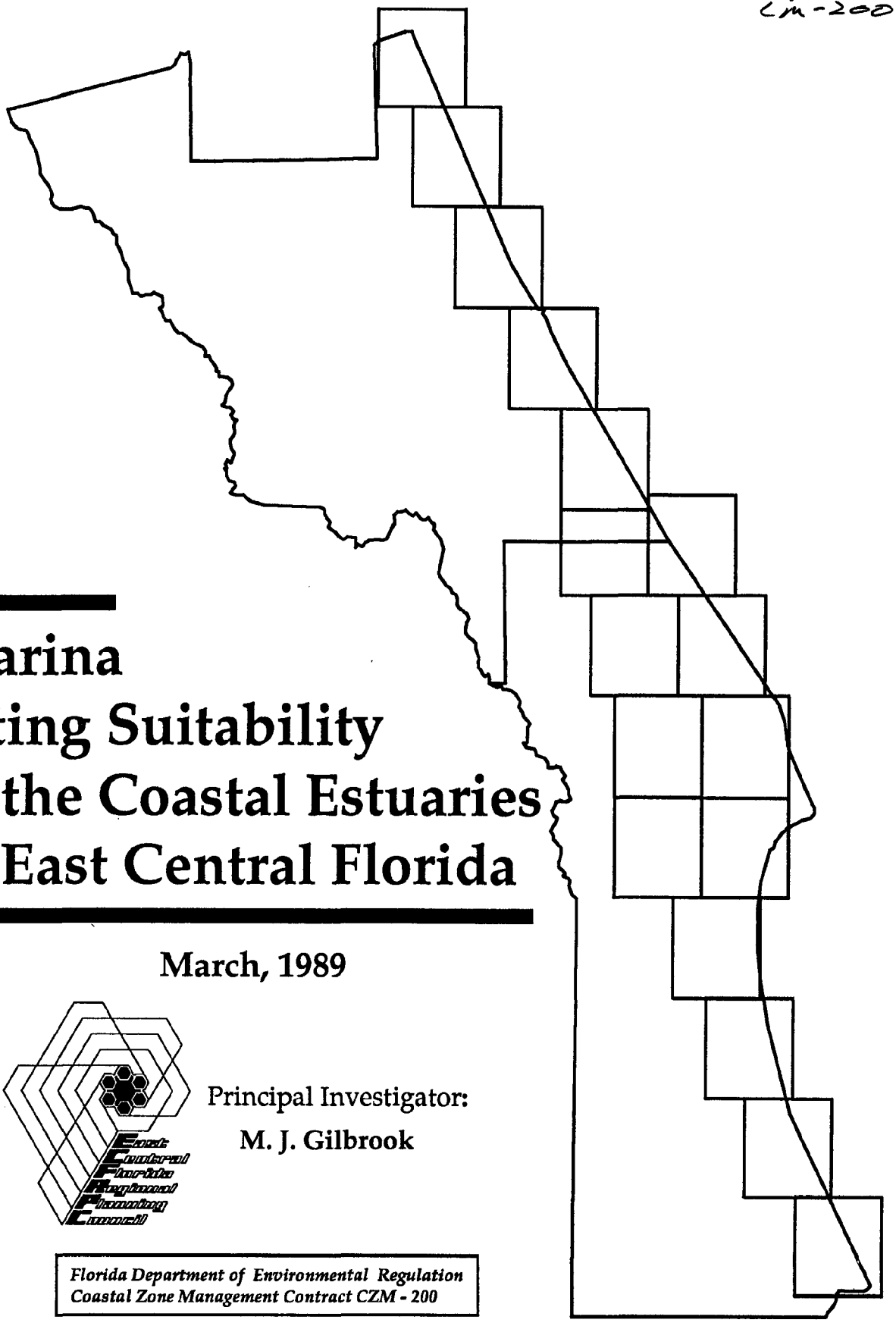

Marina Siting Suitability in the Coastal Estuaries of East Central Florida

March, 1989

Principal Investigator:
M. J. Gilbrook

East Central Florida Regional Planning Council

Florida Department of Environmental Regulation
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MARINA SITING SUITABILITY IN THE COASTAL ESTUARIES OF EAST CENTRAL FLORIDA

A STUDY PREPARED UNDER CONTRACT TO THE
FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION
OFFICE OF COASTAL MANAGEMENT

CONTRACT CZM-200

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Principal Investigator:

Michael J. Gilbrook
Section Chief
Special Projects

East Central Florida Regional Planning Council
1011 Wymore Road, Suite 105
Winter Park, FL 32789

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DATA ACCURACY DISCLAIMER

This study depicts the relative unsuitability of the estuarine areas of east central Florida for marina siting based on a number of physical, environmental and regulatory constraints. The data used in this study were the most recent and complete sources available at the time of preparation. Nevertheless, readers are warned that, due to its nature, much of the information in this study may be incomplete or subject to change. The endangered species data in particular are likely to be incomplete due to the lack of comprehensive survey data. Seagrass and vegetative cover data represent the condition of those communities at the time when they were surveyed, and may not reflect natural or artificially induced changes which have occurred since.

