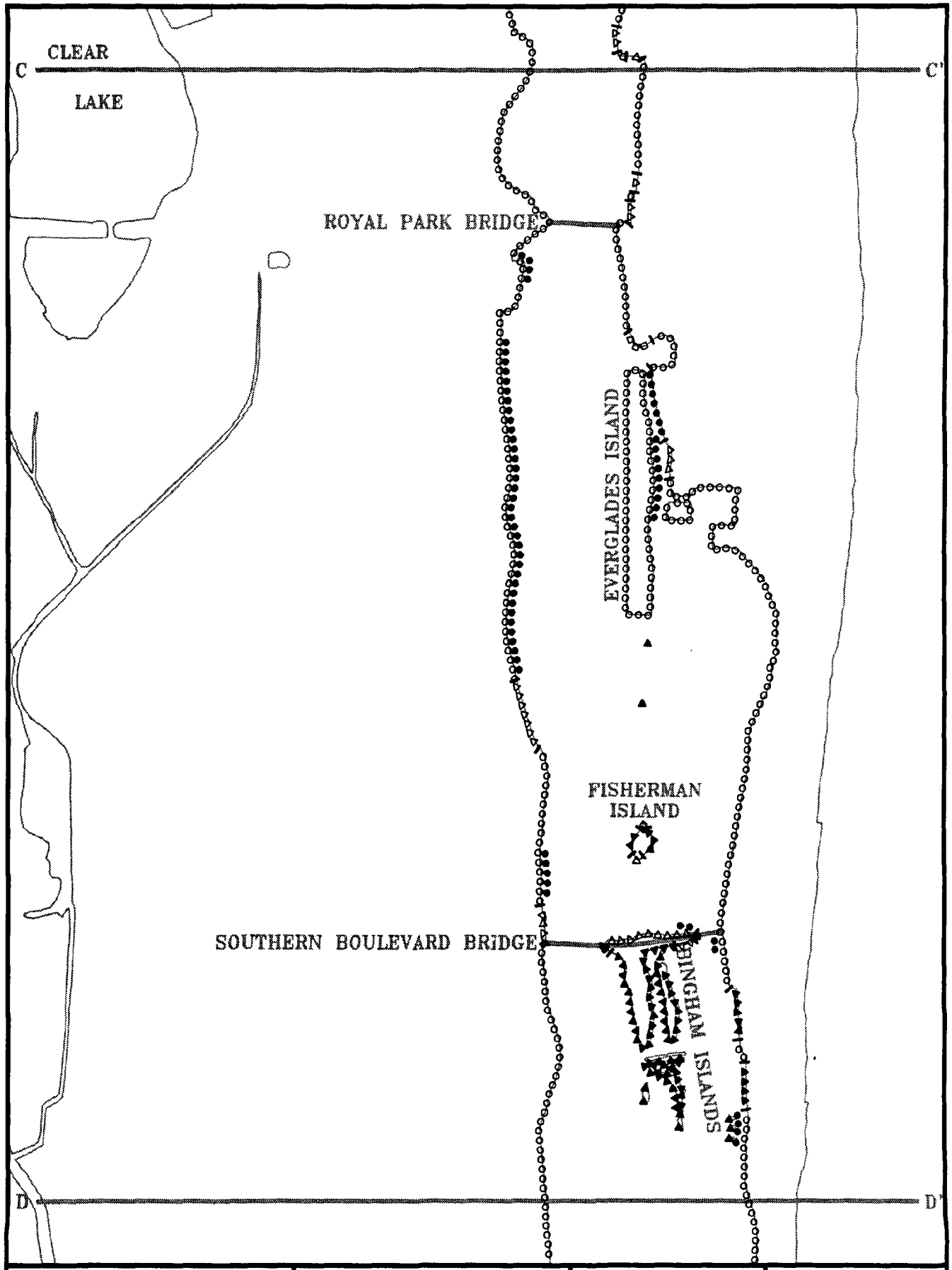
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *8-D*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SHORELINE CHARACTERISTICS

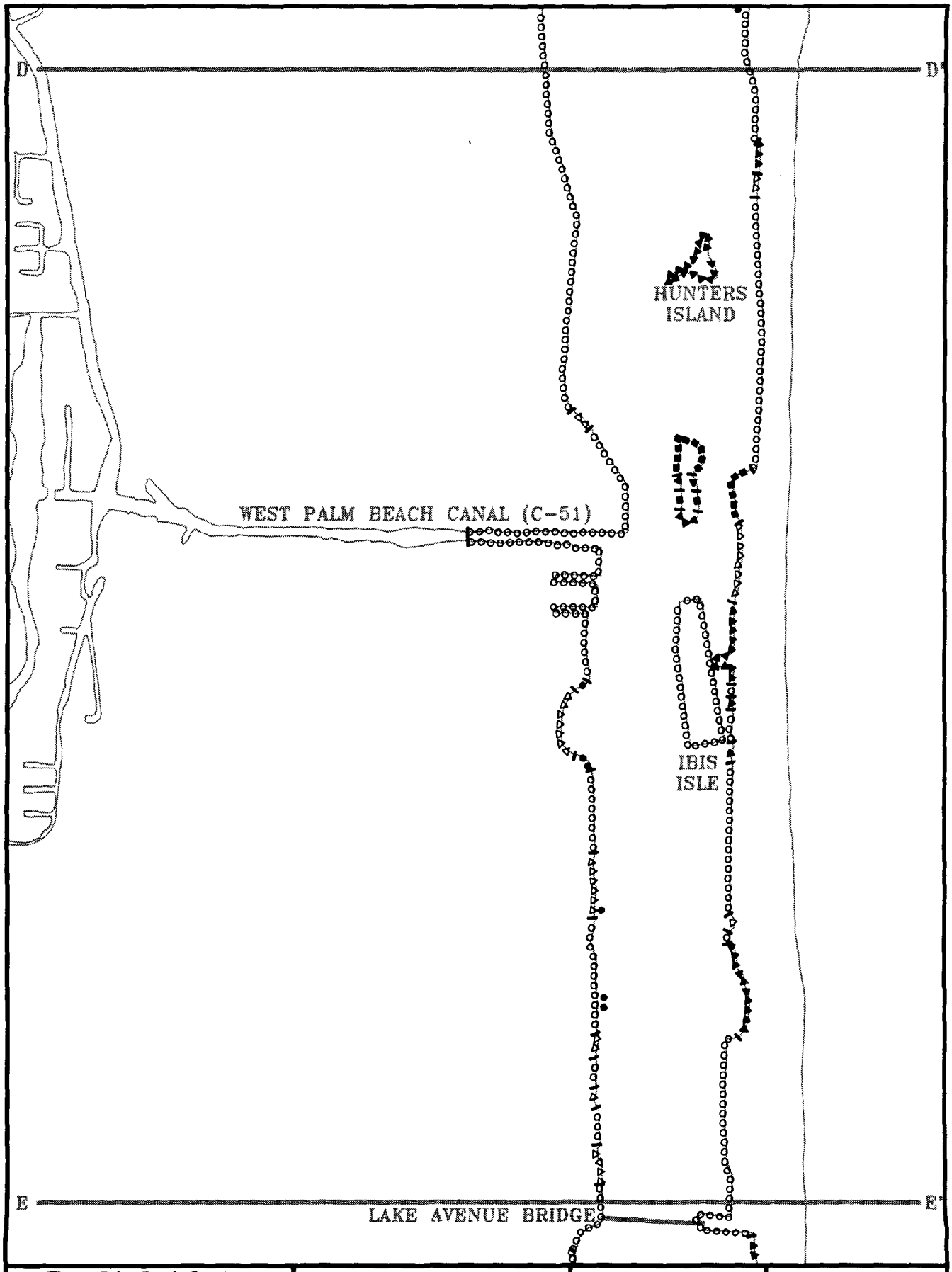
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *8-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SHORELINE CHARACTERISTICS

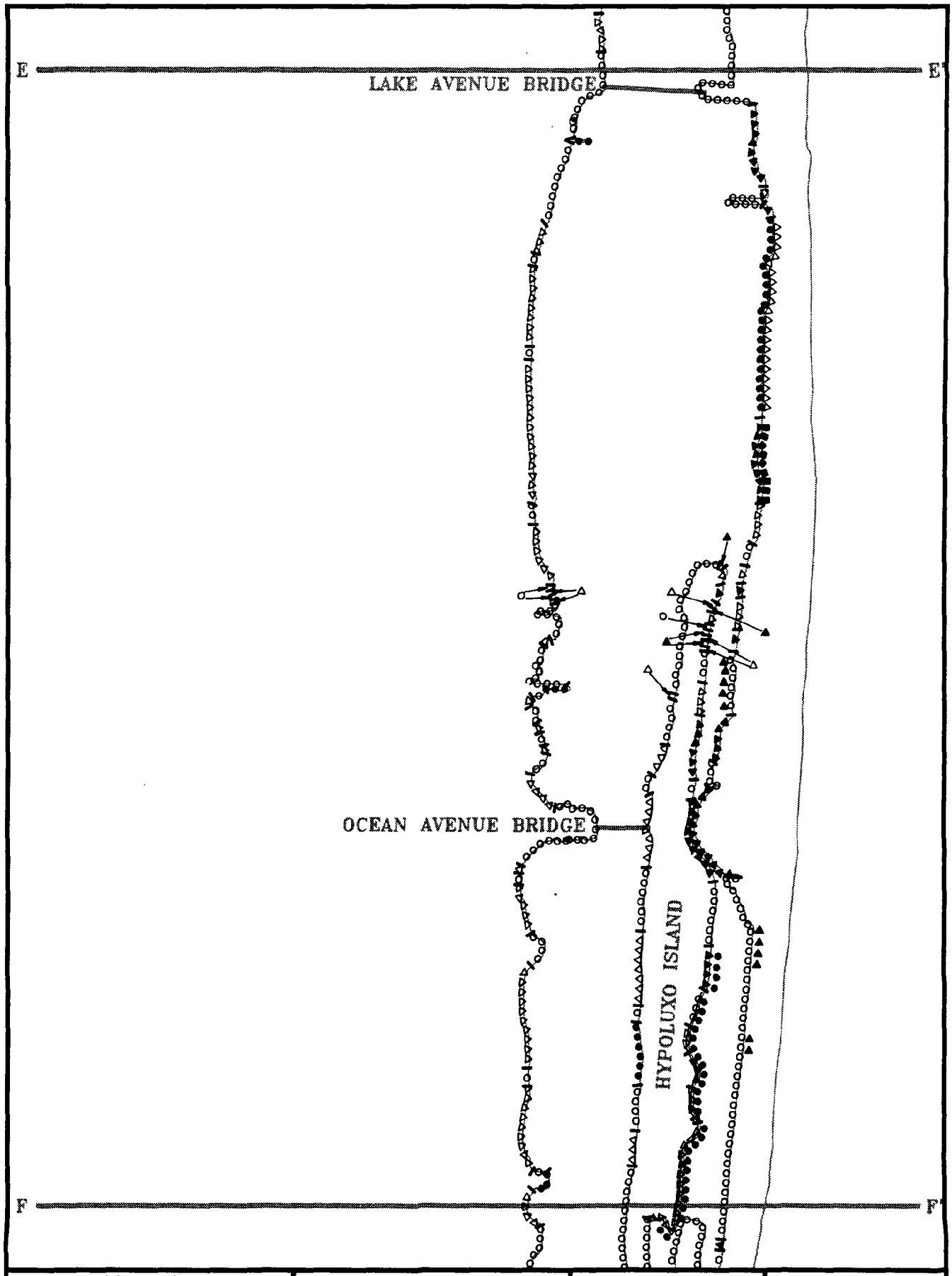
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *8-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SHORELINE CHARACTERISTICS

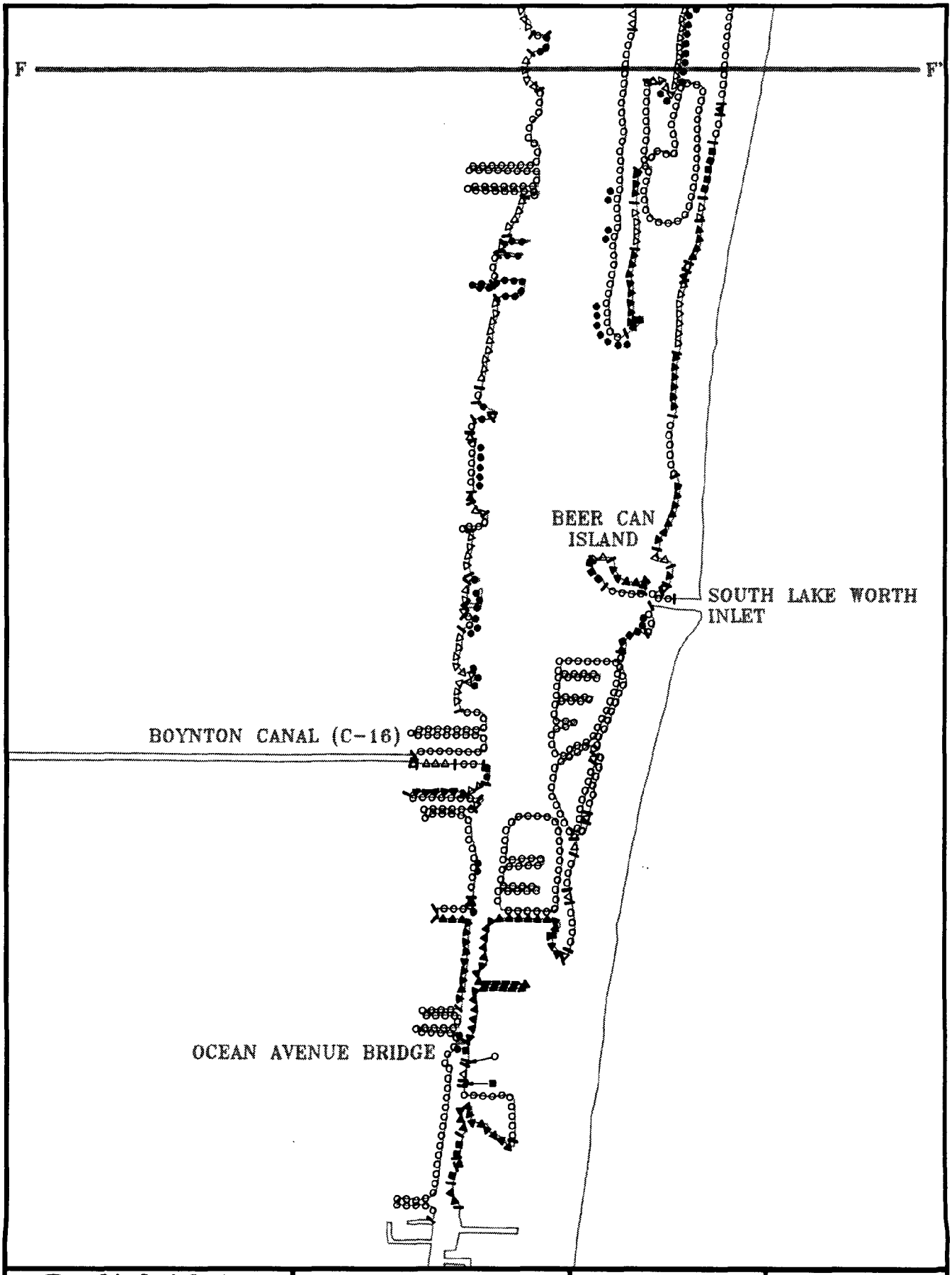
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *8-G*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SHORELINE CHARACTERISTICS

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *8-H*

5.9 SUBMERGED NATURAL RESOURCES

Submerged bottom resources in Lake Worth Lagoon include seagrass beds, macro algae, oyster habitat, corals and sponges.

Seagrasses first became established in Lake Worth Lagoon when the system was converted from freshwater to marine due to the influences of permanent inlets. Seagrasses reportedly have never been abundant (Harris et. al., 1983). In general, seagrasses are most abundant and dense in shallow areas and in areas which maintain good water clarity due to sheltering or tidal flushing.

Six species of seagrasses are known to occur in Lake Worth Lagoon. Turtle grass, *Thalassia testudinum* is capable of forming dense beds. Shoal grass, *Halodule wrightii* is most tolerant of temperature and salinity changes. Manatee grass, *Syringodium filiforme* mixes with other species in small beds. *Halophila engelmanni* and *Halophila johnsonii* and *Halophila decipiens* populate deeper areas. In Lake Worth Lagoon, *Halodule wrightii* is the most abundant species of seagrass in terms of area coverage, and occurs primarily in shallow areas. *Thalassia* and *Syringodium* are found infrequently, and are most abundant in the north end of the lagoon. *Halophila engelmanni* was observed in a single occurrence in North Lake Worth Lagoon.

Seagrass communities can be found throughout Lake Worth Lagoon. The highest concentrations of seagrass communities are located in the northeast lagoon area and in the vicinities of the Lake Worth and South Lake Worth Inlets. In northeast Lake Worth Lagoon extensive turtle grass and shoal grass communities exist in the area east of the Intracoastal Waterway between Palm Beach Isles and Big Munyon Island. The greatest abundance of manatee grass is located in the vicinity of Lake Worth Inlet. The areas north of Lake Worth Inlet, south of South Lake Worth Inlet, and in the vicinity of the Bingham Islands contain significant communities of mixed *Halophila* and *Halodule*.

Species of macro algae also become attached to the bottom or form drifting mats. Seagrass and macro algal communities are very important habitat for many marine species. Their continued survival in Lake Worth Lagoon is dependent upon protection from direct impacts and maintenance of good water quality.

Table 5 is a quantitative summary of seagrass coverage in Lake Worth Lagoon. Of the total 2110 acre area of seagrass coverage, *Halodule wrightii* is the dominant seagrass comprising 1010 acres (51%). *Halophila johnsonii* and *Halophila decipiens* are second in abundance covering 555 acres (25%). Mixed assemblage of all three species comprise 380 acres (19%). Other species of seagrass comprise only 65 acres (3%).

TABLE 5

SEAGRASS COVERAGE

SPECIES	ESTIMATED ACRES OF COVERAGE	PERCENT OF TOTAL ACRES OF SEAGRASS
Halodule wrightii, Shoal Grass	585	28%
Halophila decipiens, Paddle Grass *Halophila johnsonii*, Johnson's Seagrass	450	20%
Mixed *Halodule wrightii* and *Halophila* sp.	285	15%
Syringodium filiforme, Manatee Grass	30	1%
Thalassia testudinum, Turtle Grass	35	2%
Attached Macro-Algal Species	40	2%
Mixed *Halodule wrightii* and Attached Macro-Algal Species	425	23%
Mixed *Halophila* Species and Attached Macro-Algal Species	105	5%
Mixed *Halodule wrightii*, *Halophila* Species and Attached Macro-Algal Species	95	4%
Total - All Species	* 2110	

*(2110 acres= approximately 35% of the total submerged area of Lake Worth Lagoon)

While not as abundant as seagrass communities, other types of bottom resources including oyster bars, corals and sponges also provide important habitat functions for marine organisms. Oyster bars can be found in the vicinity of John D. MacArthur State Recreation Area, in the vicinity of the Bingham Islands and at the north end of Hypoluxo Island. Corals and sponges are limited in occurrence to areas within close proximity to the inlets.

The submerged bottom resources inventory is presented on **Figure 9**. Field observations were made of the distribution of seagrasses, macro algae, oyster habitat, corals and sponges. Observations were made by snorkeling, use of an underwater viewer, and sample collections with a sharp tined double edged thatching rake. The results of additional surveys which have been conducted for dredge and fill project evaluation were included on the map. Combinations of species of seagrasses or algae are coded as mixed assemblages. Attached macro algal species include; *Caulerpa* species (*C. sertularioides, C. prolifera, C. mexicana), Udotea* sp., *Penicillus* sp., *Halimeda* sp., *Dictyota* sp., *Padina* sp., *Hypnea* sp., *Acanthophora spicifera.* Oyster habitat includes *Crassostrea* species (*C. virginica, C. rhizophorae*). Coral species include; *Siderastrea* sp., *Porites* sp., *Monastrea* sp., *Oculina* sp., *Leptogorgia setacea.* species of sponge include; *Cliona* sp. and *Spheciospongia vesparium.*

During field studies ERM observed a conspicuous absence of seagrasses on a shallow sand bar north of Munyon Island and in shallow areas north and south of the C-51 Canal. Exact causes are unknown, but may be related to sediment characteristics or inadequate water quality resulting from the effects of canal discharges and/or poor tidal flushing.

LEGEND


Halodule wrightii SHOAL GRASS


Halophila decipiens PADDLE GRASS
Halophila johnsonii JOHNSON'S SEAGRASS


MIXED Halodule wrightii AND Halophila SPECIES


Syringodium filiforme MANATEE GRASS


Thalassia testudinum TURTLE GRASS


ATTACHED MACRO – ALGAL SPECIES – INCLUDES: Caulerpa SPECIES (C. sertularioides, C. prolifera, C. mexicana), Udotea sp., Penicillus sp., Halimeda sp., Dictyota sp., Padina sp., Hypnea sp., Acanthophora spicifera


MIXED Halodule wrightii AND ATTACHED MACRO – ALGAL SPECIES

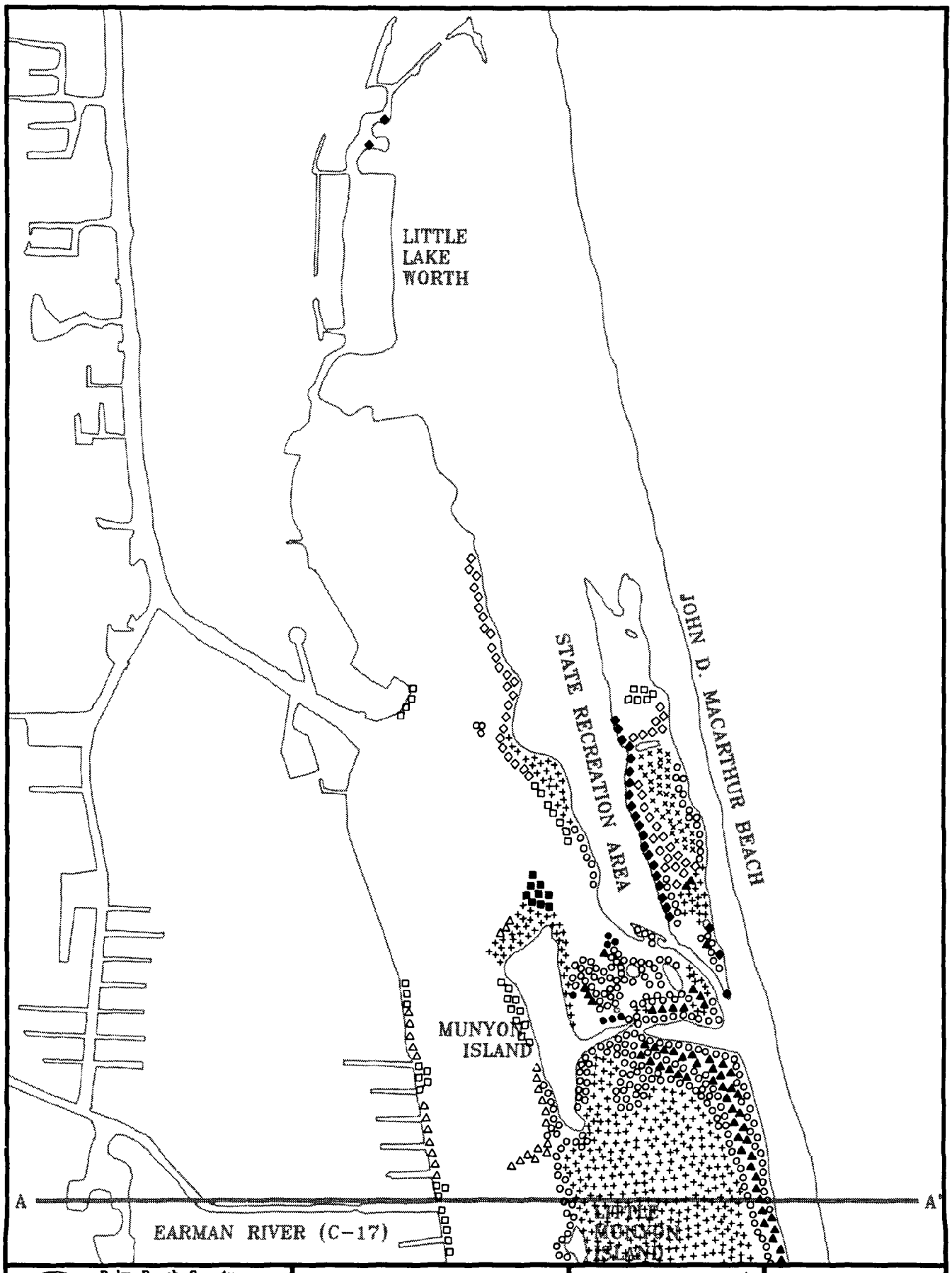

MIXED Halophila SPECIES AND ATTACHED MACRO – ALGAL SPECIES


MIXED Halodule wrightii, Halophila SPECIES AND ATTACHED MACRO – ALGAL SPECIES


Crassostrea SPECIES (C. virginica, C. rhizophorea) OYSTER BAR


CORALS (Siderastrea sp., Porites sp., Monastrea sp., Oculina sp., unidentified sp. SEA WHIP), AND SPONGES (Cliona sp. BORING SPONGE, Spheciospongia vesparium LOGGERHEAD SPONGE)

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* SUBMERGED NATURAL RESOURCES		D&M JOB NO. *20335-001-049* FIGURE *9-A*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

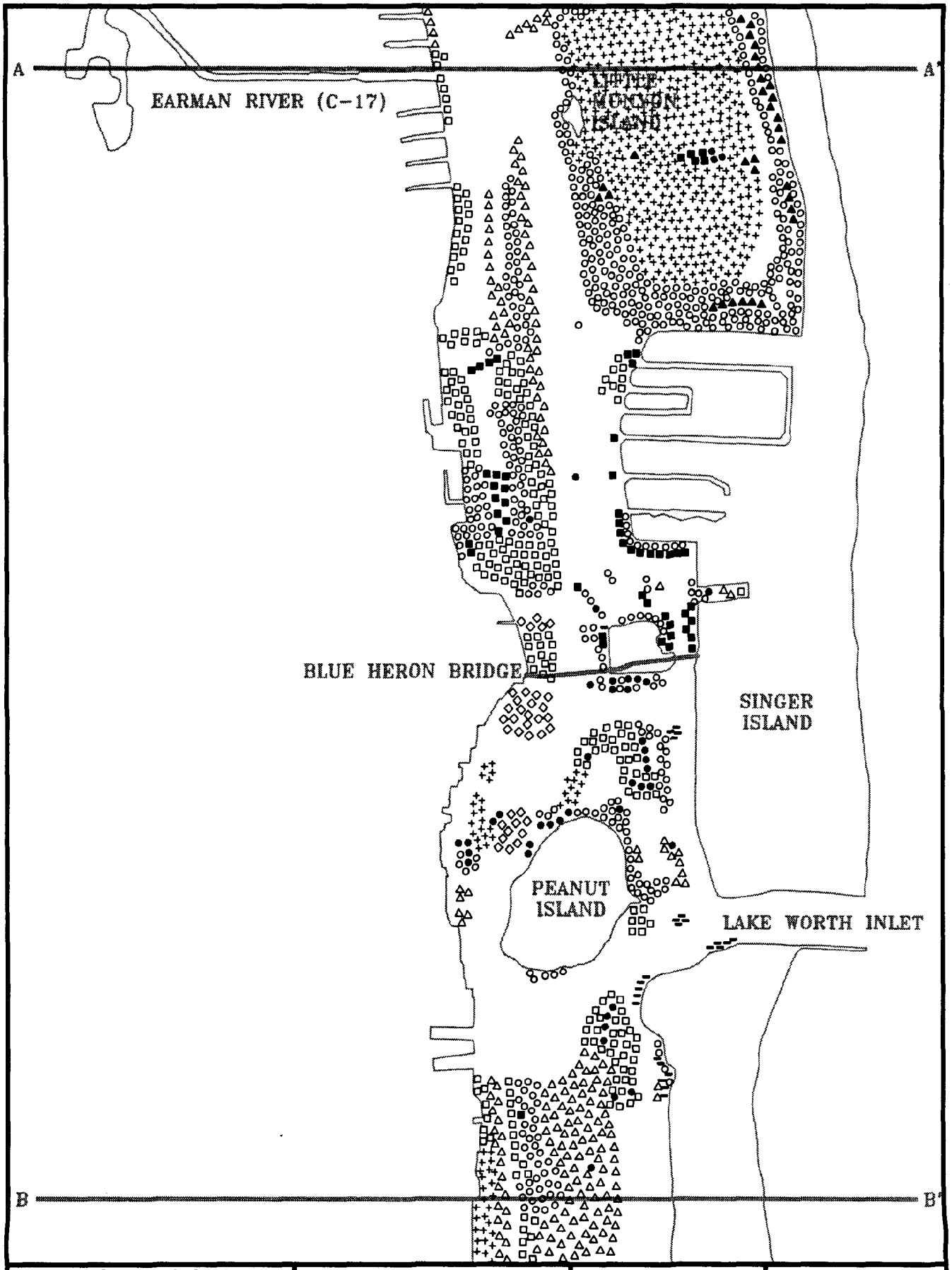
LAKE WORTH LAGOON

SUBMERGED
NATURAL RESOURCES

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
9-B



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SUBMERGED NATURAL RESOURCES

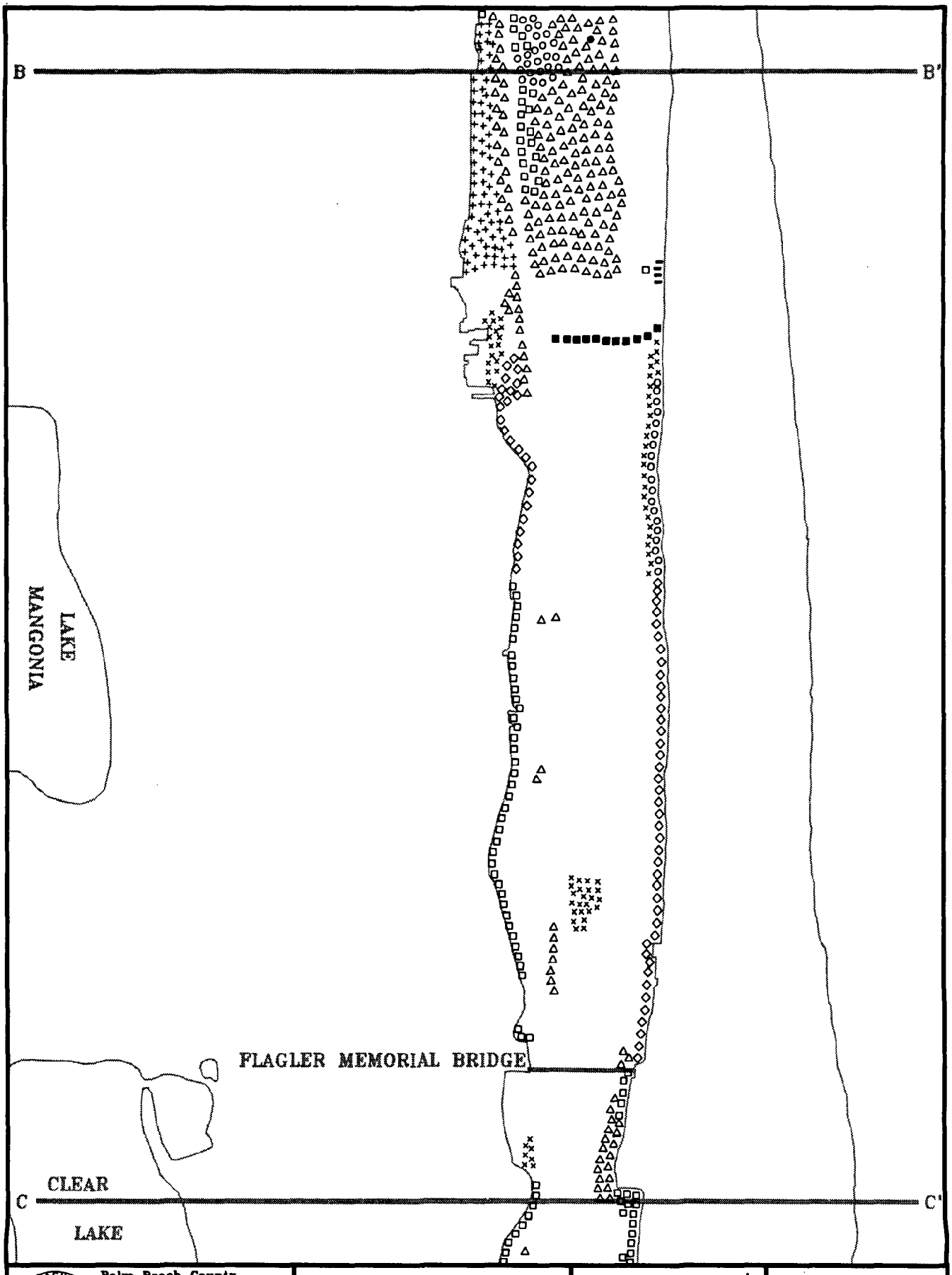
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *9-C*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

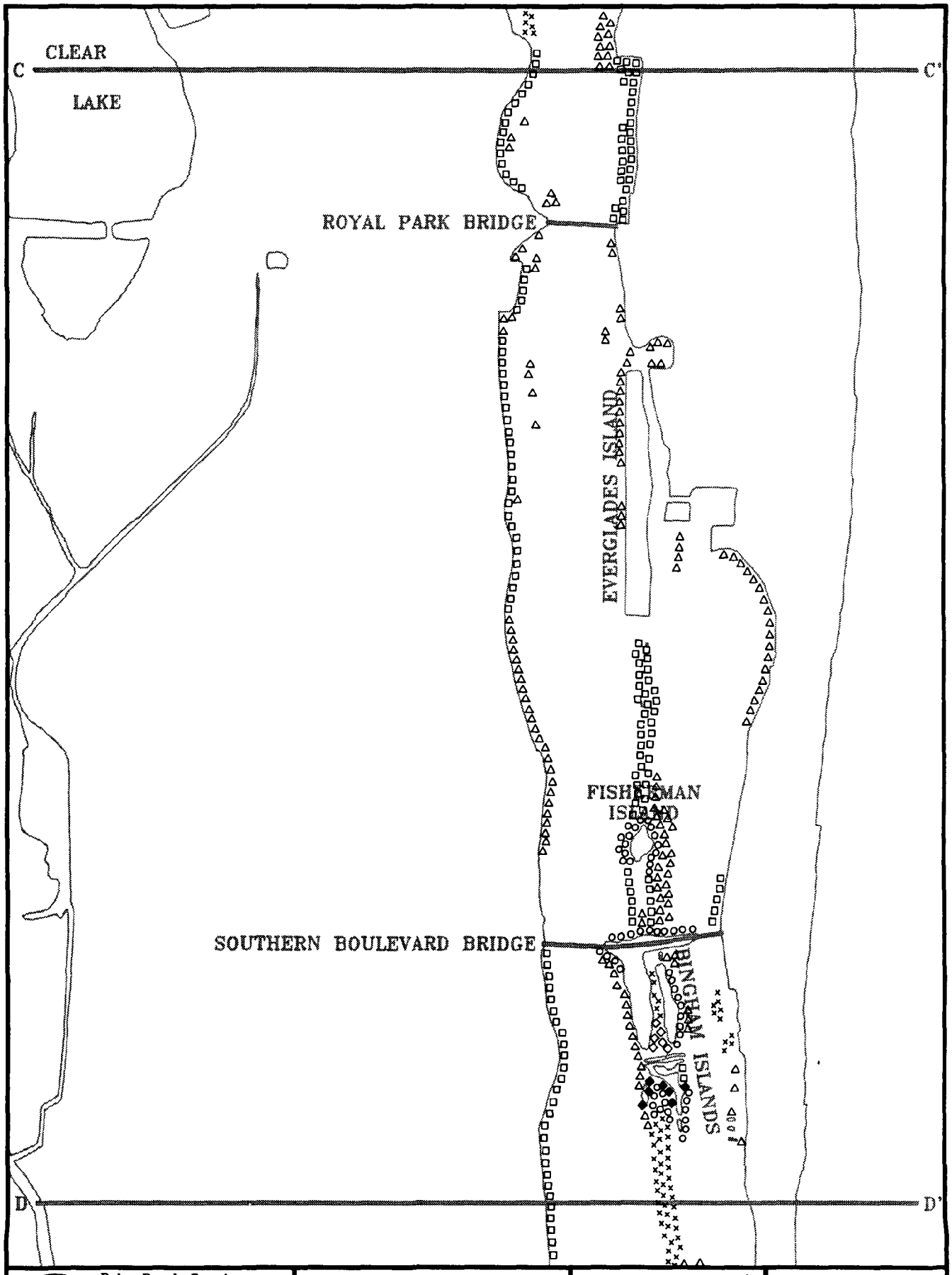
LAKE WORTH LAGOON

SUBMERGED
NATURAL RESOURCES

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
9-D



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SUBMERGED NATURAL RESOURCES

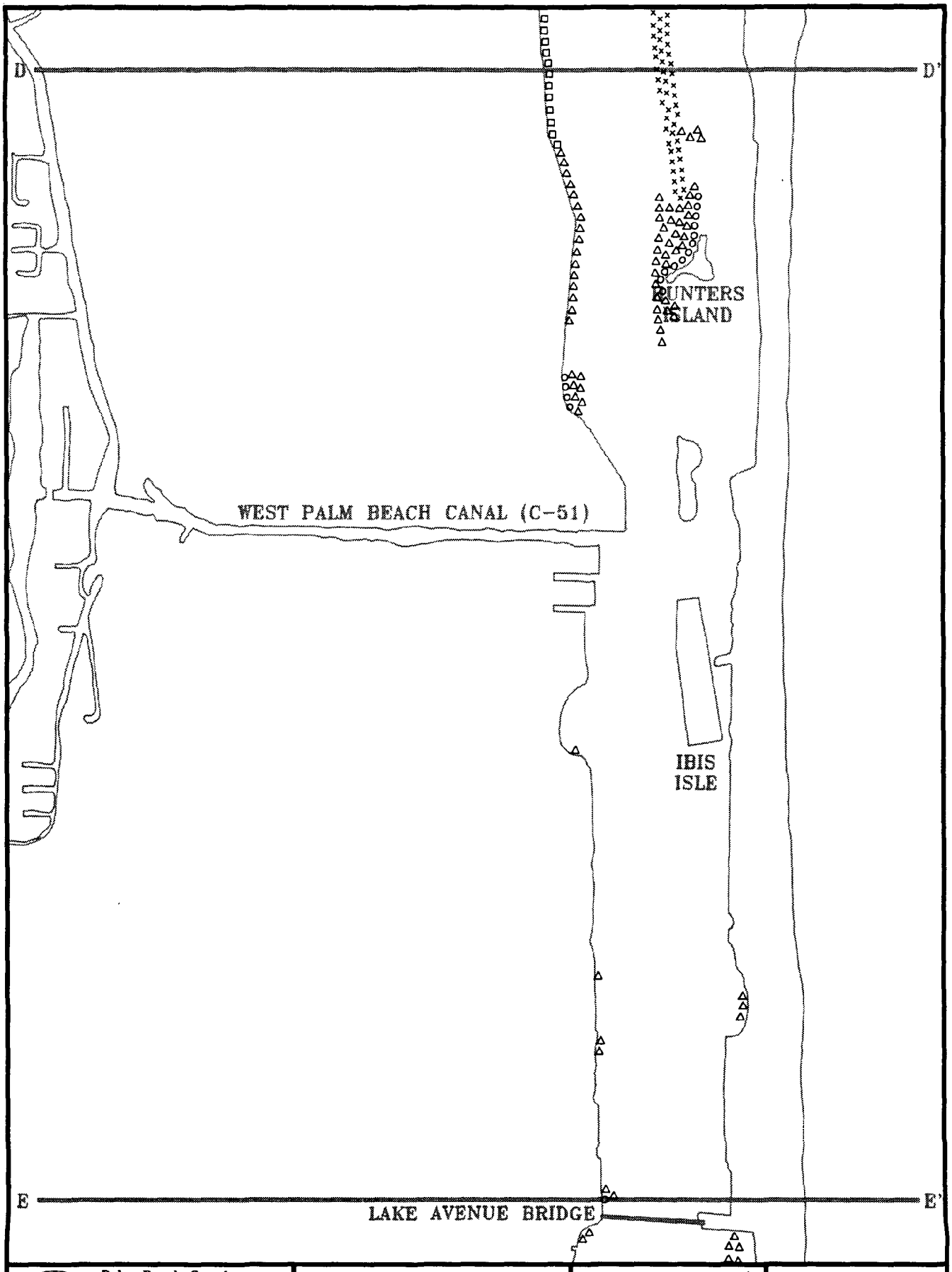
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *9-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SUBMERGED NATURAL RESOURCES

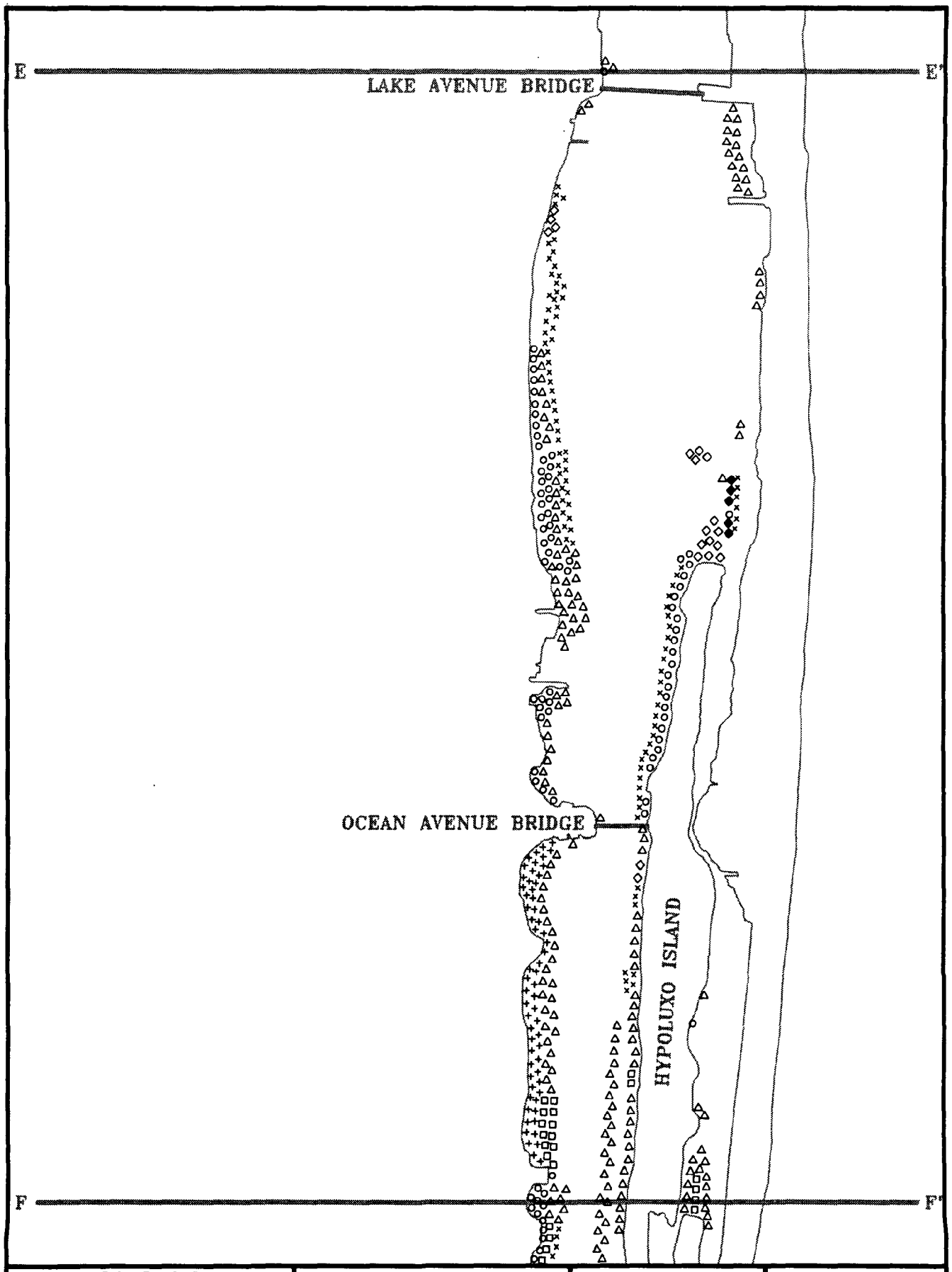
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *9-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

SUBMERGED NATURAL RESOURCES

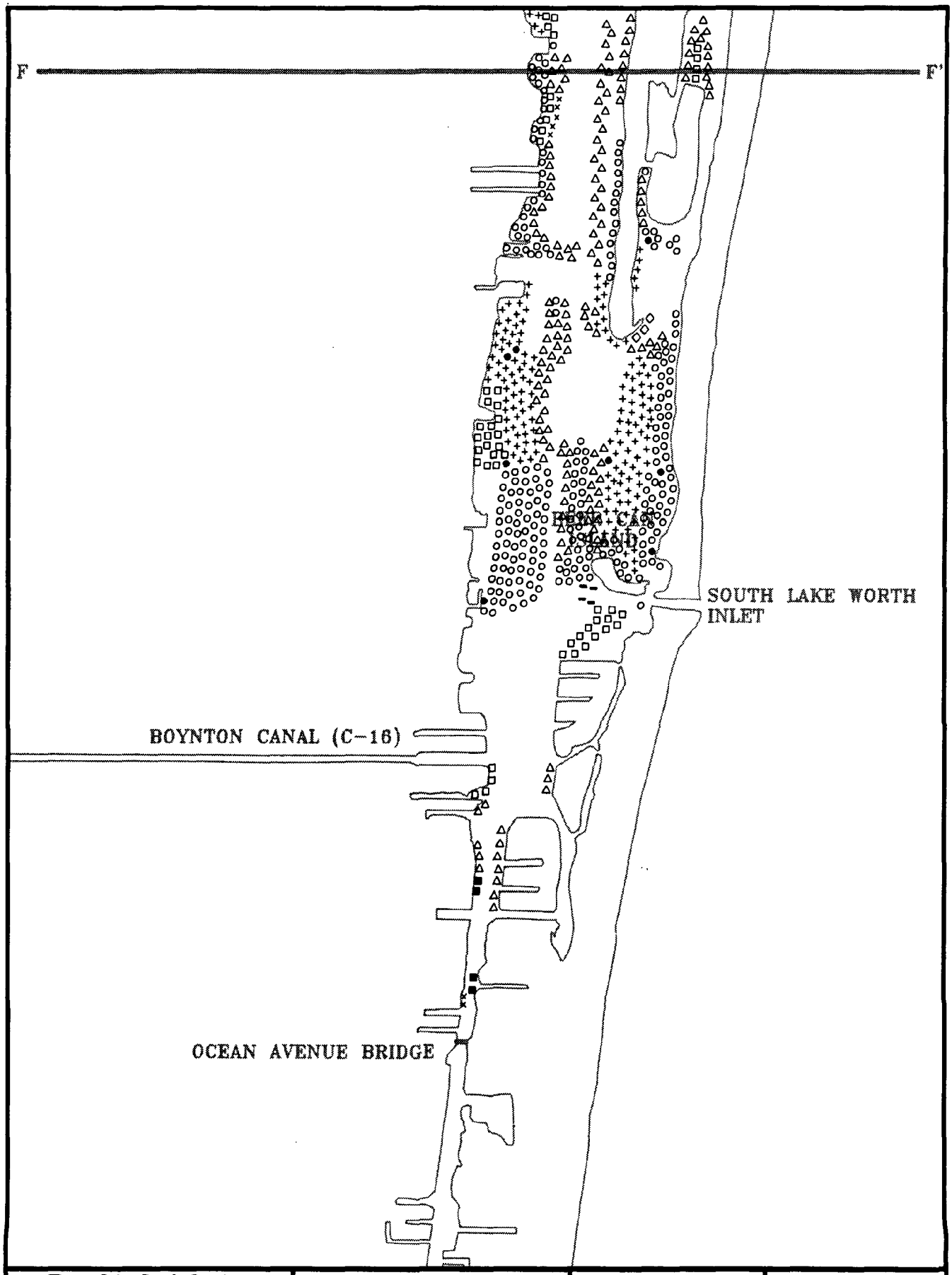
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *9-C*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

SUBMERGED
NATURAL RESOURCES

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
9-H

5.10 KNOWN OCCURRENCES OF FISH

Several studies of Lake Worth Lagoon's fish populations have been conducted over the past twenty years. **Table 6** is a list of 261 fish species which have been collected in Lake Worth Lagoon including fish species found in the vicinity of the inlets.