This document should be used for initial planning purposes only. No site should be approved for marina construction or other development or alteration based solely on the results of this study. All sites should be carefully surveyed for endangered species, seagrasses, vegetative cover and near-shore bathymetry prior to site approval. Likewise, the current limits of shellfish harvesting areas and Outstanding Florida Waters (or other restrictive water quality designations) should be determined from the Florida Department of Environmental Regulation and Florida Department of Natural Resources.

INTRODUCTION

Boats play an important role in the East Central Florida economy. According to the Florida Statistical Abstract, commercial fishing vessels landed 51.16 million pounds of fish worth $34.11 million in Brevard and Volusia counties during 1984 (BEBR, 1987). The number of commercial boats registered in 1986 stood at 1,572 in Brevard County and 826 in Volusia (BEBR, 1987). Recreational boating also figures prominently in the coastal zone. Brevard County hosts 20,651 pleasure boats, and Volusia County is home to another 16,343 (BEBR, 1987). The number of privately registered vessels increased 36% in Brevard County from 1978 to 1986, at a time when population increased by 40% (BEBR, 1987). In Volusia County, the number of registered pleasure boats increased by 71%, twice as fast as population increase (34%), indicating a greater proportion of residents turning to boating for recreation. An economic supply/demand analysis conducted for the Florida Department of Natural Resources revealed that total wet and dry boat slip storage could grow by up to 63% in Brevard County, and by as much as 89% in Volusia County (FNDR, 1984).

The lack of shelter from direct wave action on the Atlantic coastline of Brevard and Volusia counties makes it unsuitable for the siting of safe marinas or harbors. Consequently, the only locations available for the siting of marinas in the coastal zone are within the three tidal lagoons: the Indian River, Mosquito Lagoon, and the Halifax River. Although the sheltered waters of these lagoons provide seemingly ideal locations for marinas, these areas are also subject to many environmental constraints which limit their suitability for marina development.

The purpose of this study was to use Geographic Information System (GIS) technology to highlight those areas where environmental constraints limit the suitability of marinas in the East Central Florida coastal zone. It was not the intention of this study to identify locations appropriate for marinas. Instead it illustrates where, to varying degrees, physical constraints, regulatory restrictions and biological resources mitigate against marina development. This information will be valuable to local government planners and regulatory agencies involved in reviewing marina site proposals. Ideally, marinas would only be considered for those sites which this study indicates are least undesirable. It will be the job of local government planners and elected officials to assess the many other constraints to marina siting in making final marina site approval determinations.

METHODOLOGY

STUDY AREA

The study area included the estuarine areas contained within a zone extending from the northern Volusia County line to the Brevard County line at Sebastian Inlet. Analysis of the Atlantic coastline was not an objective of this study. To simplify computer processing and final map production, the study area was broken into 17 "Marina Siting Panels," each the size and shape of a USGS 7.5 minute quadrangle. These panels were superimposed over the estuaries so as to provide maximum coverage of the coastal lagoons while minimizing the mapping of extraneous areas not pertinent to the objectives of this project.

The 17 Marina Siting Panels encompass portions of 26 USGS 7.5 minute maps. Marina Siting Panel (MSP) 1 through MSP 7 encompass those parts of the project fall within Volusia County (Figure 1). MSPs 6 and 7 also include portions of Brevard County, and MSPs 8 through 17 fall entirely in Brevard County (Figure 2). The shoreline and major roadways appearing in Figures 1 and 2 were extracted from USGS Digital Line Graph (DLG) data, which were originally compiled from the digitization of 1:100,000 scale USGS 30 minute quadrangle maps. The codes within each USGS quad (e.g., QDYY-XXX) indicate the date of the DLG data (YY) and the identity of the quad (XXX) using the quad index numbers assigned by the ECFRPC (Appendix 1).

OVERVIEW OF GIS ANALYSIS

This study was conducted using a computerized *Geographic Information System* (GIS). A GIS allows for the use of computer stored, digital maps in a spatial analysis, much in the same way as a computer spreadsheet provides for numerical analysis. Using a GIS, many digital maps may be electronically combined and overlaid to produce new information in a way which would be difficult if not impossible to do by any manual method.

The use of a GIS involves several distinct phases. The first is *data collection*, whereby the data one wants to use in the study are organized in a fashion suitable for input into the computer. The next phase is *data capture*. In this phase the data are actually entered into the computer system in a form suitable for analysis. This step usually involves digitizing the data using an electronic "tracing" tablet, although other forms of data capture (such as the use of remote sensing data) are also available. Data capture may also involve editing and re- organizing of the data into meaningful data themes or layers.

The *analysis* phase follows data capture. The analysis uses a series of steps, often referred to as a *model*, which has been planned in advance to produce the desired results. The model for this study will be described in greater detail below. The *output* phase, involving the production of the final map product, is the last step in a GIS analysis. In this study the final product took the form of 17 individual maps which together illustrate marina siting suitability for the Brevard and Volusia coastal lagoon regions of East Central Florida.

The following sections describe the data capture methodology, the data themes included in the GIS analysis, and the modeling process used to produce the Marina Suitability Maps.

GIS DATA ENTRY AND FORMAT

ERDAS FILE FORMAT-- ERDAS is a raster based GIS, in which the data are represented as numerically coded *grid cells* or *pixels*. All ERDAS GIS files used in this study were geo-referenced to Universal Transverse Mercator (UTM) coordinates. Files were created at a resolution of 30 meters. That is, the smallest pixel represented in the data was 30 m on a side.

DATA COLLECTION--The input data for this study were collected for this study from a variety of sources which are described in greater detail under **GIS DATA THEMES**, below. The data, once collected, were mapped onto Mylar sheets registered to USGS 7.5 minute quadrangle maps. Whenever possible, legal descriptions were used to identify the most accurate boundary possible for a given data theme, such as shellfish harvesting areas. When such detail was not available the maps were drawn as accurately as the source data would permit. Occasionally some data theme boundaries did not coincide with geographic features which were visible on a 7.5 minute quadrangle map. In these cases boundaries were delimited by the process of scaling distances and measuring angles on the source map and using that information in reconstructing the boundary on the USGS map overlay.

DATA CAPTURE--With the exception of seagrass, land cover and endangered species data, all information was captured through the process of digitization. Polygon and point data were digitized using AutoCAD version 9 on a Calcomp 9100 digitizing tablet. UTM coordinates calculated from the longitude/latitude coordinates at the corners of each quad map were used as calibration points for the digitizer. Boundaries and labels for each data theme were placed in separate layers in AutoCAD so that they could be extracted individually for conversion to the ERDAS GIS system. A conversion utility written in-house by the East Central Florida Regional Planning Council was used to convert vector map data from AutoCAD into the raster format used by ERDAS. Seagrass and land cover data were provided to the ECFRPC as ERDAS files by other agencies. A database extract of endangered and threatened vertebrate species for the study area provided locational coordinates which were manually inserted into AutoCAD maps, and converted to ERDAS.

GIS DATA THEMES

After the input data were captured either by digitizing, by data transfer with another agency or by keyboard input they were edited to create nine (9) initial GIS data themes or layers. The GIS classification for each theme ranged from 0 to 5, where "0" represented "No Contribution" by the theme, "1" indicated "Very Low Unsuitability" for marina siting and "5," "Very High Unsuitability." Each theme is described in detail below.

SEAGRASS (GRS)--Seagrass data for Mosquito Lagoon were obtained in ERDAS format from the Kennedy Space Center (KSC) Environmental Management Office (KSC, 1988). Although compiled recently, the KSC data represent seagrass coverage data collected over a period of several years. The KSC seagrass data were originally recorded in the Florida State Plane coordinate system, but were converted to UTM coordinates using the ERDAS RECTIFY procedure. Seagrass data for the Indian River Lagoon south of Mosquito Lagoon were also obtained in ERDAS format from the Florida Department of Natural Resources (FDNR) Marine Research Institute in St. Petersburg (FDNR, 1988). These data were digitized from seagrass maps prepared by the Brevard County Office of Natural Resources Management (BCONRM, 1986). The FDNR data conformed to UTM coordinates. The seagrass data from both sources were

classified according to percent cover. For this study, the seagrass data were recoded so that coverages of 10% to 40% represented Class 4 = "Low Seagrass Cover," and greater than 40% represented Class 5 = "High Seagrass Cover." All other water areas were Class 1 = "Little or No Seagrass." All land areas were coded Class 0.

LAND COVER/HABITAT (HAB)--Land cover data derived from Landsat remote sensing data were obtained from the Florida Game and Freshwater Commission (FGFWFC, 1988). Using Landsat, the FGFWFC prepared GIS files containing twenty-two different vegetative cover and land use classifications. For the purpose of this study these classifications were combined into five classes: Class 1 = "Barren/Urban/Non-forested," Class 2 = "Upland Forested," Class 3 = "Freshwater Wetlands," Class 4 = "Coastal Marsh" and Class 5 = "Mangrove Swamp." All water areas were coded Class 0.

ENDANGERED & THREATENED SPECIES (END)--Location data for endangered or threatened vertebrate species were obtained from the Florida Natural Areas Inventory in Tallahassee Florida (FNAI, 1989). These data were provided as a dBase III file in which each record contained a latitude/longitude coordinate specifying the location at which the species was known to exist. That latitude/longitude coordinate was converted into UTM coordinates using a Lotus 123 spreadsheet and the ERDAS coordinate conversion (CCVRT) program. The resulting UTM coordinates were manually keystroked into AutoCAD to place each species occurrence into each of the seventeen AutoCAD Marina Siting Panel files. The data were represented in the AutoCAD maps as triangular symbols bearing a code which indicated the species. For example, "BE" = Bald Eagle, "GT" = Gopher Tortoise.

Many of the species listed in the FNAI database were colonial nesting birds which share the same nesting locations. These species were therefore represented by the generic symbol "CB" for "Colonial Birds," rather than their individual species names. The exception is the wood stork ("WS"), which is endangered. At sites which could receive either a "WS" or "CB" designation, the "WS" label took precedence. The locations of some of the data points were adjusted manually to make them conform to the digitized representation of the island they were intended to represent. A gopher tortoise site on the border of MSP 1 and 2 was displaced slightly both north and south so as to occur on both panels.