Both resident and transient populations are found in the lagoon, but population sizes as well as timing and nature of utilization by various species are largely unknown. Hedgepeth, 1985 collected the largest number of species during the month of July.

While conclusive data documenting the population trends of various fish species in Lake Worth Lagoon are not available, it is clear from review of historical accounts and catch records that commercial and recreational fisheries resources in the lagoon have greatly declined over the past forty years (Harris, et.al, 1983; Lewis et.al, 1985; McCrary et.al, 1985; WPB Fishing Club, 1990; Woodburn, 1961). The most likely reasons for fisheries declines are habitat destruction and water quality degradation which have been documented in other sections of this report. Improperly regulated fish harvesting is probably a contributing factor.

Table 7 is a compiled list of the 195 fish species collected in Lake Worth Lagoon. The list was phylogenetically arranged and each taxa was assigned a number. **Figure 10** depicts the locations of fish collections from Lake Worth Lagoon. The locations of stations or transects where fish were collected during six studies have been plotted on the map. The number codes for fish taxa listed on Table 7 are cited at the appropriate collecting sites. The literature source key includes code letters for each study used and code numbers to identify stations or transects. Included for each of these studies are the methods of collections and the dates the collections were made. The studies used to compile the table and map are: Hedgepeth, M., 1985; Herrema, D., J. Reed, and J. van Montfrans, 1973; Rehrer, R., 1977; Rogers, G.R., 1970; Tropical Ecosystems Inc., 1983; Woodburn, K., 1962.

The greatest numbers of fish species have been collected near Munyon Island, northwest of Palm Beach Shores, near Lake Worth Inlet, near Hunters Island and in the vicinity of South Lake Worth Inlet, all areas which contain some of the lagoon's most diverse marine habitats. It must be noted however, that sampling stations and frequencies tended to be more concentrated in those areas.

The total number of species collected in Lake Worth Lagoon (195), and in the lagoon including the vicinity of the inlets (261), is comparable to the total for the Loxahatchee River Area where 267 species have been collected (Christensen, 1965), to the Indian River Lagoon where 286 species have been collected (Gilmore et.al, 1981), and to Biscayne Bay where 193 species have been collected (DERM, 1984).

TABLE 6

LAKE WORTH FISH INCLUDING FISH FOUND IN THE VICINITY OF INLETS

I = Found in vicinity of inlets
T = Found throughout Lake Worth
* = Questionable identification (not known to occur in North America, R. Robins - personal communication).

	FAMILY GENUS, SPECIES	COMMON NAME
	BRANCHIOSTOMIDAE	
	Asymmetron sp.	lancelet
I	*Asymmetron lucayanum*	sharptail lancelet
	ORECTOLOBIDAE	
I	*Ginglymostoma cirratum*	nurse shark
	CARCHARHINIDAE	
I	*Carcharhinus brevipinna*	spinner shark
T	*Carcharhinus leucas*	bull shark
I	*Carcharhinus limbatus*	blacktip shark
I	*Carcharhinus obscurus*	dusky shark
I	*Negaprion brevirostris*	lemon shark
	SPHYRNIDAE	
I	*Sphyrna tiburo*	bonnethead
	PRISTIDAE	
I	*Pristis perotteti*	largetooth sawfish
	TORPEDINIDAE	
I	*Narcine brasiliensis*	lesser electric ray
	RAJIDAE	
I	*Raja eglanteria*	clearnose ray
	DASYATIDAE	
T	*Dasyatis americana*	southern stingray
T	*Dasyatis sabina*	Atlantic stingray
T	*Dasyatis sayi*	bluntnose stingray
T	*Gymnura micrura*	smooth butterfly ray
	MYLIOBATIDAE	
T	*Aetobatus narinari*	spotted eagle ray
T	*Rhinoptera bonasus*	cownose ray
	MOBULIDAE	
T	*Manta birostris*	Atlantic manta (juveniles)

	ELOPIDAE	
T	*Elops saurus*	ladyfish
T	*Megalops atlanticus*	tarpon
	ALBULIDAE	
I	*Albula vulpes*	bonefish (rare in Lake Worth)
	MURAENIDAE	
I	*Echidna catenata*	chain moray
T	*Gymnothorax funebris*	green moray
I	*Gymnothorax moringa*	spotted moray
I	*Muraena miliaris*	goldentail moray
I	*Uropterygius diopus*	marbled moray
	OPHICHTHIDAE	
T	*Myrophis punctatus*	speckled worm eel
	CLUPEIDAE	
	undetermined sp	
T	*Brevoortia smithi*	yellowfin menhaden
T	*Brevoortia tyrannus*	Atlantic menhaden
	Harengula sp.	sardine
I	*Harengula clupeola*	false pilchard
I	*Harengula humeralis*	redear sardine
T	*Harengula jaguana*	scaled sardine
I	*Jenkinsia lamprotaenia*	dwarf herring
	Jenkinsia majua	little-eye herring
T	*Opisthonema oglinum*	Atlantic thread herring
T	*Sardinella aurita*	spanish sardine
	ENGRAULIDAE	
	Anchoa sp.	anchovy
	Anchoa cayorum	Key anchovy
T	*Anchoa hepsetus*	striped anchovy
	Anchoa lamprotaenia	longnose anchovy
T	*Anchoa lyolepis*	dusky anchovy
T	*Anchoa mitchilli*	bay anchovy
	SYNODONTIDAE	
T	*Synodus foetens*	inshore lizardfish
I	*Trachinocephalus myops*	snakefish
	CYPRINIDAE	
T	*Notropis maculatus*	taillight shiner
	ARIIDAE	
T	*Ariopsis felis*	sea catfish
T	*Bagre marinus*	gafftopsail catfish
	BATRACHOIDIDAE	
T	*Opsanus beta*	gulf toadfish

	ANTENNARIIDAE	
I	*Antennarius ocellatus*	ocellated frogfish
T	*Antennarius scaber*	splitlure frogfish
I	*Histrio histrio*	sargassum fish
	OGCOCEPHALIDAE	
I	*Ogcocephalus nasutus*	shortnose batfish
I	*Ogcocephalus radiatus*	polka-dot batfish
	EXOCOETIDAE	
I	*Cypselurus heterurus*	Atlantic flyingfish
	HEMIRAMPHIDAE	
I	*Hemiramphus brasiliensis*	ballyhoo
I	*Hyporhamphus unifasciatus*	halfbeak
	BELONIDAE	
	Strongylura sp.	needlefish
T	*Strongylura marina*	Atlantic needlefish
T	*Strongylura notata*	redfin needlefish
T	*Strongylura timuca*	timucu
T	*Tylosurus acus*	agujon
	CYPRINODONTIDAE	
T	*Floridichthys carpio*	goldspotted killifish
T	*Fundulus confluentus*	marsh killifish
T	*Fundulus grandis*	gulf killifish
T	*Rivulus marmoratus*	rivulus
	POECILIIDAE	
T	*Heterandria formosa*	least killifish
T	*Poecilia latipinna*	sailfin molly
	ATHERINIDAE	
T	*Membras martinica*	rough silverside
T	*Menidia beryllina*	inland killifish
	FISTULARIIDAE	
I	*Fistularia tabacaria*	bluespotted cornetfish
	SYNGNATHIDAE	
T	*Hippocampus erectus*	lined seahorse
T	*Hippocampus zosterae*	dwarf seahorse
	Syngnathus sp.	pipefish
T	*Syngnathus floridae*	dusky pipefish
T	*Syngnathus louisianae*	chain pipefish
I	*Syngnathus pelagicus*	sargassum pipefish
T	*Syngnathus scovelli*	gulf pipefish

	SCORPAENIDAE	
I	*Scorpaena bergi*	goosehead scorpionfish
I	*Scorpaena calcarata*	smoothhead scorpionfish
T	*Scorpaena grandicornis*	plumed scorpionfish
	TRIGLIDAE	
	Prionotus sp.	Searobin
I	*Prionotus ophryas*	bandtail searobin
I	*Prionotus scitulus*	leopard searobin
I	*Prionotus tribulus*	bighead searobin
	CENTROPOMIDAE	
T	*Centropomus pectinatus*	tarpon snook
T	*Centropomus undecimalis*	common snook
	SERRANIDAE	
	Alphestes afer	mutton hamlet
I	*Diplectrum formosum*	sand perch
T	*Epinephelus itajara*	jewfish
I	*Epinephelus morio*	red grouper
I	*Hypoplectrus unicolor*	butter hamlet
I	*Serranus tigrinus*	harlequin bass
I	*Serranus tortugarum*	chalk bass
	PRIACANTHIDAE	
I	*Pristigenys alta*	short bigeye
	APOGONIDAE	
I	*Apogon binotatus*	barred cardinalfish
I	*Apogon pseudomaculatus*	twospot cardinalfish
I	*Apogon xenus*	sponge cardinalfish
I	*Phaeoptyx pigmentaria*	dusky cardinalfish
	POMATOMIDAE	
T	*Pomatomus saltatrix*	bluefish
	RACHYCENTRIDAE	
I	*Rachycentron canadum*	cobia
	ECHENEIDAE	
I	*Echeneis naucrates*	sharksucker
	CARANGIDAE	
	undetermined sp.	jack
I	*Alectis ciliaris*	African pompano
I	*Caranx bartholomaei*	yellow jack
I	*Caranx crysos*	blue runner
T	*Caranx hippos*	crevalle jack
T	*Caranx latus*	horse-eye jack
I	*Caranx ruber*	bar jack
I	*Decapterus macarellus*	mackerel scad
I	*Decapterus punctatus*	round scad

I	*Elagatis bipinnulata*	rainbow runner
T	*Oligoplites saurus*	leatherjacket
I	*Selar crumenophthalmus*	bigeye scad
T	*Selene vomer*	lookdown
I	*Seriola dumerili*	greater amberjack
	Trachinotus sp.	
I	*Trachinotus carolinus*	Florida pompano
T	*Trachinotus falcatus*	permit
	Trachinotus goodei	palometa
	CORYPHAENIDAE	
I	*Coryphaena hippurus*	dolphin
	LUTJANIDAE	
I	*Lutjanus analis*	mutton snapper
T	*Lutjanus apodus*	schoolmaster
I	*Lutjanus cyanopterus*	cubera snapper
T	*Lutjanus griseus*	mangrove (gray) snapper
T	*Lutjanus synagris*	lane snapper
I	*Ocyurus chrysurus*	yellowtail snapper
I	*Rhomboplites aurorubens*	vermilion snapper
	LOBOTIDAE	
T	*Lobotes surinamensis*	tripletail
	GERREIDAE	
T	*Diapterus sp.*	
T	*Diapterus auratus*	Irish pompano
T	*Diapterus plumieri*	striped mojarra
T	*Eucinostomus sp.*	mojarra
T	*Eucinostomus argenteus*	spotfin mojarra
T	*Eucinostomus gula*	silver jenny
T	*Eucinostomus harengulus*	tidewater mojarra
I	*Eucinostomus jonesi*	slender mojarra
T	*Eucinostomus melanopterus*	flagfin mojarra
T	*Gerres cinereus*	yellowfin mojarra
	Gerres sp.	mojarra
T	*Ulaema lefroyi*	mottled mojarra
	HAEMULIDAE	
I	*Anisotremus virginicus*	porkfish
	Haemulon sp.	grunt
I	*Haemulon album*	margate
T	*Haemulon aurolineatum*	tomtate
I	*Haemulon flavolineatum*	French grunt
I	*Haemulon macrostomum*	Spanish grunt
T	*Haemulon parrai*	sailors choice
I	*Haemulon plumieri*	white grunt
I	*Haemulon sciurus*	bluestriped grunt
I	*Haemulon striatum*	striped grunt
T	*Orthopris chrysoptera*	pigfish

	SPARIDAE	
	undertermined sp.	
T	*Archosargus probatocephalus*	sheepshead
T	*Archosargus rhomboidalis*	sea bream
I	*Calamus sp.*	porgy
I	*Calamus penna*	sheepshead porgy
	Diplodus argenteus	silver porgy
T	*Diplodus holbrooki*	spottail pinfish
T	*Lagodon rhomboides*	pinfish
	SCIAENIDAE	
	undetermined sp.	drum
T	*Bairdiella chrysoura*	silver perch
T	*Cynoscion arenarias*	sand seatrout
T	*Cynoscion nebulosus*	spotted seatrout
I	*Equetus acuminatus*	high-hat
I	*Equetus lanceolatus*	jackknife - fish (rare)
T	*Leiostomus xanthurus*	spot
I	*Menticirrhus americanus*	southern kingfish
T	*Micropogonias undulatus*	Atlantic croaker
I	*Odontoscion dentex*	reef croaker
T	*Pogonias cromis*	black drum
T	*Sciaenops ocellata*	red drum
I	*Umbrina coroides*	sand drum
	MULLIDAE	
I	*Mulloidichthys martinicus*	yellow goatfish
	KYPHOSIDAE	
T	*Kyphosus sectatrix*	Bermuda chub
	EPHIPPIDAE	
T	*Chaetodipterus faber*	Atlantic spadefish
	CHAETODONTIDAE	
I	*Chaetodon capistratus*	foureye butterflyfish
I	*Chaetodon ocellatus*	spotfin butterflyfish
I	*Chaetodon sedentarius*	reef butterflyfish (rare)
I	*Chaetodon striatus*	banded butterflyfish
	POMACANTHIDAE	
I	*Holacanthus bermudensis*	blue angelfish
I	*Holacanthus ciliaris*	queen angelfish
I	*Holacanthus tricolor*	rock beauty
I	*Pomacanthus arcuatus*	gray angelfish
I	*Pomacanthus paru*	French angelfish
	POMACENTRIDAE	
I	*Abudefduf saxatilis*	sergeant major
I	*Chromis cyanea*	blue chromis (rare)
I	*Chromis multilineata*	brown chromis

I	*Microspathodon chrysurus*	yellowtail damselfish (rare)
I	*Pomacentrus ? diencaeus (juvenile)*	longfin damselfish
I	*Pomacentrus dorsopunicans*	dusky damselfish
I	*Pomacentrus leucostictus*	beaugregory
I	*Pomacentrus planifrons*	threespot damselfish
I	*Pomacentrus partitus*	bicolor damselfish
I	*Pomacentrus variabilis*	cocoa damselfish
	LABRIDAE	
I	*Bodianus rufus*	Spanish hogfish
I	*Bodianus pulchellus*	spotfin hogfish (rare)
I	*Doratonotus megalepis*	dwarf wrasse
I	*Halichoeres garnoti*	yellowhead wrasse
I	*Halichoeres maculipinna*	clown wrasse
I	*Halichoeres pictus*	painted wrasse
I	*Halichoeres radiatus*	puddingwife
I	*Hemipteronotus novacula*	pearly razorfish
I	*Thalassoma bifasciatum*	bluehead wrasse
	SCARIDAE	
I	*Cryptomus roseus*	bluelip parrotfish
I	*Scarus croicensis*	striped parrotfish
I	*Scarus quacamaia*	rainbow parrotfish
I	*Scarus taeniopterus*	princess parrotfish
I	*Scarus vetula*	queen parrotfish
	Sparisoma sp.	parrotfish
I	*Sparisoma chrysopterum*	redtail parrotfish
I	*Sparisoma radians*	bucktooth parrotfish
I	*Sparisoma rubripinne*	redfin parrotfish
I	*Sparisoma viride*	stoplight parrotfish
	MUGILIDAE	
	Mugil sp.	mullet
T	*Mugil cephalus*	striped mullet
T	*Mugil curema*	white mullet
T	*Mugil gaimardianus*	redeye mullet
T	*Mugil trichodon*	fantail mullet
	SPHYRAENIDAE	
	Sphyraena sp.	
T	*Sphyraena barracuda*	great barracuda
T	*Sphyraena borealis*	northern sennet
T	*Sphyraena picudilla*	southern sennett
	POLYNEMIDAE	
I	*Polydactylus oligodon*	littlescale threadfin
	PISTOGNATHIDAE	
T	*Opistognathus maxillosus*	mottled jawfish

	CLINIDAE	
I	*Acanthemblemaria aspera*	roughhead blenny
I	*Coralliozetus bahamensis*	blackhead blenny (rare)
I	*Labrisomus nuchipinnis*	hairy blenny
T	*Paraclinus fasciatus*	banded blenny
T	*Paraclinus grandicomis*	horned blenny
I	*Paraclinus nigripinnis*	blackfin blenny
	BLENNIIDAE	
I	*Hypleurochilus aequipinnis*	oyster blenny
I	*Hypleurochilus bermudensis*	barred blenny
T	*Lupinoblennius nicholsi*	highfin blenny
	GOBIIDAE	
	undetermined sp.	goby
T	*Bathygobius soporator*	frillfin goby
I	*Coryphopterus glaucofraenum*	bridled goby
	Gobionellus sp.	goby
T	*Gobionellus boleosoma*	darter goby
T	*Gobionellus saepepallens*	dash goby
T	*Gobionellus smaragdus*	emerald goby
	Gobiosoma sp.	goby
T	*Gobiosoma bosci*	naked goby
I	*Gobiosoma gemmatum*	frecklefin goby*
I	*Gobiosoma longipala*	twoscale goby
I	*Gobiosoma oceanops*	neon goby
T	*Gobiosoma robustum*	code goby
T	*Lophogobius cyprinoides*	crested goby
T	*Microgobius gulosus*	clown goby
T	*Microgobius microlepis*	banner goby
	ACANTHURIDAE	
I	*Acanthurus chirurgus*	doctorfish
I	*Acanthurus coeruleus*	blue tang
	SCOMBRIDAE	
	Scomberomorus cavalla	king mackerel
	Scomberomorus maculatus	spanish mackerel
	Scomberomorus regalis	cero
	STROMATEIDAE	
I	*Psenes cyanophrys*	freckled driftfish
	BOTHIDAE	
	Bothus sp.	flounder
I	*Bothus ocellatus*	eyed flounder
T	*Citharichthys macrops*	spotted whiff
T	*Citharichthys spilopterus*	bay whiff
T	*Paralichthys albigutta*	gulf flounder
	Syacium sp.	flounder
T	*Syacium micrurum*	channal flounder
T	*Syacium papillosum*	dusky flounder

	SOLEIDAE	
T	*Achirus lineatus*	line sole
I	*Gymnachirus melas*	naked sole
	CYNOGLOSSIDAE	
	Symphurus sp.	tonguefish
T	*Symphurus arawak*	Caribbean tonguefish
T	*Symphurus plagiusa*	blackcheek Tonguefish
	BALISTIDAE	
	Balistes sp.	triggerfish
I	*Canthidermis maculatus*	rough triggerfish
	MONACANTHIDAE	
I	*Aluterus scriptus*	scrawled filefish
I	*Cantherhines pullus*	orange spotted filefish
	Monacanthus sp.	filefish
T	*Monacanthus ciliatus*	fringed filefish
T	*Monacanthus hispidus*	planehead filefish
	OSTRACIIDAE	
T	*Acanthostracion quadricornis*	scrawled cowfish
	Lactophrys sp.	trunkfish
I	*Lactophrys bicaudalis*	spotted trunkfish
T	*Lactophrys trigonus*	trunkfish
T	*Rhinesomus triqueter*	smooth trunkfish
	TETRAODONTIDAE	
I	*Canthigaster rostrata*	sharpnose puffer
	Sphoeroides sp.	puffer
I	*Sphoeroides dorsalis*	marbled puffer
T	*Sphoeroides nephelus*	southern puffer
T	*Sphoeroides spengleri*	bandtail puffer
T	*Sphoeroides testudineus*	checkered puffer
	DIODONTIDAE	
T	*Chilomycterus schoepfi*	striped burrfish
I	*Diodon histrix*	porcupinefish

TABLE 7

FISH COLLECTED IN LAKE WORTH LAGOON

MAP #	FAMILY GENUS, SPECIES	COMMON NAME
	BRANCHIOSTOMIDAE	
1.	*Asymmetron sp.*	lancelet
2.	*Asymmetron lucayanum*	sharptail lancelet
	CARCHARHINIDAE	
3.	*Carcharhinus limbatus*	blacktip shark
	RAJIDAE	
4.	*Raja eglanteria*	clearnose ray
	DASYATIDAE	
5.	*Dasyatis americana*	southern stingray
6.	*Dasyatis sabina*	Atlantic stingray
7.	*Dasyatis sayi*	bluntnose stingray
8.	*Gymnura micrura*	smooth butterfly ray
	ELOPIDAE	
9.	*Elops saurus*	ladyfish
	MEGALOPIDAE	
10.	*Megalops atlanticus*	tarpon
	ALBULIDAE	
11.	*Albula vulpes*	bonefish
	OPHICHTHIDAE	
12.	*Myrophis punctatus*	speckled worm eel
	CLUPEIDAE	
13.	*undetermined sp*	
14.	*Brevoortia smithi*	yellowfin menhaden
15.	*Brevoortia tyrannus*	Atlantic menhaden
16.	*Harengula sp.*	sardine
17.	*Harengula clupeola*	false pilchard
18.	*Harengula humeralis*	redear sardine
19.	*Harengula jaguana*	scaled sardine
20.	*Jenkinsia lamprotaenia*	dwarf herring
21.	*Jenkinsia majua*	little-eye herring
22.	*Opisthonema oglinum*	Atlantic thread herring
23.	*Sardinella avrita*	spanish sardine
	ENGRAVLIDAE	
24.	*Anchoa sp.*	anchovy
25.	*Anchoa cayorum*	key anchovy
26.	*Anchoa hepsetus*	striped anchovy
27.	*Anchoa lyolepis*	dusky anchovy
28.	*Anchoa mitchilli*	bay anchovy
	SYNODONTIDAE	
29.	*Synodus foetens*	inshore lizardfish
30.	*Trachinocephalus myops*	snakefish
	CYPRINIDAE	
31.	*Notropis maculatus*	taillight shiner

	ARIIDAE	
32.	*Ariopsis felis*	sea catfish
33.	*Bagre marinus*	gafftopsail catfish
	BATRACHOIDIDAE	
34.	*Opsanus beta*	gulf toadfish
	ANTENNARIIDAE	
35.	*Antennarius ocellatus*	ocellated frogfish
36.	*Histrio histrio*	sargassum fish
37.	*Antennaris scaber*	splitlure frogfish
	OGCOCEPHALIDAE	
38.	*Ogcocephalus radiatus*	polkadot batfish
39.	*Ogcocephalus nasutus*	shortnose batfish
	HEMIRAMPHIDAE	
40.	*Hypolhamphus unifasciatus*	halfbeak
	BELONGIDAE	
41.	*Strongylura sp.*	needlefish
42.	*Strongylura marina*	Atlantic needlefish
43.	*Strongylura notata*	redfin needlefish
44.	*Strongylura timuca*	timucu
45.	*Tylosurus acus*	agujon
	CYPRINODONTIDAE	
46.	*Floridichthys carpio*	goldspotted killifish
47.	*Fundulus confluentus*	marsh killifish
48.	*Fundulus grandis*	gulf killifish
	POECILIIDAE	
49.	*Heterandria formosa*	least killifish
50.	*Poecilia latipinna*	sailfin molly
	ATHERINIDAE	
51.	*Membras martinica*	rough silverside
52.	*Menidia beryllina*	tidewater silverside
	FISTULARIIDAE	
53.	*Fistularia tabacaria*	bluespotted cornetfish
	SYNGNATHIDAE	
54.	*Hippocampus erectus*	lined seahorse
55.	*Hippocampus zosterae*	dwarf seahorse
56.	*Syngnathus sp.*	pipefish
57.	*Syngnathus floridae*	dusky pipefish
58.	*Syngnathus louisianae*	chain pipefish
59.	*Syngnathus pelagicus*	sargassum pipefish
60.	*Syngnathus scovelli*	gulf pipefish
	SCORPAENIDAE	
61.	*Scorpaena bergi*	goosehead scorpionfish
62.	*Scorpaena calcarata*	smoothhead scorpionfish
63.	*Scorpaena grandicornis*	plumed scorpionfish
	TRIGLIDAE	
64.	*Preionotus sp.*	Searobin
65.	*Prionotus ophryas*	bandtail searobin
66.	*Prionotus scitulus*	leopard searobin
67.	*Prionotus tribulus*	bighead searobin
	CENTROPOMIDAE	
68.	*Centropomus pectinatus*	tarpon snook
69.	*Centropomus undecimalis*	common snook

	SERRANIDAE	
70.	*Diplectrum formosum*	sand perch
	PRIACANTHIDOE	
71.	*Pristigenys alta*	short bigeye
	APOGONIDOE	
72.	*Apogon pseudomaculatus*	twospot cardinalfish
73.	*Phaeoptyx pigmentaria*	dusky cardinalfish
	POMATOMIDAE	
74.	*Pomatomus saltatrix*	bluefish
	CARANGIDAE	
75.	*undetermined sp.*	jack
76.	*Carany bartholomaei*	yellowjack
77.	*Caranx cuysos*	blue runner
78.	*Carany hippos*	crevalle jack
79.	*Carany latus*	horse-eye jack
80.	*Decapterus macarellus*	mackerel scad
81.	*Decapterus punctatus*	round scad
82.	*Oligoplites saurus*	leatherjacket
83.	*Selene vomer*	lookdown
84.	*Seriola sp.*	amberjack
85.	*Trachinotus sp.*	_____
86.	*Trachinotus carolinus*	Florida pompano
87.	*Trachinotus Falcatus*	permit
	CORYPHAENIDAE	
88.	*Coryphaena hippurus*	dolphin
	LUTJANIDAE	
89.	*Lutjanus analis*	mutton snapper
90.	*Lutjanus apodus*	schoolmaster
91.	*Lutjanus griseus*	mangrove (gray) snapper
92.	*Lutjanus synagris*	lane snapper
93.	*Rhomboplites aurorubens*	vermilion snapper
	LOBOTIDAE	
94.	*Lobotes surinamensis*	tripletail
	GERREIDAE	
95.	*Diapterus sp.*	_____
96.	*Diapterus auratus*	Irish pompano
97.	*Diapterus plumieri*	striped mojarra
98.	*Eucinostomus sp.*	mojarra
99.	*Eucinostomus argenteus*	spotfin mojarra
100.	*Eucinostomus gula*	silver jenny
101.	*Eucinostomus harengulus*	tidewater mojarra
102.	*Eucinostomus jonesii*	slender mojarra
103.	*Eucinostomus melanopterus*	flagfin mojarra
104.	*Gerres cinereus*	yellowfin mojarra
105.	*Gerres sp.*	mojarra
106.	*Ulaema lefroyi*	mottled mojarra
	POMADASYIDAE	
107.	*Haemulon sp.*	grunt
108.	*Haemulon aurolineatum*	tomtate
109.	*Haemulon flavolineatum*	French grunt
110.	*Haemulon macrostomum*	spanish grant
111.	*Haemulon parrai*	sailors choice
112.	*Haemulon sciurus*	bluestriped grunt
113.	*Haemulon striatum*	striped grunt
114.	*Orthopris chrysoptera*	pigfish

	SPARIDAE	
115.	*undertermined sp.*	
116.	*Archosargus probatocephalus*	sheepshead
117.	*Archosargus rhomboidalis*	sea bream
118.	*Calamus sp.*	porgy
119.	*Calamus penna*	sheepshead porgy
120.	*Diplodus holbrooki*	spottail pinfish
121.	*Lagodon rhomboides*	pinfish
	SCIAENIDAE	
122.	*undetermined sp.*	drum
123.	*Bairdiella chrysoura*	silver perch
124.	*Cynoscion arenarios*	sand seatrout
125.	*Cynoscion nebulosus*	spotted seatrout
126.	*Leiostomus xanthurus*	spot
127.	*Menticirrhus americanus*	southern kingfish
128.	*Micropogonias undulatus*	Atlantic croaker
129.	*Odontoscion dentex*	reef croaker
130.	*Pogonias cromis*	black drum
131.	*Sciaenops ocellata*	red drum
132.	*Umbrina coroides*	sand drum
	EPHIPPIDAE	
133.	*Chaetodipterus faber*	Atlantic spadefish
	POMACANTHIDAE	
134.	*Pomacuathus arcuatus*	gray anglefish
	POMACENTRIDAE	
135.	*Abudefduf saxatilis*	sergeant major
	LABRIDAE	
136.	*Halichoeres maculipinna*	clown wrasse
137.	*Hemipteronotus novacula*	pearly razorfish
	SCARIDAE	
138.	*Cryptomus roseus*	bluelip parrotfish
139.	*Sparisoma sp.*	parrotfish
140.	*Sparisoma chrysopterum*	redtail parrotfish
141.	*Sparisoma radians*	bucktooth parrotfish
	MUGILIDAE	
142.	*Mugil sp.*	mullet
143.	*Mugil cephalus*	striped mullet
144.	*Mugil curema*	white mullet
145.	*Mugil gaimardianus*	redeye mullet
146.	*Mugil trichodon*	fantail mullet
	SPHYRAENIDAE	
147.	*Sphyraena sp.*	
148.	*Sphyraena barracuda*	great barracuda
149.	*Sphyraena borealis*	northern sennet
150.	*Sphyraena picudilla*	southern sennett
	POLYNEMIDAE	
151.	*Polydactylus oligodon*	littlescale threadfin
	CLINIDAE	
152.	*Paraclinus fasciatus*	banded blenny
	BLENNIIDAE	
153.	*Lupinoblennius nicholsi*	highfin blenny

	GOBIIDAE	
154.	*undetermined sp.*	goby
155.	*Bathygobius soporator*	frillfin goby
156.	*Coryphopterus glaucofraenum*	bridled goby
157.	*Gobionellus sp.*	goby
158.	*Gobionellus boleosoma*	darter goby
159.	*Gobionellus smaragdus*	emerald goby
160.	*Gobiosoma sp.*	goby
161.	*Gobiosoma bosci*	naked goby
162.	*Gobiosoma longipala*	twoscale goby
163.	*Gobiosoma gemmatum*	frecklefin goby
164.	*Gobiosoma robustum*	code goby
165.	*Lophogobius cyprinoides*	crested goby
166.	*Microgobius gulosus*	clown goby
167,	*Microgobius microlepis*	banner goby
	NOMEIDAE	
168.	*Psenes cyanophrys*	freckled driftfish
	BOTHIDAE	
169.	*Bothus sp.*	flounder
170.	*Bothus ocellatus*	eyed flounder
171.	*Citharichthys macrops*	spotted whiff
172.	*Citharichthys spilopterus*	bay whiff
173.	*Paralichthys albigutta*	gulf flounder
174.	*Syacium sp.*	flounder
175.	*Syacium micrurum*	channal flounder
176.	*Syacium papillosum*	dusky flounder
	SOLEIDAE	
177.	*Achirus lineatus*	line sole
	CYNOGLOSSIDAE	
178.	*Symphurus sp.*	tonguefish
179.	*Symphurus arawak*	caribbean tonguefish
180.	*Symphurus plagiusa*	blackcheek tonguefish
	BALISTIDAE	
181.	*Balistes sp.*	triggerfish
	MONACANTHIDAE	
182.	*Aluterus scriptus*	scrawled filefish
183.	*Monacanthus sp.*	filefish
184.	*Monacanthus ciliatus*	fringed filefish
185.	*Monacanthus hispidus*	planehead filefish
	OSTRACIIDAE	
186.	*Acanthostracion guadricornis*	scrawled cowfish
187.	*Lactophrys sp.*	trunkfish
188.	*Lactophrys trigonus*	trunkfish
189.	*Lactophrys trigueter*	smooth trunkfish
	TETRAODONTIDAE	
190.	*Sphoeroides sp.*	puffer
191.	*Sphoeroides nephelus*	southern puffer
192.	*Sphoeroides spengleri*	bandtail puffer
193.	*Sphoeroides testudineus*	checkered puffer
	DIODONTIDAE	
194.	*Chilomycterus schoepfi*	striped burrfish
195.	*Diodon histrix*	porcupinefish

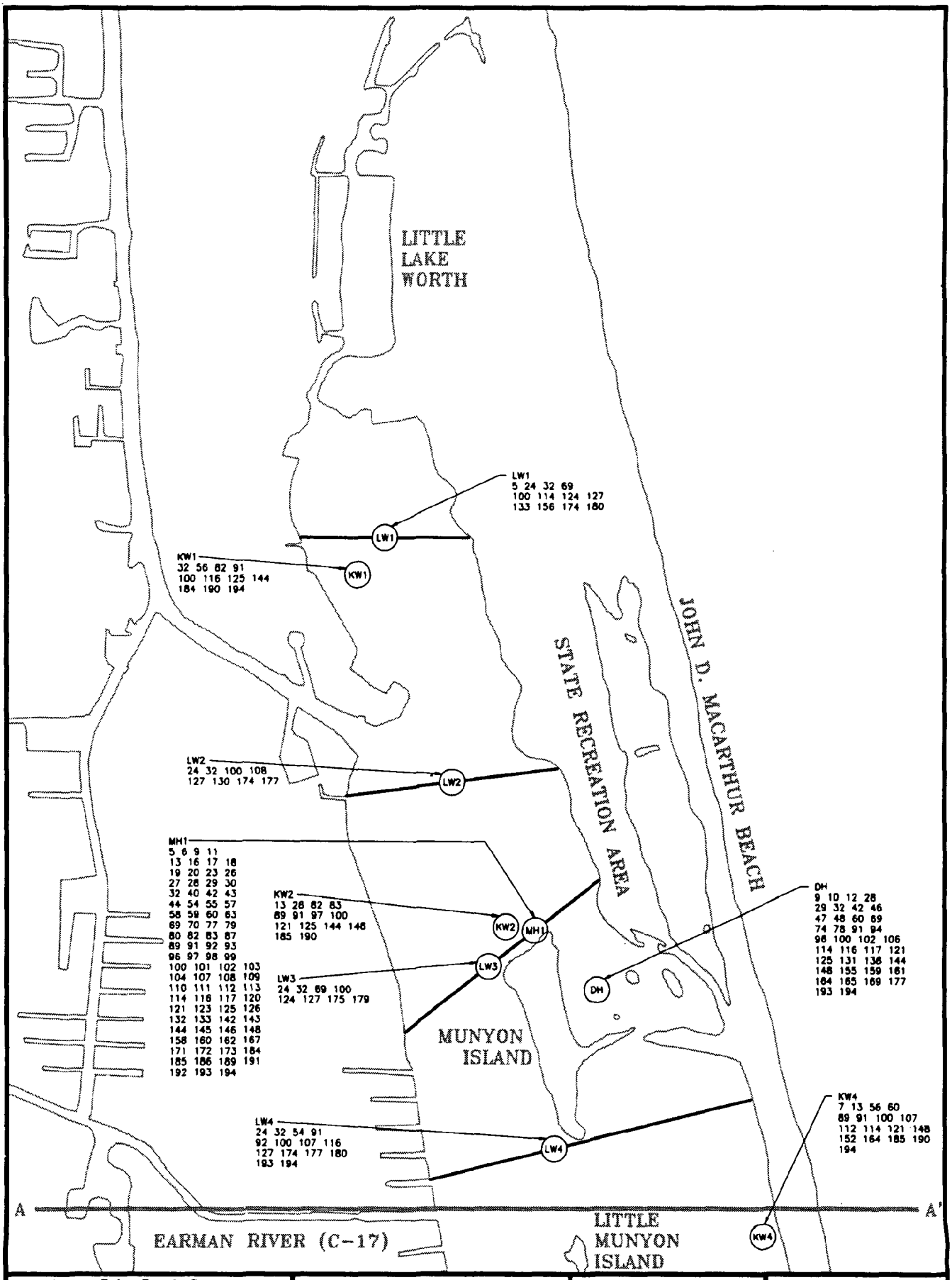
*Questionable identification (not known to occur in North America)

LEGEND

DEIS = DEIS, D., R. WALESKY, H. RUDOLPH, 1983. AREA PLANNING BOARD STUDY – UNPUBLISHED	BENTHIC SAMPLE IN AUGUST 1982.
MH# = HEDGEPETH, M., 1985. FLA DNR STUDY – UNPUBLISHED	DAY SEINE TRAWLS BIWEEKLY BETWEEN SEPTEMBER 1982 AND AUGUST 1983.
DH = HERREMA, D., J. REED, AND J. VAN MONTFRANS, 1973. – UNPUBLISHED	COLLECTIONS BY ROTENONE, DIP NETS AND SEINE TRAWLS, DAYTIME IN DECEMBER 1972, AND JANUARY 1973
RR# = REHRER, R., 1977. UNIV. OF MIAMI STUDY – UNPUBLISHED	DAY TRAWLS, DAY AND NIGHT GILL NETS COLLECTED DURING MAY AND OCTOBER 1973 AND 1974, AUGUST 1974 AND JANUARY 1975.
LW# = ROGERS, R., 1970. US EPA STUDY – UNPUBLISHED	NIGHT TRAWLS COLLECTED BETWEEN JULY 29 AND AUGUST 30, 1970.
KW# = WOODBURN, K., 1962. FLA BOARD OF CONSERVATION STUDY – UNPUBLISHED	COLLECTIONS BY SEINE TRAWLS AND PUSHNETS DAYTIME IN AUGUST 1961.

Numbers Correspond To Fish Taxa Listed In Table 7

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* KNOWN OCCURRENCES OF FISH		D&M JOB NO. *20335-001-049* FIGURE *10-A*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

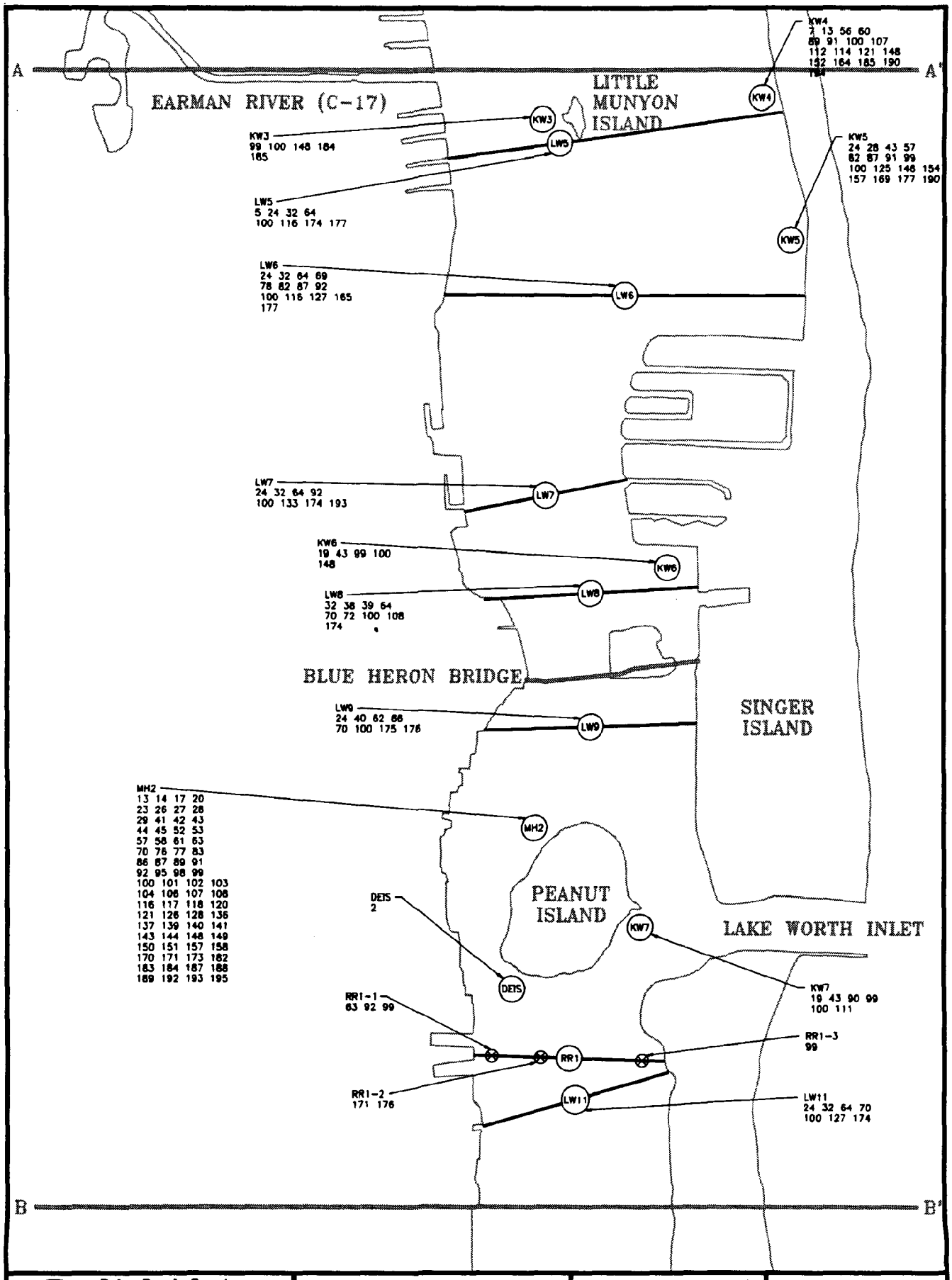
LAKE WORTH LAGOON

KNOWN OCCURRENCES
OF FISH

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
10-B



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

KNOWN OCCURRENCES OF FISH

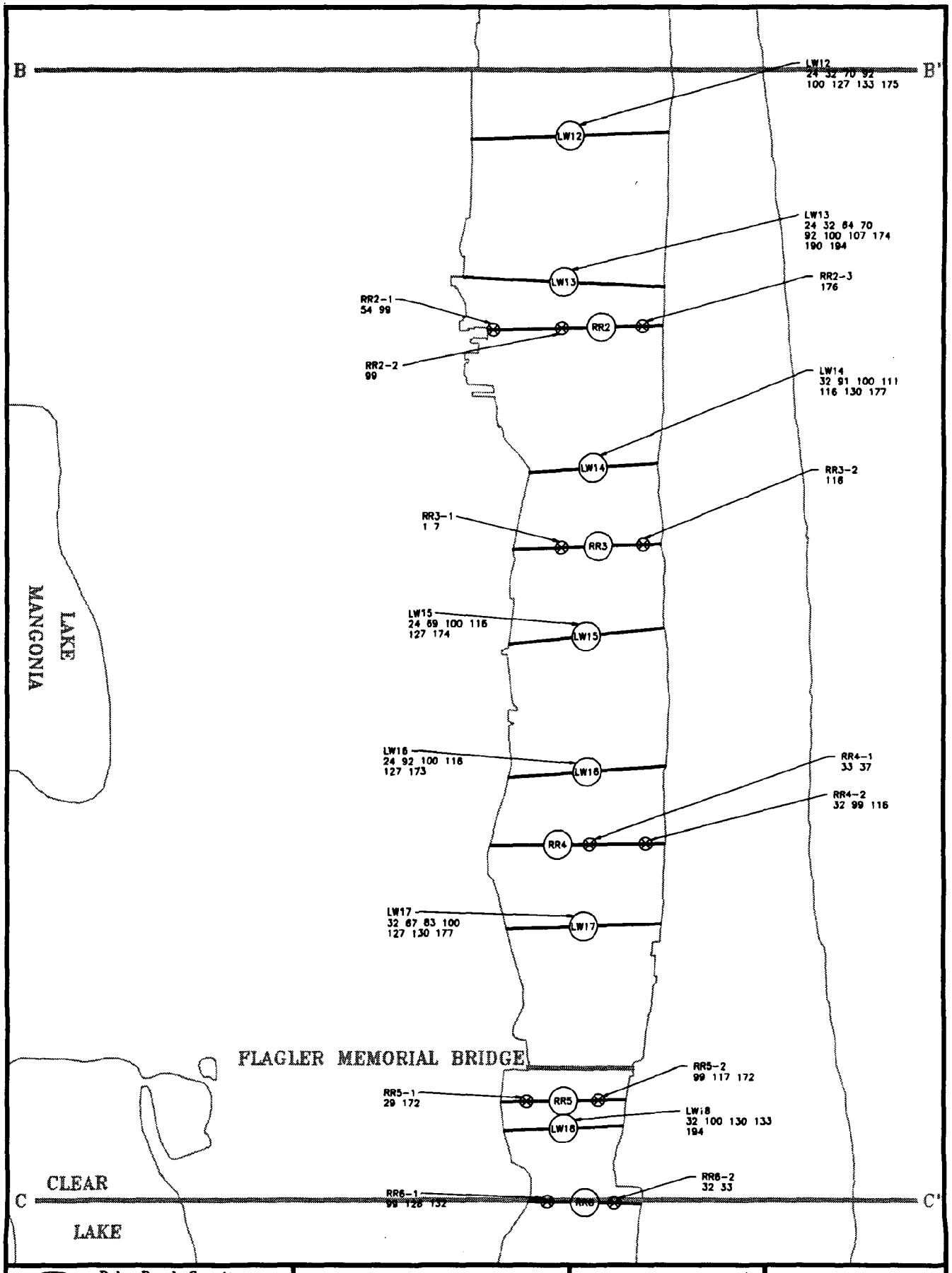
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *10-C*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

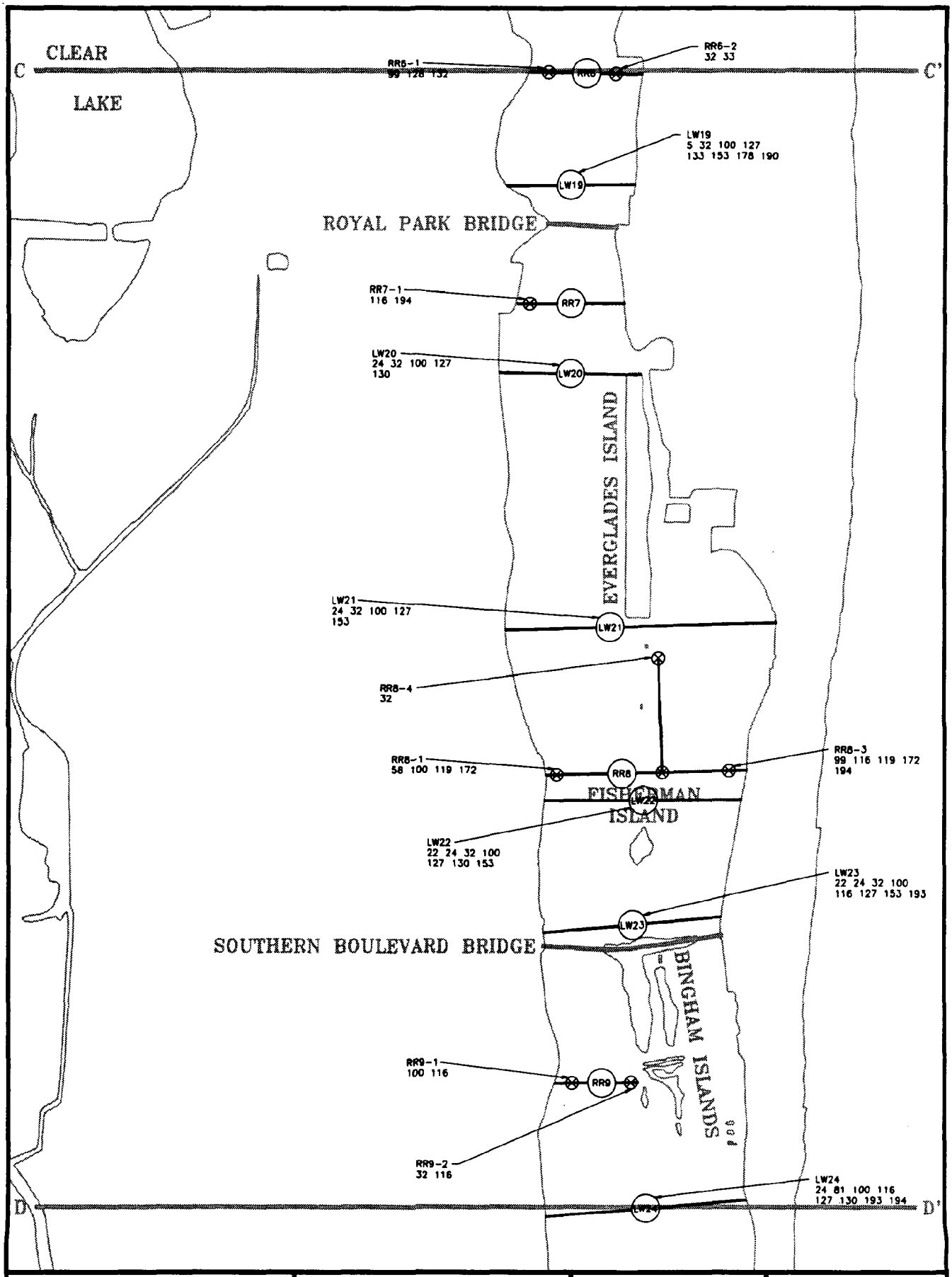
KNOWN OCCURRENCES
OF FISH

0 1000 2000
SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
10-D



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

KNOWN OCCURRENCES OF FISH

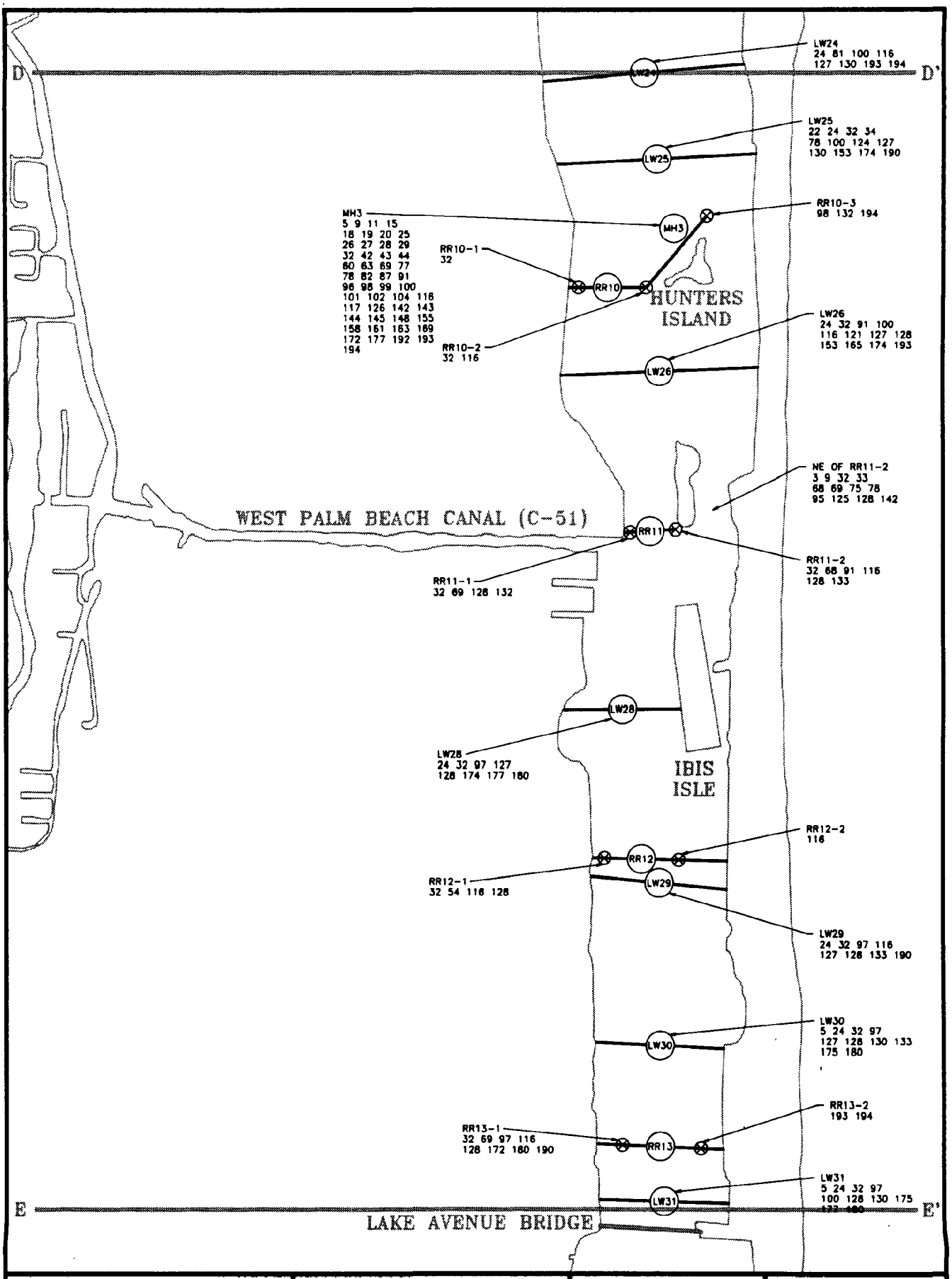
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *10-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

KNOWN OCCURRENCES OF FISH

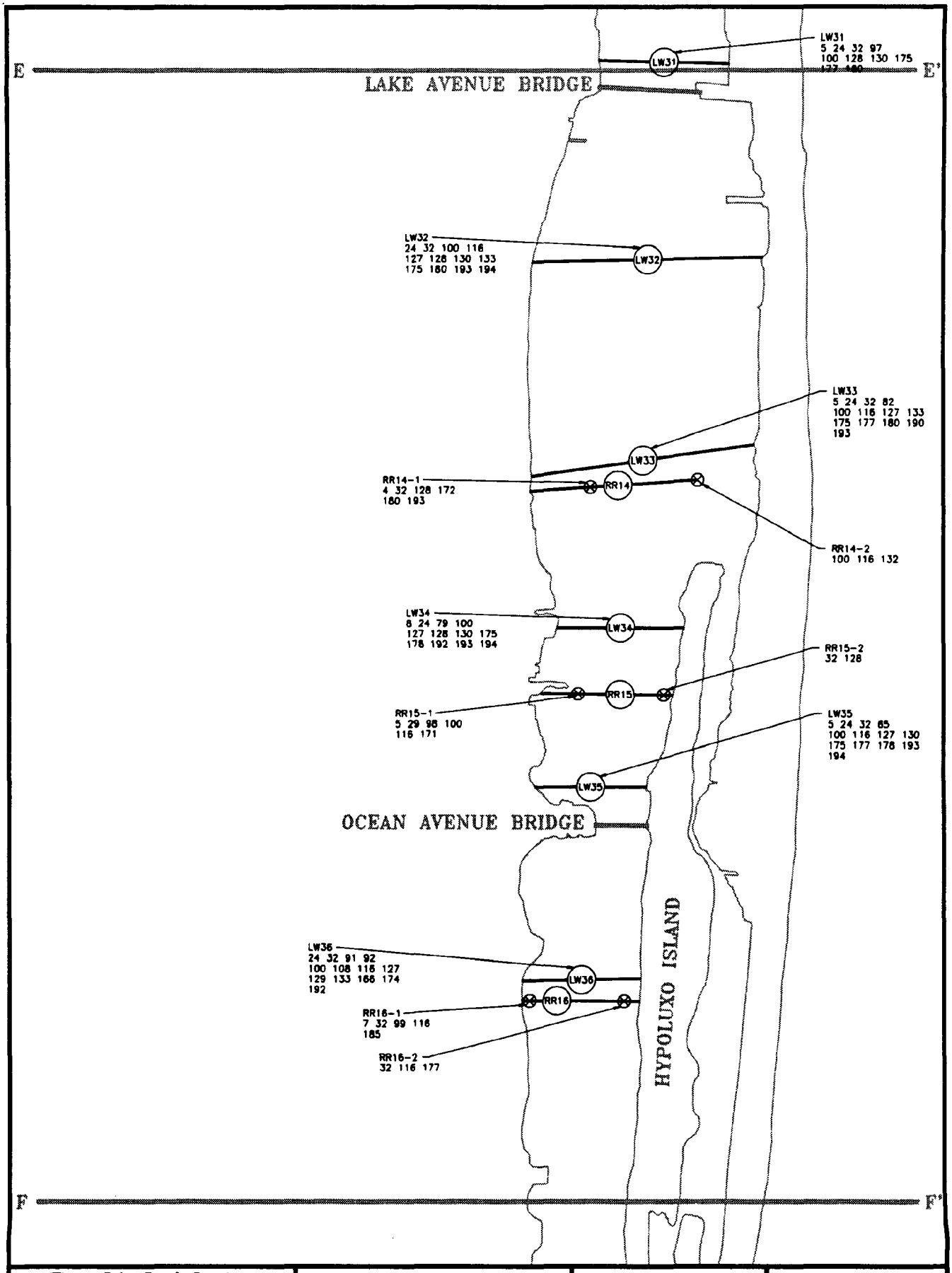
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20395-001-049*

FIGURE *10-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

KNOWN OCCURRENCES OF FISH

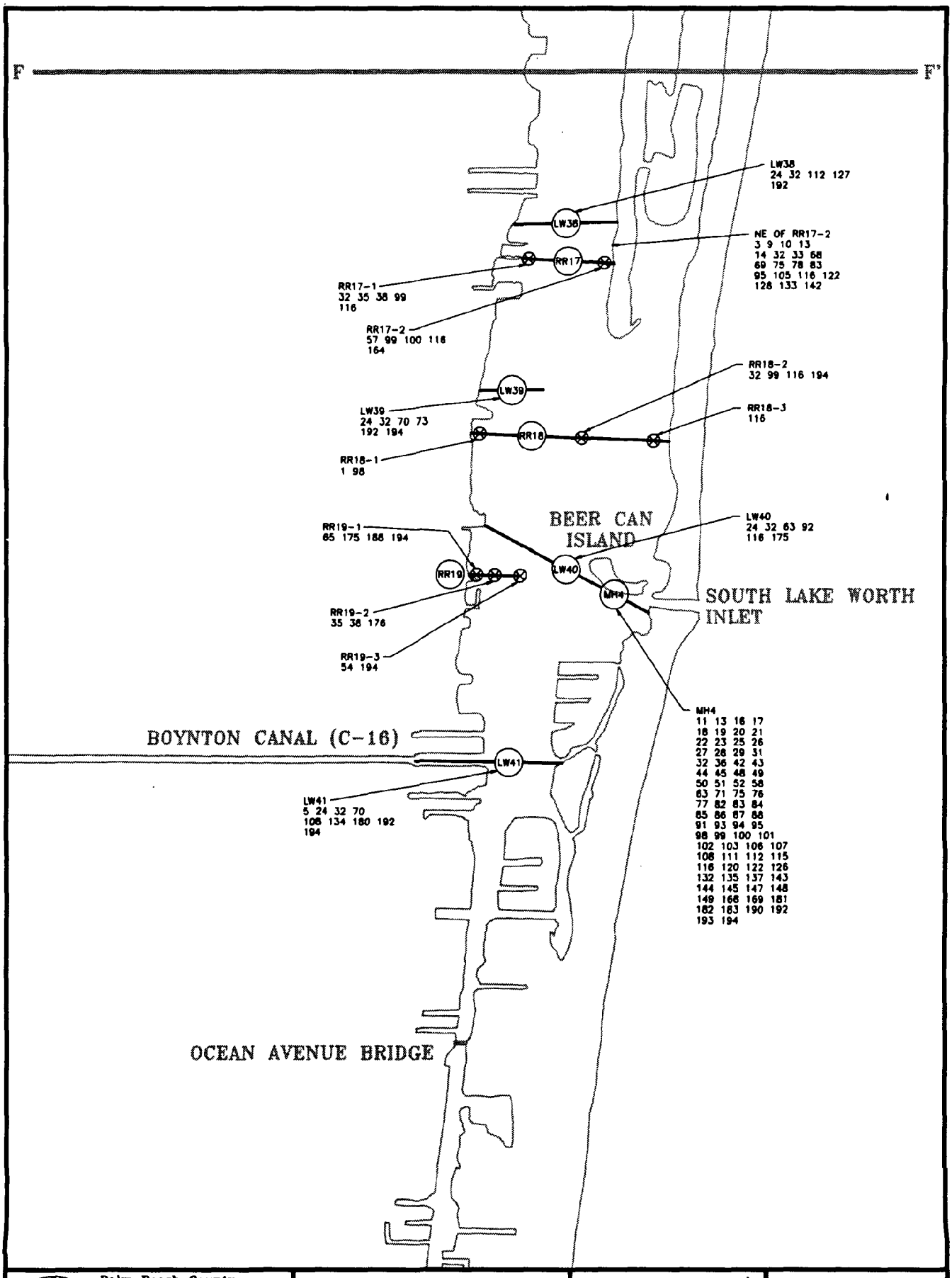
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *10-G*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

KNOWN OCCURRENCES
OF FISH

0 1000 2000
SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
10-H

5.11 ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN

The shoreline of Lake Worth Lagoon is almost completely developed and densely populated leaving very few native areas suitable to support appreciable numbers of protected (endangered threatened and rare species and species of special concern) plant and/or animal species. All known protected plants occur either in John D. MacArthur State Recreation Area located in northeast Lake Worth Lagoon or Gemini Botanical Gardens located in Manalapan just north of South Lake Worth Inlet. While some protected species may occur elsewhere along the shore of Lake Worth Lagoon, their presence is unrecorded at this time. Protected animals which occur in the study area are transient in nature, making it difficult to document all known occurrences. For example, manatees could be in any area of the lagoon at any time.

Table 8 is a listing of protected plant and animal species which have been identified in or are likely to naturally inhabit the Lake Worth Lagoon study area. The list includes a total of 40 species including 13 plants, 1 mammal, 4 reptiles, 18 birds, and 4 fishes. The status of each species and the listing agencies or organizations are noted on the table. No attempt was made to address beach and dune species in this report.

Table 9 is a listing of protected plant species which are present at Gemini Botanical Gardens (GBG), a private botanical garden established in 1986. The site was originally cleared of native vegetation in 1946 when a private residence and garden were built. One area of native hammock remains. The goals of the GBG are to cultivate and preserve the wide species diversity and plant density once found in the native ecosystem, and to assemble a documented collection of native plants that might be used for such purposes as safeguarding the germplasm of endangered species. Most listed plants have been introduced to GBG since 1986.

In addition to species listed on the tables *Halophila johnsonii*, a species of seagrass which occurs in abundance in Lake Worth Lagoon has been designated by the Florida Natural Areas Inventory as a species of limited distribution and recommended for inclusion on the state list of threatened plant species. *Halophila johnsonni* may be more abundant in Lake Worth Lagoon than anywhere else in the state (personal communications, W.J. Kenworthy, NMFS, December, 1990).

Figure 11 depicts known occurrences, probable sighting locations, and desirable habitat for naturally occurring protected species. The information presented on the map was derived from the following sources: municipal comprehensive plans; Florida Natural Areas Inventory; MacArthur State Recreation Area records; Florida Department of Natural Resources; Gemini Botanical Gardens; Florida Game and Freshwater Fish Commission; Pine Jog Environmental Studies Center; ERM records and observations.

The map's symbols are located in areas where listed species would most likely occur. All listed plants are documented as occurring within the boundaries of MacArthur State Recreation Area or Gemini Botanical Gardens. All manatee locations are situated in areas that would be attractive to manatees. These areas include grass beds (feeding areas), freshwater discharges, and the Florida Power and Light Riviera Beach Power Plant discharge (warm water). The sea turtle locations are in grassbed areas suitable for feeding. Other reptile species symbols are located in suitable areas of habitat. Wading bird symbols are located in intertidal areas suitable for feeding. Shorebird symbols are located on sandy or pebbly beaches. Other bird species symbols are located in areas in which ERM made sightings. Snook symbols are located in areas which contain structure such as bridges, oyster bars and rock outcrops. Other fish species symbols are located in areas of suitable habitat.

TABLE 8

ENDANGERED SPECIES, THREATENED SPECIES, RARE SPECIES AND SPECIES OF SPECIAL CONCERN THAT MIGHT BE FOUND IN AND AROUND LAKE WORTH LAGOON, PALM BEACH COUNTY, FLORIDA

LATIN NAME	COMMON NAME	STATUS
PLANTS		
Acrostichum aureum	Golden Leather Fern	E
Acrostichum danaeifolium	Giant Leather Fern	T
Cereus pentagonus	Dildo Cactus	T
Chrysophyllum oliviforme	Satin Leaf	E
Encyclia tampensis	Butterfly Orchid	T
Ophioglossum palmatum	Hand Fern	E
Opuntia humifusa	Twistspine Prickly Pear	T
Opuntia stricta	Prickly Pear	T
Phlebodium aureum	Golden polypody	T
Psilotum nudum	Whisk Fern	T
Tillandsia paucifolia	Wild Pine	T
Tillandsia valenzuelana	Soft Leaf Wild Pine	T
Vittaria lineata	Shoestring Fern	T
VERTEBRATES		
MAMMALS		
Trichecus manatus latirostris	West Indian Manatee	E
REPTILES		
Caretta caretta caretta	Loggerhead Turtle	T
Chelonia mydas mydas	Green Turtle	E
Gopherus polyphemus	Gopher Tortoise	SSC
Drymarchon corais couperi	Indigo Snake	SSC
BIRDS		
Ajaia ajaja	Roseate Spoonbill	SSC
Aramus guarana	Limpkin	SSC
Casmerodius albus	Great Egret	SSC
Charadrius melodus	Piping Plover	T
Egretta rufescens	Reddish Egret	SSC
Egretta thula	Snowy Egret	SSC
Egretta tricolor	Tricolored (Louisiana) Heron	SSC
Egretta caerulea	Little Blue Heron	SSC
Eudocimus albus	White Ibis	SSC
Falco peregrinus tundrius	Artic Peregrine Falcon	E
Haematopus palliatus	American Oystercatcher	SSC
Nyctanassa violacea	Yellowcrowned Nigh Heron	SSC

Nycticorax nycticorax	Blackcrowned Nigh Heron	SSC
Pandion haliaetus	Osprey	SSC
Pelecanus occidentalis	Brown Pelican	SSC
Plegadis falcinellus	Glossy Ibis	SSC
Sterna antillarum	Least Tern	T
Vireo altiloquus	Blackwhiskered Vireo	R

FISHES

Centropomus undecimalis	Common Snook	SSC
Gobionellus stigmaturus	Spottail Goby	SSC
Oostethus lineatus	Opossum Pipefish	R
Rivulus marmoratus	Rivulus	SSC

STATUS DESIGNATION KEY:

E=Endangered
T=Threatened
R=Rare
SSC=Species of Special Concern

The status of the above listed plant and animal species was determined by one or more of the following agencies and/or publications:

Florida Game and Freshwater Fish Commission; United States Fish and Wildlife Service; Florida Department of Agriculture; Rare and Endangered Biota of Florida (Pritchard Series).

TABLE 9

Plants of Gemini Botanical Gardens

NAME	COMMON NAME	STATUS
Acacia choriophylla	Tamarindillo	E
Acoelorrhaphe wrightii	Paurotis palm	T
Anemia adiantifolia	Pine fern	T
Bletia purpurea	Pine pink	T
Campyloneurum phyllitidis	Strap fern	T
Cassia keyensis	Big Pine Partridge Pea	T
Cereus eriophorus var. *fragrans*	Fragrant woolbearing cerus	E
C. gracilis	West coast prickly apple	E
C. robinii	Tree cactus	E
Clusia rosea	Balsam apple	E
Commelina gigas	Climbing dayflower	T
Cordia sebestena	Geiger tree	E
Cucurbita okeechobeensis	Okeechobee gourd	E
Cupania glabra	Cupania	E
Cyrtopodium punctatum	Cowhorn orchid	E
Dryopteris ludoviciana	Florida shield fern	T
Encyclia cochleata	Shell orchid	T
Equisetum hymale	Scouring rush	T
Eugenia confusa	Redberry ironwood	T
E. rhombau	Red stopper	E
E. simpsonii	Simpson's ironwood	T
Guaiacum sanctum	Lignumvitae tree	E
Hippomane manicella	Manchineel	T
Hypelate trifoliata	Inkwood	T
Ilex krugiana	Krug's holly	E
Ipomoea microdactyla	Wild potato morning glory	E
Jacquemontia reclinata	Beach clustervine	E
Jacquinia keyensis	Joewood	T
Lycopodium cernuum	Nodding club moss	T
Lycopodium dichotomum	Hanging club moss	E
Nephrolepsis biserrata	Boston fern	T
Nolina atopocarpa	FL Beargrass	E
N. brittoniana	Brittons beargrass	E
Oncidium variegatum	Dancing lady orchid	E
Opuntia cubensis	Prickly pear	T
O. spinosissima	Semaphore cactus	E
Peperomia floridana	Everglades	E
Polyrrhiza lindenii	Ghost orchid	E
Polystachya flavescens	Pale flowered polystachya	T
Pseudophoenix sargentii	Buccaneer palm	E
Rhipsalis baccifera	Mistletoe cactus	E
Roystonea elata	FL Royal palm	E
Sabal etonia	Scrub palmetto	T
Sabal minor	Dwarf palmetto	T
Strumpfia maritima	Pride-of-big-pine	E

Suriana maritima	Bay cedar	E
Swietenia mahogani	West Indian mahogany	T
Tetrazygia bicolor	Tetrazygia	T
Thelypteris kunthii	Aspidium fern	T
Tillandsia flexuosa	Twisted air plant	T
T. setacea	Wild pine air plant	T
Trismeria trifoliata	Braken fern	T
Vanilla planifolia	Commercial vanilla	T
Verbena maritima	Coastal vervain	E
Zanthoxylum flavum	Yellowhart	E

LEGEND

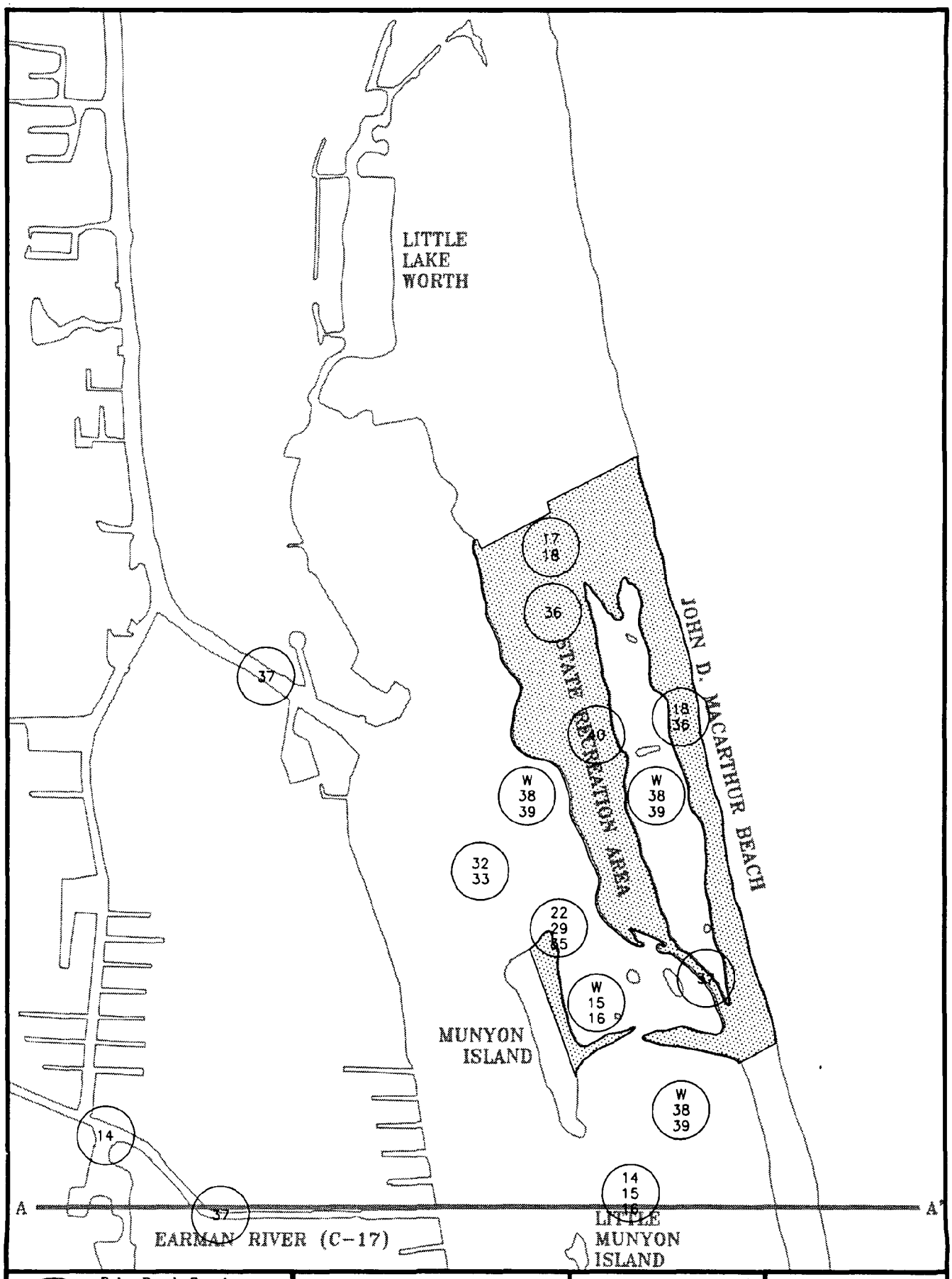
	SPECIES	STATUS
	PLANTS	
1	*Acrostichum aureum* – Golden Leather Fern	E
2	*Acrostichum danaeifolium* – Giant Leather Fern	T
3	*Cereus pentagonus* – Dildo Cactus	T
4	*Chrysophyllum oliviforme* – Satin Leaf	E
5	*Encyclia tampensis* – Butterfly Orchid	T
6	*Ophioglossum palmatum* – Hand Fern	E
7	*Opuntia humifusa* – Twistspine Prickly Pear	T
8	*Opuntia stricta* – Prickly Pear	T
9	*Phlebodium aureum* – Cabbage Palm Fern	T
10	*Psilotum nudum* – Whisk Fern	T
11	*Tillandsia paucifolia* – Wild Pine	T
12	*Tillandsia valenzuelana* – Soft Leaf Wild Pine	T
13	*Vittaria lineata* – Shoestring Fern	T
	VERTEBRATES	
	MAMMALS	
14	*Trichecus manatus latirostris* – West Indian Manatee	E
	REPTILES	
15	*Caretta caretta caretta* – Loggerhead Turtle	T
16	*Chelonia mydas mydas* – Green Turtle	E
17	*Gopherus polyphemus* – Gopher Tortoise	SSC
18	*Drymarchon corais couperi* – Indigo Snake	SSC
	BIRDS	
(W) 19	*Ajaia ajaja* – Roseate Spoonbill	SSC
(W) 20	*Aramus guarana* – Limpkin	SSC
21	*Casmerodius albus* – Great Egret	SSC
(W) 22	*Charadrius melodus* – Piping Plover	T
(W) 23	*Egretta rufescens* – Reddish Egret	SSC
(W) 24	*Egretta thula* – Snowy Egret	SSC
(W) 25	*Egretta tricolor* – Tricolored Heron	SSC
(W) 26	*Egretta caerulea* – Little Blue Heron	SSC
(W) 27	*Eudocimus albus* – White Ibis	SSC
28	*Falco peregrinus tundrius* – Arctic Peregrine Falcon	E
29	*Haematopus palliatus* – American Oystercatcher	SSC
(W) 30	*Nyctanassa violacea* – Yellow-crowned Night Heron	SSC
(W) 31	*Nycticorax nycticorax* – Black-crowned Night Heron	SSC
32	*Pandion haliaetus* – Osprey	SSC
33	*Pelecanus occidentalis* – Brown Pelican	SSC
(W) 34	*Plegadis falcinellus* – Glossy Ibis	SSC
35	*Sterna antillarum* – Least Tern	T
36	*Vireo altiloquus* – Black-whiskered Vireo	R
	AMPHIBIANS	
	(none)	
	FISHES	
37	*Centropomus undecimalis* – Common Snook	SSC
38	*Cobionellus stigmaturus* – Spottail Goby	SSC
39	*Oostethus lineatus* – Opossum Pipefish	R
40	*Rivulus marmoratus* – Rivulus	SSC

(W) = WADING BIRD GROUP
E = Endangered
T = Threatened
R = Rare
SSC = Species of Special Concern

The status of the above listed plant and animal species was determined by one or more of the following agencies and/or publications:

Florida Game and Freshwater Fish Commission; United States Fish and Wildlife Service; Florida Department of Agriculture; Rare and Endangered Biota of Florida (Pritchard Series)

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN		D&M JOB NO. *20335-001-049* FIGURE *11-A*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

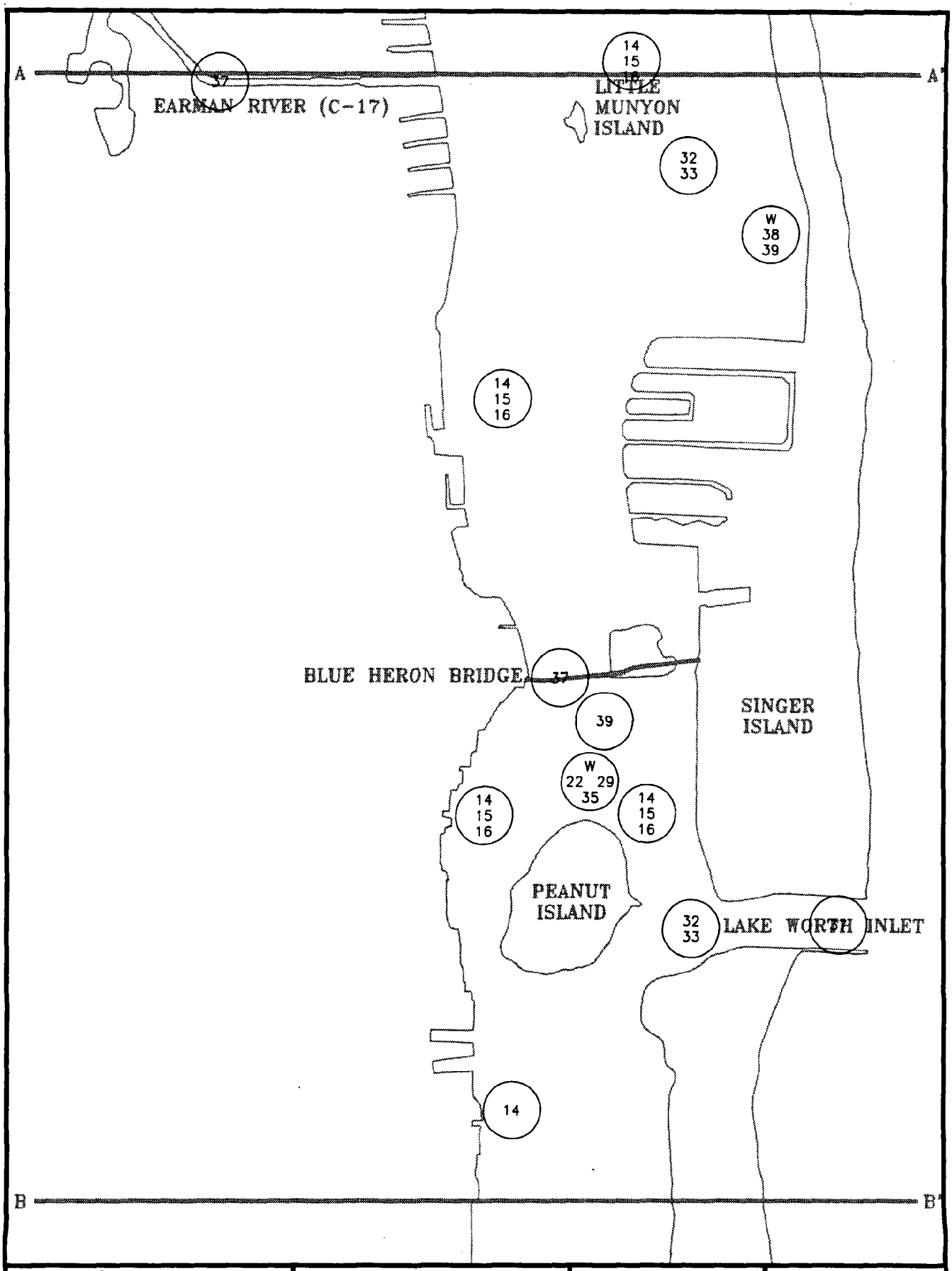
ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN

0 1000 2000

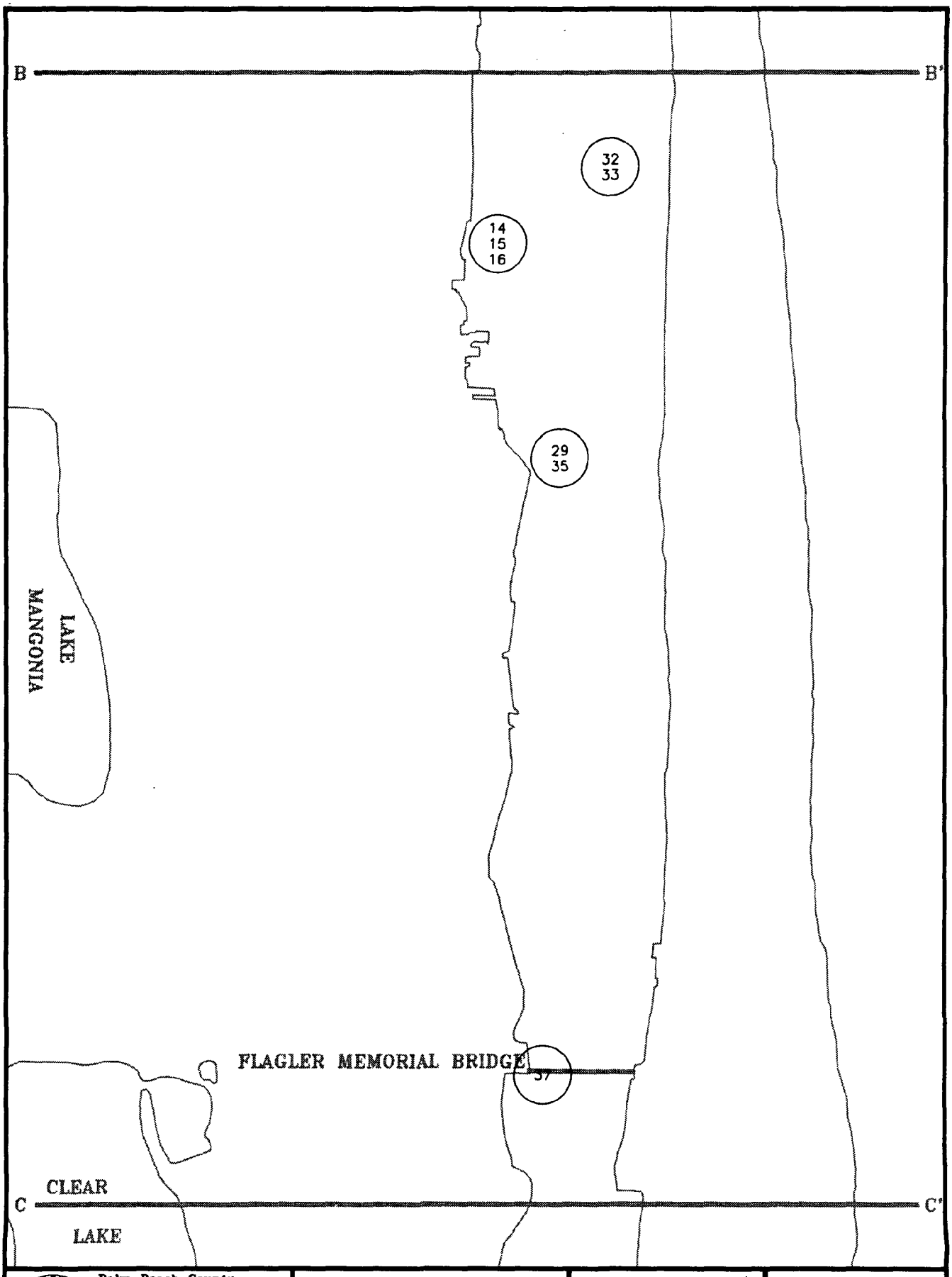
SCALE (FEET)

D&M JOB NO. *20335-001-049*

FIGURE *11-B*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *11-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN

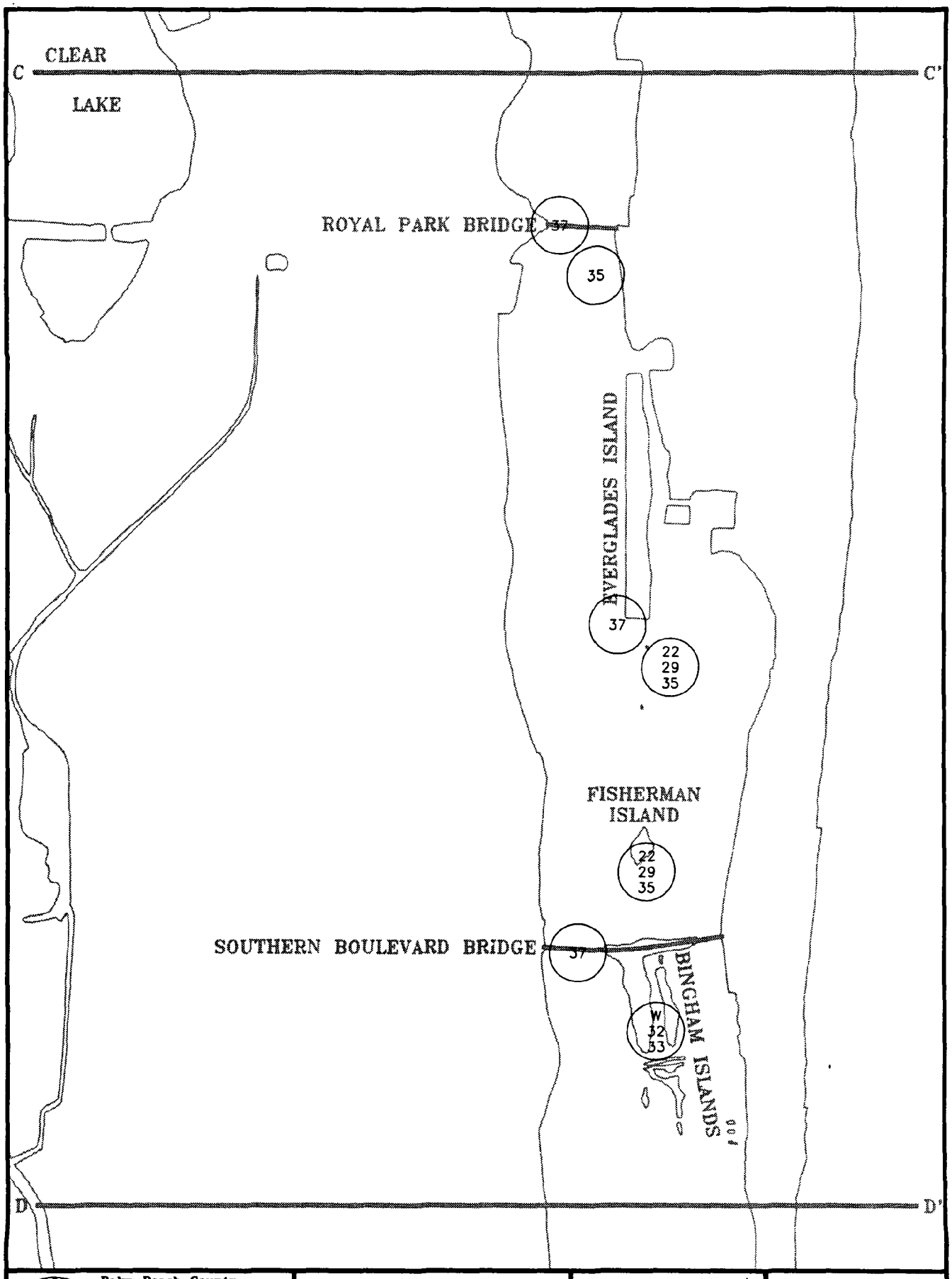
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *11-D*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN

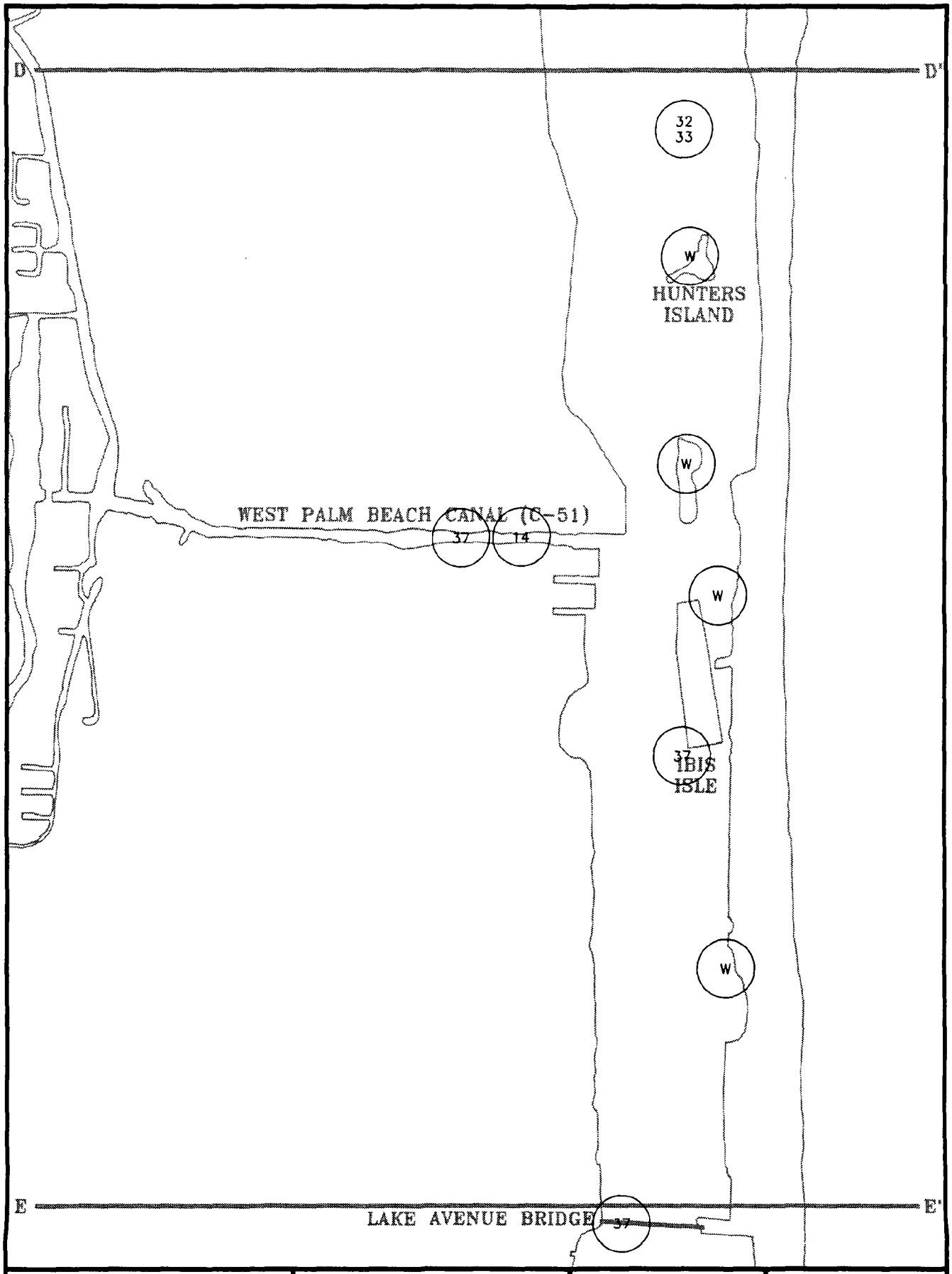
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *11-E*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

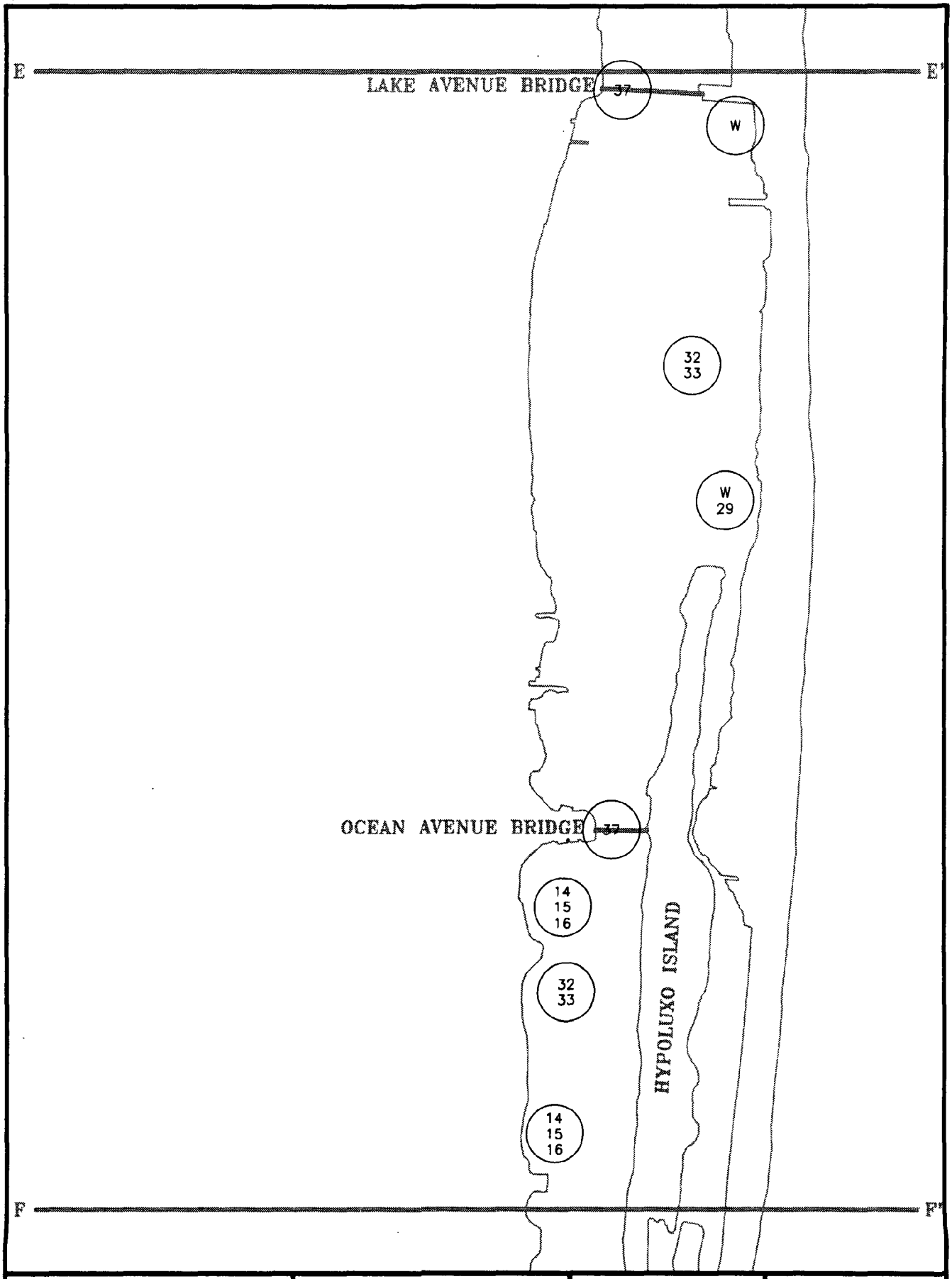
LAKE WORTH LAGOON

ENDANGERED, THREATENED
AND RARE SPECIES AND
SPECIES OF SPECIAL CONCERN

0 1000 2000
SCALE
(FEET)
N

D&M JOB NO.
20335-001-049

FIGURE
11-F



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN

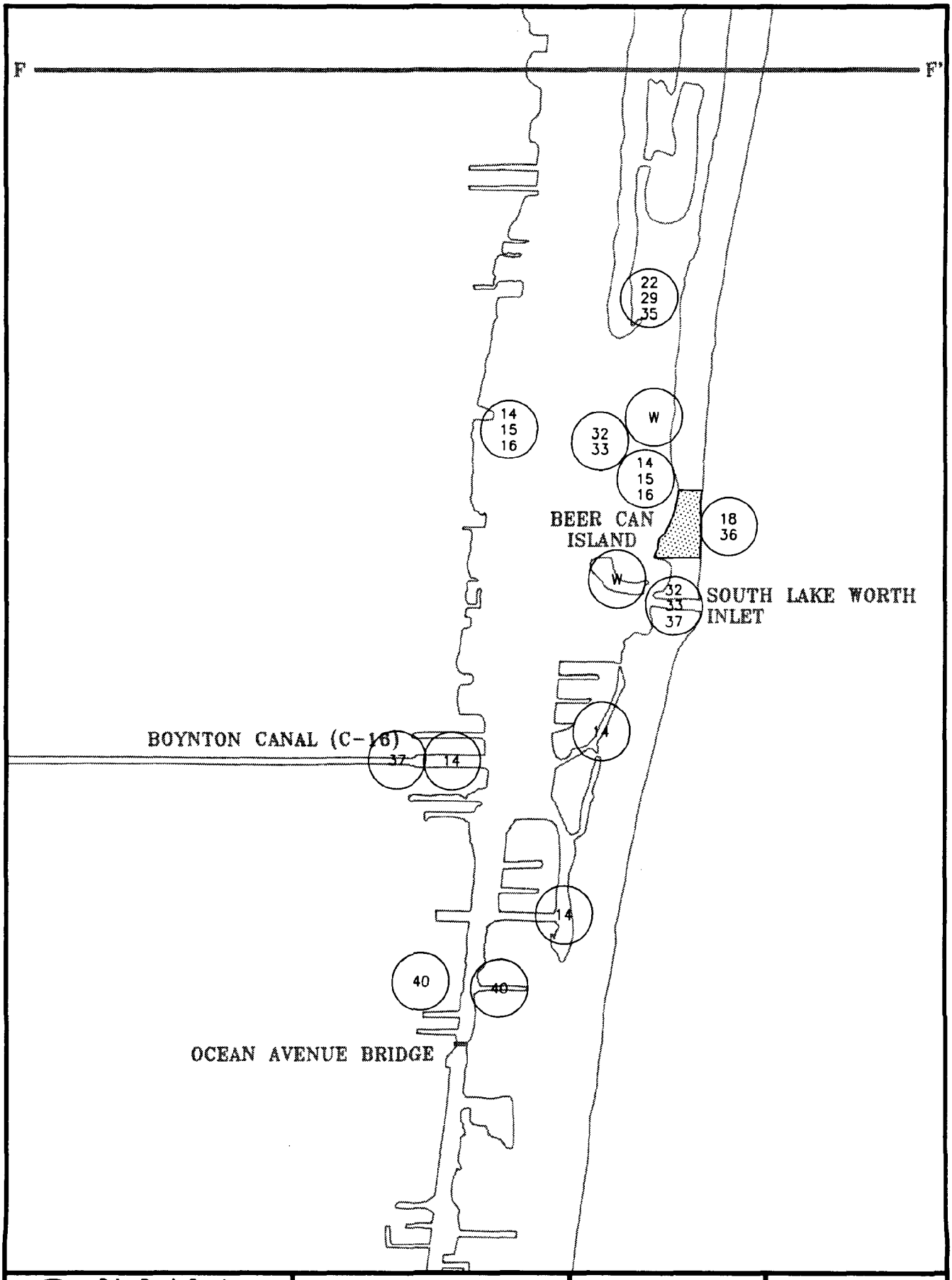
0 1000 2000

SCALE (FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
11-G



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

ENDANGERED, THREATENED AND RARE SPECIES AND SPECIES OF SPECIAL CONCERN

0 1000 2000

SCALE (FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
11-H

5.12 MARINAS AND DOCKS

Forty seven (47) major marinas comprising 2558 wet boat slips and 2156 dry storage racks are located in the Lake Worth Lagoon study area. In addition, hundreds of private docks have been constructed by shoreline residential property owners, and several commonly utilized anchorage areas for live aboard boats are known to exist. Public boat launching facilities exist at eight locations.

Locations of marinas and boat ramps were determined from municipal comprehensive plans, the Riviera Beach DRI, and field observations. Boat docks were identified from the 1989 "Redi" aerial photographs. Public access areas include parks, inlets and public docks where water activities take place. Marina characteristics were determined from a telephone or personal interview survey. The information gathered included name of facility, location, the number of wet boat slips, the number of dry boat racks, and status of fuel, boat repair and sewage pump-out facilities. Boat ramps were inspected to determine their launching and vehicle parking capacities. The information from this survey has been compiled and is presented on **Table 10**. The locations of docks, marinas, boat ramps and public access areas located within the study area are depicted on **Figure 12.** The numbers on the map correspond to the marinas as numbered on Table 10.

Boats, marinas and associated activities are known to have cumulative impacts which contribute to water quality degradation. Metals emitted from anti-fouling paints, nutrients and bacteria contained in wastes which are flushed overboard, oils and greases associated with power boats, and chemicals utilized for boat maintenance are all potential sources of pollution associated with boats and marinas. In addition, boating activity can directly impact habitat resources by propeller dredging, boat wake induced erosion, and disturbance of wildlife (e.g., boat collisions with manatees).

The survey indicates that Lake Worth Lagoon has storage/dock facilities for almost five thousand boats. This number does not include docking facilities associated with private homes and condominiums, boats anchored offshore, or boats launched at boat ramps. Of the forty seven commercial marina facilities servicing Lake Worth Lagoon, eleven allow live aboard boats, while only three provide sewage pump out facilities. Eighteen marinas provide boat repairs, and twenty one have fueling facilities. While major single sources of pollution are not likely, it is probable that the cumulative effect of these activities contributes to water quality degradation in Lake Worth Lagoon.

TABLE 10

LAKE WORTH MARINA AND BOAT RAMP SURVEY - 1990

* = planned

	# OF WET SLIPS	# OF DRY RACKS	Y/N FUEL	Y/N BOAT REPAIR	Y/N LIVE ABOARDS	Y/N PUMP OUT FACILITIES	COMMENTS
# MARINAS							
1. Charter boats (Boynton Beach)	33	0	N	N	N	N	
2. Waters Edge Marina Inc.(Boynton Beach)	41	0	Y	N	N	N	
3. Club Nautico (Boynton Beach)	20	0	N	N	N	N	
4. Palm Beach Marina (Hypoluxo)	0	220	Y	Y	N	N	
5. Palm Beach Yacht Center (Hypoluxo)	60	300	Y	Y	N	N	
6. Sportsman Park (Lantana)	11	0	N	N	N	N	Boat ramp
7. Burger Boat Company (Lantana)	54	0	Y	Y	N	N	
8. Gundlach's Marina (Lantana)	* 28	350	Y	Y	N	*N	
9. Murrelle Marina (Lantana)	40	0	N	Y	N	N	
10. Flagler Yacht Club (West Palm Beach)	22	0	N	N	N	N	Private
11. The Harbor Towers & Marina (West Palm Beach)	11	0	0	N	N	N	Private
12. Town of PB Municipal Docks (Palm Beach)	78	0	N	N	Y	Y	
13. Palm Harbor Marina (West Palm Beach)	166	0	Y	N	Y	N	
14. Flagler Marina (Yacht Club) (Palm Beach)	45	0	Y	N	Y	N	
15. Spencer Boat Company (West Palm Beach)	100	0	Y	Y	N	N	
16. Rybovich Diesel & Marine (West Palm Beach)	57	0	N	Y	N	N	Boat Construction and Service
17. Flotilla Club (West Palm Beach)	16	10	N	N	N	N	
18. Sailfish Club of Florida (Palm Beach)	85	16	Y	N	Y	N	Private

TABLE 10							
19. Cracker Boy Boat Works Inc. (Riviera Beach)	5	150	N	Y	Y	N	Service facility
20. Riviera Bch Municipal Marina (Riviera Beach)	137	180	Y	N	Y	Y	
21. Old Slip Marina (Riviera Beach)	50	0	N	Y	Y	N	
22. Pelican Pier (Riviera Beach)	20	0	N	N	N	N	
23. Perry Oceanographics Inc. (Riviera Beach)	3	0	N	N	N	N	For large vessels
24. Hudgins Fish Company Inc. (Riviera Beach)	35	0	Y	N	N	N	Commercial fish company
25. Rybovich Diesel & Marine Service Inc. (North) Riviera Beach	31	10	Y	Y	N	N	Service facility
26. Tanner's Marine Center (Riviera Beach)	10	0	N	Y	N	N	Service facility
27. Newport Cove Marine Center (Riviera Beach)	5	200	Y	Y	N	N	
28. Blue Heron Docks (Riviera Beach)	20	0	N	N	Y	N	
29. Sailfish Marina (Palm Beach Shores)	100	0	Y	N	Y	N	
30. Buccaneer Marina (Palm Beach Shores)	18	0	Y	N	N	N	
31. Cannonsport Marina (Palm Beach Shores)	29	0	Y	N	N	N	
32. Captains Walk Condominium (Palm Beach Shores)	18	0	N	N	N	N	Private
33. Intercoastal Club (Palm Beach Shores)	12	0	N	N	N	N	Private
34. Lake Park Marina (Lake Park)	224	0	N	N	N	N	Boat ramps
35. Bassett Boat Company (North Palm Beach)	11	90	Y	Y	N	N	
36. Paradise Harbor & Villas (North Palm Beach)	34	0	N	N	N	N	Private
37. Lotts Brothers Bait, Tackle & Marina (North Palm Beach)	26	0	Y	N	N	N	
38. Anchorage Park Marina (North Palm Beach)	30	195	N	N	N	N	Boat ramp
39. North Palm Beach Marina (North Palm Beach)	150	0	Y	Y	Y	N	
40. Old Port Cove Marina (South) (North Palm Beach)	300	0	N	N	N	N	
41. Old Port Cove Marina (North)	91	0	N	N	N	N	
42. Harbor Point Marina (Palm Beach Gardens)	75	0	Y	N	Y	Y	

TABLE 10							
43. Marina at Twelve Oaks (North Palm Beach) Condominium	66	0	N	N	N	N	Private
44. Soverel Harbor Inc. (Palm Beach Gardens)	160	318	Y	Y	N	(proposed)	
45. Seminole Boat Yard (Palm Beach Gardens)	9	60	N	Y	N	N	Service facility
46. E & H Boatworks Inc. (Palm Beach Gardens)	10	12	N	Y	N	N	Service facility
47. The Way's Club (Palm Beach Gardens)	12	40-45	N	Y	N	N	Service facility
PUBLIC BOAT RAMPS LOCATION	# RAMPS	*RAMP CAPACITY	ON SITE TRAILER PARKING SPACES			OFF SITE TRAILER PARKING SPACES	
1. Boat Club Park (Boynton)	4	6	90			60	
2. Sportsman Park (Lantana)	2	4	18			15	
3. Bryant Park (Lake Worth)	2	4	38			36	
4. Currie Park (Riviera Beach)	4	6	70			0	
5. Phil Foster Park (Riviera Beach)	2	4	66			0	
6. Lake Park (Lake Park)	4	4	50			0	
7. Anchorage Park (North Palm Beach)	1	2	10			0	
8. Juno Park (Juno Beach)	1	1	15			0	
*Ramp Capacity = the number of vehicles that can launch boats at one time at the facility.							

LEGEND

MARINAS

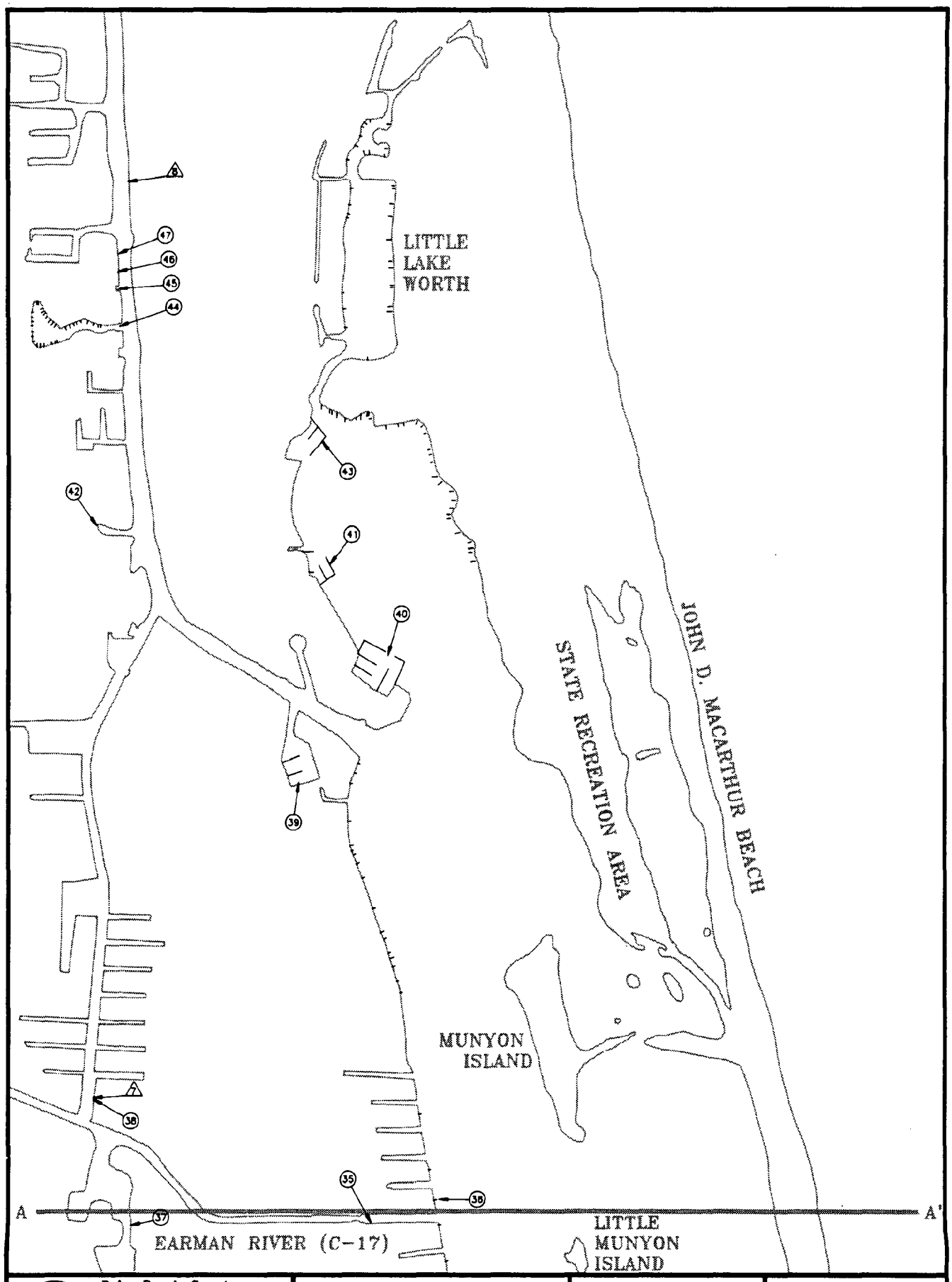
① CHARTER BOATS
② WATERS EDGE MARINA
③ CLUB NAUTICO
④ PALM BEACH MARINA
⑤ PALM BEACH YACHT CENTER
⑥ SPORTSMAN PARK
⑦ BURGER BOAT COMPANY
⑧ GUNDLACH'S MARINA
⑨ MURRELLE MARINA
⑩ THE HARBORTOWERS AND MARINA
⑪ FLAGLER YACHT CLUB
⑫ TOWN OF PALM BEACH MUNICIPAL DOCKS
⑬ PALM HARBOR MARINA
⑭ FLAGLER MARINA (YACHT CLUB)
⑮ SPENCER BOAT COMPANY
⑯ RYBOVICH DIESEL AND MARINE SERVICE INC. (SOUTH)
⑰ FLOTILLA CLUB
⑱ SAILFISH CLUB OF FLORIDA
⑲ CRACKER BOY BOAT WORKS INC.
⑳ RIVIERA BEACH MUNICIPAL MARINA
㉑ OLD SLIP MARINA
㉒ PELICAN PIER
㉓ PERRY OCEANOGRAPHICS INC.
㉔ HUDGINS FISH COMPANY INC.
㉕ RYBOVICH DIESEL AND MARINE SERVICE INC. (NORTH)
㉖ TANNER'S MARINE CENTER
㉗ NEW PORT COVE MARINE CENTER
㉘ BLUE HERON DOCKS
㉙ SAILFISH MARINA
㉚ BUCCANEER MARINA
㉛ CANNONSPORT MARINA
㉜ CAPTAIN'S WALK
㉝ INTERCOASTAL CLUB
㉞ LAKE PARK MARINA
㉟ BASSETT BOAT COMPANY
㊱ PARADISE HARBOR & VILLAS
㊲ LOTT BROTHERS BAIT, TACKLE AND MARINA
㊳ ANCHORAGE PARK MARINA
㊴ NORTH PALM BEACH MARINA
㊵ OLD PORT COVE MARINA (SOUTH)
㊶ OLD PORT COVE MARINA (NORTH)
㊷ HARBOR POINT MARINA
㊸ MARINA AT TWELVE OAKS CONDOMINIUM
㊹ SOVEREL HARBOR INC.
㊺ SEMINOLE BOAT YARD
㊻ E & H BOAT WORKS
㊼ THE WAY'S MARINA

PUBLIC BOAT RAMPS	LOCATION
⚓1 BOAT CLUB PARK	BOYNTON
⚓2 SPORTSMAN PARK	LANTANA
⚓3 BRYANT PARK	LAKE WORTH
⚓4 CURRIE PARK	WEST PALM BEACH
⚓5 PHIL FOSTER PARK	RIVIERA BEACH
⚓6 LAKE PARK MARINA	LAKE PARK
⚓7 ANCHORAGE PARK	NORTH PALM BEACH
⚓8 JUNO PARK	JUNO BEACH

— PUBLIC PIER/PUBLIC ACCESS

– BOAT DOCK

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* MARINAS AND DOCKS		D&M JOB NO. *20335-001-049* FIGURE *12-A*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

MARINAS AND DOCKS

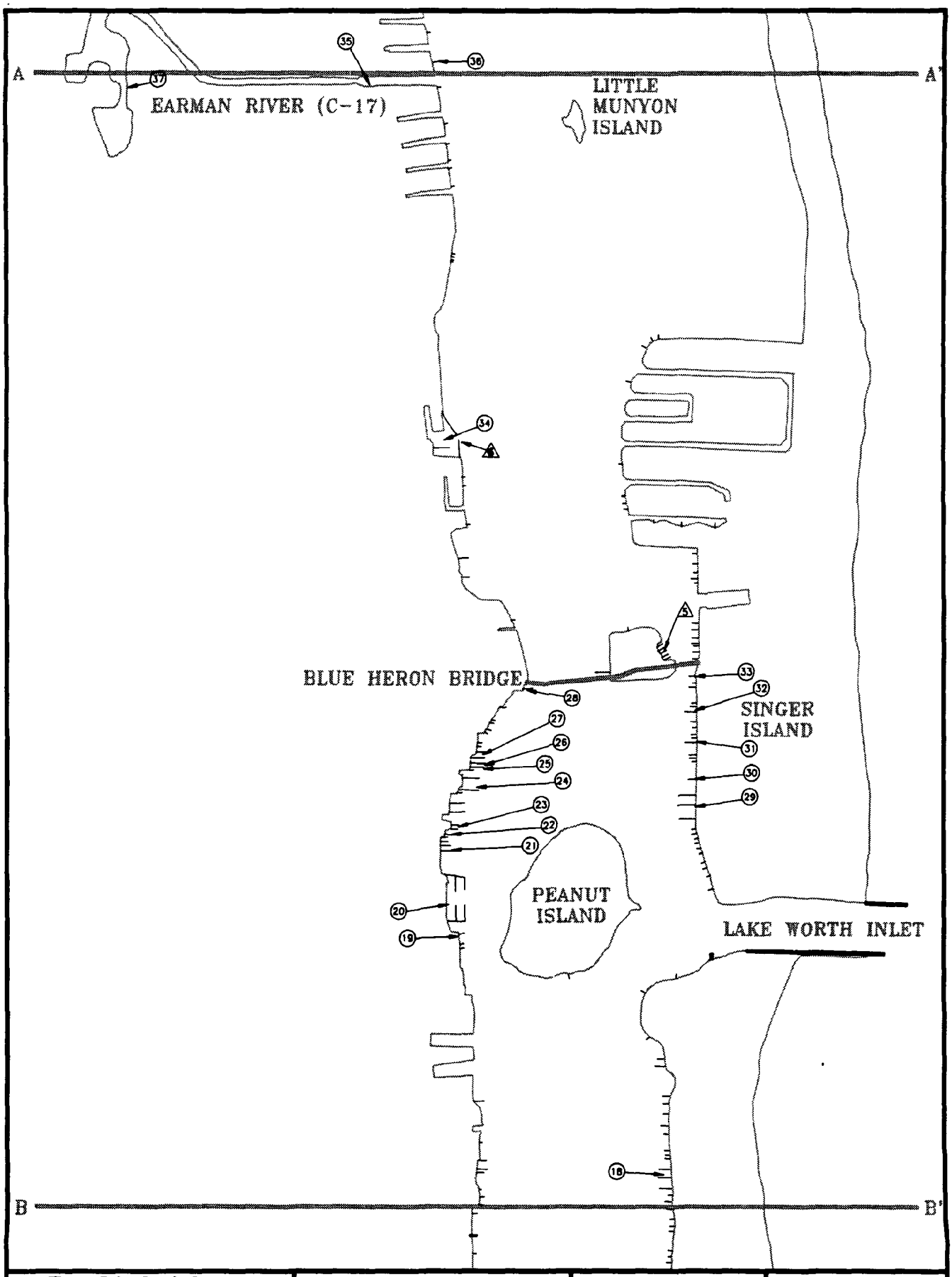
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *12-B*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

MARINAS AND DOCKS

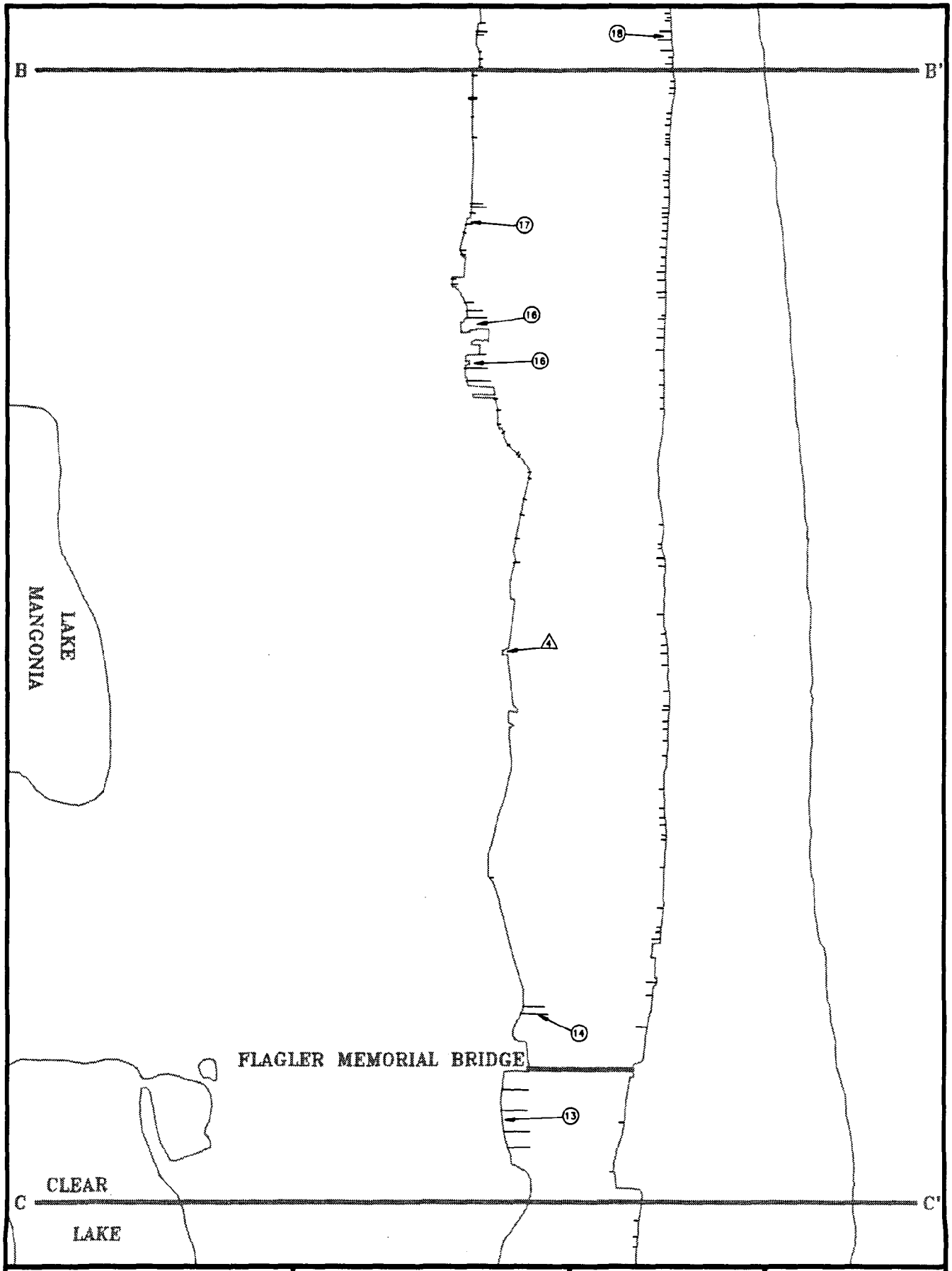
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *12-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

MARINAS AND DOCKS

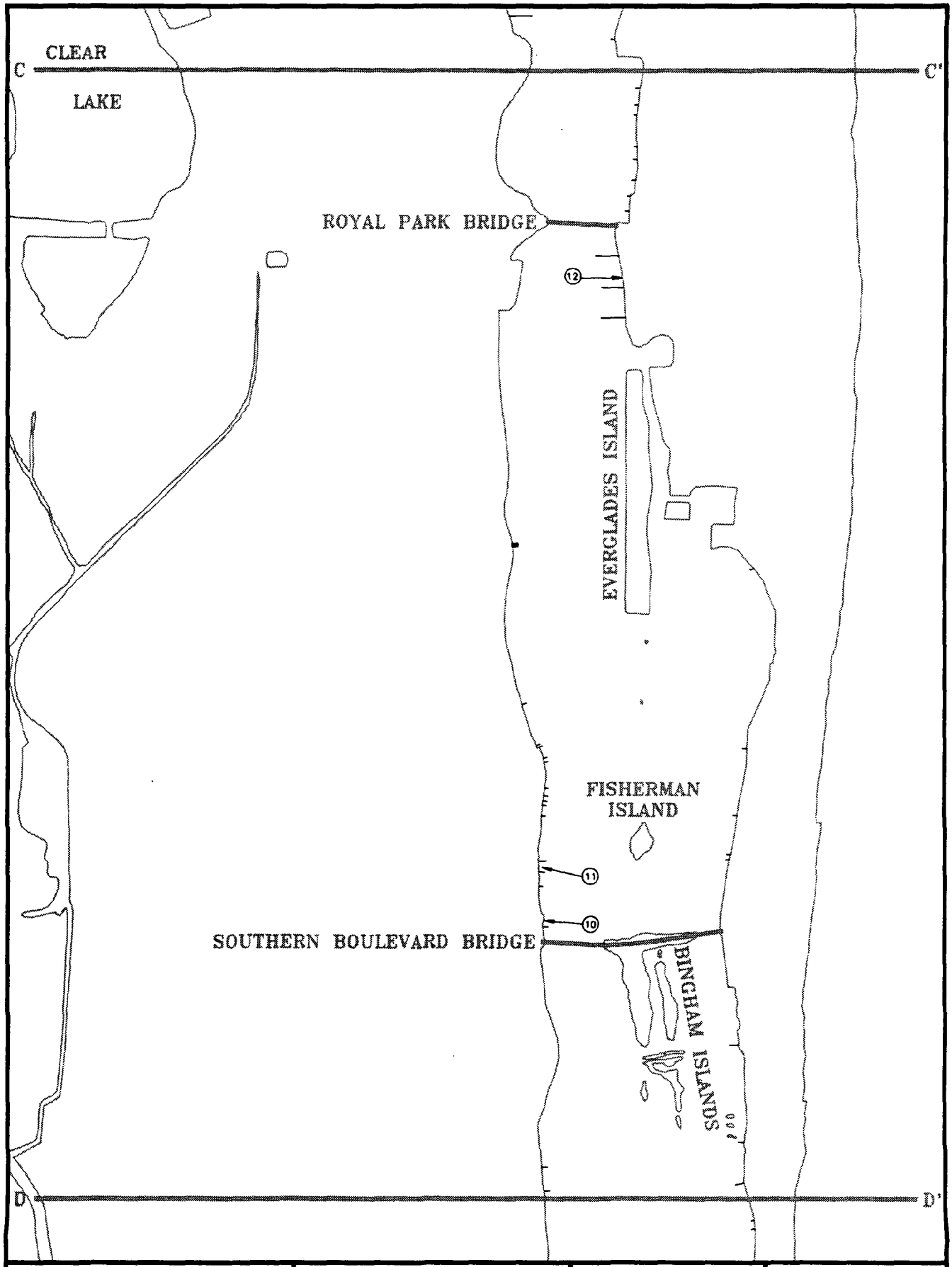
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *12-D*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

MARINAS AND DOCKS

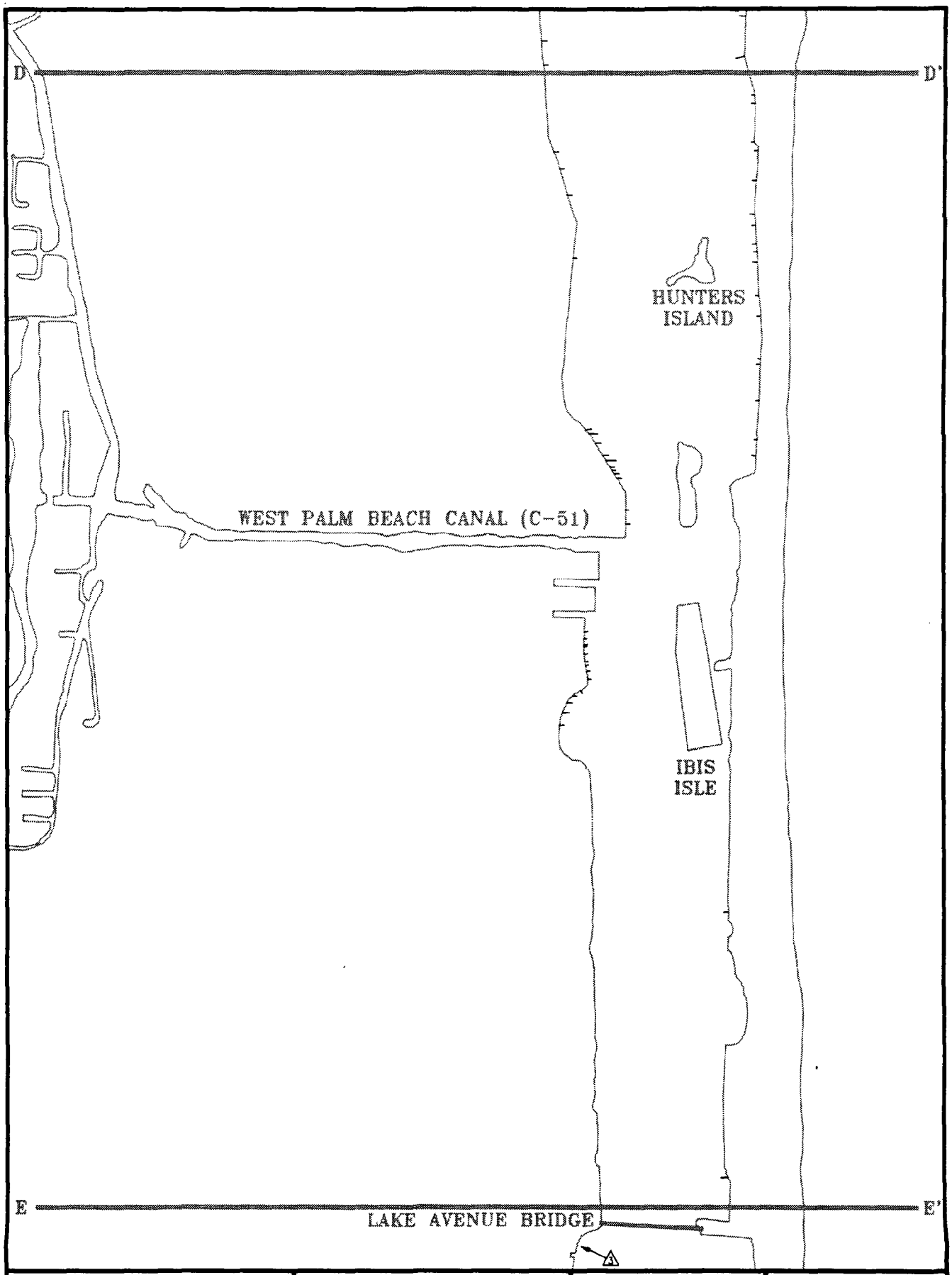
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *12-E*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

MARINAS AND DOCKS

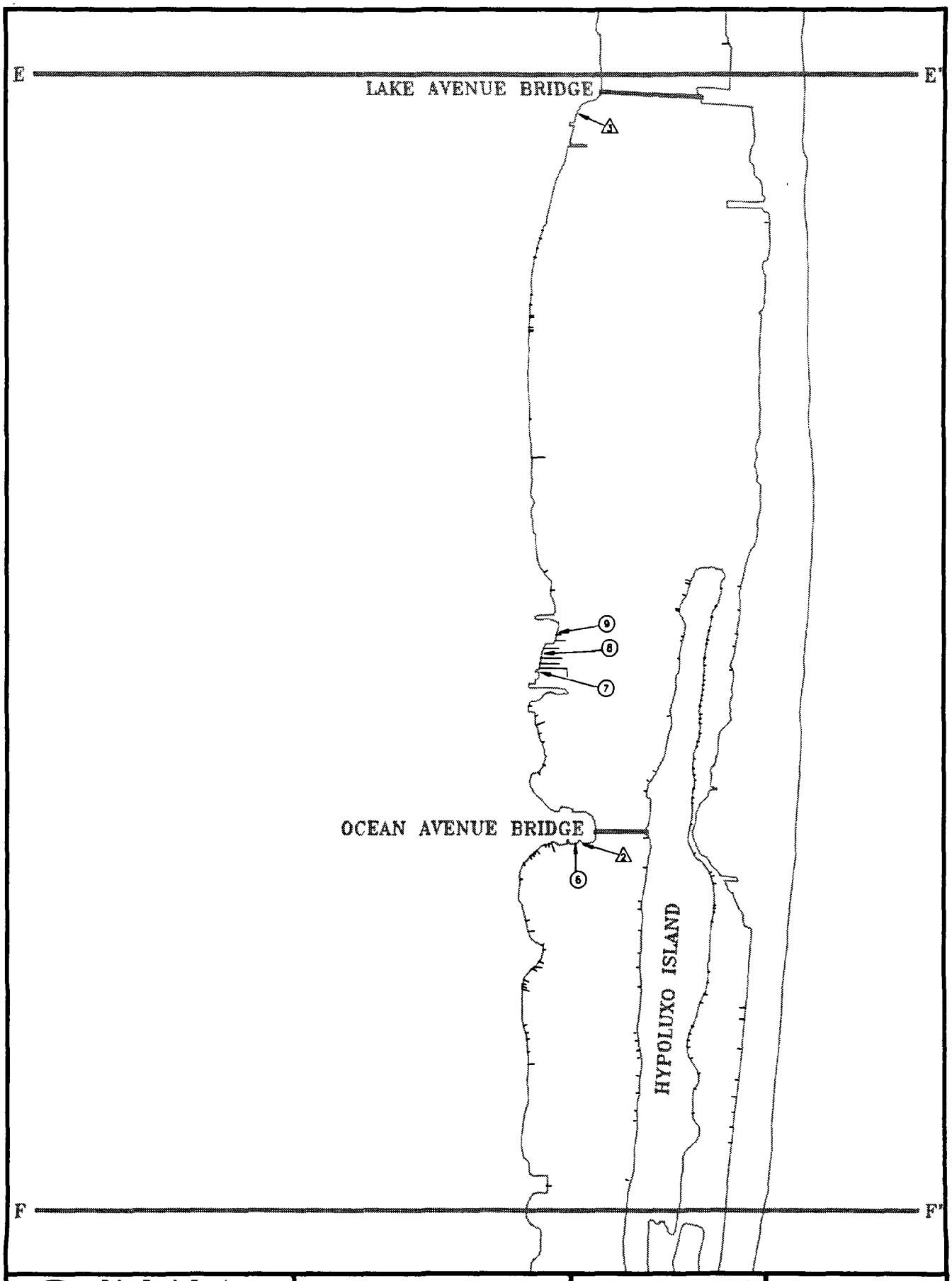
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *12-F*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

MARINAS AND DOCKS

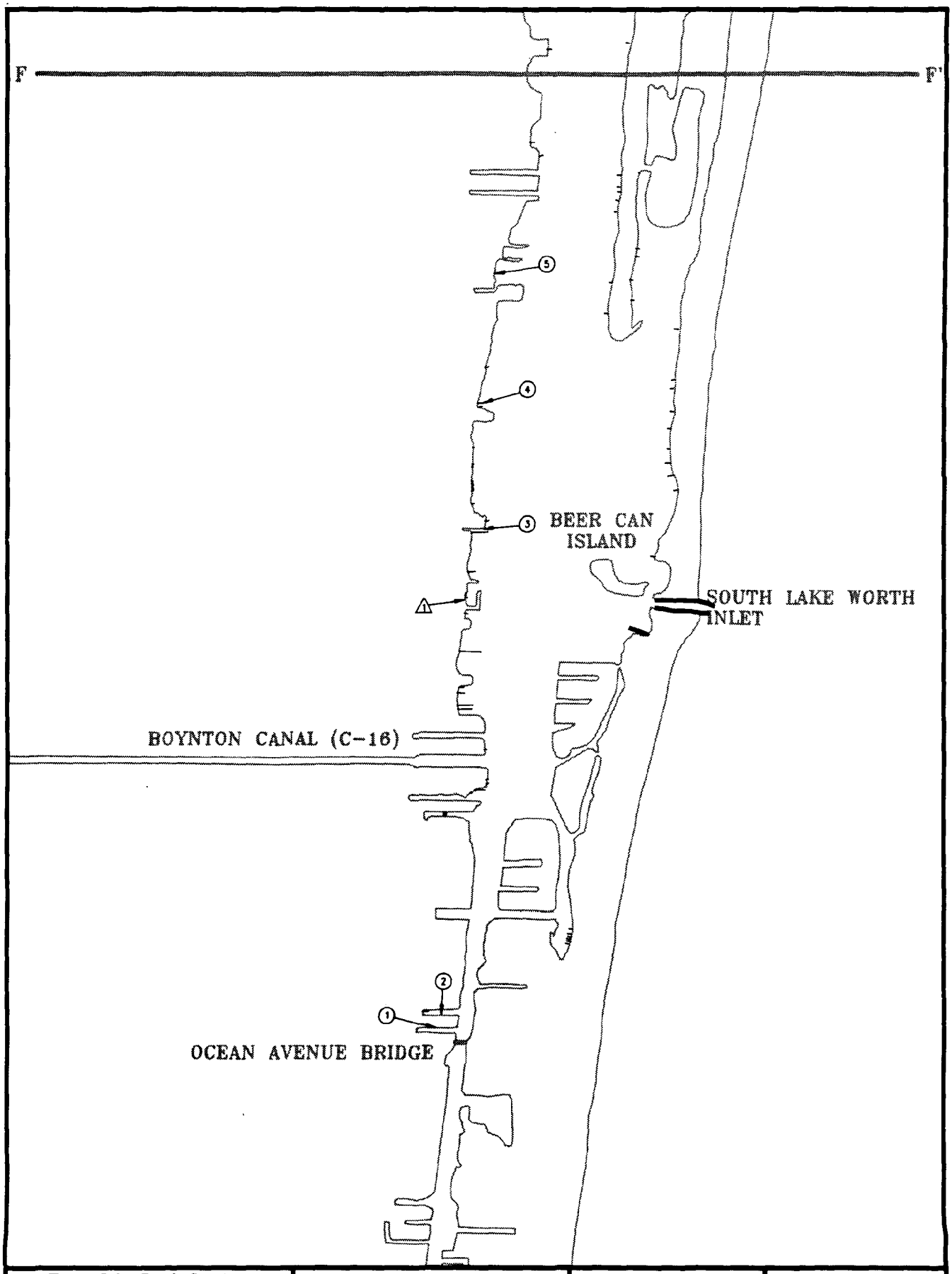
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *12-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

MARINAS AND DOCKS

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *12-H*

5.13 WATER QUALITY

5.13.1 Water Chemistry

Water quality studies have been ongoing in Lake Worth Lagoon since the late 1960's. The Environmental Protection Agency conducted a large scale water quality survey in 1969-1970. In subsequent years, the USGS, Florida Department of Environmental Regulation (DER), Palm Beach County Health Department, and ERM have collected numerous water quality data.