The points from the FNAI data may represent either a single nesting pair, such as with bald eagles, or a population of animals, such as scrub jays or gopher tortoises. Sometimes the points merely represent a single collected individual (e.g., an eastern indigo snake captured at Sebastian Inlet State Park, MSP 17). These data should not be interpreted as the only sites at which these species occur. They merely represented those locations where listed species are known to occur, based on the government reports and the scientific literature. Their inclusion in this study is intended to highlight areas where the presence of endangered or threatened species may contribute to the unsuitability of certain areas for marina siting. Other areas with similar habitat may also support these species. The failure of this study to identify endangered or threatened species at a given location should not be taken as assurance that they do not exist there. All sites considered for marina construction should be surveyed for the presence of listed species before approvals are given.

This data theme also contained the locations of colonial bird nesting sites identified in a study entitled *The Sensitivity of Coastal Environments and Wildlife to Spilled Oil in the East-central Florida Region* (FDCA, 1984). These sites were mostly spoil islands which are used by many colonial nesting bird species. Since many of these locations appeared on the FNAI list, the same site was often

recorded from both data sources. However, the FNAI data only represented a point, whereas the FDCA (1984) information allowed entire islands or shoreline areas to be identified and digitized. In such cases, the island or shoreline area was digitized as a polygon in AutoCAD, labeled with the appropriate species symbols, and converted to ERDAS. Once again, "WS" labels took precedence over "CB" designations.

These data represented only a point, or at most a small area. For the purpose of this study, a "buffer" zone was generated around these points or areas. The rationale for this approach was two-fold. First, although the FNAI data were recorded as a single point, that point often represented a much larger area of suitable habitat which could support the species. This was especially true of points which represented a population of animals, rather than a single individual (e.g., scrub jay clans). Secondly, the marina siting suitability analysis had to account for the habitat needs of the species at each site. Preserving the single tree in which an eagle nest occurs, for example, would not adequately protect that species. Consequently, the study must envelope each listed species location with a zone which signifies the *minimum* area considered unsuitable for development.

All sites harboring bald eagles ("BE") or wood storks ("WS") were surrounded by a zone 16 pixels (480 m, 1574 ft) in radius. This approximates the 1500 ft restriction zone recommended for bald eagle nests by the U.S. Fish and Wildlife Service (USDOI, 1987). All other species were surrounded by zones 6 pixels (180 m, 590 ft) in radius. This approximates the 500 ft setback from colonial bird nesting colonies recommended by the USFWS at bridge construction projects in Volusia County (cf. FDOT, 1985). The 180 m radius circle also encloses an area approximately 25 acres in size, which is the recommended minimum habitat size for gopher tortoises (Cox, et al., 1987) and scrub jays (ECFRPC, 1986). The buffers generated around each data point or area by the ERDAS program SEARCH were recoded to Class 5 = "Listed Species." All other areas were Class 1 = "No Listed Species."

WATER DEPTH (DPT)--Bathymetric (depth sounding) data, measured as feet below Mean Low Water (MLW) were obtained from NOAA Nautical charts. All depth soundings which appeared on the chart were digitized into AutoCAD. The NOAA charts did not provide coverage of parts of the Banana River. In those areas, depth sounding points were digitized from USGS 7.5 minute quad maps. USGS Digital Line Graph (DLG) data were used as the map base for the bathymetric maps. Shorelines, which have an effective depth of 0 MLW, were drawn from the USGS DLG data. The Intracoastal Waterway Channel (ICW) was digitized directly from USGS 7.5 minute quads. The ICW was assigned a value of 8 ft MLW throughout the study area, although it the ICW measured 12 ft deep in parts. Because it was only necessary to distinguish between those areas greater or less than 4 ft MLW for this study, the ICW could be treated the same throughout.

Shoreline, ICW and depth sounding data were converted to ERDAS .DIG file format and used as input for the ERDAS contour mapping routine, SURFACE. The default interpolation algorithm, which maximized the importance of nearby depth values, was used in generating the surface model. The resulting contour maps were recoded to create two classes: Class 1 = "4 ft MLW and greater" and Class 5 = "Less than 4 ft MLW." All land areas were coded Class 0.

DISTANCE FROM INTRACOASTAL WATERWAY (ICW)--The distance from the ICW was a criterion used in the analysis. The ICW and all collateral and appending channels were digitized from USGS 7.5 minute quad maps and converted to ERDAS GIS format. The ERDAS SEARCH program created a 30 pixel (900 m, 2953 ft) buffer around the channels. This buffer was recoded and

combined with land cover data to produce five classes representing increasing shoreline distance from the channel in 180 m (590 ft) increments: Class 1 = "Very Near (0 to 180 m)," Class 2 = "Near (180 to 360 m)," Class 3 = "Moderate (360 to 540 m)," Class 4 = "Far (540 to 720 m)," and Class 5 = "Very Far (720 m or greater)." Water areas were assigned Class 0.

SHELLFISH HARVESTING AREAS (SFH)--The boundaries of approved and conditional shellfish harvesting areas were digitized from information provided by the FDNR. These data were coded as Class 4 = "Conditional" and Class 5 = "Approved." All other water areas were coded Class 1 = "Non-shellfish Harvesting," and land areas were coded Class 0.

STATE AND FEDERAL PARKS (PKS)--The boundaries of the Cape Canaveral National Seashore, the Merritt Island Wildlife Refuge and all state parks in the study area were digitized. These areas were converted to ERDAS and combined with land cover data to recode appropriate land areas to Class 5 = "State/U.S. Park," including those areas which occurred in more than one park. All other land areas were designated Class 1 = "Non-parks Areas."

OUTSTANDING FLORIDA WATERS (OFW)--Aquatic Preserves in the study area have been designated as OFWs. The Aquatic Preserve boundaries were digitized and converted to ERDAS Class 5 = "Outstanding Florida Waters." The water areas included within the boundaries of the state and federal parks were also listed as OFWs. Consequently, those areas were overlaid with the OFWs from the Aquatic Preserves to produce the final OFW map series. All other water areas were Class 1 = "Non-OFW," and land areas were Class 0.

CRITICAL MANATEE HABITAT (MAN)--Areas of critical manatee habitat were drawn on Mylar manuscripts based on the information given in *Preliminary assessment of habitat protection needs for West Indian Manatees on the east coast of Florida and Georgia* (Marine Mammal Commission, 1988). Each area depicted on the maps in this publication was coded to represent the habitat requirements which the area satisfied for manatees. These areas were coded in ERDAS with values representing the most significant of the various designations they were given. For example, if an area was shown as being important for "Resting, Cavorting" then it was ranked Class 2, but an area designated "Resting, Feeding" was ranked Class 3. The *importance* of the habitat needs met by a site, and not the *number* of designations it received, was the criterion used in assigning relative values to the manatee habitat designations. Areas designated "Travel Corridors" in the ICW were ignored; because they included the entire estuary, such designations contributed little in discriminating between alternative marina sites. The resulting classifications were: Class 1 = "Not Important," Class 2 = "Resting, Cavorting or Travel," Class 3 = "Feeding *or* Watering," Class 4 = "Feeding *and* Watering," Class 5 = "Warm Water Refuge." Land areas were assigned Class 0.

Using a technique similar to that for the *ENDANGERED & THREATENED SPECIES* Theme, a 27 pixel (810 m, 2657 ft, 0.5 mile) buffer was placed around all Class 2, 3, 4 and 5 areas. The size of the buffer was chosen to illustrate the need for a "safety zone" around the area of critical concern itself, since manatees may congregate in a vicinity larger than the point of interest. This is especially true of power plant sites used as warm water refugia. *The size of the buffer was chosen arbitrarily, and should not be considered the limit of concern around valuable manatee sites. Marina development or other construction around a manatee site should proceed only after consultation with the FDNR and USFWS.*

GIS MODELING AND ANALYSIS PROCEDURE

BASIS FOR GIS MODELING--A survey of local governments in the east central Florida coastal zone in late 1988 revealed that , although most allowed marina development, few had specific marina criteria in their development ordinances or their comprehensive plans (Table 1). Of those which had marina standards, most dealt with zoning, road access and utilities issues. Only the standards in the Brevard County comprehensive plan addressed marina site selection criteria based on environmental or physical constraints. These criteria are essentially the same as those which can be found in Policy 40.8 of the East Central Florida Comprehensive Regional Policy Plan (ECFRPC, 1987). Most of these criteria are modeled after those developed by the Florida Department of Natural Resources (FDNR, 1984). An additional criterion used by the FDNR in DRI review in recent years calls for marinas to be located preferentially within 1 mile of ocean inlets. However, this criterion is only meaningful if marinas are serving vessels which are bound for open water; since most recreational watercraft probably stay in the coastal estuaries, this criterion is of little value in siting marinas designed to serve recreational demands. Additional policies in the East Central Florida Comprehensive Regional Policy Plan (CRPP) address issues pertinent, though not specific to, marina siting. These include the policies on wetlands (Policies 40.1, 43.1), endangered species (Policies 44.1 and 44.2), and preservation of natural habitat (Policies 43.2, 43.3). Copies of these policies appear in Appendix 2.

As a consequence of these considerations, the marina siting suitability model for this project has been based on the standards of the CRPP. The essential characteristics of these criteria are as follows: (1) Marinas should be located so as to limit impacts to wetlands and seagrass beds, (2) marinas should be located as close to existing dredged channels as possible, (3) marinas should not be located where they may adversely affect conditional or approved shellfishing areas, (4) marinas should be located where water depths are at least 4' MLW, (5) marinas should avoid areas considered critical to manatees and other endangered or threatened species. In addition to those standards, the following criteria were considered: (6) Marinas should avoid areas designated as Outstanding Florida Waters, and (7) marinas should be discouraged in state and federal parks. This last point was given low priority since marina development may be appropriate for some parks (FDER, 1984). The organization of the nine data themes discussed in the previous section satisfied the data requirements needed to conduct a site suitability analysis based on these criteria. The details of how the data were manipulated to produce an assessment of marina siting suitability appear below.