The lack of a well organized long term water quality monitoring effort makes it difficult to analyze long term water quality trends in great detail. Inconsistencies in sampling locations, sampling frequency, methodology and parameters analyzed contribute to this difficulty. In an effort to analyze trends in Water Quality for Lake Worth Lagoon, data which is contained in STORET, the U.S. Environmental Protection Agency (EPA) water quality data base was retrieved for the years 1969 - 1990. For the trend analysis, the Trophic State Index, (TSI), which is utilized by Florida Department of Environmental Regulation to generate the yearly water quality assessment for the State of Florida (305b report) was selected.

The water quality of lakes and estuaries in Florida is described by the TSI which is a measure of the potential for algal growth. The components which make up the TSI include total nitrogen (TN), total phosphorus (TP), chlorophyll-A (CHLA) and Secchi depth (SD). The index is based upon a trophic classification scheme developed by R.E. Carlson in 1977 (Hand, et.al, 1988).

The first step in calculating the TSI is to average raw data, by months (if enough data is available) to adjust for seasonal effects and then calculate the mean of the monthly averages for each parameter sampled at each station. In some of the early data total nitrogen averages were not available, therefore averages had to be calculated from the raw data.

The next step involves calculating the TSI. The calculations for TSI are consistent with DER's most recent water quality evaluations which are explained in the 1988 305b report (Hand et.al, 1988).

Equations which generate the TSI are:

CHLA = 16.8 + 14.4 x LOG (CHLA value)
SD = 60 - 30 x LOG (SD value)

TN = 56 + 19.8 x LOG (TN value)
TP = 18.6 X LOG (TP value x 1000) - 18.4
TSI = (CHLA + SD + NUTR*) / 3

where: LOG = Natural Log
: value = ug/l CHLA, m SD, mg/l TP, mg/l TN.

where: * means If TN/TP > 30 then NUTR* = TP
If TN/TP < 10 then NUTR* = TN
If 10<TN/TP<30 then NUTR* = (TP + TN)/2

The scale for TSI is from 0 to 100 where a high score indicates eutrophication (high in nutrients). DER has outlined the following breakout for evaluating water quality of estuaries:

	Estuaries
Good	0 - 49
Fair	50 - 59
Poor	60 - 100

Lake Worth Lagoon water quality stations with EPA STORET code numbers were located from station descriptions found in records from the Florida Department of Environmental

Regulation, Southeast District, Port St Lucie Office's Lake Worth Water Quality Basin Assessment Survey for Fiscal year 1985, and from ERM files. The station locations are presented on **Figure 13.**

The TSI of twenty four STORET stations in Lake Worth was analyzed for three time periods, 1975-1979, 1980-1984, 1985-1990. For years prior to 1975 there was insufficient data to calculate the TSI. The results of the TSI calculations are presented in **Table 11.** A summary of the TSI trends are presented on **Table 12.**

In general, the TSI analysis indicates that water quality either remained fairly constant or slightly improved for most stations over the fifteen year period. The average TSI for Lake Worth Lagoon stations for the period 1986-1990 is 46, which classifies overall water quality at the lower end of the good range. In general, water quality has slightly improved from Little Lake Worth south to the vicinity of Royal Park Bridge. Water quality in the Earman River remains poor, and impacts the lagoon at the confluence point. Water quality of the West Palm Beach Canal (C-51) has slightly improved, but the discharge impacts the lagoon as far north as Southern Boulevard Bridge, where poor water quality has existed for the entire period of record. From C-51 south through the area of study, water quality has slightly improved in recent years. Boynton Canal (C-16) exhibits the best water quality of the three major canal inflows. This analysis suggests that the major pollution sources are the canal inflows, and that poor tidal dilution of the C-51 discharge is compounded near the Southern Boulevard Bridge.

In an effort to determine if a correlation between slightly improving water quality and reduction of waste water inflow exists, trends in fecal coliform bacteria were analyzed. Once again, a lack of consistent sampling is apparent, making a definitive trend analysis impossible. The analysis does indicate declining fecal coliform values at some STORET stations. The West Palm Beach Canal (C-51) continues to be the major source of fecal coliform. A summary of the fecal coliform data is presented in **Table 13.**

TABLE 11 : TROPHIC STATE INDEX CALCULATIONS

TROPHIC STATE INDEX CALCULATIONS FOR 1975-79

STORET#	Location	Station	Type	# of obs.	Begin year	End year	SD	NITRO	PHOS	CHLA	TSI
28010723	INTRACOSTAL WWY AT PALM B GARDE	21FLA761230	ESTUARY	17	75	79	ND	0.635	0.128	ND	47.01
28010724	LITTLE LAKE WORTH AT PGA BLVD BR	21FLA761230	ESTUARY	16	75	79	ND	0.76	0.128	ND	50.57
28010725	ICW AT US 1 BRIDGE	21FLA761230	ESTUARY	17	75	79	ND	0.689	0.147	ND	48.62
28010726	CANAL C-17 AT ALT A1A BRIDGE	21FLA761230	ESTUARY	18	75	79	ND	2.877	0.212	ND	79.08
28010727	EARMAN RIVER AT US 1 BRIDGE	21FLA761230	ESTUARY	15	75	79	ND	0.855	0.135	ND	52.90
28010728	LAKE WORTH AT BLUE HERON BLVD BR	21FLA761230	ESTUARY	16	75	79	ND	0.509	0.092	ND	42.63
28010734	WP CANAL AT SO. OLIVE AVE BRIDGE	21FLA761230	ESTUARY	18	75	79	ND	1.048	0.172	ND	56.93

TROPHIC STATE INDEX CALCULATIONS FOR 1980-85

STORET#	Location	Station	Type	# of obs.	Begin year	End year	SD	NITRO	PHOS	CHLA	TSI
28010723	INTRACOSTAL WWY AT PALM B GARDE	21FLA761230	ESTUARY	4	80	85	1.8	0.341	0.057	9.3	41.99
28010724	LITTLE LAKE WORTH AT PGA BLVD BR	21FLA761230	ESTUARY	7	80	85	ND	0.893	0.211	ND	53.76
28010725	ICW AT US 1 BRIDGE	21FLA761230	ESTUARY	7	80	85	ND	1.256	0.226	ND	60.51
28010726	CANAL C-17 AT ALT A1A BRIDGE	21FLA761230	ESTUARY	7	80	85	ND	2.403	0.214	ND	77.38
28010727	EARMAN RIVER AT US 1 BRIDGE	21FLA761230	ESTUARY	7	80	85	0.875	1.567	0.218	19.3	62.78
28010728	LAKE WORTH AT BLUE HERON BLVD BR	21FLA761230	ESTUARY	11	80	85	1.85	0.605	0.154	5	42.52
28010734	WP CANAL AT SO. OLIVE AVE BRIDGE	21FLA761230	ESTUARY	10	80	85	0.95	1.376	0.234	14.5	59.72
28010769	LAKE WORTH AT SOUTHERN BLVD BRDGE	21FLA820904	ESTUARY	10	80	85	ND	1.688	0.525	ND	66.36
28010771	ICW AT OCEAN AVE, BOYNTON	21FLA820904	ESTUARY	9	80	85	ND	1.271	0.244	ND	60.75
28010773	LITTLE LK WORTH-CNTR, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.7	0.281	0.059	10.3	41.78
28010774	MUNYON TRANS W, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.525	0.242	0.033	11.5	42.41
28010775	MUNYON TRANS MID, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.075	0.231	0.067	10.3	45.07
28010776	MUNYON TRANS E, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	0.925	0.236	0.076	6.2	44.26
28010777	E OF ICW NAV MRKR 3, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.575	0.224	0.06	13.7	42.40
28010778	CURRIE PK WEST, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.25	0.330	0.077	8.1	44.75
28010779	CURRIE PK M10, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1	0.339	0.078	4.7	44.55
28010780	CURRIE PK EAST, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.25	0.340	0.068	10	45.96
28010781	LK WRTH AT ROYAL PALM, LKWRTH BAS	21FLA841228	ESTUARY	4	80	85	1.175	0.436	0.079	10.8	48.59
28010782	ICW NAV MRKR 28, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	0.925	0.608	0.189	12	53.68
28010783	LK WRTH AT SR812, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.1	0.369	0.076	15.5	49.90
28010784	ICW NAV MRKR 44, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.425	0.318	0.059	19	47.29
28010785	ICW NAV MRKR 48, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.275	0.320	0.069	9.2	44.97
28010786	C-16 NR CONTROL STRUCT LKWRTH BA	21FLA841228	ESTUARY	4	80	85	1.675	0.470	0.106	12.9	46.40
28010787	ICW AT SR 804, LK WRTH BAS	21FLA841228	ESTUARY	4	80	85	1.15	0.366	0.082	6.5	45.22

TABLE 11 continued:

TROPHIC STATE INDEX CALCULATIONS FOR 1986-90

STORET#	Location	Station	Type	# of obs.	Begin year	End year	SD	NITRO	PHOS	CHLA	TSI
28010723	INTRACOSTAL WWY AT PALM B GARDE	21FLA761230	ESTUARY	1	86	90	1.7	0.368	0.054	ND	40.14
28010724	LITTLE LAKE WORTH AT PGA BLVD BR	21FLA761230	ESTUARY	2	86	90	ND	0.47	0.08	ND	41.05
28010725	ICW AT US 1 BRIDGE	21FLA761230	ESTUARY	1	86	90	ND	1.52	0.13	ND	68.21
28010726	CANAL C-17 AT ALT A1A BRIDGE	21FLA761230	ESTUARY	2	86	90	ND	1.49	0.075	ND	62.90
28010727	EARMAN RIVER AT US 1 BRIDGE	21FLA761230	ESTUARY	2	86	90	1	0.803	0.251	ND	55.83
28010728	LAKE WORTH AT BLUE HERON BLVD BR	21FLA761230	ESTUARY	2	86	90	2.333	0.194	0.067	ND	29.06
28010734	WP CANAL AT SO. OLIVE AVE BRIDGE	21FLA761230	ESTUARY	2	86	90	1.667	0.579	0.155	ND	44.92
28010769	LAKE WORTH AT SOUTHERN BLVD BRDGE	21FLA820904	ESTUARY	2	86	90	ND	1.735	0.34	ND	66.91
28010771	ICW AT OCEAN AVE, BOYNTON	21FLA820904	ESTUARY	1	86	90	ND	3.05	0.22	ND	80.00
28010773	LITTLE LK WORTH-CNTR, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	1.867	0.375	0.054	ND	38.92
28010774	MUNYON TRANS W, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	1.833	0.284	0.043	ND	36.45
28010775	MUNYON TRANS MID, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	0.967	0.264	0.048	ND	45.32
28010776	MUNYON TRANS E, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	1.033	0.234	0.035	ND	43.13
28010777	E OF ICW NAV MRKR 3, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	2.4	0.144	0.022	ND	25.68
28010778	CURRIE PK WEST, LK WRTH BAS	21FLA841228	ESTUARY	2	86	90	1.233	0.275	0.031	ND	42.08
28010779	CURRIE PK M10, LK WRTH BAS	21FLA841228	ESTUARY	2	86	90	1.733	0.277	0.033	ND	37.04
28010780	CURRIE PK EAST, LK WRTH BAS	21FLA841228	ESTUARY	2	86	90	1.7	0.389	0.034	ND	43.16
28010781	LK WRTH AT ROYAL PALM, LKWRTH BAS	21FLA841228	ESTUARY	2	86	90	1.533	0.368	0.035	ND	44.58
28010782	ICW NAV MRKR 28, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	0.833	0.464	0.056	ND	53.14
28010783	LK WRTH AT SR812, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	1.4	0.438	0.039	ND	47.30
28010784	ICW NAV MRKR 44, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	1.3	0.423	0.043	ND	45.55
28010785	ICW NAV MRKR 48, LK WRTH BAS	21FLA841228	ESTUARY	2	86	90	1.633	0.354	0.03	ND	42.72
28010786	C-16 NR CONTROL STRUCT LKWRTH BA	21FLA841228	ESTUARY	2	86	90	2.267	0.346	0.037	ND	35.22
28010787	ICW AT SR 804, LK WRTH BAS	21FLA841228	ESTUARY	1	86	90	1.725	0.276	0.036	ND	37.08

Numerical values for each parameter are averages for the period indicated.
SD = secchi depth (meters)
NITRO = total nitrogen (mg/l)
PHOS = total phosphorous (mg/l)
CHLA = chlorophyll a (ug/l)
TSI = trophic state index
ND = no data available

TABLE 12 TROPHIC STATE INDEX TREND CALCULATION SUMMARY

STORET#	Location	Station	Type	# of obs.	Begin year	End year	TSI 1975-79	TSI 1980-85	TSI 1986-90
28010723	INTRACOSTAL WWY AT PALM B GARDE	21FLA761230	ESTUARY	36	75	90	47 GOOD	42 GOOD	40 GOOD
28010724	LITTLE LAKE WORTH AT PGA BLVD BR	21FLA761230	ESTUARY	28	75	87	51 FAIR	54 FAIR	41 GOOD
28010725	ICW AT US 1 BRIDGE	21FLA761230	ESTUARY	27	75	87	49 GOOD	61 POOR	68 POOR
28010726	CANAL C-17 AT ALT A1A BRIDGE	21FLA761230	ESTUARY	28	75	87	79 POOR	77 POOR	63 POOR
28010727	EARMAN RIVER AT US 1 BRIDGE	21FLA761230	ESTUARY	46	75	90	53 FAIR	63 POOR	56 FAIR
28010728	LAKE WORTH AT BLUE HERON BLVD BR	21FLA761230	ESTUARY	47	75	90	43 GOOD	43 GOOD	29 GOOD
28010734	WP CANAL AT SO. OLIVE AVE BRIDGE	21FLA761230	ESTUARY	46	75	90	57 FAIR	60 POOR	45 GOOD
28010769	LAKE WORTH AT SOUTHERN BLVD BRDGE	21FLA820904	ESTUARY	12	80	87	ND	66 POOR	67 POOR
28010771	ICW AT OCEAN AVE, BOYNTON	21FLA820904	ESTUARY	11	80	87	ND	61 POOR	80 POOR
28010773	LITTLE LK WORTH-CNTR, LK WRTH BAS	21FLA841228	ESTUARY	20	84	90	ND	42 GOOD	39 GOOD
28010774	MUNYON TRANS W, LK WRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	42 GOOD	36 GOOD
28010775	MUNYON TRANS MID, LK WRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	45 GOOD	45 GOOD
28010776	MUNYON TRANS E, LK WRTH BAS	21FLA841228	ESTUARY	14	84	90	ND	44 GOOD	43 GOOD
28010777	E OF ICW NAV MRKR 3, LK WRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	42 GOOD	26 GOOD
28010778	CURRIE PK WEST, LK WRTH BAS	21FLA841228	ESTUARY	19	84	90	ND	45 GOOD	42 GOOD
28010779	CURRIE PK M10, LK WRTH BAS	21FLA841228	ESTUARY	16	84	90	ND	45 GOOD	37 GOOD
28010780	CURRIE PK EAST, LK WRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	46 GOOD	43 GOOD
28010781	LK WRTH AT ROYAL PALM, LKWRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	49 GOOD	45 GOOD
28010782	ICW NAV MRKR 28, LK WRTH BAS	21FLA841228	ESTUARY	16	84	90	ND	54 FAIR	53 FAIR
28010783	LK WRTH AT SR812, LK WRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	50 FAIR	47 GOOD
28010784	ICW NAV MRKR 44, LK WRTH BAS	21FLA841228	ESTUARY	20	84	90	ND	47 GOOD	46 GOOD
28010785	ICW NAV MRKR 48, LK WRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	45 GOOD	43 GOOD
28010786	C-16 NR CONTROL STRUCT LKWRTH BA	21FLA841228	ESTUARY	18	84	90	ND	46 GOOD	35 GOOD
28010787	ICW AT SR 804, LK WRTH BAS	21FLA841228	ESTUARY	18	84	90	ND	45 GOOD	37 GOOD

If the TSI is between 0-49, the water quality is classified as GOOD.
If the TSI is between 50-59, the water quality is classified as FAIR.
If the TSI is between 60-100, the water quality is classified as POOR.
ND = no data available

TABLE 13
FECAL COLIFORMS SUMMARY

	1975-1980				1981-1985				1986-1990			
	Total # of sampling events	Total # samples exceeding 200	Total # samples exceeding 400	Total # samples exceeding 800	Total # of sampling events	Total # samples exceeding 200	Total # samples exceeding 400	Total # samples exceeding 800	Total # of sampling events	Total # samples exceeding 200	Total # samples exceeding 400	Total # samples exceeding 800
Station #												
28010723	15	4			4				2			
28010724	15	1			7				2		1	
28010725	15	1		1	7				2			
28010726	15	3	2		7				2			
28010727	15	2		2	11				4			
28010728	15	1		1	11				4			
28010734	15	6	2	2	9		1	2	5	1	1	
28010769	3				7		1		2			
28010771	3				6	1			1			
28010773	0				4				2			
28010774	0				4				3			
28010775	0				4				3			
28010776	0				4				2			
28010777	0				3				3			
28010778	0				4				3			
28010779	0				4				3			
28010780	0				3				3			
28010781	0				4				3			
28010782	0				4				3			
28010783	0				4	1			3			
28010784	0				4				2			
28010785	0				4				3			
28010786	0				4				3			
28010787	0				4				3			

* Sample thresholds values are per 100 ml of sample and correlated to State Standards for Bacteriological Quality in Class III Waters [FAC Rule 17-302.560(5)]

5.13.2 Sediment Chemistry

Lake Worth Lagoon Sediment Chemistry has been investigated by: Rodgers, 1970; SFWMD, 1977; Rudolph, 1989; Schropp and Calder, 1989. SFWMD found sediments at the south end of the lagoon to be higher in carbon, nitrogen, and phosphorus concentrations than sediments at the north end of the lagoon.

Sediments from Lake Worth Lagoon were sampled and analyzed by Schropp and Calder in 1983 and 1989. Samples taken in 1983 were localized in the area of the Port of Palm Beach (6 stations) and were analyzed for appearance and metals contents. Twenty one stations throughout Lake Worth Lagoon were sampled in 1989, with one station located in the Port of Palm Beach (PPB-009).

The locations of sediment sampling stations are depicted on **Figure 13.** The locations were determined from station descriptions on field forms used by the Florida Department of Environmental Regulation, Office of Coastal Zone Management, unpublished study of the sediment chemistry of Lake Worth (Schropp, S. and F. Calder, 1989).

Stations sampled in 1983 were not re-sampled in 1989. All stations sampled in 1989 were analyzed for appearance and metals content. In addition, 6 stations (LWO-3, LWO-11, LWO-13, LWO-15, LWO-16, and LWO-17) were analyzed for the presence of semivolatile organics, polycyclic aromatic hydrocarbons (PAH's and N-PAH's), and pesticides.

Analyses for semivolatile organics were below detection limits. Pesticides scans were also below detection limits for all compounds except Aroclor-1254, a polychlorinated biphenyl (PCB) based pesticide which was found at two stations, LWO-11 and LWO-13, in amounts ranging from 10 to 14 ug/kg dry weight. Several of the PAH compounds were detected at all six stations. Compounds found above detection limits included benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)Fluoranthene, fluoranthene, indenopyrene, pyrene, phenanthrene, and 2-methylnaphthalene. PAH's are derivatives of petroleum products, especially diesel fuels.

Metals concentrations were examined against normalized curves following the method of the Department of Environmental Regulation (DER, 1987, A Guide to the Interpretation of Metal Concentrations in Estuarine Sediments). Station concentrations above normal limits were found for cadmium (1983 data), chromium (1983 and 1989 data), copper (1983 and 1989 data), lead (1983 and 1989 data), nickel (1989 data), and zinc (1983 and 1989 data). Since the stations sampled in 1983 were not re-sampled in 1989, no trend analysis is possible. Of those metals found above normal concentrations, lead appeared to be the most prevalent, followed by zinc, nickel, copper, cadmium and chromium. Mercury, which can not be examined against normalized curves was present in slightly elevated concentration at stations near the Port of Palm Beach.

Elevated metal concentrations and the presence of PAH's are indicative of a system which chronically receives significant runoff from urban development areas. Their presence in the sediments of Lake Worth Lagoon is not surprising considering historical and present land uses as well as water quality trends.

5.13.3 Benthic Fauna

The literature indicates that a number of studies of benthic macroinvertebrate populations have been conducted over the past twenty years. However, a detailed trend analysis is not possible due to the lack of fixed station long term sampling data. EPA (1970) collected samples from 339 stations, but the sorting and identification was never completed. Reed (1975) collected 171 taxa from 11 stations during 1972 -1973. Deis (1978) collected 134 taxa from 12 stations in 1977. Tropical Ecosystems Inc. (1983) duplicated the Reed study in 1982 - 1983 and identified 310 taxa. Rudolph (1989) collected 262 from six stations in Lake Worth Lagoon in 1985. Rudolph found a reduction in diversity when compared to the TEI study, and the species diversity values were comparable to other moderately polluted estuaries.

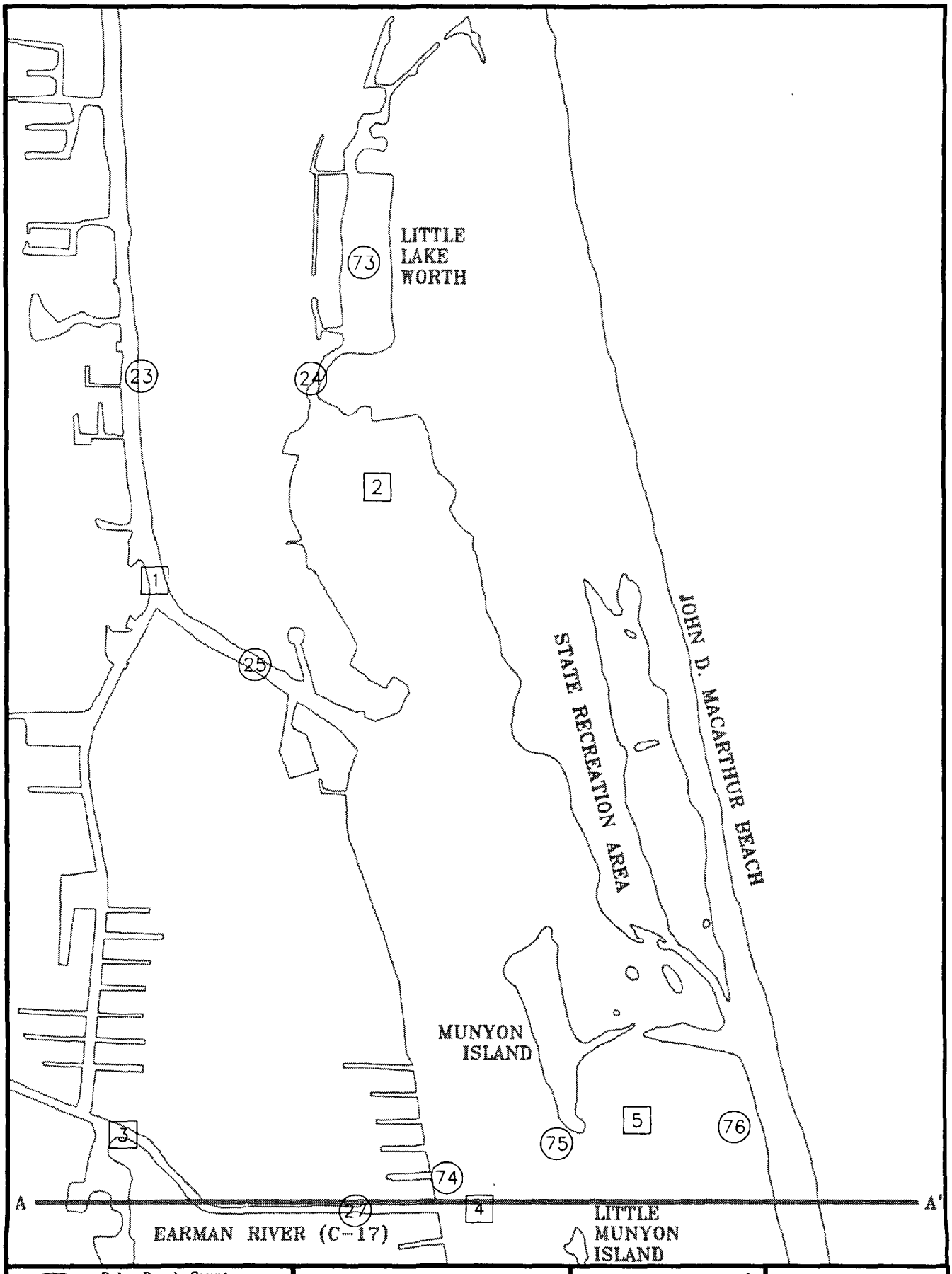
LEGEND

(XX) STORET # 280107__

[XX] DER SEDIMENT STATION #

[PX] DER SEDIMENT STATION PPB#

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* WATER QUALITY STATIONS		D&M JOB NO. *20335-001-049* FIGURE *13-A*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

WATER QUALITY STATIONS

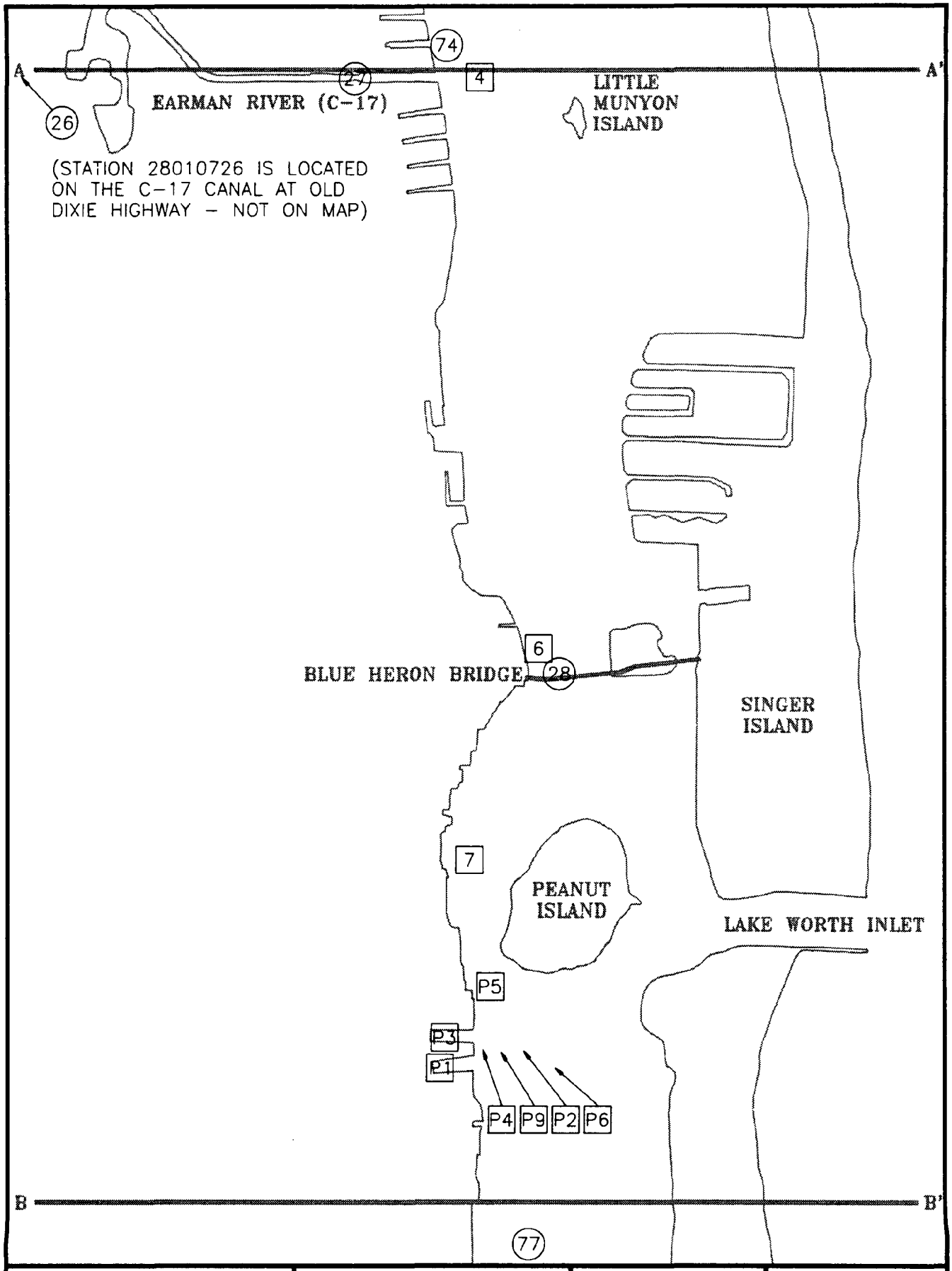
0 1000 2000

SCALE
(FEET)

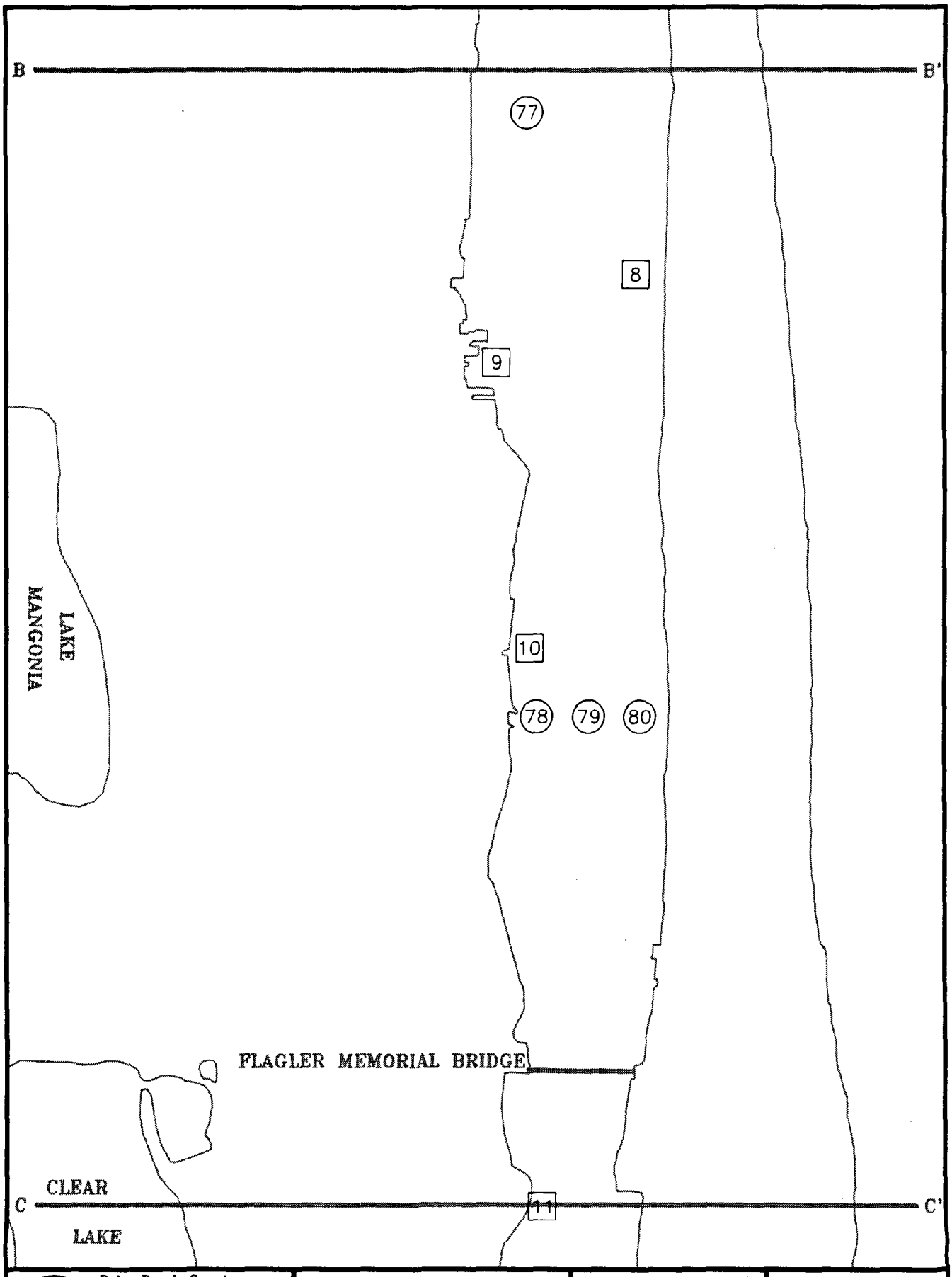
N

D&M JOB NO.
20335-001-049

FIGURE
13-B



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT	*LAKE WORTH LAGOON* WATER QUALITY STATIONS	0 1000 2000 SCALE (FEET) N	D&M JOB NO. *20335-001-049* FIGURE *13-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

WATER QUALITY STATIONS

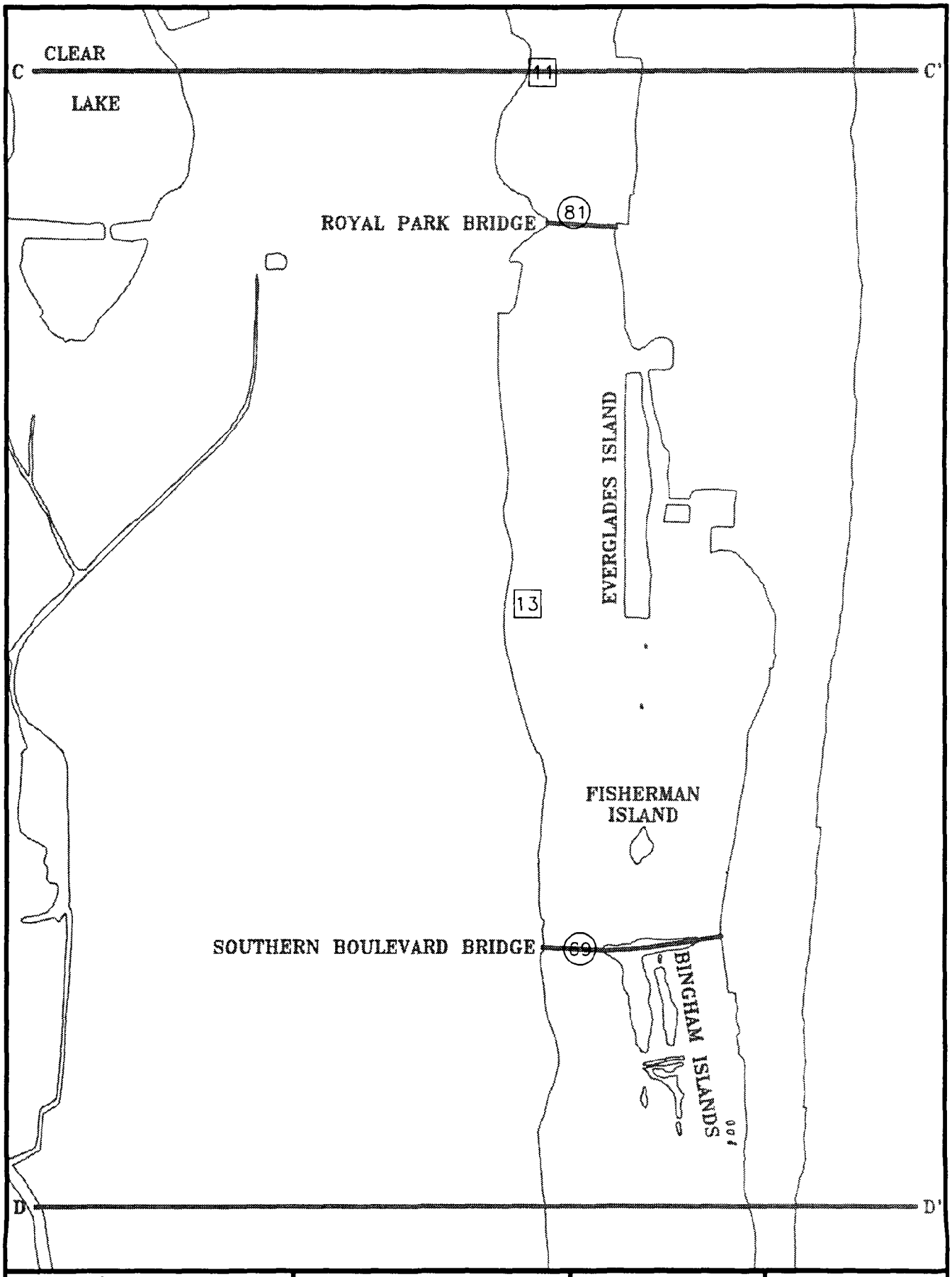
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *13-D*