ANALYSIS FLOWCHART--Figure 3 depicts the steps in the GIS modeling process used to produce the final Marina Siting Suitability Maps for each of the 17 MSPs. Since ERDAS can only operate on four (4) map files simultaneously in a single analysis, the nine (9) original data themes had to be reduced to four or less prior to the production of final maps. This was achieved through the production of four "Intermediate Files" from the nine data layers for each MSP. The 17 sets of Intermediate files were combined as shown to produce the 17 final Marina Siting Suitability Maps. The output of several alternative modeling schemes was evaluated, and this process was deemed most representative of all the contributing suitability factors.

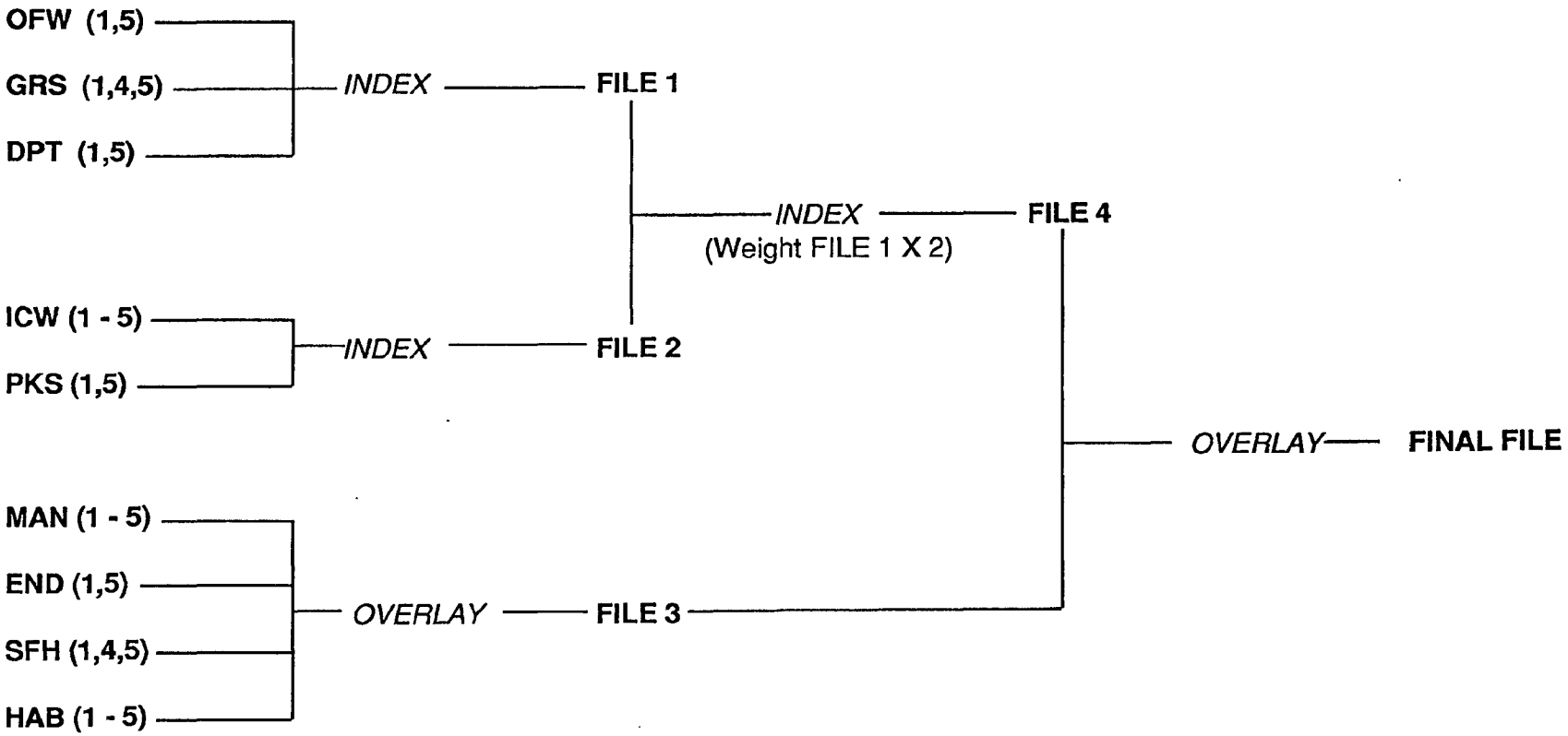
INTERMEDIATE FILES--The ERDAS INDEX and OVERLAY procedures were used to produce the Intermediate Files. The operation of the two procedures produced quite different results. In the OVERLAY process, two or more files were examined pixel by pixel, with each pixel in one file compared to the pixel in the same relative position in all other files. The maximum value of the pixels in all

Table 1

RESULTS OF THE LOCAL GOVERNMENT SURVEY FOR MARINA SITING STANDARDS IN COASTAL AREAS OF BREVARD AND VOLUSIA COUNTIES

JURISDICTION	ALLOW CONSTRUCTION	CRITERIA ESTABLISHED
BREVARD COUNTY	YES	NO
CAPE CANAVERAL	YES	NO
COCOA	YES	YES
INDIAN HARBOR BEACH	YES	NO
MELBOURNE	YES	NO
MELBOURNE BEACH	NO	NO
ROCKLEDGE	NO	NO
SATELLITE BEACH	NO	NO
TITUSVILLE	YES	YES
NUMBER OF "YES"	6	2
PERCENTAGE OF "YES"	66.7%	22.2%
VOLUSIA COUNTY	YES	NO
DAYTONA BEACH	YES	NO
DAYTONA BEACH SHORES	NO	NO
EDGEWATER	NO	NO
HOLLY HILL	YES	NO
NEW SYMRNA BEACH	YES	NO
ORMOND BEACH	YES	NO
PONCE INLET	YES	YES
PORT ORANGE	YES	NO
SOUTH DAYTONA	YES	NO
NUMBER OF "YES"	8	1
PERCENTAGE OF "YES"	80.0%	10.0%

FIGURE 3
Marina Siting Suitability GIS Model



NOTES:
(1) Abbreviations for input files are those used in the **DATA THEMES** Section.
(2) Numbers in parentheses represent the class values in the input files.
(3) See **GIS MODELING AND ANALYSIS** Section for discussion of *INDEX* and *OVERLAY* procedures.

files was used to generate a new output file. For example, if a given pixel had a value of "3" in one file, "1" in a second and "5" in a third, the OVERLAY result for that pixel would be "5." The INDEX procedure also examined two or more files pixel by pixel. However, in this case the output was the average of the values contributed by each file. For the example given above, the INDEX result would have been:

$$\frac{3 + 1 + 5}{3} = 3$$

The OVERLAY procedure produced a map on which an extreme result on *any* data theme was important. The INDEX procedure provided a means of scaling the relative unsuitability of a site based on several factors which contributed towards the site's unsuitability, yet none of which singly made the site unsuitable. The details of the production of each Intèrmediate File are described below.

Intermediate File 1--This file was the result of an INDEX procedure on the OFW, GRS and DPT data themes. All three themes dealt exclusively with water coverages, and were essentially dichotomous ("present" or "absent") in nature. Although GRS was ranked with two classes for seagrass, they were both highly rated (Class 4 and 5). Because none of these themes necessarily exclude marina siting by themselves, the INDEX procedure was thought more suitable than OVERLAY for the production of this Intermediate File.

Intermediate File 2--The ICW and PKS layers were combined in an INDEX procedure to produce this file. Both layers were for land coverages only. Because the PKS layer was dichotomous (either "Park" or "Non-Park"), it would tend to dominate the output for parks sites, raising their unsuitability value over that which would be assigned based on distance alone.

Intermediate File 3--An OVERLAY procedure was used to combine the MAN, END, SFH and HAB layers. These layers included both land and water coverages. The presence of a high unsuitability value on any one of these themes was considered important enough to render the area unsuitable, despite low values on any other layer.

FINAL MARINA SITING SUITABILITY MAPS--The production of the final maps was a two-step process. First, Intermediate File 1 and Intermediate File 2 were combined in a "weighted" INDEX procedure to create Intermediate File 4. The "weighting" multiplied the values from Intermediate File 1 by two (2) prior to the averaging of values from Intermediate File 2. This step ensured that the physical/biological/regulatory restraints from Intermediate File 1 would not be "diluted" by low rankings in "Non-Parks" areas. This had the effect of reducing the visibility of the PKS boundaries in the final marina siting maps. However, since marinas may be sited on parkland it was thought that differentiation of marina site suitability which emphasized the factors of Intermediate File 1 was more appropriate than an approach which tended to collect all "Park" and "Non-Park" lands into a single classes regardless of vegetative cover or seagrass presence.

The result of the above INDEX procedure was combined with Intermediate File 3 in an OVERLAY analysis. Once again, this ensured that the important MAN, SFH, END and HAB constraints appeared in the final map, as well as sites which were deemed unsuitable due to collectively high values for OFW, GRS, DPT, ICW and PKS themes.

RESULTS

AutoCAD DATA INPUT LAYERS--Figures 4 through 20 depict the data which were captured in AutoCAD prior to conversion to the ERDAS raster format. Shorelines from 1:100,000 scale USGS DLG data have been superimposed to provide geographic references. The accompanying Legend provides an explanation for all symbols found on the 17 maps. Many of the features on the maps overlap, and symbols have been placed near borders to aid the reader in distinguishing coincident coverages. Line widths have also been varied to assist in identification of individual features. The seagrass (GRS), depth contour (DPT) and land cover (HAB) layers could not be represented on these maps, since they existed only in raster format. Digital copies of the ERDAS raster input used in the GRS, DPT and HAB data themes can be obtained from the East Central Florida Regional Planning Council on IBM formatted diskettes, or inspected at the Council offices.