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

WATER QUALITY STATIONS

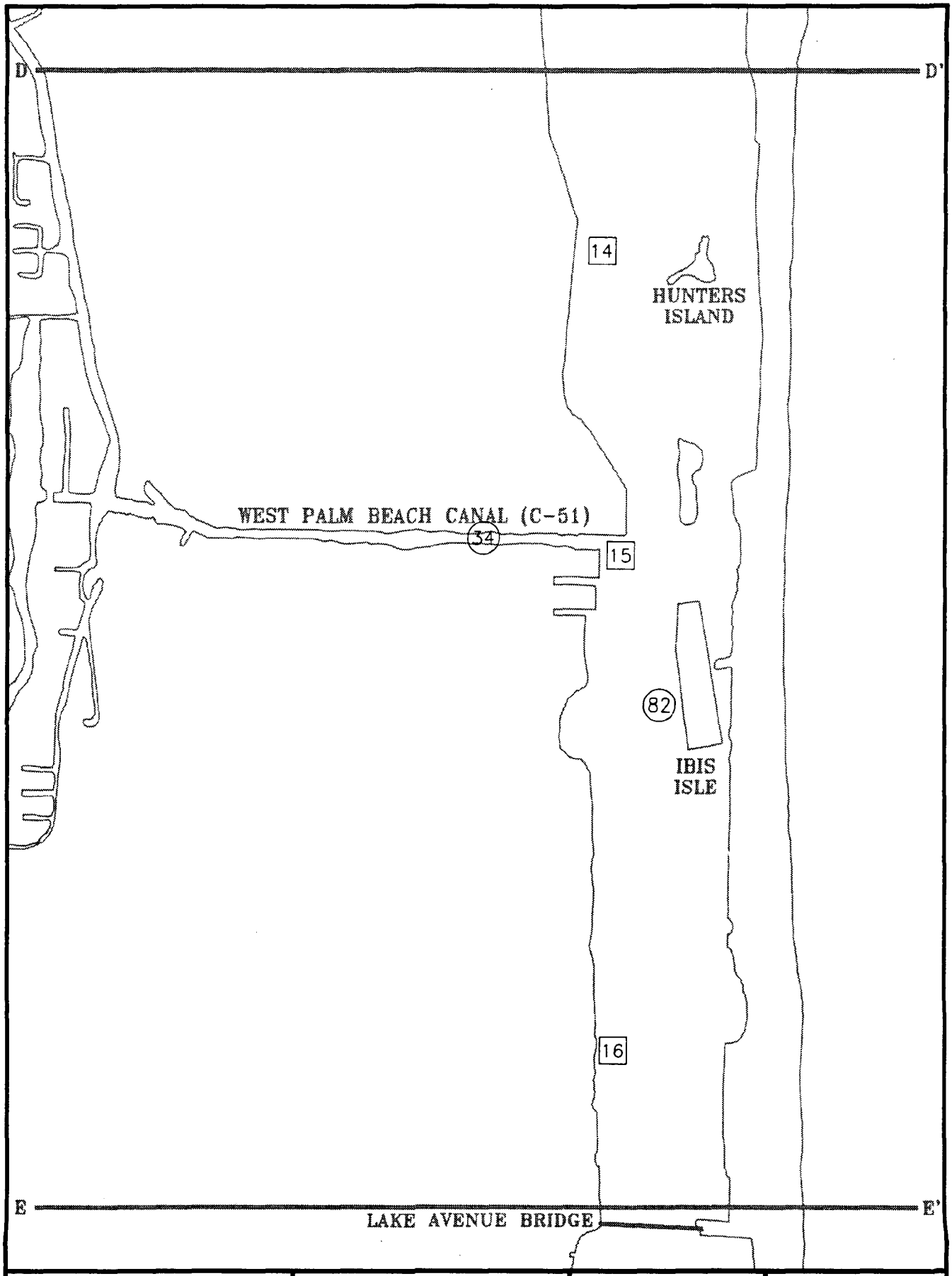
0 1000 2000

SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
13-E



Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON

WATER QUALITY STATIONS

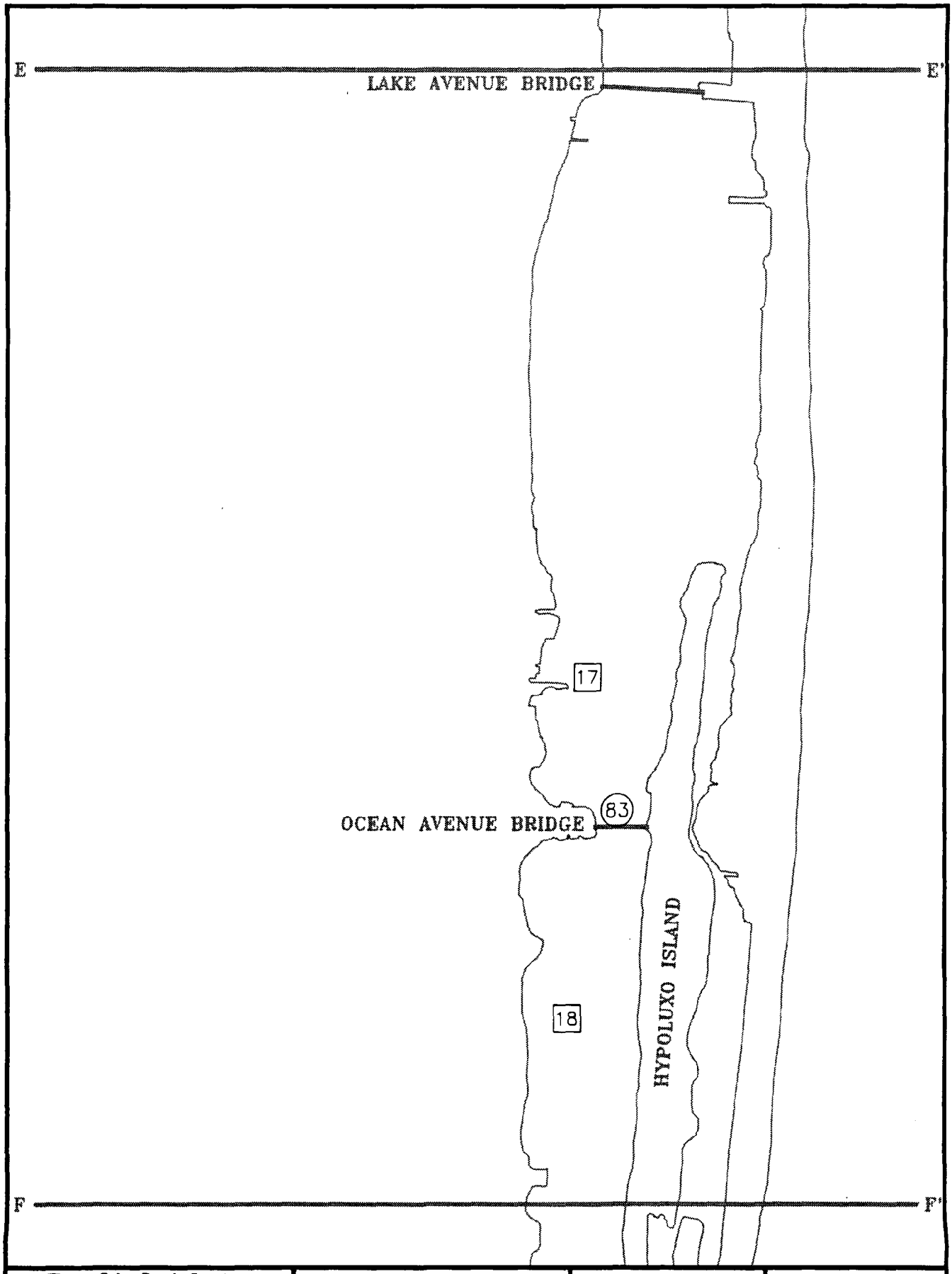
0 1000 2000

SCALE
(FEET)

N

D&M JOB NO.
20335-001-049

FIGURE
13-F



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

WATER QUALITY STATIONS

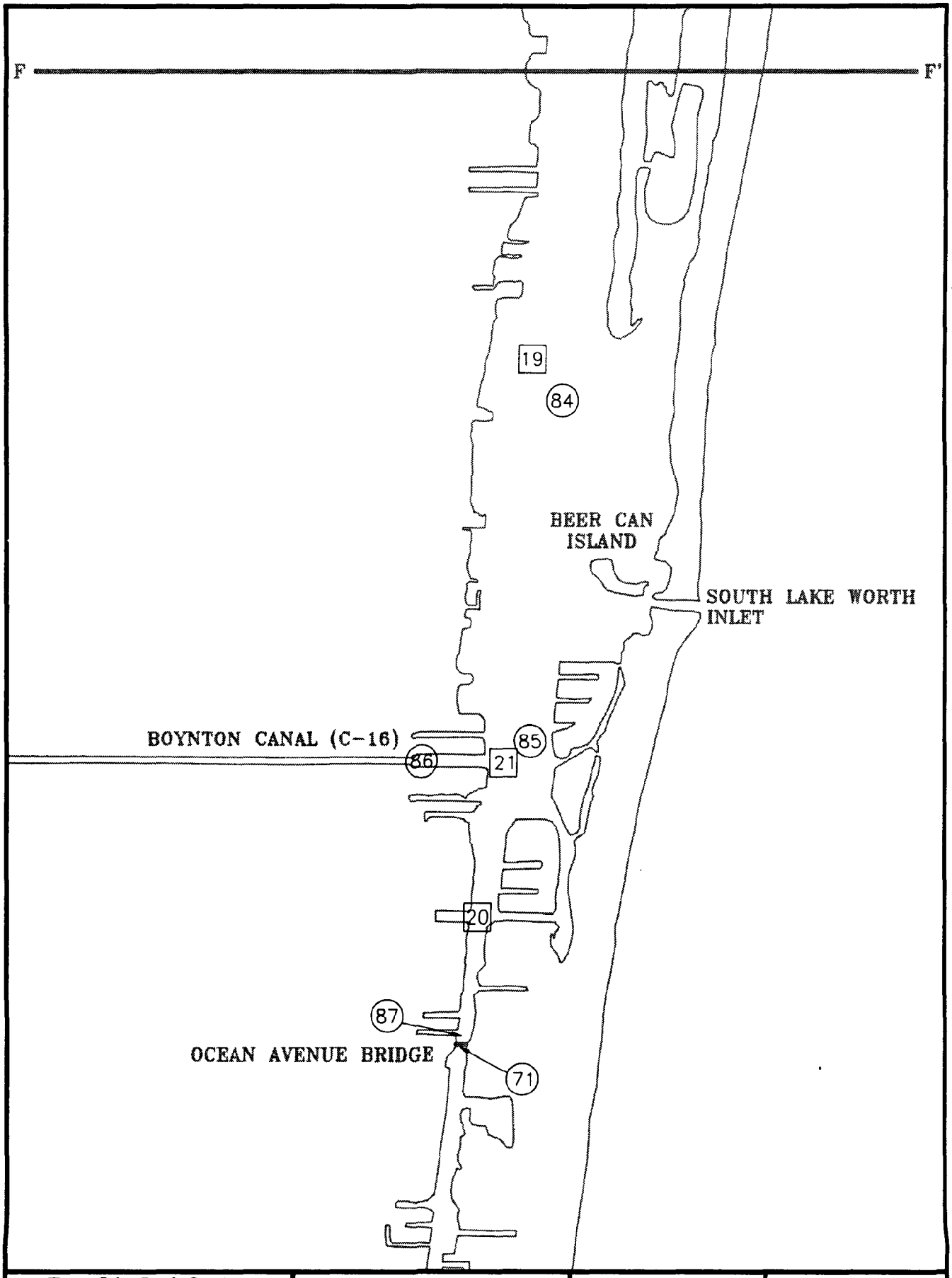
0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *13-C*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON

WATER QUALITY STATIONS

0 1000 2000

SCALE (FEET)

N

D&M JOB NO. *20335-001-049*

FIGURE *13-H*

6.0 HABITAT RESTORATION AND ENHANCEMENT

Palm Beach County adopted a vessel registration fee ordinance (No.88-40) effective June, 1989, for the expressed purpose of generating revenue to finance enhancement projects for water bodies within the county.

The ordinance directs that the monies be used for:

1. The protection of valuable coastal and lagoon habitats
2. The maintenance and enhancement of fisheries and habitats.
3. The construction of artificial reefs.

In order to initiate restoration and enhancement activities in Lake Worth Lagoon prior to implementation of a comprehensive management plan, an inventory of project types, project areas, and ratings has been developed in conjunction with the resource inventory.

The projects which are identified are primarily geared toward habitat improvement, with water quality enhancement being a secondary benefit.

6.1 PROJECT TYPES

Five habitat restoration and enhancement project types which may be implemented in Lake Worth Lagoon were identified and evaluated. They are described below:

Shoreline Wetlands Creation

Red mangrove wetland creation projects have a high probability for success if the proper substrate elevation is established; if daily tidal influence is assured; and if the area is protected from erosive wave energy. Red mangroves can be established along shorelines,

and in areas from which exotic vegetation is removed and the substrate is scraped down to intertidal elevation. If high wave energy exists along a shoreline, it may be necessary to protect the planting area with rip rap. Lake Worth Lagoon has a number of shoreline areas and spoil islands which could be regraded and revegetated with red mangroves. Cordgrass, *Spartina alterniflora* can be planted in place of red mangroves on sites prepared to similar conditions to create salt marsh areas. However, in Lake Worth Lagoon, salt marsh areas will eventually become replaced by red mangrove communities through natural successional processes. Communities of black, white and buttonwood mangrove are more difficult to created than shoreline red mangrove communities due to problems associated with the establishment and stabilization of precise substrate elevations required to support these species and prevent invasion by undesirable exotic species. These factors increase the difficulty of creating the more diverse wetland systems.

Artificial Reefs

Structures can be placed on the lagoon bottom to create artificial reef habitats. The structures will be rapidly colonized by a variety of marine epifauna and are known to attract and ultimately produce diverse assemblages of fish. A variety of inorganic materials can be used for reef construction as long as they can be successfully anchored to the bottom, or have sufficient weight to prevent their movement by tides and currents. Artificial reef projects must also be constructed in a manner which will prevent them from becoming hazards to navigation. In general, areas near the inlets have higher marine diversity and would benefit the most from this type of project. Holes which have been created by dredging are potential sites for this type of project.

Rip Rap Shoreline Stabilization

Rock or concrete rubble rip rap can be placed along the base of existing bulkheads and along high energy shorelines for shoreline stabilization and habitat creation purposes. Rip rap creates habitat similar in ecological value to habitat created by artificial reef structures.

When placed at the base of bulkheads, rip rap dissipates reflected wave energy which would have produced bottom scouring. Rip rap can also be used an alternative to vertical bulkheads or can be placed waterward of shoreline wetland plantings for wave protection. Many areas which could benefit from this type of project exist along the shoreline of Lake Worth Lagoon.

Seagrass and Oyster Bed Creation

Seagrass beds occur in varying composition and density throughout Lake Worth Lagoon. In general, the most viable grass beds occur in shallow areas with good water clarity. If an area does not support seagrasses, it is generally due to inappropriate site conditions. Survival of plantings in such areas has been relatively unsuccessful in projects undertaken in other similar water bodies. An unsuccessful seagrass bed creation project was undertaken at Bicentennial Park, Riviera Beach as a mitigation requirement of a DER wetland alteration permit. Several experimental designs are currently being studied throughout Florida to provide an open artificial structure and promote oyster growth along existing bulkheads. In the future, experimental projects of this type will be evaluated and utilized if appropriate.

Public Information

Public information describing the natural resources of Lake Worth Lagoon and describing the efforts of ERM to protect and enhance these resources could be provided in the form of signs and displays and other written information located at boat ramps, public parks and marina facilities located along Lake Worth. Public awareness will lead to appreciation, which will lead to resource protection and support of the restoration and enhancement efforts.

6.2 PROJECT AREAS

Lake Worth Lagoon can best be characterized as an urban estuary. The majority of Lake Worth's shoreline and islands are dominated by urban development. For this reason there are very few areas remaining which contain high quality diverse habitat components. Virtually all of the remaining habitat areas have been impacted to some extent by human activities, and present considerable opportunities for enhancement and restoration. It is recommended that habitat restoration and enhancement efforts in Lake Worth be focused upon the best remaining diverse habitat areas, with the objective of maintaining, protecting and improving them as examples of diverse and productive native habitat. For the purposes of this investigation, only project sites which are located on publicly owned lands or lands accessible to the public have been considered. Potential project sites were identified through field investigation and review of aerial photographs.

Listed below are four significant areas which contain relatively diverse habitat components with potential for restoration and enhancement.

Habitat Area 1.

The northeastern section of Lake Worth Lagoon in the vicinity of John. D. MacArthur State Recreation Area is the best remaining example of the native ecosystem. This area contains numerous seagrass beds, shoreline mangrove fringes, hardwood hammocks, mangrove islands and embayments. The area also contains Big and Little Munyon Islands and another smaller island. These islands have been impacted by dredge spoil disposal and subsequent invasion by exotic plant species. Big Munyon Island retains a remnant coastal hammock in its interior portion (**Appendix 8.3**). Since Big Munyon Island is under public ownership as a component of the Florida State Park System, an ambitious exotic removal, shoreline configuration and stabilization, and saltmarsh/mangrove shoreline planting program could be undertaken to improve the habitat value of the island. Within the Singer Island portion of the recreation area there is a recently cleared corridor along State Road A1A. This

corridor could be planted with wetland and upland plant species. This habitat area also contains elevated areas of spoil that have attracted exotic vegetation such as Australian Pine and Brazilian Pepper that could be removed.

Habitat Area 2

The area in the vicinity of Lake Worth Inlet maintains high marine productivity because of the tidal influence provided by the inlet. A submerged area north of the Blue Heron Blvd. Bridge and immediately west of Palm Beach Isles has been deepened by past dredging, and has a potential for development of an inshore artificial reef. The area will require further investigation to determine the feasibility of such a project. Also in the vicinity of Lake Worth Inlet is the 72 acre Peanut Island which was created by dredge spoil deposition. The majority of the island is covered by Australian Pines. Peanut Island has been recognized as having great potential as a public recreation area. If Peanut Island is acquired by the state or county for public recreation purposes, reconfiguration of portions of the shoreline and interior for native habitat restoration could be undertaken in association with park development.

Habitat Area 3

The areas immediately north and south of the Southern Boulevard Bridge and east of the Atlantic Intracoastal Waterway channel contain a number of small spoil islands known as Fishermans Island, The Bingham Islands and Hunters Island. Mangrove wetlands and seagrass beds are fairly abundant in the vicinity. This area is undeveloped, and is known for a moderate concentration of bird life. The islands are owned by the Town of Palm Beach. The types of activities previously suggested for Big Munyon Island could be undertaken to improve the habitat value of this diverse area.

Habitat Area 4

The area in the vicinity of South Lake Worth Inlet is subject to considerable tidal influence, and contains several habitat areas which could be enhanced. Beer Can Island which is located just northwest of the inlet has a badly eroding western shoreline, which could be protected with rip rap or enhanced a fringing mangrove community.

Shoreline habitat creation could also be done at Ocean Inlet Park located south of the inlet. Just north of the Ocean Boulevard Bridge (Boynton Beach), the Intracoastal Waterway bisects the largest mangrove swamp in the southern portion of Lake Worth. The edges of the swamp are eroding and could be protected from wave energy by placement of rip rap. A similar site exists immediately south of the Ocean Avenue Bridge.

Additional projects not located within the four habitat areas previously described have also been identified. All of the potential projects which have been identified are summarized in **Table 14.** The project sites are identified on **Figure 14.**

6.3 PROJECT EVALUATION

The conceptual projects which have been identified were evaluated and rated through the use of a evaluation matrix which takes into account the following criteria:

> Construction resources requirements - considers access and staging for project construction, relative cost of materials equipment and labor required per unit of project, and any known unique construction problems associated with the project. The evaluation assumes that different types of construction activities can be made equivalent by adjusting linear distance or volume of construction activity. (eg: 50 linear feet of shoreline plantings may be equal to one tenth acre of artificial reef).

Maintenance requirements - considers the level of maintenance and monitoring required to assure project success. Maintenance considerations include items such as exotic plant control, replanting/replacement and general cleanup. Monitoring effort required can range from visual inspection to intensive data collection.

Ecological benefits - the level of ecological benefit is dependent upon the size of project, existing conditions of the resources in the vicinity, ongoing human impacts in the area, and diversity of functions provided by the restored or enhanced habitat.

Land availability - considers public versus private ownership, as well as the probability of the owners permission and level of support for restoration efforts.

Public acceptance - considers whether the project may be objectionable to a particular special interest for reasons such as aesthetics or use restrictions. A project may also be of little interest, or may be highly supported by the general public.

Probability for success - considers site conditions which may effect the success of the project, as well as known success rates for similar completed projects.

Proximity to significant natural resources - considers whether the project is within, close to, or isolated from an area of significant natural resources. The assumption is that clustered habitat resources will be of greater ecological value than small isolated habitat areas.

Evaluation criteria values are presented in **Table 15.** The completed evaluation matrix is presented in **Table 16.** The evaluation matrix is an attempt to develop standard evaluation criteria for the comparison of conceptual projects. The resulting ratings are recommended only as a guideline to the selection of projects which are undertaken. Additional projects can be evaluated using the same matrix, and numerical values for evaluation criteria can be modified if complications are discovered during the planning phase of a given project.

TABLE 14

HABITAT RESTORATION AND ENHANCEMENT PROJECTS SUMMARY

Project No.	Project Name	Project Type	Project Owner	Project Area	Comments	Project Rating
1	MacArthur State Park Area	Shoreline Plantings/Rip Rap	Florida Department of Natural Resources	Up to 4000 linear ft. of shoreline and 5000 linear ft. of roadside.	Requires removal of exotic vegetation, mobilization of equipment and materials to the island will be required, a moderate energy shoreline may increase maintenance requirement.	A
2	Palm Beach Isles-Hole	Artificial Reef	Florida Department of Natural Resources	Approximately 10 acres	Barges and other heavy equipment will be required to transport reef building structures to the site. Should be highly utilized by marine fauna due to close proximity to inlet. Low maintenance, primarily monitoring. Obstruction of navigation may be a permitting concern.	A
3.	Peanut Island	Shoreline Plantings/Rip Rap	U.S. Coast Guard, Palm Beach County, Port of Palm Beach	Up to 7000 linear ft.	Requires mobilization of equipment and material to Island. Moderate energy shoreline and heavy human use may increase maintenance requirement. May be included in future park development plant.	B
4.	N. Lakeway Drive - Palm Beach	Shoreline Plantings/Rip Rap	Palm Beach Country Club and Golf Course	1500 linear ft.	Accessible by conventional equipment. Some removal of exotic vegetation required. Should not conflict with existing land use. Moderate energy shoreline may increase maintenance requirements.	B
5.	West Palm Beach Bulkhead	Rip Rap	City of West Palm Beach	6000 linear ft.	Rip rap can be placed at the toe of the existing bulkhead with land based equipment. Habitat value will be diminished due to location. May cause a maintenance concern; i.e., litter trap.	C
6.	Royal Park Bridge-Hole	Artificial Reef	Florida Department of Natural Resources	Undetermined area	Barges and other heavy equipment will be required to transport reef building materials to the site. Location is isolated from other resource areas and inlets. Proximity to channel and residences may result in concerns and objections.	C
7.	Southern Boulevard Bridge-NW Shore	Shoreline Plantings/Rip Rap	City of West Palm Beach	600 linear feet	Located in the vicinity of other resources but in a highly developed area. Site is accessible by convention land based equipment. Maintenance requirements may be increased by heavy human activity in area.	B

8.	Palm Beach Islands	Shoreline Plantings	Town of Palm Beach	Several linear miles of shoreline	Accessible by boat only. Will require removal of some exotic vegetation. Low energy shorelines and limited human activity will reduce maintenance needs. Located in an area of significant resources.	A
9.	Southern Boulevard Bridge - Hole	Artificial Reef	Florida Department of Natural Resources	Undetermined area	Barges and other heavy equipment required to transport reef building materials to the site. Located in the vicinity of significant resources but away from inlets. Impacts to navigation may be a permitting issue.	B
10.	Ocean Avenue-Phipps Ocean Park Vicinity	Shoreline Plantings/Rip Rap	Town of Palm Beach and Private	2900 linear ft.	Removal of exotic vegetation will be required. Somewhat isolated from other resources. Accessible by conventional land based equipment. Ibis Isles residents may object.	B
11.	C-51 Shoreline	Shoreline Plantings/Rip Rap	South Florida Water Management District	400 linear ft.	Accessible by conventional land based equipment. High energy generated by spillway discharge may create maintenance problems. Isolated from significant resources.	C
12.	Lake Worth Golf Course	Shoreline Plantings/Rip Rap	City of Lake Worth	7000 linear ft.	Shoreline has some existing mangrove and rip rap areas. Removal of exotic vegetation will be required. Isolated from significant resource areas. Accessible by conventional land based equipment. Moderate energy shoreline.	B
13.	Ocean Avenue - South Palm Beach	Shoreline plantings/ Rip Rap	Privately Owned, adjacent to road corridor	5000 linear ft.	Accessible by conventional land based equipment. Removal of exotic vegetation will be required. Isolated from significant resource areas. Moderate energy shoreline. Degree of cooperation by adjacent residents unknown.	C
14.	Half Moon Bay - Hole	Artificial Reef	Florida Department of Natural Resources	Undetermined area	Barges and other heavy equipment required to transport reef building materials to the site. Isolated from significant resources. Adjacent upland property owners may object concerning impacts to navigation.	C
15.	Hypoluxo Spit	Shoreline Plantings	Town of Manalapan	400 linear ft.	Site access is limited. Area is already vegetated by wetland plants to some degree. The level of support by adjacent residents is unknown. Site is somewhat isolated.	C

16.	Boynton Beach Boat Civic Park	Shoreline Plantings/ Rip Rap	City of Boynton Beach	600 linear ft.	Accessible by conventional land based equipment. Site already has some rip rap and mangroves. Close proximity to significant resources. Site limited in size.	A
17.	Beer Can Island	Shoreline Plantings/Rip Rap	South Lake Worth Inlet District, and Privately Owned	500 linear ft.	Adjacent to inlet in an area of fairly diverse marine resources. Removal of exotic vegetation will be required. Accessible only by barge or boat. Area of high shoreline energy and heavy public use.	A
18.	Ocean Inlet Park	Shoreline Plantings/Rip Rap	Palm Beach County Parks & Recreation Department	500 linear ft.	Adjacent to inlet in a fairly diverse marine area. Accessible by conventional based equipment. High energy shoreline and heavy public use.	B
19.	Ocean Ridge and Boynton Beach Mangrove Areas	Rip Rap	Florida Inland Navigation District, Corps of Engineers	4500 linear ft.	Eroding mangrove shoreline can be protected by rip rap. Barges and special equipment required to transport materials to the site. Project area is somewhat isolated. Maintenance requirements minor.	B
20.	County Owned Mangrove Preserve	Shoreline Plantings/Rip Rap	Palm Beach County Department of Environmental Resources Management	7.0 acres	Eroding mangrove shoreline can be protected by rip rap. Interior areas can be graded and planted with mangroves. Barges and special equipment required. Area is isolated. Minor maintenance requirements.	A
Other	Parks, Marinas, Public Access Areas	Public Information	Various Owners	Over 50 potential sites	Signs, displays, and other written information regarding the natural resources of Lake Worth Lagoon can be distributed to promote protection and support for restoration and enhancement.	

TABLE 15

PROJECT EVALUATION CRITERIA VALUES

Matrix Value	1	2	3
Evaluation Criteria			
Construction Resources Requirements	Special equipment, materials or services which will inflate cost per unit.	Conventional Construction with minor special considerations.	Conventional construction and labor.
Maintenance Requirements	Intensive maintenance required.	Moderate routine maintenance required.	Minor maintenance or monitoring only required.
Ecological Benefits	Minor benefits.	Moderate benefits.	Significant benefits.
Land Availability	Privately owned.	Public ownership by a non-resource related entity.	Public ownership by a resource related entity.
Social Acceptance	Some interests may object.	Neither significant objection or support anticipated.	Significant public support likely.
Probability for Success	Poor-risky project.	Good chance for success.	Excellent chance of success.
Proximity to Significant Natural Resources	Isolated.	Within close proximity to a significant resource area.	Within a significant resource area.

TABLE 16

PROJECT EVALUATION MATRIX

Project Number / Evaluation Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Construction Resources Requirements	2	1	1	3	2	1	3	2	1	3	3	3	3	1	1	3	1	3	1	1
Maintenance Requirements	3	3	2	2	1	3	2	2	3	2	1	2	2	3	2	2	2	2	3	3
Ecological Benefits	3	3	3	2	1	1	2	3	2	2	1	2	2	1	1	2	3	2	2	3
Land Availability	3	3	2	1	2	3	2	3	3	3	3	2	1	3	2	3	3	3	3	3
Public Acceptance	3	3	3	2	2	1	2	3	1	2	1	2	1	1	2	2	2	1	2	3
Probability for Success	3	3	2	2	2	2	2	3	2	2	1	3	2	2	2	2	3	2	2	3
Project Location in Proximity to Significant Natural Resources	3	3	3	2	1	1	2	3	2	2	1	1	1	1	2	3	3	3	1	3
Total Score	20	19	16	14	11	12	15	19	14	16	11	15	12	12	12	17	17	16	14	19
Rank (A-C)	A	A	B	B	C	C	B	A	B	B	C	B	C	C	C	A	A	B	B	A

No of Projects within each range and corresponding rank	Totals Score Range	Rank	Total Number of Projects
	(17-20)	A	6
	(14-16)	B	8
	(11-13)	C	6

LEGEND

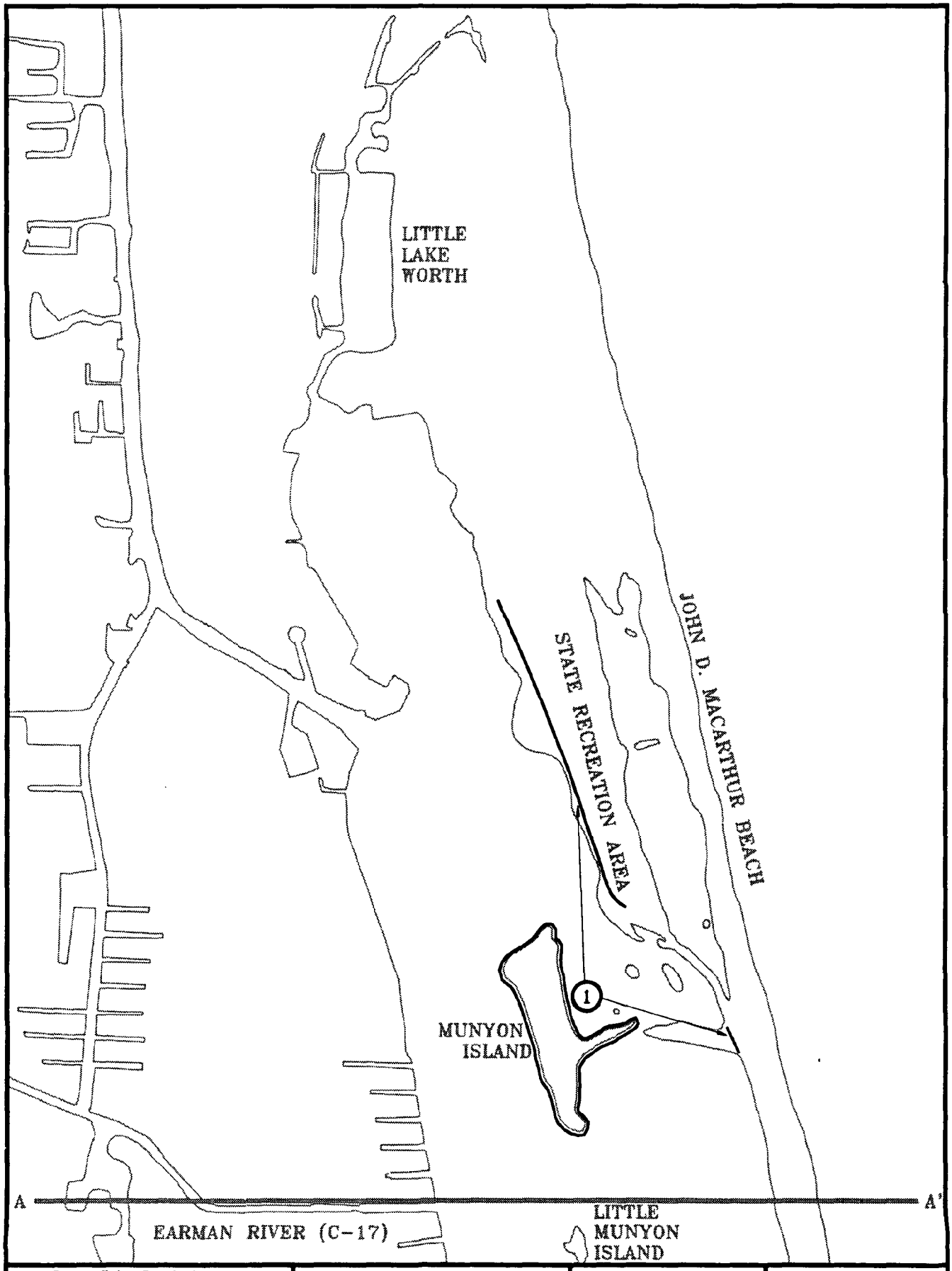
PROJECT NO.	PROJECT	PROJECT TYPE
1	MACARTHUR STATE PARK AREA	SHORELINE PLANTINGS/RIP RAP
2	PALM BEACH ISLES – HOLE	ARTIFICIAL REEF
3	PEANUT ISLAND	SHORELINE PLANTINGS/RIP RAP
4	N. LAKEWAY DRIVE – PALM BEACH	SHORELINE PLANTINGS/RIP RAP
5	WEST PALM BEACH BULKHEAD	RIP RAP
6	ROYAL PARK BRIDGE – HOLE	ARTIFICIAL REEF
7	SOUTHERN BOULEVARD BRIDGE – NW SHORE	SHORELINE PLANTINGS/RIP RAP
8	PALM BEACH ISLANDS	SHORELINE PLANTINGS
9	SOUTHERN BOULEVARD BRIDGE – HOLE	ARTIFICIAL REEF
10	OCEAN AVENUE – PHIPPS OCEAN PARK VICINITY	SHORELINE PLANTINGS/RIP RAP
11	C–51 SHORELINE	SHORELINE PLANTINGS/RIP RAP
12	LAKE WORTH GOLF COURSE	SHORELINE PLANTINGS/RIP RAP
13	OCEAN AVENUE – SOUTH PALM BEACH	SHORELINE PLANTINGS/RIP RAP
14	HALF MOON BAY – HOLE	ARTIFICIAL REEF
15	HYPOLUXO ISLAND SPIT	SHORELINE PLANTINGS
16	BOYNTON BEACH BOAT CLUB PARK	SHORELINE PLANTINGS/RIP RAP
17	BEER CAN ISLAND	SHORELINE PLANTINGS/RIP RAP
18	OCEAN INLET PARK	SHORELINE PLANTINGS/RIP RAP
19	OCEAN RIDGE AND BOYNTON BEACH MANGROVE AREAS	RIP RAP
20	COUNTY–OWNED MANGROVE PRESERVE	SHORELINE PLANTINGS/RIP RAP

Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION AND ENHANCEMENT PROJECT AREAS

D&M JOB NO. *20335-001-049*

FIGURE *14-A*



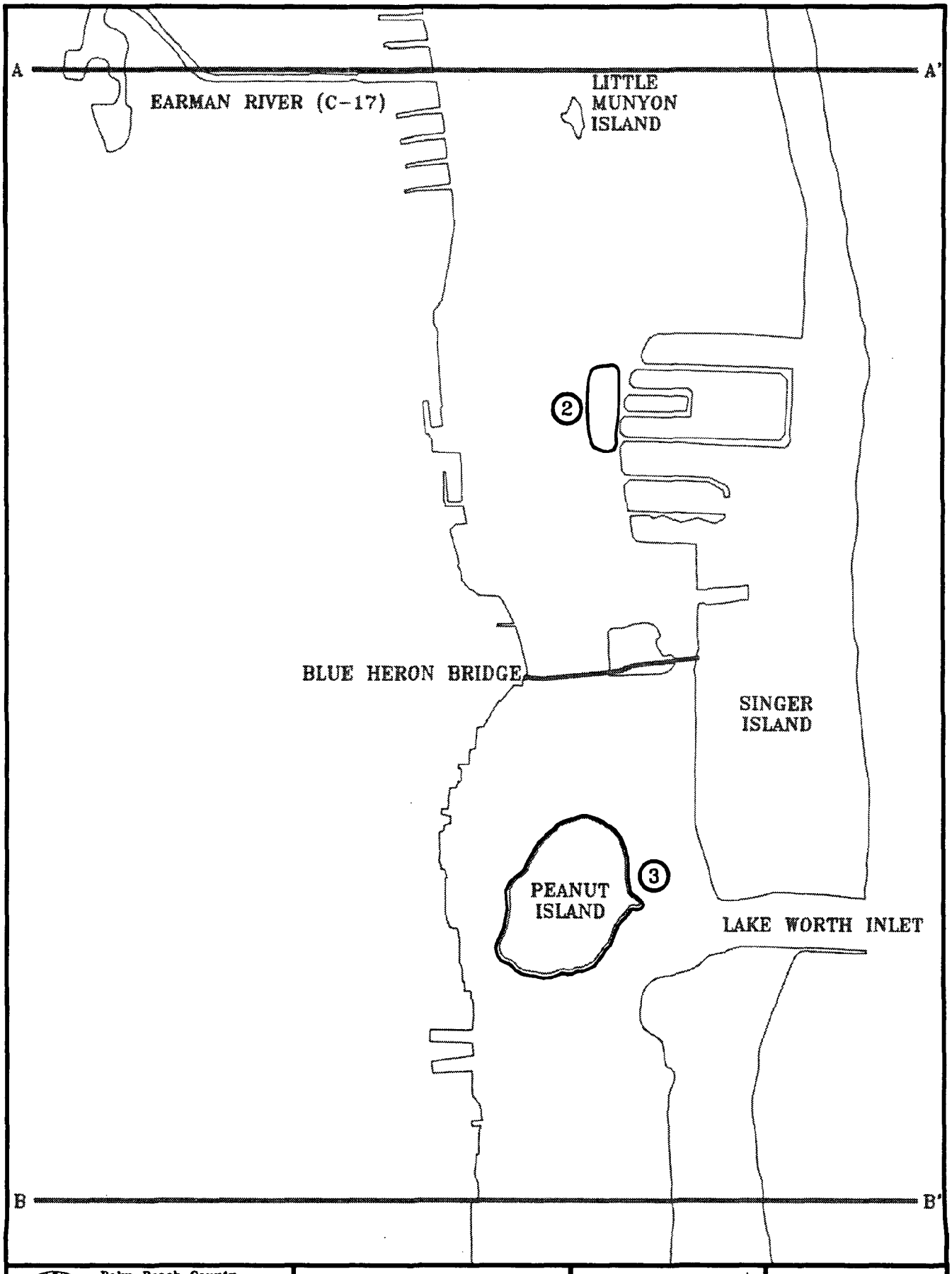
Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION
AND ENHANCEMENT
PROJECT AREAS

0 1000 2000
SCALE
(FEET)

D&M JOB NO.
20335-001-049

FIGURE
14-B



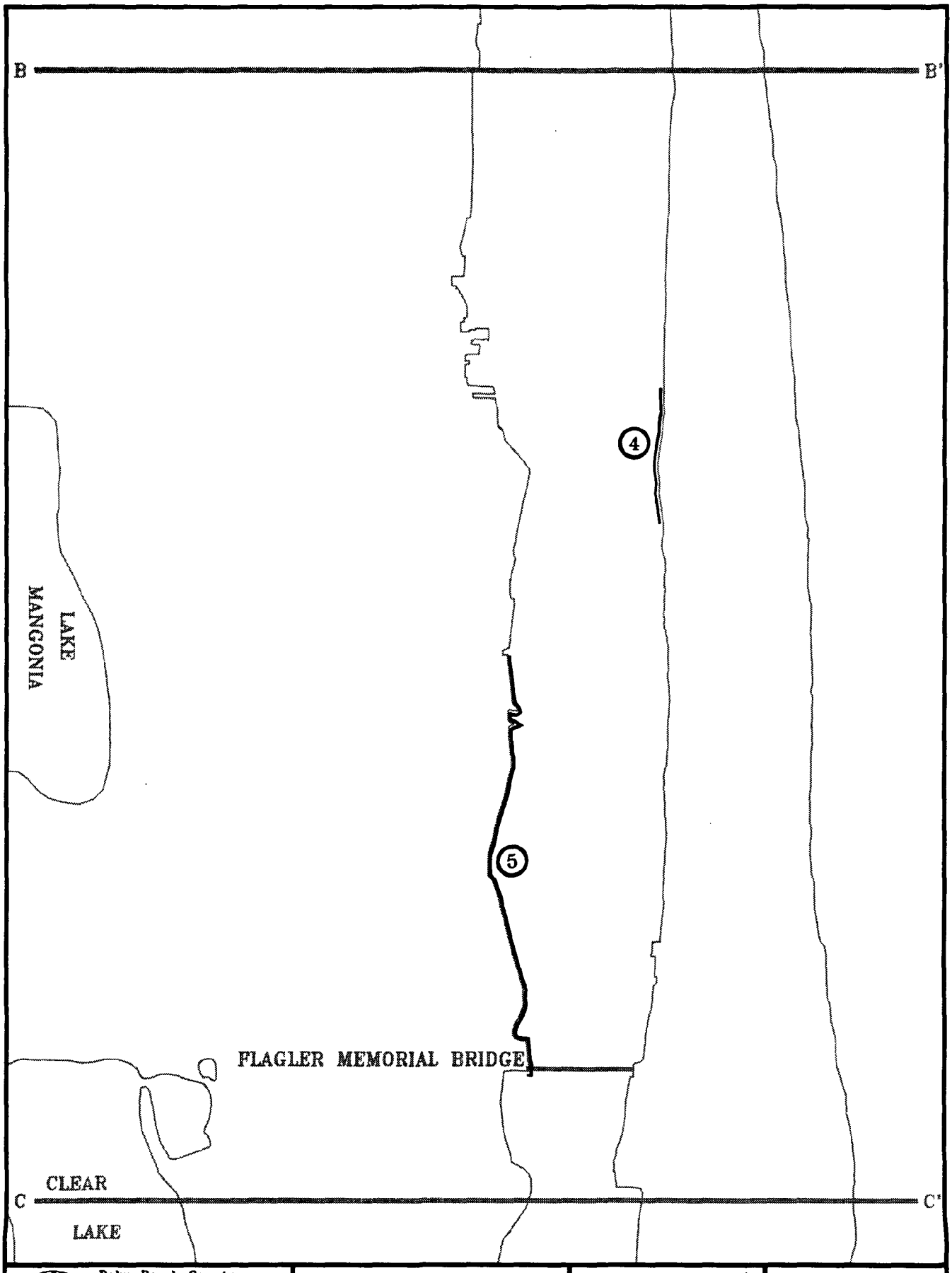
Palm Beach County
Department of
ENVIRONMENTAL
RESOURCES
MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION
AND ENHANCEMENT
PROJECT AREAS

0 1000 2000
SCALE
(FEET)
N

D&M JOB NO.
20335-001-049

FIGURE
14-C



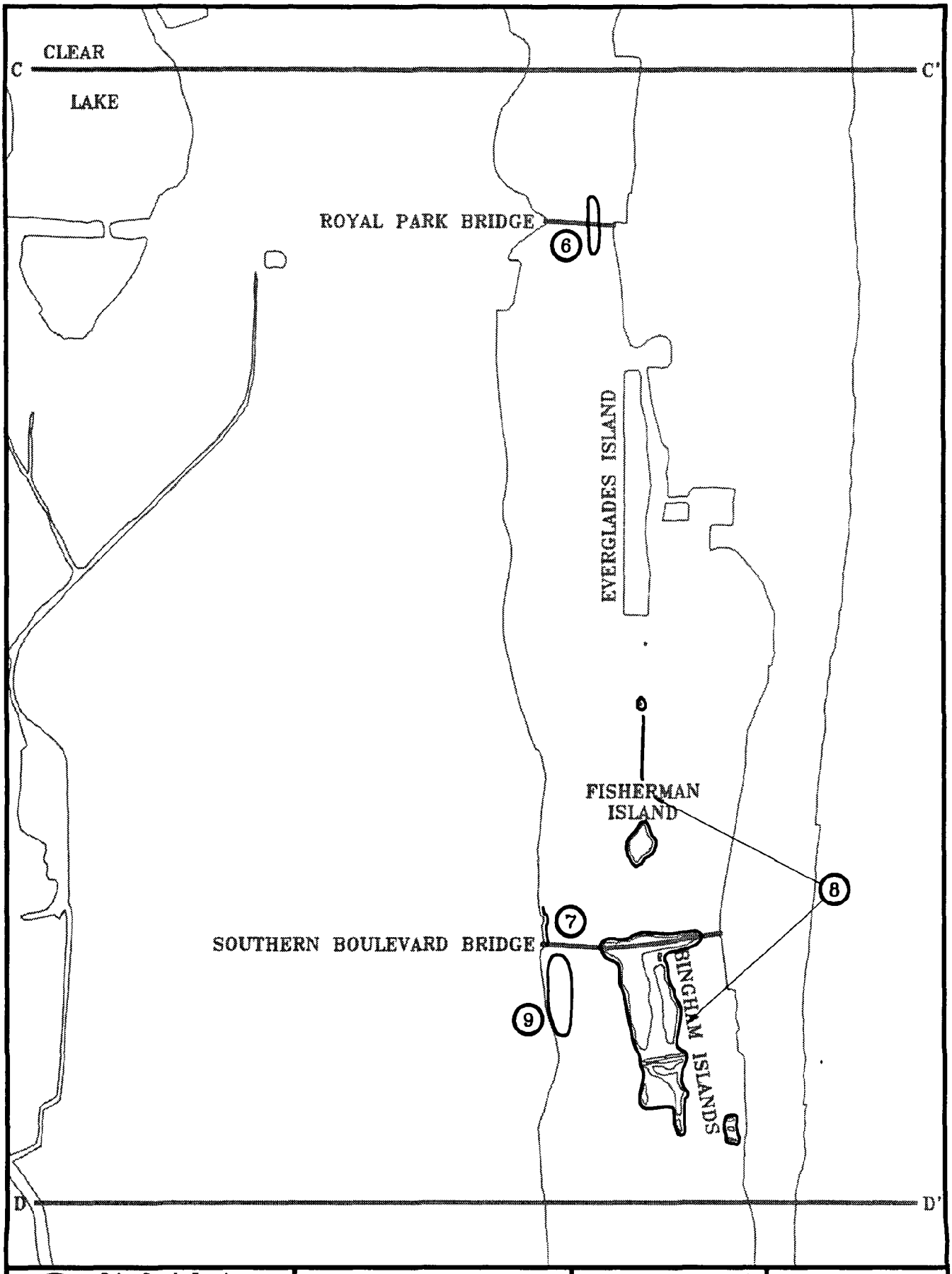
Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION AND ENHANCEMENT PROJECT AREAS

0 1000 2000
SCALE (FEET)

D&M JOB NO. *20335-001-049*

FIGURE *14-D*



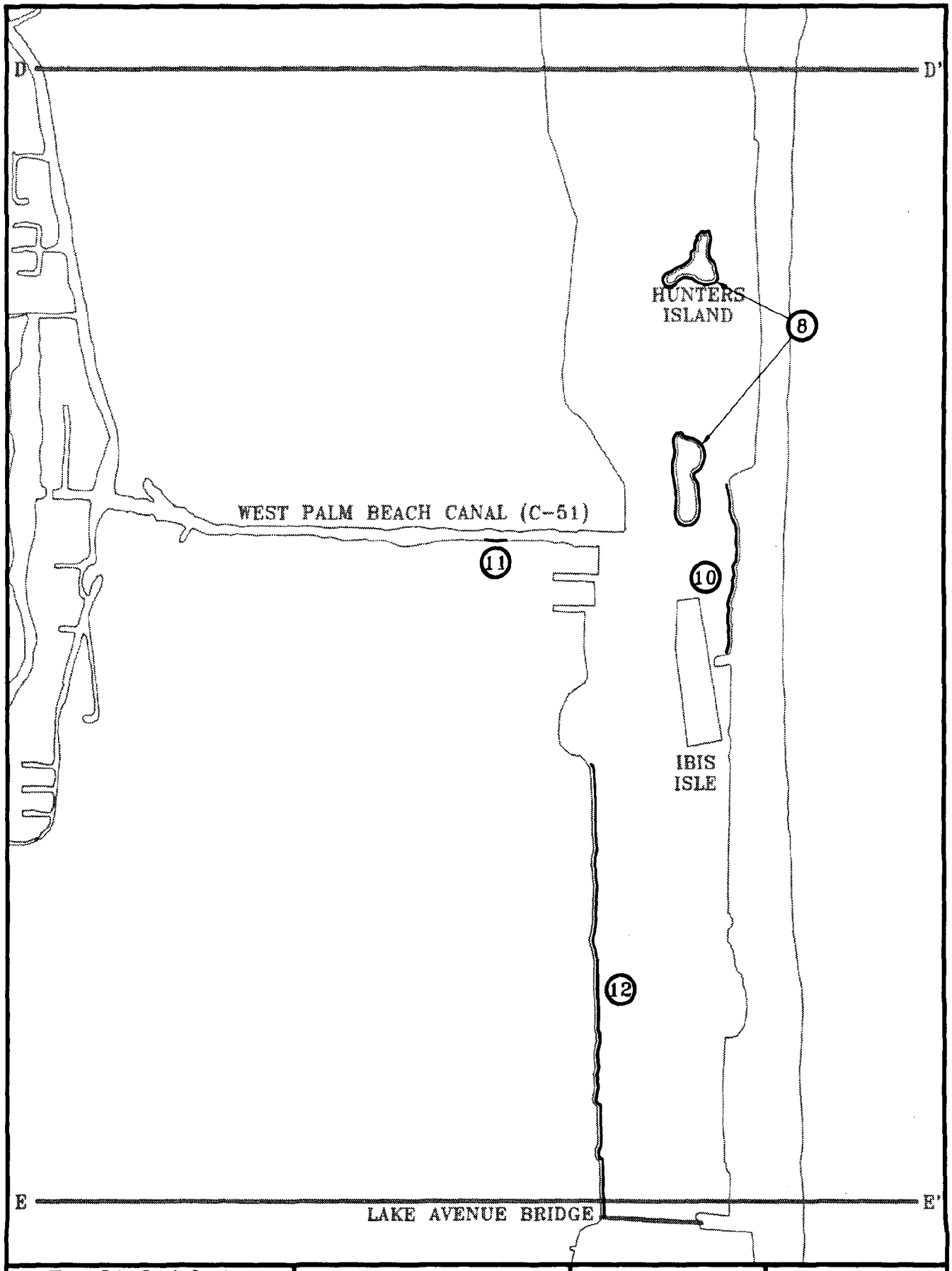
Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION AND ENHANCEMENT PROJECT AREAS

0 1000 2000
SCALE (FEET)
N

D&M JOB NO. *20335-001-049*

FIGURE *14-E*



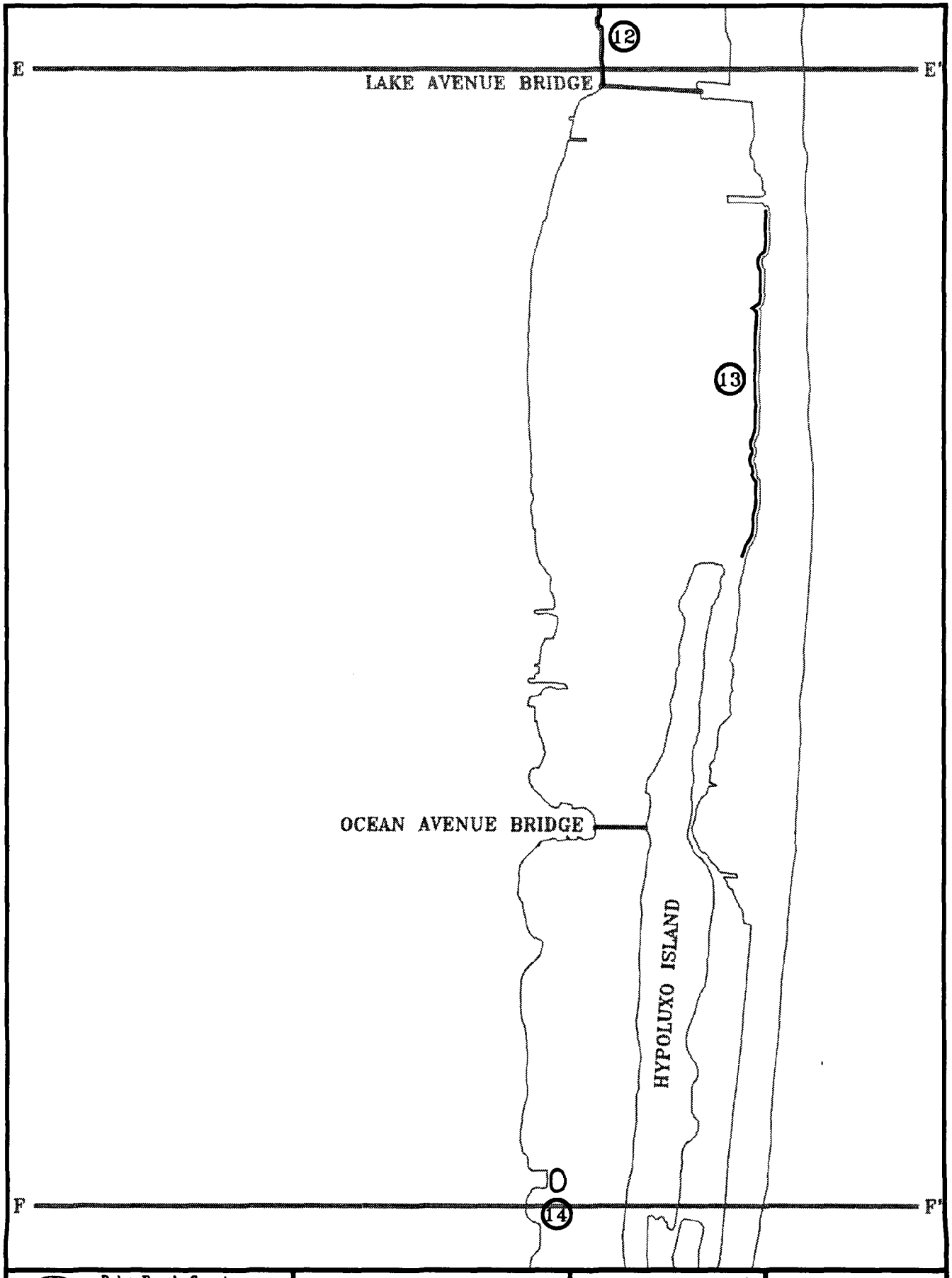
Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION AND ENHANCEMENT PROJECT AREAS

0 1000 2000
SCALE (FEET)
N

D&M JOB NO. *20335-001-049*

FIGURE *14-F*



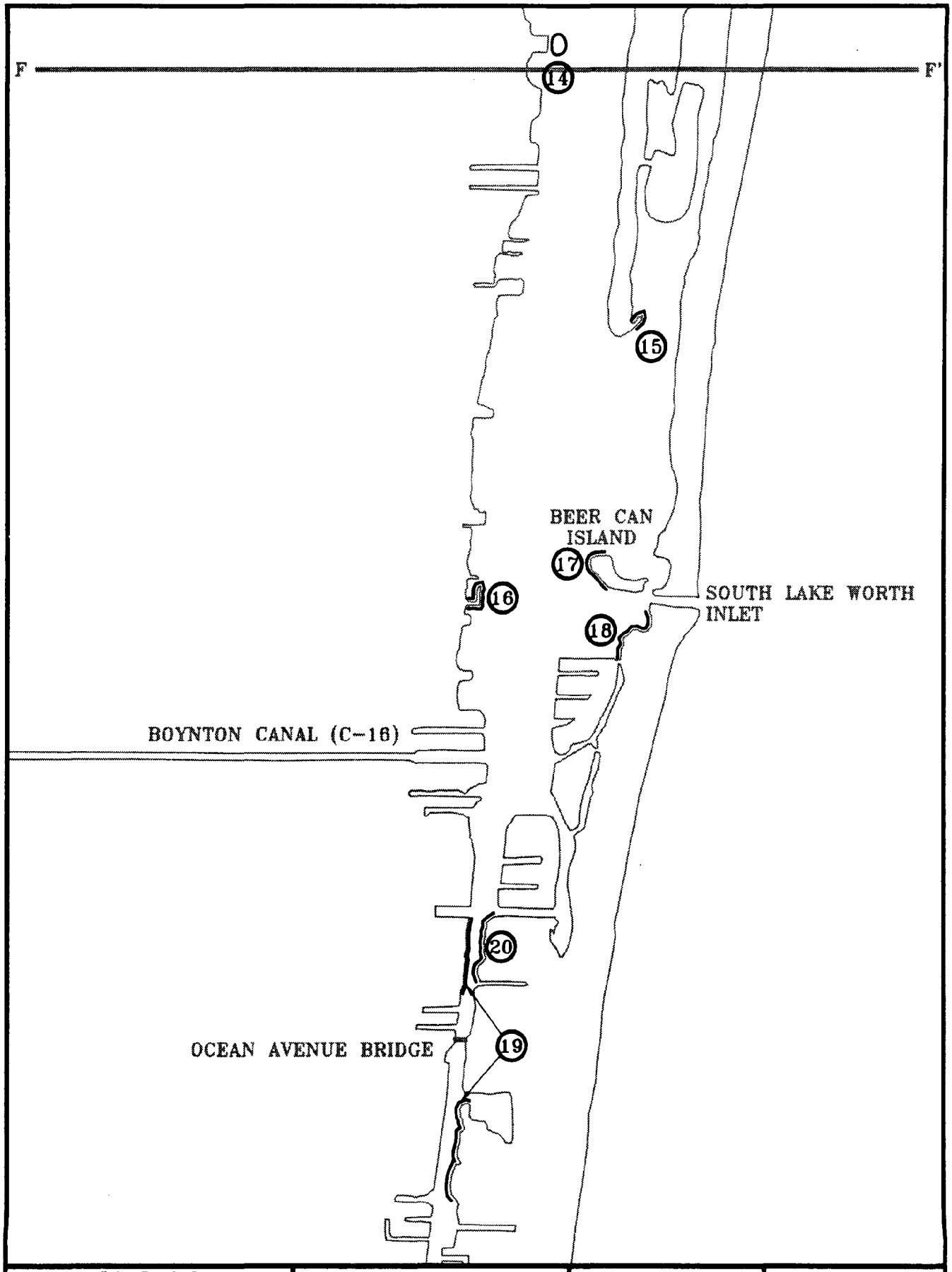
Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION AND ENHANCEMENT PROJECT AREAS

0 1000 2000
SCALE (FEET)
N

D&M JOB NO. *20335-001-049*

FIGURE *14-G*



Palm Beach County Department of ENVIRONMENTAL RESOURCES MANAGEMENT

LAKE WORTH LAGOON
HABITAT RESTORATION AND ENHANCEMENT PROJECT AREAS

0 1000 2000
SCALE (FEET)

D&M JOB NO. *20335-001-049*

FIGURE *14-H*

7.0 NATURAL RESOURCES EVALUATION AND RECOMMENDATIONS

Analysis of the information used to compile this report leads to several observations regarding the status of water quality and natural resources in Lake Worth Lagoon.

1. Lake Worth Lagoon was historically a freshwater lake. Man's activities have changed it to a productive estuarine lagoon over the past 100 years. As an important fish and wildlife, recreational, and aesthetic resource it is desirable to maintain Lake Worth Lagoon as a healthy estuarine lagoon system.

2. Overall water quality has stabilized or slightly improved in recent years. Water quality is currently classified by the TSI at the lower end of the good range. Benthic diversity and sediment chemistry suggest a chronic condition of moderate pollution. Since point sources have been significantly reduced in recent years, stormwater runoff is apparently the major source of pollutants. The presence of PAH's and elevated metals concentrations in lagoon sediments supports this assumption. Over three hundred stormwater outfall pipes discharge directly to Lake Worth Lagoon. Hundreds of other outfalls discharge into C-16, C-17, and C-51, the major freshwater inflows to the lagoon. Additionally, the impact of stormwater discharge can be expected to increase as undeveloped lands in the canal drainage basins are converted to urban types of development. In order to improve water quality in Lake Worth, elimination of remaining point sources, as well as treatment or diversion of stormwater discharges must occur. Strategies which could be employed after proper investigation, identification of problem areas, and planning efforts include stormwater retrofit or diversion, stormwater utilities, and increased performance criteria for new sources.

3. Boating and marina activity in Lake Worth Lagoon contribute to overall water quality and habitat degradation. Proper monitoring and management of boating activities will minimize the impact while still providing recreational boating opportunities.

4. Drastic habitat losses have occurred through the years as a result of shoreline urbanization and dredge and fill activities. Over 65% of the shoreline has been bulkheaded. Over 87% of the original mangrove habitat has been lost resulting in only 19% of the shoreline (including islands) being fringed by mangroves. Despite direct impacts by dredge and fill activities and indirect impacts of degraded water quality, considerable areas of habitat, including over 2000 acres of segrass beds remain, and a diverse population of fish and wildlife species utilize the habitat areas. Remaining habitat should be protected through regulation, public awareness, and public acquisition. Until the time when an overall management plan can be implemented, enhancement and restoration of impacted habitats should be pursued where feasible as suggested in the Habitat Restoration and Enhancement section of this report.

5. Existing monitoring programs do not provide data which is adequate to definitively track ongoing resource trends. As restoration, management and enhancement activities are implemented, an ongoing comprehensive water quality and habitat monitoring program should also be implemented to measure the degree of success of various activities in the overall enhancement of Lake Worth Lagoon.

APPENDIX

SECTION 8.0

APPENDIX 8.1

References/Literature Data Base Contents

Applied Biology, Inc. 1976. Ecological Parameter Monitoring at the Riviera Plant. Florida Power & Light Company Report.

Area Planning Board of Palm Beach County. 1974. Stormwater Study Design, West Palm Beach. Area Planning Board of Palm Beach County.

Area Planning Board of Palm Beach County. 1979. Palm Beach County 208 Areawide Waste Treatment Management Plan. Area Planning Board of Palm Beach County.

Area Planning Board of Palm Beach County. 1980. A Profile of Palm Beach County Municipalities, July 1980. Area Planning Board of Palm Beach County.

Arthur V. Strock and Associates, Inc. 1983. Sand Search in South Lake Worth. Report Prepared for Palm Beach County.

Austin, D. F., Weise, J.G. 1972. Annotated Checklist of the Boynton Beach Hammock. Quarterly Journal of the Florida Academy of Science. 35:145-154.

Bach, S.D. 1984. Summary of Water Quality Sediment and Biological Studies for Lake Worth, Florida. Unpublished.

Bane, L.L. 1979. A Seasonal Study of Sessile Marine Fouling Organisms in Northern Lake Worth, Florida. M. S. Thesis Florida Atlantic Univ.

Barry, J. J. III. 1981. Letter From Florida Department of Health and Rehabilitative Services to Trust for Public Land Regarding Little Munyon Island.

Beccasio, A. D., Fotheringham, N., Redfield, A.E., Frew, R. L., Levitan, W.M., Smith, J.E., Woodrow, J.O., Jr. 1982. Gulf Coast Ecological Inventory: User's Guide and Information Base. Report #FWS/OBS/82/55.

Beeler, E. I., O'Shea, T. J. 1988. Distribution and Mortality of the West Indian Manatee (*Trichechus manatus*) in the Southeastern United States: A Compilation and Review of Recent Information. National Ecology Research Center Report No. 88-09.

Birnhak, B.K. 1974. An Examination of the Influence of Fresh Water Canal Discharges on Salinity in Selected Southeastern Florida Estuaries. South Florida Environmental Project, Report #DI-SFEP-74-19.

Bishop, W. M. 1973. Palm Beach County Water Quality Management Plan. Volume 1 Implementation Strategy. Area Planning Board of Palm Beach County.

Boynton Beach, City of. 1989. Comprehensive Plan. City Comprehensive Plan

Brink, L. 1976. Bicentennial Commission of Riviera Beach, Florida. A History of Riviera Beach.

Brogan, J. 1987. Boat Owners Want Their Place in The Sun. Palm Beach Post, February 16, 1987.

Bromwell and Carrier, Inc. 1989. Long-Range Dredged Material Management Plan for the Intracoastal Waterway in Palm Beach County, Florida. Prepared for Florida Inland Navigation District.

Brucker, W. M. 1958. Palm Beach County From Lake Worth Inlet to South Lake Worth Inlet, Florida, Beach Erosion Control Study. 85th Congress 2nd Session, House Document No. 342, U.S. Government Printing Office.

Bruun, P.M., Battjes, J.A., Chiu, T.Y., Purpura, J. A. 1966. Coastal Engineering Model Studies of Three Florida Coastal Inlets. Engineering Progress at the University of Florida, Volume XX, No. 6 Bulletin #122 Section E.

Caldwell, J. M. 1950. Bypassing Sand at South Lake Worth Inlet, Florida. Proceedings of the First Coastal Engineering Conference, Pages 320-325.

Causaras, C. R. 1981. Annotated Bibliography of the Geology and Hydrology of the Surficial Aquifers in Dade, Broward and Palm Beach Counties, Florida. U.S.G.S. Open File Report 82-154.

Central and Southern Florida Flood Control District 1968. Present and Projected Land Use Analysis of the Earman River Canal (C-17) West Palm Beach, Florida. Central and Southern Florida Flood Control District.

Central and Southern Florida Flood Control District. 1973. Preliminary Evaluation Report on Land and Water Management Planning in the C-51 Watershed. Prepared for Division of State Planning, State Department of Administration.

Chiu, T. Y., Van De Kreeke, J., Dean, R.G. 1970. Residence Times of Waters Behind Barrier Islands. Completion Report to the Office of Water Resources Research, Department of the Interior.

Christensen, B. A., Snyder, R.M. 1975. Physical Modeling of Scour Initiation and Sediment Transport in Distorted Tidal Models. Symposium on Modeling Techniques, Vol. 11, September, 1975.

Christensen, R. F. 1965. An Ichthyological Survey of Jupiter Inlet and Loxahatchee River, Florida. M. S. Thesis, Florida State University, December 1965.

Clark, J., Smith, W. G., Kendall, A. W., Jr., Rahay, M. P. 1970. Studies of Estuarine Dependence of Atlantic Coastal Fishes. Bureau of Sport Fisheries Wildlife Technical Paper No. 59.

Coastal and Oceanographic Engineering Department. 1971. Observations at South Lake Worth Inlet. University of Florida (71/010).

Coastal and Oceanographic Engineering Laboratory. 1968. Interim Report, South Lake Worth Inlet Study. University of Florida (68/001).

Coastal and Oceanographic Engineering Laboratory. 1969. Sand Tracing Program for Specific Areas on the Lower East Coast of Florida, Palm Beach Area From Lake Worth Inlet to South Lake Worth Inlet. University of Florida (69/005).

Coastal and Oceanographic Engineering Laboratory. 1969. Sand Tracing Program for Specific Areas on the Lower East Coast of Florida, Riviera Beach to Lake Worth Inlet. University of Florida (69/008).

Coastal Planning and Engineering, Inc. 1986. Beach and Inlet Shoal Monitoring at Manalapan and Ocean Ridge for Palm Beach County.

Coastal Engineering Laboratory. 1958. Engineering Information on the Behavior of Lake Worth Inlet Resulting From the Proposed Deepening of the Inlet to Accommodate Vessels of Greater Depth. University of Florida (58/001).

Coastal Engineering Laboratory. 1964. Coastal Engineering Study of South Lake Worth Inlet. University of Florida (64/005).

Coastal Engineering Laboratory. 1965. The Effect of South Lake Worth Inlet and its Bypassing Plant on Adjacent Shores; Present and New Installation. University of Florida (65/004).

Consulting Engineering and Science, Inc. 1988. Riviera Beach Benthic Vegetation Map, Bathymetric Data. Map Report.

Continental Shelf Associates, Inc. 1983. Environmental Characterization and Impact Assessment of the Proposed South Lake Worth Sand Source Site. Submitted to Palm Beach County Commission.

Cotter, D. D. 1974. Tide-Induced Net Discharge in Lagoon-Inlet Systems. University of Miami, RSMAS, Technical Report No. 74031.

Cox, A. C. 1988. Distribution and Species Composition of Tree Islands in Martin and Palm Beach Counties. M. S. Thesis, Florida Atlantic University.

Cubit Engineering Ltd. 1986. Preliminary Evaluation of Proposed Alternatives for Sand Bypassing at South Lake Worth Inlet. Report for the Town of Ocean Ridge.

Cubit Engineering Ltd. 1988. Florida Department of Natural Resources Amended Order Relating to South Lake Worth Inlet, Evaluation of Gee and Jenson Report.

Cullen, P. 1973. Who Killed Lake Worth? Almost Everyone. Palm Beach Post Article, December 23, 1973, Section B, Page 1.

Curl, D. W. 1986. Palm Beach County, An Illustrated History. Published by Windsor Publication, Inc.

CZR Incorporated. 1989. Half Moon Bay Seagrass and Benthic Survey. Unpublished Letter to K. Hovnanian.

Davis, J. H., Jr. 1983. The Natural Features of Southern Florida. Florida Geological Bulletin No. 25:6-307.

Davis, T. 1985. Loxahatchee Basin Water Quality Fiscal Year 1984. Unpublished Report of Florida Department of Environmental Regulation.

Davis, T. L. 1985. Lake Worth Basin Water Quality Assessment Fiscal Year 1985. Florida Department of Environmental Regulation Report.

Davis, P., Barry, J., Lubitz, S. 1987. Report on Live Aboard Vessels Moored in Open Waters. Palm Beach County Health Department File Report.

Dean, R. G. 1983. Draft-Erosion Considerations Along the Beaches of The Town of Ocean Ridge, Phase 1 Results. Report to the Town of Ocean Ridge.

Dean, R. G. 1988. Florida Department of Natural Resources Amended Order Relating to South Lake Worth Inlet, Evaluation of Gee and Jenson Report and Recommended Methodology and Results.

Deis, D. R. 1978. The Effects of a Wastewater Outfall on Benthic Invertebrates in Lake Worth (Palm Beach County), Florida. M. S. Thesis, Florida Atlantic University.

DERM. Fisheries Assessment, Final Report to DERM. June 1, 1984.

Dowgiallo, M. J., Sheifer, I. C., Everdale, F. G., Pechmann, K. B., Predoehl, M. D., Waltz, T. W. 1988. Marine Environmental Assessment Southeastern U.S. 1986 Annual Summary. U S. Department of Commerce, National Oceanic and Atmospheric Administration.

Dubois, B. W. 1975. Shipwrecks in the Vicinity of Jupiter Inlet. Privately Printed.

Duever, L. C., Iverson, G. B., Lund, P.F., Duever, J. J., Porzel, F. P., Burch, J. N., Meeder, J.D. 1981. Resource Inventory and Analysis of the John D. MacArthur Beach State Recreation Area. Publication of The Nature Conservancy and Ecosystem Research Unit.

Earman, J. S., Earman, E. A. 1977. Big Joe Earman. Private Printing.

Ebel, P. 1979. Habitat Destruction. Palm Beach Post, August 5, 1979.

Eden, E. W. 1957. Effect of Lake Worth and South Lake Worth Inlets on the Movement of Littoral Material. Proceedings of the Sixth Coastal Engineering Conference, Pages 439-456.

Eyre, L. A. 1971. Tidewater Shorelines in Broward and Palm Beach Counties, Florida: An Analysis of Characteristics and Changes Interpreted From Color Infrared and Thermal Aerial Imagery. Technical Report #11, Florida Atlantic University, Department of Geography.

Fineren, W. W. 1924. The Proposed South Lake Worth Ocean Inlet Near Boynton, Florida. The Florida Engineer and Contractor.

First Federal Savings & Loan Assoc. of Lake Worth. 1967. Lure of the Sun, A Story of Palm Beach County, Lake Worth, Florida. Historical Publication.

Florida Board of Conservation. 1955. Sand Transfer Across Lake Worth Inlet, A Method of Correcting Erosion At An Inlet. Water Survey and Research Paper Number 14.

Florida Department of Environmental Regulation. 1977. Memo to Terry Davis from Alok Krishen Regarding North Lake Worth Finger Canals Statistical Analysis of Metal Data. Florida Department of Environmental Regulation Memo.

Florida Department of Environmental Regulation. 1980. Permit Application For City of Riviera Beach Marine/Recreation Complex. File #DF 50-27818.

Florida Department of Environmental Regulation. 1982. Bioassays of the Anchorage Drive Wastewater Treatment Plant, North Palm Beach, Palm Beach County, Florida. NPDES #FL0029106. Florida Department of Environmental Regulation, Biology.

Florida Department of Environmental Regulation. 1983. Permit Application Appraisal, File No. 500729109, Field Report on Proposed Dock Construction at Sailfish Marina, Palm Beach County. Florida Department of Environmental Regulation File.

Florida Department of Environmental Regulation. 1984. Memo To Mike Nichols From Harvey Rudolph Regarding Benthic Macroinvertebrate Survey for the Millings Dredge and Fill Project. Florida Department of Environmental Regulation Memo.

Florida Department of Environmental Regulation. 1985. Bioassays of the Seacoast Utilities Sewage Treatment Plant, North Palm Beach, Palm Beach County, Florida, NPDES #FL0029106. Florida Department of Environmental Regulation Report.

Florida Department of Environmental Regulation. 1986. Bioassays of the Seacoast Utilities Sewage Treatment Plant, North Palm Beach, Palm Beach County, Florida. FDER Report, NPDES #FL0029106.

Florida Department of Environmental Regulation. 1987. Bioassays of Florida Power & Light Company Riviera Beach Plant, Cooling Water Discharge Riviera Beach, Palm Beach County, Florida. Biology Section, Division of Environmental Programs. NPDES #FL0001546.

Florida Department of Environmental Regulation. 1989. Memo to Larry O'Donnell and Becky Moore from Harvey Rudolph Dated August 13, 1984. Florida Department of Environmental Regulation Memo.

Florida Department of Environmental Regulation. 1989. Bioassays of Seacoast Utilities Sewage Treatment Plant, North Palm Beach, Palm Beach County, Florida. Biology Section Reprot, NPDES #FL0029106.

Florida Department of Environmental Regulation. 1990. Public Works Program - Navigation - Flood Damage Prevention, Shore Protection, Environmental Restoration and Enhancement. FDER Publication.

Fl. Interagency Adv. Comm. on Submerged Land Mgt. 1968. Bulkhead Line Review and Recommendations for Brevard, Dade, Monroe, Palm Beach, Pinellas, Lee, Manatee, Duval, and Sarasota Counties. WMD 333.91617.

Florida Department of Natural Resources. 1984. Loxahatchee River-Lake Worth Creek Aquatic Preserve Management Plan. Management Plan.

Florida Department of Natural Resources. 1989. Inventory of Outdoor Recreation Facilities and Participation Data. Unpublished Computer Printout.

Florida Sportsman. 1981. Showers Plus Spillways. Florida Sportsman, September 1981, Pages 7-9.

Florida Sportsman. 1983. The Ins And Outs Of A "In" Inlet. Florida Sportsman, August 1983. Pages 16-20.

Florida Sportsman. 1985. The Fishy Flats of Lake Worth. Florida Sportsman, November 1985, Pages 7-12.

Florida Sportsman. 1987. The Wall Walkers of West Palm Beach. Florida Sportsman, November 1987, Pages 36-41.

Florida Sportsman. 1988. The Fishy Lake of Palm Beach County. Florida Sportsman, April 1988, Pages 67-70.

Florida State Board of Health. 1950. Lake Worth Pollution Survey 1949-50. Bureau of Sanitary Engineering Report.

Florida State Board of Health. 1960. Southeast Florida Canal Study. Bureau of Sanitary Engineering Study.

Florida State Board of Health. 1962. Progress Report - Lake Worth Survey - July-August 1962. Bureau of Sanitary Engineering Report.

Frost, G. 1965. Sand Transfer Facilities, Palm Beach County.

Garces, H. 1988. Distribution and Ecology of Taltric Amphipods at Lake Wyman, Boca Raton, Florida. M.S. Thesis, Florida Atlantic University.

Gee and Jenson, Inc. 1988. Engineering Report Response to the Florida Department of Natural Resources' Amended Order, Dated January 11, 1988: Report Prepared for the South Lake Worth Inlet District.

Gilmore, R. G., Jr. 1977. Fishes of the Indian River Lagoon and Adjacent Waters. Bulletin of Florida State Museum, Biological Sciences 22(3):101-148. DNR-WPB, Ed Irby.

Gilmore, R. G., Jr., Donohoe, C., Cooke, D., Herrema, D. 1981. Fishes of the Indian River Lagoon and Adjacent Waters. Harbor Branch Foundation, Inc., Technical Report No. 41.

Goolsby, D. A., Mattrow, H.C. Lamonds, A. G., Maddy, D. V., Rollo, J. R. 1976. Analysis of Historical Water-quality Data and Description of Plan for Sampling Network in Central and Southern Florida. U.S. Geological Survey Water Resources Investigation 76-52.

Hagan, J.E. 1970. Preliminary Report on Lake Worth. U.S. Government Memorandum to Paul J. Traina, Chief of Technical Services, Southeast Water Lab. PBC ERM, DNR - Ed Irby.

Hagan, J. E. III. 1972. Estuarine Surveys in the Southeast. Coastal Zone Pollution Management, Proceedings of the Symposium, Charleston, S.C., Feb. 21-22, 1972.

Hand, J., Tauxe, V., Friedemann, M. 1988. Water Quality Assessment for the State of Florida, July 1988 Techical Report (305B). FDER Bureau of Surface Water Management.

Harbor Branch Foundation. 1990. Indian River Coastal Zone Museum Holdings - Lake Worth Lots. Unpublished Listing. PBC ERM Files, HBF.

Haris, B., K.D. Haddad, R.A. Steindinger, J.A. Huff. 1983. Assessment of Fisheries Habitat: Charlotte Harbor and Lake Worth, Florida Department of Natural Resources.

Harper, R. M. 1927. Natural Resources of Southern Florida. 18th Annual Report of Florida Geological Survey.

Hedgepeth, M., 1985. Ecological Comparisons of Ichthyofaunal Communities in Lake Worth and the Loxahatchee River, Palm Beach and Martin Counties, Southeastern Florida with Special References to the Effects of Anthropogenic Changes. Unpublished Report for the Florida Department of Natural Resources Bureau of Marine Research Marine Research Laboratory St. Petersburg. Fl.

Herd, G., Kalber, F., Marsh, G. A., Pimentel, P., Stephan, C. R., Akhurst, D.O. 1972. A Report on Water Quality of Lake Worth. Aquatic Council of the Palm Beaches, Unpublished.

Herrema, D. J. 1974. Marine and Brackish Water Fishes of Southern Palm Beach and Northern Broward Counties. M.S. Thesis, Florida Atlantic University.

Iverson, G. B., Austin, D. F. 1988. Inventory of Native Ecosystems in Palm Beach County Phase III Report Location and Evaluation of Sites for Possible Preservation as Wilderness Island Park Preserves. Florida Atlantic University Consultants to Palm Beach County Report.

Jolley, J. W., Jr. 1973. Report on the December 6, 1973 Bio-Physical Survey of Peanut Island, Palm Beach County Florida (Proposed Land Acquisition). A Report to the Florida Department of Natural Resources, Bureau of Planning and Grants.

Jolley, J. W., Jr. 1976. Comments Concerning Proposed Development of North Lake Worth In And Around Little Munyon Island. A Letter to G. Tolman, DER.

Jolley, J. W., Jr. 1979. Bibliography and Summary Concerning the Biological Status and use of Lands and Waters of Lake Worth, Palm Beach County, Florida. Unpublished. PBC ERM, WPB-Fishing Club File.

Jolley, J. W., Jr., Irby, E. W., Jr. 1977. Comments Concerning the Proposed Four-Lane Construction of A1A on Singer Island. Letter to J. Howland, DOT.

K. C. Mock and Associates. 1962. Investigation of Tidal Hydraulics of the South Lake Worth Inlet and Its Effect on Tide Levels in Lake Worth.

Kelso, J. 1976. Fewer Mangroves Mean Fewer Fish To Catch. Palm Beach Post, March 16, 1976.

Kelso, J. 1976. God Never Built A Seawall. Palm Beach Post, March 14, 1976.

Kelso, J. 1976. Restoration of Lake Worth - Two Alternatives. Palm Beach Post.

Kirtley, D. L. 1966. Intertidal Reefs of Sabellariidae (Annelida, Polychaeta) Along the Coasts of Florida. Unpublished M. S. Thesis, Florida State University.

Kirtley, D. W., 1966. Reefbuilding Polychaetous Annelids, Family Sabellariidae, in Florida. 1966 Annual Meeting, S. E. Section of Geological Society of America, Abstract 30.

Klein, H., Armbruster, J. T., McPherson, B. F., Freiberger, H.J. 1975. Water and the South Florida Environment. U.S. Geological Survey Water Resources Investigation 24-75.

Knappen Tippetts Abbett McCarthy, Engineers. 1954. Report on Sand Transfer Facility at Lake Worth Inlet, Palm Beach, Florida.

Lake Worth, City of. No Date. Comprehensive Plan. City of Lake Worth Comprehensive Plan.

Lake Worth Historian. 1896. Pages 15 and 16 of Lake Worth Historian.

Land, L. F. 1975. Effects of Lowering Interior Canal Stages on Salt-Water Intrusion into the Shallow Aquifer in Southeast Palm Beach County, Florida. USGS Open File Report FL 75-74.

Land, L. F. 1977. Ground-Water Resources of the Riviera Beach Area, Palm Beach County, Florida. USGS Water Resources Investigations 77-47.

Land, L. F., Rogis, H. G., Schneider, J.J. 1973. Appraisal of the Water Resources of Eastern Palm Beach County, Florida. USGS Report of Investigations #67.

Lantana, Town of. 1989. Town of Lantana Comprehensive Plan. Town Comprehensive Plan.

Lee, T. N. 1975. Circulation and Exchange Processes in Southeast Florida's Coastal Lagoons. University of Miami, RSMAS, Technical Report TR75-3.

Lewis, R. R. III., Gilmore, R. G., Jr., Crewz, D. W., Odum, W. E. 1985. Mangrove Habitat and Fishery Resources of Florida. Florida Aquatic Habitat and Fishery Resources.

Lin, S. 1982. Preliminary Report on Rainstorm of April 23-26, 1982. South Florida Water Management District, Water Resources Division.

Linehan, M. C. 1980. Early Lantana, Her Neighbors and More...Bryon Kennedy & Company, St. Petersburg.

Lyman, F. B. 1937. *Conus mus* Hwass., in Lake Worth, Florida. Nautilus, Vol. 50(3):103-104.

Mangrove Systems, Inc. 1983. Sailfish Marina Biological Survey Report. Prepared for Gerald M. Ward, P.E., Consulting Engineer.

Mann, T. M. 1977. Impact of Developed Coastline on Nesting and Hatchling Sea Turtles in Southeastern Florida. M.S. Thesis, Florida Atlantic University.

Mann, T. M. 1978. Impact of Developed Coastline on Nesting Sea Turtles in Southeastern Florida. Proceedings of the Florida and Interregional Conference on Sea Turtles. Florida Marine Resources. Publication No. 33.

Marsh, G. A. 1974. An Ecological Study of the Intracoastal Waterway and Adjacent Canal Systems at Boca Raton, Florida. Final Report, Joint FAU-FIU Center for Urban and Environmental Problems.

Masthead, The. No date. The Official Publication of Old Port Yacht Club - North Palm Beach. Local Newsletter.

Michael G. Purmont and Associates, Inc. 1980. Topographic Survey of MacArthur Park.

Michael G. Purmont and Associates, Deerfield Beach, Florida.

Middleton, S. R. 1959. Installation and Operation of Fixed Sand Bypassing Plant at Lake Worth Inlet, Florida. Shore and Beach, Volume 27(1):32-35.

Mikkelson, P. S., Mikkelson, P. M., 1986. List of Molluscan Species of Peanut Island, Lake, Worth, Florida. Unpublished, 1st Revision, March 1986.

Miller, R. A. 1979. Characteristics of Four Urbanized Basins in South Florida. U. S. Geological Survey Open File Report 79-694.

Miller, W. L. 1975. Nutrient Concentrations of Surface Waters for Southern Florida, September 1970 to April 1975. U.S. Geological Survey Open-File Report FL-75010.

Miller, W. L., Lietz, A. C. 1976. Quality-Of-Water Data, Palm Beach County, Florida 1970-1975. U.S. Geological Survey Open-File Report 76-784.

Milleson, J. F., Goodrick, R. L. 1979. Environmental Assessment of Munyon Island and Surrounding Aquatic Habitats. South Florida Water Management District.

Mock, Roos & Search, Inc. 1975. Preliminary Storm Drainage Study for City of Lake Worth, Florida. Engineering Investigation Report.

Morris, F. W., Christensen, B. A. 1976. Hydrodynamics and Flushing Characteristics of Residential Canals in Palm Beach County. Hydraulics Laboratory, University of Florida Report to Palm Beach County Commission.

Mucha, F. 1989. Peanut Island. Newsletter of Greater Miami Shell Club, May 6, 1989.

Murphy, E. B., Steidinger, K. A., Roberts, B. S., Williams, J. Jolley, J.W., Jr. 1975. An Explanation for the Florida East Coast *Gymnodinium breve* Red Tide of November 1972. Limnology and Oceanography, Vol. 20, No. 3:481-486.

McClelland, S. 1981. C-17 Canal (Earman River) Intensive Survey Documentation. Florida Department of Environmental Regulation Bureau of Water Analysis, WQTS. Vol. 1, No. 38.

McCollum, S H., Cruz, O. E., Stem, L.T., Wittstruck, W. H., Ford, R. D., Watts, F. C. 1978. Soil Survey of Palm Beach Area, Florida. Soil Conservation Service In Cooperation With Institute of Food and Agricultural Sciences.

McCrary, J. P., Jolley, J. W., Tapp, C., Waldner, R. E. 1985. Overview of Habitat Degradation in Florida. Unpublished Document of Palm Beach County Chapter of the Florida Conservation Association.

New River Times. No Date. New River Times Magazine. Waterfront Publishing Magazine.

Packard, J. M. 1981. Abundance, Distribution, and Feeding Habits of Manatees (*Trichechus manatus*) Wintering Between St. Lucie and Palm Beach Inlets, Florida. U. S. Fish and Wildlife Service.

Palm Beach County Environmental Resource Management 1983. Sewerage Spill - West Palm Beach. Palm Beach County Environmental Resource Management Report.

Palm Beach County Environmental Resource Management 1983. Seagrass Map of North Lake Worth, South of Munyon Island. Unpublished Map.

Palm Beach County Environmental Resource Management 1984. Lake Worth Sewerage Discharge Study. Palm Beach County Environmental Resource Management Report.

Palm Beach County Environmental Resource Management 1987. Seacoast Utilities - Anchorage (Earman River) Palm Beach County Environmental Resource Management Report.

Palm Beach County Environmental Resource Management 1987. Seacoast Utilities (Earman River) Study. Field Notes and Newspaper Article.

Palm Beach County Environmental Resource Management 1988. Lake Shore Quadrille. Unpublished Seagrass Map.

Palm Beach County Environmental Resource Management 1989. Seagrass Survey, Lake Worth. Unpublished Map.

Palm Beach County Environmental Resource Mgmt. 1987. Live Aboards. Boat Survey.

Palm Beach County Health Department. 1972. Land Use Plan. Land Use Plan for Palm Beach County.

Palm Beach County Health Department. 1986. Riviera Beach Water Treatment Plant Survey. Unpublished File From Palm Beach County Health Department. PBC ERM Files - C.V.

Palm Beach County Health Department. 1974. Palm Beach County Marina Data file. Unpublished. PBC ERM Files.

Pierce, C. W., 1970. Pioneer Life in Southeast Florida. University of Miami Press, Coral Gables, Florida. WMD Library 975.93P.

Piley, O.H., Jr., Sharma, D. C., Wanless, H. R., Doyle, L. J., Pilkey, O.H., Sr., Neal, W. J., Gruver, B. L. 1984. Living with the East Florida Shore. Duke University Press Book.

Raymond, P. W., Rose, P.M. 1981. Manatees *Trichecus manatus*: Abundance and Distribution in and Around Several Florida Power Plant Effluents. Annual Report of FP&L, Contract No. 31534-825111.

Reed, J. K. 1975. Benthic Macrofaunal Associations in Lake Worth, Florida, and Their Use as Indicators of Water Quality. M.S. Thesis, Florida Atlantic Univerity.

Reed, J. K. 1977. Benthic Macrofaunal Associations in Lake Worth, Florida. Florida Scientist 40 (Suppl. 1):11. Palm Beach County Environmental Resource Management Files.

Rehrer, R. G. 1976. Part II: Distribution of Algae and Animals of Lake Worth in Relation to Salinity. In: Van De Kreeke, Freshwater Inflow and its Effects on the Salinity and Biota of Shallow Lagoons.

Rehrer, R. G. 1977. Biological and Physical Data from Lake Worth, Florida. May 1973-January 1975. University of Miami, RSMAS, Data Report DR-77-3.

Rehrer, R. G. 1977. Effects of Freshwater Inflow on Selected Macroinvertebrates and Fishes in Lake Worth, Florida. University of Miami, RSMAS, Technical Report.

Research Planning Institute, Inc. 1984. The Sensitivity of Coastal Environments and Wildlife to Spilled Oil in the Treasure Coast Region. RPI/R/84/8/2-22 Prepared for the Florida Department of Community Affairs.

Reynolds, J. E., III., Wilcox, J. R. 1985. Abundance of the West Indian Manatee (*Trichechus manatus*) Around Selected Florida Power Plants Following Winter Cold Fronts: 1982-1983. Bulletin of Marine Science, 36(3):413-422, 1985.

Reynolds, J. E., III. 1984. Distribution and Abundance of the West Indian Manatee (*Trichechus manatus*) Around Selected Florida Power Plants Following Winter Cold Fronts: 1983-1984. Final Report Prepared for Florida Power and Light Company.

Reynolds, J. E., III. 1985. Distribution and Abundance of the West Indian Manatee (*Trichechus manatus*) Around Selected Florida Power Plants Following Winter Cold Fronts: 1984-1985. Final Report Prepared for Florida Power and Light Company.

Reynolds, J. E., III. 1986. Distribution and Abundance of the West Indian Manatee (*Trichechus manatus*) Around Selected Florida Power Plants Following Winter Cold Fronts: 1985-1986. Final Report Prepared for Florida Power and Light Company.

Reynolds, J. E., III. 1987. Distribution and Abundance of the West Indian Manatee (*Trichechus manatus*) Around Selected Florida Power Plants Following Winter Cold Fronts: 1986-1987. Final Report Prepared for Florida Power and Light Company.

Reynolds, J. E., III. 1988. Distribution and Abundance of the West Indian Manatee (*Trichechus manatus*) Around Selected Florida Power Plants Following Winter Cold Fronts: 1987-1988. Final Report Prepared for Florida Power and Light Company.

Reynolds, J. E., III. 1989. Distribution and Abundance of the West Indian Manatee (*Trichechus manatus*) Around Selected Florida Power Plants Following Winter Cold Fronts: 1988-1989. Final Report Prepared for Florida Power and Light Company.

Richardson, D. R. 1976. Habitat and Successional Changes of the Atlantic Coastal Ridge of Palm Beach County, Florida. M. S. Thesis, Florida Atlantic University.

Richardson, D. R. 1977. Vegetation of the Atlantic Coastal Ridge of Palm Beach County, Florida. Florida Scientist, 40:281-330.

Richardson, D. R. 1984. (*Amphitecna latifolia)* (Bignoniaceae) In Florida. Florida Scientist, Vol. 47(1):73-75.

Rodis, H. G. 1973. Encroaching Salt Water in Northeast Palm Beach County, Florida. U.S.G.S. Map Series 59.

Rogers, G. R., (no date) U.S. Environmental Protection Agency. Unpublished data of 1970 Study of Lake Worth Lagoon, Florida.

Rogers, G. R. 1972. Studies of Lake Worth Lagoon. Environmental Protection Agency, Unpublished Mimeo.

Rose, P. M., McCutcheon, S. P. 1980. Manatees (*Trichechus manatus*): Abundance and Distribution In and Around Several Florida Power Plant Effluents. Final Report Prepared for Florida Power and Light Company, Contract No. 31534 86626.

Rudolph, H. 1989. A Benthic Invertebrate Survey of Lake Worth, Florida in February and August, 1985 - A Biological Basin Assessment Survey. Florida Department of Environmental Regulation, Southeast Florida District Report.

Rusnak, G. A., Stockman, K. W., Hofmann, H. A. 1966. The Role of Shell Material in the Natural Replenishment Cycle of the Beach and Nearshore Area Between Lake Worth Inlet and the Miami Ship Channel.

Schneider, J. R. 1973. Tidal Relations along the Intracoastal Waterway, Palm Beach County, Florida. U.S.G.S. Open File Report FL-73021.

Schroeder, M. D. 1954. Water Resources of Palm Beach County, Florida. Florida Bureau of Geology Report of Investigations No. 13.

Schropp, S. and F. Calder, 1989. Florida Department of Environmental Regulation. Tallahassee Office, Coastal Zone Management Section - Unpublished Study of Lake Worth Sediments.

Senour, C. 1959. Sand Bypassing Plant at Lake Worth Inlet, Florida. American Society of Civil Engineers, Journal of the Waterways and Harbor Division, Vol. 85:69-87.

Snyder, D. 1984. Species Richness, Abundance and Occurrence of Grassbed Fishes From Jupiter Inlet, Florida. M.S. Thesis, Florida Atlantic University.

South Florida Regional Planning Council. 1976. Analysis of Coastal Land Use for Broward, Dade, Martin, Palm Beach, and St. Lucie Counties. Prepared for Coastal Zone Planning.

South Florida Water Management District. 1977. Estuarine Impact Evaluation (Lake Worth). In: Water Use and Supply Development Plan. Volume III. A. Lower Coast Planning Area Technical Exhibit A-H.

Terczak, E. No date. Lake Worth - EPA Study Invertebrate Data. Unpublished.

Travers, J. W. 1928. History of Beautiful Palm Beach.

Tropical Ecosystems, Inc., Deis, D. R., Walesky, R. E., Rudolph, H. D. 1983. A Reevaluation of the Benthic Macroinvertebrate Associations in Lake Worth, Florida. Unpublished Document Submitted to the Area Planning Board of Palm Beach County.

Tropical Ecosystems, Inc., Walesky, R. E. 1982. Inventory of Benthic Samples Collected During the Lower Florida Estuary Study. Unpublished M. S. Thesis Submitted to the Area Planning Board of Palm Beach County.

U.S. Army Corps of Engineers. 1973. Draft Environmental Impact Statement, Canal 17, Survey Review Report. Survey Review Report.

U.S. Army Corps of Engineers, Beach Erosion Board. 1953. A Study of Sand Movement at South Lake Worth Inlet, Florida Technical Memorandum 42.

U.S. Army Corps of Engineers. 1948. Survey Review Report on Lake Worth Inlet, Florida.

U.S. Army Corps of Engineers. 1958. Palm Beach County from Lake Worth Inlet to South Lake Worth Inlet, Florida: Beach Erosion Control Study. House Document Number 342, 85th Congress, 2nd Session.

U.S. Army Corps of Engineers. 1961. Palm Beach County, Florida, From Martin County Line to Lake Worth Inlet and From South Lake Worth Inlet to Broward County Line: Beach Erosion Control Study.

U.S. Army Corps of Engineers. 1971. Palm Beach Harbor, Florida. Technical Bulletin 17, Committee on Tidal Hydraulics.

U.S. Army Corps of Engineers. 1974. Sand Transfer Plant, Lake Worth Inlet, Palm Beach County.

U.S. Army Corps of Engineers. 1974. The Ports of Miami, Port Everglades, and Palm Beach, Florida. Port Series 16.

U.S. Army Corps of Engineers. 1988. Section 111 Definite Project Report, Palm Beach Harbor, Florida.

U.S. Coast and Geodetic Survey. 1884. Lake Worth. U.S. National Ocean Survey.

U. S. Environmental Protection Agency. 1972. Palm Beach County Sewage Improvement Program. Final Environmental Statement, NTIS Report.

U.S. Fish and Wildlife Service. 1982. Gulf Coast Ecological Inventory: West Palm Beach, Charlotte Harbor, Key West, Miami, Florida. Map.

U.S. Geological Survey. 1973. Land Use and Land Cover, 1973, West Palm Beach, Florida. U.S. Geological Survey Land Use Series Map L-85.

U.S. National Oceanic & Atmospheric Administration. 1980. National Ocean Survey, Intracoastal Waterway, Palm Shores to West Palm Beach.

University of Florida. 1958. A Model Study of Lake Worth Inlet. Florida Engineering and Industrial Experiment Station.

University of Florida. 1971. Hydrographic Study for the Improved Flushing of Lake Worth. Department of Coastal and Oceanographical Engineering.

Van Armen, J. 1975. Canal Flowrates and Data From Storm. Personal Files.

Van Armen, Jr. 1984. South Florida's Estuaries. In: Environments of South Florida Present and Past II by Miami Geological Society.

Van De Kreeke, J., Wang, J. D., Rehrer, R. G., Roessler, M. A. 1976. Freshwater Inflow and its Effect on the Salinity and Biota of Shallow Lagoons. University of Miami Technical Report.

Van De Kreeke, J., Wang, J. D. 1978. Tidal Hydraulics and Salt Balance of Lake Worth, Florida. Proceedings of the 16th International Conference on Coastal Engineering, Hamburg.

Van De Kreeke, J., Wang, J. D. 1976. Tidal Hydraulics and Salt Balance of Lake Worth. University of Miami Technical Report (Draft).

Vare, C. N. No date. A Comparison of Two Geographically Separate Estuarine Environments With Emphasis on the Physical-Chemical Parameters That May Influence the Existence of Particular Species of Seagrasses. Unpublished, Submitted for Geography Seminar GEO6938 Florida Atlantic University.

Vare, C. 1983. Seagrass Map of Little Munyon Island. Unpublished.

Vines, W. R. 1970. Surface Waters, Submerged Lands, and Waterfront Lands. Consultants Report for Housing and Urban Development Project No. Fla. P104(8).

Vines, W. R. 1970. Recreation and Open Space. For the Palm Beach County Area Planning Board.

Wainwright, S. 1977. A Study of the Benthic Macroinvertebrates Associated With a Wastewater Outfall. Unpublished Report Prepared for G. Alex Marsh, Ph.D. Florida Atlantic University.

Waldner, R. E., Lago, M. K. Potter, C. S., Waite, L. A. 1989. Rationale for the Preservation of Wetlands Currently Zoned RS-5, Located Along the Western Shore of Singer Island, Riviera Beach, Florida. A Report Submitted to the City of Riviera Beach, Florida.

Walker, J. R., Dunham, J. W. 1977. Lake Worth Inlet Case Study. American Society of Civil Engineers, Proceedings of Coastal Sediments 1977:602.

Wang, J. D. 1977. Hydrodynamics and Salt Dispersion Models For 1-Dimensional Estuaries. Documentation and Users Manual, University of Miami.

Watts, G. M. 1953. A Study of Sand Movement at South Lake Worth Inlet, Florida. Beach Erosion Board Technical Memorandum Ad Number 24 439.

Watts, G. M. 1953. A Study of Sand Movement at South Lake Worth Inlet, Florida. U.S. Army Corps of Engineers, Beach Erosion Board, Technical Memorandum TM-42.

Webb, A. D. 1976. The Benthic Ecology of the Intracoastal Waterway and Adjacent Canal Systems at Boca Raton, Florida. M.S. Thesis, Florida Atlantic University.

West Palm Beach, City of. 1989. Coastal Management Element of the City of West Palm Beach Florida Comprehensive Plan. Prepared by Department of Community Development and Planning.

West Palm Beach, City of. 1989. Sanitary Sewer, Solid Waste, Drainage, Potable Water, and Natural Groundwater Aquifer Recharge Element of the City of West Palm Beach Florida Comprehensive Plan. Prepared by City of West Palm Beach Department of Community Development and Planning.

West Palm Beach Fishing Club. 1989. Letter to Riviera Beach City Council. Letter Concerning Proposed Ordinance No. 2011883.

West Palm Beach Fishing Club. 1990. Unpublished Records of Fish Catches for Tournaments in Palm Beach County Since 1934. Unpublished records.

White, J.J. 1899. Shells of Lake Worth, Florida. Nautilus, Vol. 12(12):142-143.

Winner, B. 1988. Peanut Island. American Conchologist Vol. 16(3).

Woodburn, K. 1963. Memorandum to City Commission, City of West Palm Beach. Unpublished Memorandum Dated May 28, 1963.

Woodburn, K. D. 1961. Biological Survey of North Lake Worth (Palm Beach County) With Special Reference to Bulkhead Lines. Marine Lab, Salt Water Fish Division, Florida State Board of Conservation.

Woodburn, K. D. 1963. The Future of Lake Worth (Palm Beach County, Florida). FSB CML 63-2, Florida Board of Conservation.

Yeend, J. S. 1983. Hydrographic Survey, South Lake Worth Inlet, Palm Beach County, Florida. Report for Board of Commissioners of South Lake Worth Inlet District.

Zurmuhlen, F. H. 1958. The Sand Transfer Plant at Lake Worth Inlet. Proceedings of the Sixth Conference on Coastal Engineering, Pages 457-462.

APPENDIX 8.2–TABLE A

GRAIN SIZE CHARACTERISTICS		
grain size (mm)	phi scale (ϕ) units	type of sediment
64 - 256	-6 - -9	cobble
4 - 64	-2 - 04	pebble
2 - 4	-1	granule
1 - 2	0	very coarse sand
.5 - 1.0	1	coarse sand
0.25 - 0.5	2	medium sand
0.125 - 0.25	3	fine sand
0.063 - 0.125	4	very fine sand
0.031 - 0.063	5	coarse silt
<0.004	8 - 14	silt and clay
PHI GRADE SCALE - A geometric grade series, ϕ(phi)=-1.4427 log. (d(mm)/1mm) d(mm) (1mm) ($2^{-(\phi)}$)		
PHI MEDIAN DIAMETER - mid point of the particle size distribution (ϕ50th percentile)		
PHI MEAN DIAMETER - an average of the phi median medium diameter (ϕ50) and one standard deviation on either side of the median (ϕ16 and ϕ84)		
SORTING COEFFICIENT	The following verbal limits indicates relative sorting.	
	less than 0.35 = very well sorted	
	0.35 to 0.50 = well sorted	
	0.50 to 1.00 = moderately sorted	
	1.00 to 2.00 = poorly sorted	
	2.00 to 4.00 = very poorly sorted	
	greater than 4.00 = extremely poorly sorted	
SKEWNESS	The quality of asymmetry shown by a frequency distribution around the medium particle size. Positive skewness - coarser particles exceed finer particles. Negative skewness - finer particles exceed coarser particles. The following verbal limits indicates relative skewness.	
	-1.00 to -0.30 = very negative skewd	
	-0.30 to -0.10 = negative skewd	
	-0.10 to +0.10 = nearly symetrical	
	+0.10 to +0.30 = positive skewed	
	+0.30 to +1.00 = very positive skewed	
KURTOSIS	The ratio of the sorting in the extremes of the particle size distribution compared with the sorting in the central part. The following verbal limits indicate kurtosis.	
	0.67 to 0.90 = platykurtic (less peaked than the ponding normal frequency distribution)	
	0.90 to 1.11 = mesokurtic (closely resembling a normal frequency distribution)	
	1.11 to 1.50 = leptokurtic (more peaked than the corresponding normal frequency distribution)	
	1.50 to 3.00 = very leptourtic	
	greater than 3.00 = extremely leptokurtic	

APPENDIX 8.2 – TABLE B

STUDY: REED, J. K., 1975

TABLE 1

Averages of bimonthly sedimentary data from six sampling periods for each station.

Percent gravel, sand, silt, clay; mean particle diameter in phi units, median particle diameter in phi units and millimeters, and standard deviation(sorting) in phi units.

STATION #	NEAR EQUIVALENT EPA STATION	% GRAVEL	% SAND	% SILT	% CLAY	M z (0)	M d (o)	M d (mm)	O 1 (0)
1	LW35E	1.9	58.8	26.5	12.8	3.99	3.40	0.095	2.72
2	LWa32G	3.2	70.0	17.7	9.1	3.28	2.48	0.179	2.80
4	LW31B	0.2	20.7	59.1	20.0	6.01	6.24	0.013	2.34
5	LW31A	2.6	87.5	6.4	3.5	2.16	2.12	0.230	1.65
6	LW28C	0.0	24.9	54.3	20.7	5.94	5.91	0.017	2.27
9	LW27A	0.4	92.6	4.0	3.0	2.30	2.32	0.200	1.10
11	LW26A	2.0	93.3	2.6	2.1	1.86	1.81	0.285	1.12
13	LW25A	2.7	90.5	4.6	2.2	2.15	2.24	0.212	1.29
14	LW22C	6.4	91.0	1.2	1.4	1.63	1.74	0.299	1.11
17	LW20C	0.7	84.5	10.3	4.5	2.75	2.50	0.177	1.64
18	LW15A	0.1	51.2	39.5	9.2	4.45	3.95	0.065	2.18

APPENDIX 8.2 - TABLE C

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
WEIGHT PERCENT IN PHI UNITS																	
STATION #	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	MEDIAN PHI	SORTING COEFFICIENT	SKEWNESS	KURTOSIS
1A										14.7	9.0	76.3		4.34	0.81	-0.50	1.62
1C						0.3	3.3	16.1	23.7	20.1	11.3	25.3		2.33	1.61	0.09	0.69
1E					1.9	2.5	5.0	7.2	38.9	37.3	7.1	0.1		1.86	1.10	-0.17	1.32
1F					0.6	1.5	4.8	6.6	31.7	39.9	14.1	0.8		2.12	1.09	-0.16	1.21
1H					0.3	2.1	6.0	7.9	61.4	18.4	1.9	2.0		1.55	0.87	-0.02	1.76
2A						0.1	3.3	20.6	23.3	15.1	13.1	24.5		2.18	1.65	0.14	0.66
2C						0.2	0.8	2.1	17.9	56.5	22.2	0.4		2.52	0.80	-0.03	1.24
2E							3.0	13.5	25.3	22.5	13.1	22.5		2.36	1.53	0.10	0.77
2G					12.9	7.7	12.9	9.5	28.5	23.1	5.0	0.5		1.25	1.90	-0.36	0.83
2I					2.7	3.1	6.4	6.7	36.1	31.9	11.9	1.3		1.86	1.34	-0.18	1.39
3A						0.4	2.1	16.8	77.5	2.6	0.2	0.3		1.40	0.54	-0.26	1.16
3C					2.5	10.1	16.7	9.8	26.8	28.7	5.0	0.4		1.40	1.59	-0.30	0.77
3E						0.1	1.1	2.9	20.6	54.1	17.0	4.2		2.47	0.87	-0.01	1.29
3G						3.2	25.8	26.4	18.0	11.7	6.2	8.8		0.80	1.67	0.30	0.96
4A					1.2	1.3	1.7	1.7	16.0	61.0	13.4	3.9		2.46	0.88	-0.14	1.70
4C						1.3	3.0	7.5	41.0	37.3	7.5	2.5		1.93	0.98	0.01	1.15
4E							1.2	11.7	21.8	16.1	15.1	34.1		2.95	1.53	-0.11	0.68
4G					4.1	7.8	12.5	13.4	36.5	15.7	8.7	1.4		1.34	1.65	-0.20	1.12

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
4H					4.0	7.7	10.7	13.4	48.0	12.5	3.3	0.5		1.30	1.38	-0.38	1.21
4I					0.6	1.4	4.9	5.4	44.1	22.8	13.7	7.0		1.85	1.28	0.18	1.26
4K					0.7	2.7	4.6	14.1	25.0	40.1	12.7	0.2		2.08	1.23	-0.28	1.11
4M						7.3	5.9	8.6	52.5	17.6	6.8	1.3		1.54	1.28	-0.14	2.00
4O					0.8	1.9	2.7	10.2	64.1	14.3	4.5	1.6		1.54	0.83	0.10	1.77
4Q					0.6	1.3	3.0	19.3	56.5	12.2	4.3	2.8		1.46	0.95	0.06	1.61
5A					0.8	0.7	1.4	4.0	61.6	29.3	1.0	1.2		1.70	0.70	0.11	1.04
5C					11.5	5.8	8.5	12.6	41.1	18.1	1.8	0.5		1.28	1.69	-0.43	1.11
5E					3.9	2.7	5.1	6.3	26.5	39.1	15.1	1.4		2.14	1.39	-0.32	1.45
5G					6.7	8.4	8.8	10.6	47.6	15.0	1.3	1.6		1.33	1.53	-0.43	1.21
5I					2.6	8.7	15.1	15.1	34.3	13.4	8.8	2.1		1.25	1.64	-0.14	1.07
5K						2.2	2.5	5.2	37.8	37.0	14.1	1.2		2.06	1.01	-0.04	1.12
5M					3.3	3.8	6.9	6.4	38.2	25.4	14.6	1.4		1.77	1.48	-0.17	1.43
5O				2.2	1.5	3.5	5.3	8.8	51.4	17.7	8.4	1.3		1.56	1.34	-0.13	2.00
5Q					1.2	0.5	0.8	16.2	68.8	10.1	2.2	0.4		1.46	0.67	-0.05	1.46
6C						0.3	1.0	5.5	22.2	37.5	31.3	2.2		2.56	1.03	-0.12	0.92
6E					1.1	0.5	1.8	3.1	19.1	44.7	28.0	1.8		2.55	1.01	-0.13	1.15
6G						1.3	3.4	4.5	12.2	48.4	28.6	1.5		2.59	1.06	-0.20	1.41
6I					1.2	1.3	2.8	4.9	23.9	51.0	14.5	0.4		2.31	1.01	-0.26	1.31
6K						0.7	1.7	2.0	9.2	58.1	27.9	0.4		2.63	0.77	0.02	1.23
6M						0.3	1.0	1.8	8.1	55.1	33.3	0.4		2.70	0.76	0.01	1.06
6O					1.1	2.1	2.9	3.2	17.6	54.0	18.9	0.3		2.43	1.07	-0.26	1.69

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
6Q					4.0	1.9	2.4	2.9	38.2	46.7	3.7	0.2		2.01	1.08	-0.33	1.53
6R					0.2	0.4	1.3	3.0	31.2	51.9	11.3	0.7		2.27	0.79	-0.07	0.97
7A						1.3	1.7	2.3	6.8	25.3	53.2	9.4		3.24	0.98	-0.29	1.24
7C						0.2	0.7	3.1	18.0	40.7	33.6	3.7		2.69	0.93	-0.08	0.92
7F						0.1	0.9	1.4	13.1	47.8	23.4	13.4		2.72	0.99	0.18	1.08
8A						0.3	1.3	4.7	20.0	65.0	4.5	4.1		2.36	0.82	-0.16	1.55
8C					0.3	0.3	0.8	3.1	9.7	39.8	44.8	1.3		2.90	0.84	-0.17	0.98
8E					0.8	0.7	1.5	4.1	24.9	43.0	24.2	0.8		2.42	1.01	-0.11	1.07
8G						2.4	2.5	8.3	60.4	26.0	0.3	0.2		1.61	0.76	0.02	1.34
8I					4.3	8.2	6.8	12.5	47.2	18.6	2.4	0.1		1.39	1.41	-0.37	1.34
9A					1.9	1.8	1.6	5.0	42.3	39.3	5.4	2.7		1.94	0.99	-0.05	1.27
9C					0.6	0.5	7.0	36.6	37.3	16.4	1.2	0.4		1.14	0.97	0.02	0.98
9E						1.7	4.0	9.4	32.6	35.5	16.5	0.4		2.07	1.09	-0.09	1.09
9G					4.5	6.1	9.6	16.0	28.2	20.5	14.6	0.5		1.49	1.69	-0.17	1.04
9I						1.9	2.6	9.7	35.1	45.6	5.0	0.1		2.02	0.88	-0.23	0.97
9K					0.5	1.7	4.4	14.1	27.0	39.7	12.5	0.1		2.06	1.17	-0.23	1.07
10aA						0.7	2.3	8.4	32.2	51.5	4.9	0.0		2.13	0.83	-0.28	0.95
10aD			8.6	1.5	2.8	3.6	6.5	8.3	16.0	37.7	14.8	0.2		2.07	2.25	-0.58	1.33
10bA					0.1	0.3	1.4	4.0	35.8	54.1	4.1	0.1		2.15	0.71	-0.21	0.84
10bC		8.2	3.3	2.7	5.5	9.6	8.3	9.1	32.4	18.4	2.3	0.2		1.10	2.48	-0.55	1.02
11A					2.5	1.8	3.4	10.4	28.0	45.1	8.5	0.4		2.09	1.15	-0.31	1.24
11B					2.6	4.5	6.7	4.1	40.0	40.6	1.5	0.1		1.80	1.19	-0.34	1.44

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
11C					6.3	7.9	7.3	6.0	28.3	36.2	7.8	0.2		1.80	1.73	-0.44	1.19
11D	14.7	0.0	0.0	0.0	2.8	6.0	3.5	5.8	20.8	34.9	11.0	0.5		1.83	-	-	-
11E					9.8	4.8	4.8	10.4	32.0	33.0	4.5	0.7		1.63	1.68	-0.44	1.22
11F					3.3	4.3	4.1	8.5	24.6	42.9	12.0	0.4		2.12	1.39	-0.39	1.42
11G						0.6	0.6	1.4	10.6	63.6	23.0	0.2		2.58	0.71	0.05	1.33
11H					10.7	6.0	13.0	15.9	32.8	15.4	6.0	0.2		1.13	1.74	-0.29	1.04
11I						1.8	1.9	4.9	30.6	44.1	16.0	0.8		2.25	0.98	-0.12	1.11
11J						0.7	0.7	2.7	13.1	47.5	34.7	0.5		2.69	0.84	-0.05	1.01
11K						0.3	0.6	2.5	14.1	32.9	47.8	1.7		2.98	0.88	-0.27	0.90
12A					0.4	1.6	2.3	5.3	62.9	25.7	1.5	0.3		1.64	0.75	0.05	1.32
12C						0.8	1.5	1.7	14.8	47.1	30.7	3.5		2.66	0.88	-0.03	1.01
12E						0.3	0.4	0.9	4.5	28.2	64.0	1.8		3.25	0.69	-0.31	0.93
12I					3.2	4.9	11.0	7.4	15.8	32.6	22.8	2.3		2.24	1.75	-0.39	1.03
13A						1.9	3.2	5.1	24.0	45.5	16.9	3.4		2.35	1.10	-0.15	1.26
13C						0.7	1.6	2.7	21.3	60.7	10.7	2.3		2.39	0.77	-0.12	1.30
13E						3.7	4.2	6.4	17.2	45.5	19.5	3.5		2.41	1.26	-0.25	1.42
13G						0.3	1.1	2.6	35.4	55.3	4.8	0.6		2.19	0.68	-0.15	0.80
14A					0.8	3.3	7.2	8.5	25.6	39.8	12.1	2.6		2.11	1.31	-0.29	1.24
14C					1.8	5.0	7.2	5.8	22.0	44.3	11.0	2.9		2.18	1.44	-0.39	1.40
14E						1.0	2.8	24.4	64.6	6.6	0.5	0.2		1.34	0.69	-0.17	1.10
14F					0.2	0.8	1.0	5.5	76.2	15.8	0.2	0.4		1.56	0.55	0.05	1.35
15A						0.2	5.6	13.6	15.7	16.4	15.9	32.6		2.91	1.69	-0.19	0.71

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
15C					0.5	2.7	2.7	6.2	18.2	40.7	15.4	14.1		2.50	1.39	-0.03	1.27
15E					2.9	3.8	6.5	7.3	25.2	32.7	13.8	7.9		2.13	1.63	-0.19	1.39
15G					0.7	1.6	5.4	7.3	28.8	41.9	11.5	2.9		2.15	1.13	-0.19	1.26
16A						0.3	3.3	4.6	18.6	44.8	12.7	15.8		2.52	1.30	0.07	1.31
16C						0.4	10.3	18.3	26.8	27.2	7.2	9.8		1.78	1.48	0.01	1.07
16E						0.08	5.3	6.5	19.6	27.5	18.0	23.1		2.68	1.51	-0.04	0.89
16G						3.9	9.6	12.0	28.2	32.1	9.2	5.0		1.87	1.42	-0.17	1.17
16I					7.0	20.9	22.5	11.1	12.0	14.9	6.1	5.4		-0.02	2.03	0.28	0.81
17A					0.5	2.7	3.1	4.8	38.9	38.0	7.3	4.7		2.00	1.10	0.05	1.38
17C						1.8	2.5	30.1	60.4	5.0	0.3	0.1		1.26	0.67	-0.21	0.86
17E					1.5	0.5	2.4	30.4	59.3	5.6	0.2	0.1		1.26	0.69	-0.18	0.87
17G					0.8	3.7	7.0	8.0	34.7	39.6	4.0	2.1		1.88	1.19	-0.27	1.26
17H					0.1	2.2	6.2	8.4	18.9	42.7	13.7	7.8		2.33	1.38	-0.16	1.35
18A					7.1	5.6	5.5	7.9	42.0	29.3	1.8	0.8		1.57	1.53	-0.41	1.55
18C		38.2	24.8	9.0	5.7	7.8	5.0	2.6	4.3	2.2	0.2	0.3		-4.52	2.21	0.58	1.04
18E						1.3	4.4	13.4	60.2	15.9	3.2	1.7		1.51	0.86	-0.01	1.54
19A					1.0	4.1	8.3	20.4	44.1	15.1	4.5	2.5		1.37	1.25	-0.08	1.34
19C					9.4	6.5	8.6	7.9	42.3	24.1	0.8	0.4		1.42	1.65	-0.44	1.12
19E						0.4	4.4	16.6	30.5	17.0	12.1	19.0		1.94	1.59	0.23	0.81
19F						0.4	4.4	18.9	22.0	15.9	12.5	26.1		2.27	1.67	0.08	0.66
20A		11.1	0.0	0.0	13.1	10.0	10.5	7.8	33.8	11.7	1.0	0.9		0.68	2.39	-0.48	0.95
20C						0.5	3.1	9.2	64.3	22.9				1.58	0.71	0.04	1.38

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																
20E						0.5	0.8	3.2	51.5	42.8	1.1	0.2		1.88	0.65	0.08	0.75
20G					8.7	14.5	16.9	19.8	36.7	2.3	0.4	0.9		0.50	1.45	-0.30	0.78
21A			25.7		11.3	4.7	7.9	7.5	23.1	14.6	3.1	2.2		0.06	2.86	-0.28	0.56
21C						0.7	2.1	5.0	66.3	25.4	0.2	0.3		1.64	0.68	0.09	1.25
21E					1.9	3.0	8.1	14.4	61.5	10.4	0.2	0.6		1.37	0.97	-0.34	1.56
21F					14.3	7.1	16.8	15.7	26.0	17.5	1.9	0.9		0.76	1.84	-0.25	0.87
21G					3.2	2.9	8.0	13.8	41.5	27.9	2.2	0.4		1.53	1.25	-0.26	1.25
21I					3.1	10.6	21.1	23.2	25.8	11.4	2.5	2.2		0.65	1.45	-0.05	0.93
21J					6.2	5.1	6.1	4.0	8.9	25.7	39.5	4.5		2.77	1.92	-0.56	1.22
21L						0.4	8.1	17.7	17.4	14.4	12.8	29.1		2.44	1.80	-0.05	0.67
22A					12.2	9.8	7.8	11.5	44.1	14.0	0.4	0.2		1.20	1.69	-0.50	0.91
22C					0.1	0.1	0.5	1.2	94.4	3.7	0.0	0.0		1.51	0.32	0.0	0.74
22E					6.4	2.3	5.6	10.0	51.7	22.5	1.2	0.3		1.50	1.31	-0.34	2.15
22G						2.3	6.8	33.0	40.9	12.6	2.7	1.8		1.19	1.01	-0.03	1.10
22I					6.4	7.3	17.0	19.6	29.0	15.1	3.1	2.5		0.99	1.62	-0.17	1.02
23A						1.0	2.0	38.1	53.1	5.0	0.4	0.4		1.17	0.69	-0.09	0.81
23C					0.8	0.6	2.9	28.5	46.5	12.6	3.7	4.5		1.37	1.07	0.16	1.33
23E					0.8	1.4	3.3	22.8	50.2	17.3	3.2	1.1		1.43	0.93	-0.03	1.18
23G					1.2	3.3	4.5	7.6	45.6	36.6	0.9	0.3		1.73	0.99	-0.18	1.33
24H						1.2	5.8	32.0	39.2	15.8	3.0	2.9		1.28	1.07	0.08	1.10
25A						0.2	3.4	15.3	19.7	21.4	18.5	21.5		2.53	1.57	-0.02	0.77
25C						1.1	3.1	7.1	28.7	52.6	7.2	0.4		2.19	0.91	-0.25	1.12

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
25E						4.8	11.5	21.0	36.1	23.3	2.5	0.9		1.35	1.21	-0.15	0.97
25G						1.9	3.6	38.9	45.6	7.6	1.3	1.1		1.12	0.82	0.02	0.98
25J					1.4	1.8	3.9	16.7	45.3	20.5	5.0	5.5		1.58	1.25	0.07	1.50
26A				7.8	2.4	4.9	3.1	11.9	48.5	19.1	2.0	0.4		1.41	1.68	-0.47	1.90
26C						0.9	2.1	2.7	12.9	72.5	8.1	0.8		2.43	0.69	-0.19	1.62
26E					1.7	5.2	13.3	17.5	55.3	6.7	0.1	0.3		1.22	1.09	-0.42	1.07
26G						0.2	17.5	19.4	18.2	14.3	9.8	20.5		1.71	1.91	0.14	0.71
26I		21.1	5.7	4.0	3.5	2.6	3.3	37.8	17.3	3.0	0.7	0.9		0.26	2.82	-0.61	0.61
26J						0.3	4.6	12.7	20.1	16.4	11.9	33.9		2.75	1.65	-0.08	0.69
27A						0.1	0.4	4.2	47.1	45.0	2.3	0.9		1.96	0.66	0.02	0.74
27C	46.8				8.0	4.6	5.2	9.3	16.7	8.2	0.8	0.4		-2.60	-	-	-
27D					15.8	4.2	11.7	18.1	34.5	13.3	1.2	1.1		1.00	1.82	-0.42	0.97
28A						0.3	2.2	3.7	22.3	41.4	14.3	15.9		2.52	1.24	0.12	1.08
28C			17.5		2.3	12.5	29.2	16.1	9.9	5.8	3.1	3.6		0.40	2.68	-0.17	1.40
28E					7.2	2.0	3.3	6.8	16.4	18.7	21.3	24.5		2.77	2.03	-0.30	1.11
29A						0.2	0.4	1.4	8.8	0.6	44.3	44.3		3.87	0.92	-0.21	1.29
29C						1.3	4.7	10.8	43.0	37.9	2.0	0.4		1.78	0.90	-0.12	1.06
29E			24.3		5.7	3.6	6.3	7.6	24.1	19.3	6.0	3.1		1.11	3.03	-0.48	0.69
29G					0.1	0.3	1.3	2.2	7.3	9.4	21.8	57.6		4.13	1.12	-0.52	1.13
30A						0.5	3.3	24.8	58.4	11.2	1.4	0.4		1.37	0.77	-0.09	1.17
30C					8.3	6.9	11.4	21.3	49.9	1.9	0.1	0.2		1.04	1.32	-0.54	1.06
30E							11.5	33.6	23.7	11.5	7.0	12.7		1.21	1.63	0.34	0.99

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
31A					25.2	31.6	17.8	9.4	7.4	5.1	1.8	1.8		1.22	1.68	0.37	1.10
31B							0.2	1.8	10.3	24.3	18.0	45.4		3.74	1.17	-0.32	0.77
31C					10.1	7.3	14.9	15.9	24.5	16.2	4.1	7.0		1.07	2.00	-0.11	1.06
31E							0.7	7.6	16.5	16.4	17.6	41.3		3.50	1.44	-0.33	0.74
31G						0.2	2.0	6.0	25.3	8.8	19.3	38.5		3.40	1.48	-0.30	0.67
32A		56.9		1.6		0.7	1.4	2.6	25.1	10.6	0.8	0.5		-5.12	3.18	0.83	0.50
32C						0.9	2.0	6.3	58.8	31.0	0.7	0.3		1.69	0.73	0.05	1.08
32E					7.9	13.4	15.0	11.4	23.1	24.0	2.8	2.4		1.10	1.81	-0.27	0.76
32G							2.4	17.8	35.4	18.6	8.2	17.6		1.84	1.52	0.30	0.96
32I						0.2	2.7	14.0	21.2	21.4	12.8	27.7		2.56	1.58	0.02	0.71
32K						3.4	5.4	49.6	33.0	7.0	0.9	0.7		0.83	0.90	0.10	1.12
32L					0.1	2.2	13.9	14.9	17.7	19.3	14.7	17.3		2.07	1.86	-0.03	0.78
33A						11.8	13.0	29.8	32.4	10.8	1.3	0.9		0.85	1.30	-0.15	1.09
33C					1.8	1.7	9.6	14.5	41.3	29.2	1.4	0.6		1.54	1.15	-0.22	1.10
33E					7.8	6.9	12.4	13.2	32.5	24.4	1.7	1.0		1.30	1.64	-0.35	0.95
33G					0.3	0.7	2.8	4.6	36.1	48.5	4.0	3.1		2.11	0.90	-0.13	1.14
33I					0.4	0.5	0.8	3.5	89.9	4.6	0.1	0.2		1.50	0.35	-0.03	0.79
34A		1.5	0.7	1.3	1.4	3.6	2.8	16.5	55.7	16.0	0.4	0.2		1.4	1.15	-0.35	1.89
34C					13.0	24.0	16.4	10.1	13.1	15.6	4.0	3.8		-0.21	2.04	0.24	0.77
34E					1.7	1.3	5.2	6.8	36.6	44.3	3.4	0.8		1.96	0.97	-0.26	1.17
34G						1.3	4.7	7.3	31.0	43.5	10.4	1.8		2.13	1.05	-0.17	1.21
35A							1.5	17.7	26.5	15.7	11.3	27.3		2.27	1.60	0.15	0.66

APPENDIX 8.2-TABLE C CONT.

STUDY: R. ROGERS, 1972 EPA STUDY OF LAKE WORTH LAGOON: SEDIMENT GRAIN SIZE ANALYSIS																	
35C					3.8	1.9	6.9	12.9	51.2	14.4	5.1	3.8		1.48	1.34	-0.10	2.08
35E						1.2	2.2	9.2	65.0	20.4	0.8	0.3		1.57	0.70	0.05	1.42
36A			0.7	0.7	0.4	17.5	13.4	29.3	30.1	6.7	1.0	0.3		0.59	1.37	-0.17	0.87
36C					1.4	5.8	17.5	14.2	24.9	24.4	5.7	6.0		1.45	1.67	-0.09	0.93
36E					0.1	0.3	0.4	0.9	5.7	16.7	24.3	24.3	27.3	4.07	1.37	-0.12	0.85
37A					3.4	10.2	15.8	18.6	36.9	13.9	1.0	0.3		1.06	1.40	-0.31	0.93
37C					0.6	2.2	4.7	10.4	44.5	32.1	3.8	1.7		1.72	1.02	-0.10	1.22
37E						1.4	1.8	12.2	64.7	18.4	1.1	0.4		1.53	0.70	0.04	1.41
38A					1.9	1.2	3.1	13.4	61.5	17.4	1.0	0.4		1.49	0.84	-0.13	1.61
38C						0.1	3.6	18.3	21.8	16.7	12.6	27.0		2.38	1.65	0.06	0.66
38E						0.6	6.2	10.6	43.2	23.2	9.9	6.2		1.75	1.22	0.13	1.27
39A					1.5	4.5	7.8	12.0	52.8	17.9	2.6	0.9		1.46	1.16	-0.25	1.70
39C					0.8	1.8	3.9	16.0	59.8	16.6	0.8	0.3		1.46	0.85	-0.16	1.53
39E					4.4	6.9	12.1	12.5	37.6	22.2	3.5	0.9		1.38	1.51	-0.32	1.03
39H					1.6	2.3	6.0	11.4	68.2	9.4	0.3	0.7		1.42	0.86	-0.30	1.90
40A					0.2	0.7	1.1	10.4	83.9	3.4	0.1	0.3		1.45	0.46	-0.18	1.17
40C						0.2	0.5	1.4	16.1	80.9	0.7	0.3		2.39	0.50	-0.24	1.17
40E							0.4	2.1	26.7	66.8	3.9	0.1		2.31	0.61	-0.26	0.92
40F					0.3	0.5	2.2	12.3	16.8	49.3	17.4	1.1		2.36	1.07	-0.24	1.15
41A					2.2	2.9	5.2	26.0	43.2	13.4	4.3	2.9		1.32	1.22	-0.04	1.40
41C					0.6	0.8	4.1	5.5	14.4	60.3	13.4	1.1		2.41	0.98	-0.31	1.85
41E					4.6	3.9	6.9	25.9	51.6	6.3	0.6	0.2		1.17	1.09	-0.36	1.36

APPENDIX 8.2 – TABLE D

STUDY: H. RUDOLPH, 1989								
Weight Percent in PHI Units * - Data Not on Overlay								
Date	Station #	Equivalent EPA Station	<-1	0+1	2	3	4	5
Feb 85	773			0.1	1.1	2.0	4.3	92.5
Feb 85	*775	LW 4H	0.2	3.5	13.9	39.7	35.0	7.7
Feb 85	*728	LW 9D	1.8	10.2	20.4	41.8	23.4	2.4
Feb 85	*778	LW 15A	1.2	5.1	30.2	28.7	12.9	21.9
Feb 85	*734	LW 27A	0.1	7.7	75.6	14.2	0.7	1.7
Feb 85	784	LW 40F	1.5	26.1	56.9	13.8	0.4	1.3
Aug 85	*778	LW 15A	2.0	17.5	53.5	22.6	1.9	2.5

APPENDIX 8.2 - TABLE E

STUDY: SCHROPP, S. & F. CALDER, 1989									
Weight Percent in PHI Units									
Replicate A									
Station #	<-1	0.25	1.25	2	2.75	3.75	>3.75	Mean Phi	Mean mm
1		1	2	9	58	29.8	0.2	2.51	0.18
2	2	13	11	13	31	17	13	2.18	0.22
3	2	2	7	33	42	12.4	1.6	2.03	0.24
4	4	9	13	40	24	8	2	1.59	0.33
5	3	5	10	30	32	12.6	7.4	2.05	0.24
6	1	4	37	32	3	17.7	5.3	1.69	0.31
7	3	6	11	43	21	13.4	2.6	1.78	0.29
8	6	7	10	24	5	40.9	7.1	2.17	0.22
PPB 9	3	7	3	6	75.9	0.8	4.3	2.10	0.23
9	6	6	10	54	17.6	3.9	2.5	1.51	0.35
10	3	4	11	40	14	22.5	5.8	2.03	0.25
11	4	6	30	42	11.6	2.2	4.2	1.39	0.38
13	23	22	13	11	8	19.2	3.8	0.86	0.55
14	5	6	6	10	33	32.4	7.6	2.34	0.20
15	2	4	9	40	28	12.8	4.2	1.97	0.26
16	17	22	19	17	33.3	6.7	2	0.79	0.58
17	9	10	21	32	17	9	2	1.31	0.41
18	6	7	9	35	30	8.5	4.5	1.74	0.30
19	7	19	11	23	13	20.8	6.2	1.59	0.33
20	2	2	16	15	43	19.4	2.6	2.17	0.22
21	2	2	6	50	28	7.8	4.2	1.96	0.26

APPENDIX 8.2 - TABLE F

Tropical Ecosystems Inc., 1983

Weight Percent in PHI Units
* - Values are Approximate

Date	Station #	Equivalent EPA Station	Equivalent Reed Station	<-1	0+1	2 & 3	4	5
Apr 82	1	LW 35E	1	1	5	82	15	17
Aug 82	1	LW 35E	1	1	4	75	13	7
Apr 82	2	LW 32G	2	3	9	56	17	15
Aug 82	2	LW 32G	2	2	4	41	7	46
Apr 82	3	LW 31B	4	2	2	8	28	60
Aug 82	3	LW 31B	4	2	5	5	10	78
Apr 82	4	LW 31A	5	1	2	26	28	43
Aug 82	4	LW 31A	5	0	4	41	19	36
Apr 82	5	LW 28C	6	2	5	63	14	16
Aug 82	5	LW 28C	6	1	3	20	28	48
Apr 82	6	LW 27A	9	2	0	97	1	0
Aug 82	6	LW27A	9	0	5	94	1	0
Apr 82	7	LW 26A	11	0	10	87	2	1
Aug 82	7	LW 26A	11	2	8	88	2	0
Apr 82	8	LW 25A	13	7	11	65	11	6
Aug 82	8	LW 25A	13	4	4	85	7	0
Apr 82	9	LW 22C	14	2	10	84	2	2
Aug 82	9	LW 22C	14	0	6	92	2	0
Apr 82	10	LW 20C	17	3	5	50	18	26
Aug 82	10	LW 20C	17	1	5	80	10	4
Apr 82	11	LW 15A	18	0	1	27	36	36
Aug 82	11	LW 15A	18	2	3	53	22	20
Apr 82	12	LW 11F		10	6	52	26	6
Aug 82	12	LW 11F		3	4	62	30	1
Apr 82	13	LW 9D		1	5	64	29	1
Aug 82	13	LW 9D		0	2	40	16	42
Apr 82	14	LW 4H		0	2	49	38	11
Aug 82	14	LW 4H		5	7	56	14	18

APPENDIX 8.3

MUNYON ISLAND PARTIAL PLANT LIST
by Anne Cox 11/12/90

TREES	
Black mangrove	*Avicennia germinans*
Gumbo limbo	*Bursera simaruba*
Australian pine *	*Casuarina equisetifolia*
Pigeon plum	*Coccoloba diversifolia*
Seagrape	*Coccoloba uvifera*
Buttonwood	*Conocarpus erecta*
Royal poinciana (Cult)	*Delonix regia*
Strangler fig	*Ficus aurea*
Blolly	*Guapira discolor*
White mangrove	*Laguncularia racemosa*
Ironwood	*Krugiodendron ferreum*
Sapodilla (Cult)	*Manilkara zapota*
Mastic	*Mastichodendron foetidissimum*
Chinaberry (Cult) *	*Melia azedarach*
Red mulberry	*Morus rubra*
Red mangrove	*Rhizophora mangle*
Cabbage palm	*Sabal palmetto*
Bloodberry	*Rivina humilis*
Brazilian pepper *	*Schinus terebinthifolius*
SHRUBS	
Flexible caper	*Capparis flexuosa*
Papaya *	*Carica papaya*
Snowberry	*Chiococca alba*
Coin vine	*Dalbergia ecastophyllum*
White stopper	*Eugenia axillaris*
Surinam cherry (Cult) *	*Eugenia uniflora*
Spanish stopper	*Eugenia foetida*
Florida privett	*Forestiera segregata*
Wild coffee	*Psychotria nervosa*
Randia	*Randia aculeata*
Wild lime	*Zanthoxylum fagara*
Unknown shrub *	
HERBS AND FORBS	
Ragweed	*Ambrosia artemisiifolia*
Sea ox-eye daisy	*Borrichia frutescens*
Grey nicker	*Caesalpinia bonduc*
Periwinkle	*Catharanthus roseus*
Stinging nettle	*Cnidoscolus stimulosus*
Sedge	*Cyperus* sp.
Crowfoot grass	*Dactyloctenium aegyptium*
Seaside heliotrope	*Heliotropium curassavicum*
Railroad vine	*Ipomoea pes-caprae*
Iva	*Iva imbricata*
Wild balsam apple	*Momordica charantia*

Prickly pear cactus	*Opuntia* sp.
Corky passionflower	*Passiflora suberosa*
Sea purslane	*Sesuvium portulacastrum*
Ball moss	*Tillandsia recurvata*
Unknown vine	
Unknown shrub (purple flowers)	

(Cult) Indicates cultivated. Possibly planted by previous owners of property.
* Indicates exotic, escaped from cultivation, or reseeding in the wild.

PARTIAL PLANTLIST FOR SMALL ISLAND IMMEDIATELY SOUTH OF BURNT BRIDGE
by Anne Cox 11/12/90

TREES	
Black mangrove	*Avicennia germinans*
Seagrape	*Coccoloba uvifera*
Buttonwood	*Conocarpus erecta*
White mangrove	*Laguncularia racemosa*
Cabbage palm	*Sabal palmetto*
Brazilian pepper *	*Schinus terebinthifolius*
SHRUBS	
Coin vine	*Dalbergia ecastophyllum*
HERBS AND FORBS	
Sea ox-eye daisy	*Borrichia frutescens*
Sea purselane	*Sesuvium portulacastrum*

* Indicates exotic, escaped from cultivation, or reseeding in the wild.