ERDAS MARINA SITING SUITABILITY MAPS--Figures 21 through 37 represent the final Marina Siting Suitability maps. The maps are color coded to represent five suitability classes, from "Very Low Unsuitability" to "Very High Unsuitability." An overlay of shorelines and roadways from 1:100,000 scale USGS DLG were overlaid on the maps to provide geographic references. The inputs which were responsible for any given pattern in Figures 21 through 37 can be discerned through inspection of Figures 4 through 20, together with consideration of the special modeling steps noted in **GIS DATA THEMES** and **GIS MODELING AND ANALYSIS PROCEDURE.**

LEGEND
FIGURES 4 - 20

AQUATIC PRESERVES

TMAP	Tomoka Marsh Aquatic Preserve
MLAP	Mosquito Lagoon Aquatic Preserve
IRAP	Indian River Aquatic Preserve
BRAP	Banana River Aquatic Preserve

STATE AND FEDERAL PARKS

BCSP	Bulow Creek State Park
LPSP	Lighthouse Point State Park
CCNS	Cape Canaveral National Seashore
MINWR	Merritt Island National Wildlife Refuge
SISP	Sebastian Inlet State Park

SHELLFISH HARVESTING

SFH-A	Approved Shellfish Harvesting
SFH-C	Conditional Shellfish Harvesting

ENDANGERED AND THREATENED SPECIES

BE	Bald Eagle
WS	Wood Stork
SJ	Florida Scrub Jay
CB	Colonial Nesting Birds (various species)
GT	Gopher Tortoise
MS	Mole Snake
SBM	Southern Beach Mouse
SL	Florida Scrub Lizard
IS	Eastern Indigo Snake

MANATEE CRITICAL HABITAT AREAS (MT-)

R	Resting
C	Cavorting
F	Feeding
W	Freshwater Source
WWR	Warm Water Refuge

INTRACOASTAL WATERWAY CHANNEL . . . . . .

FIGURE 4

MARINA SITING PANEL 01

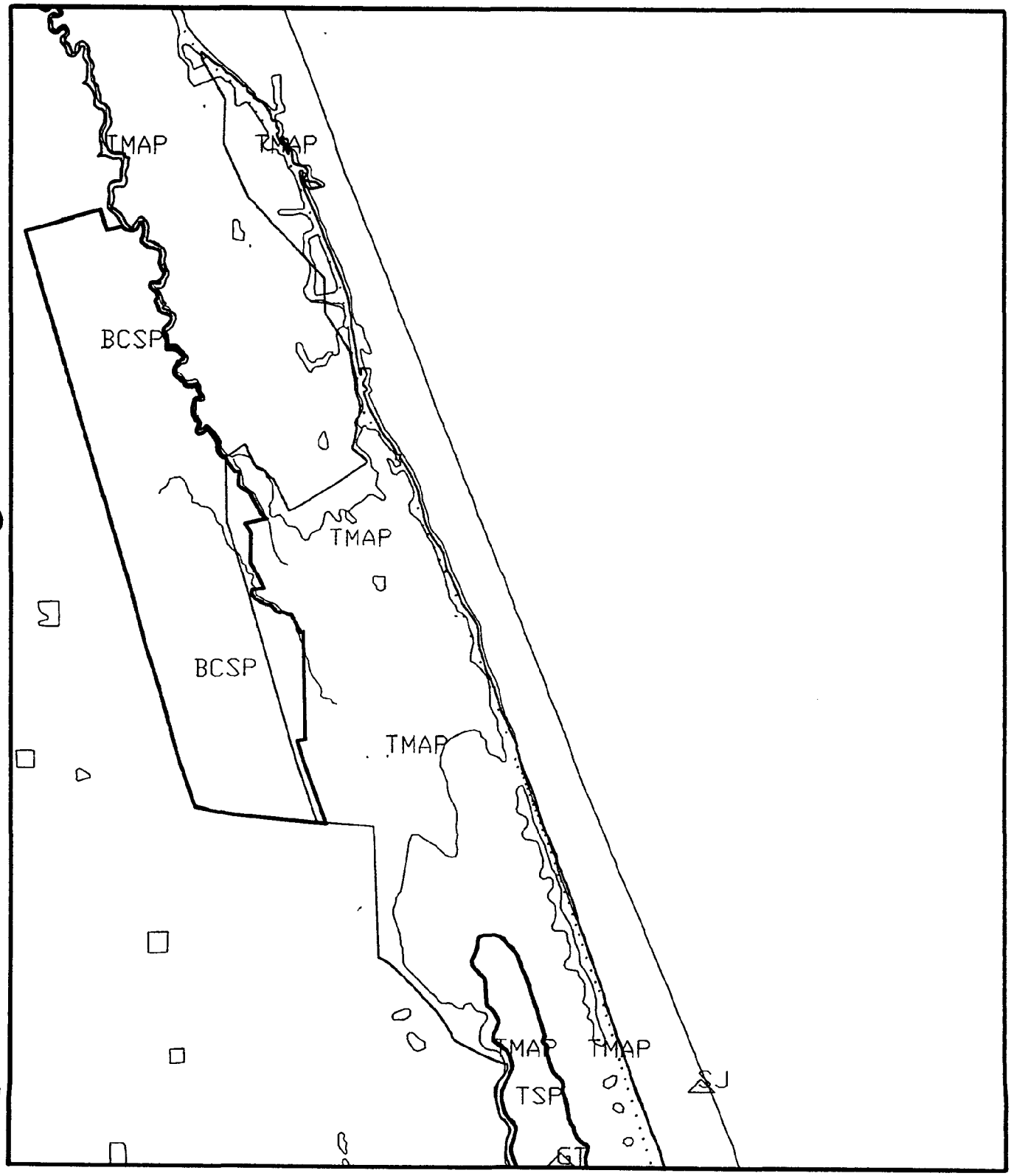


FIGURE 5
MARINA SITING PANEL 02

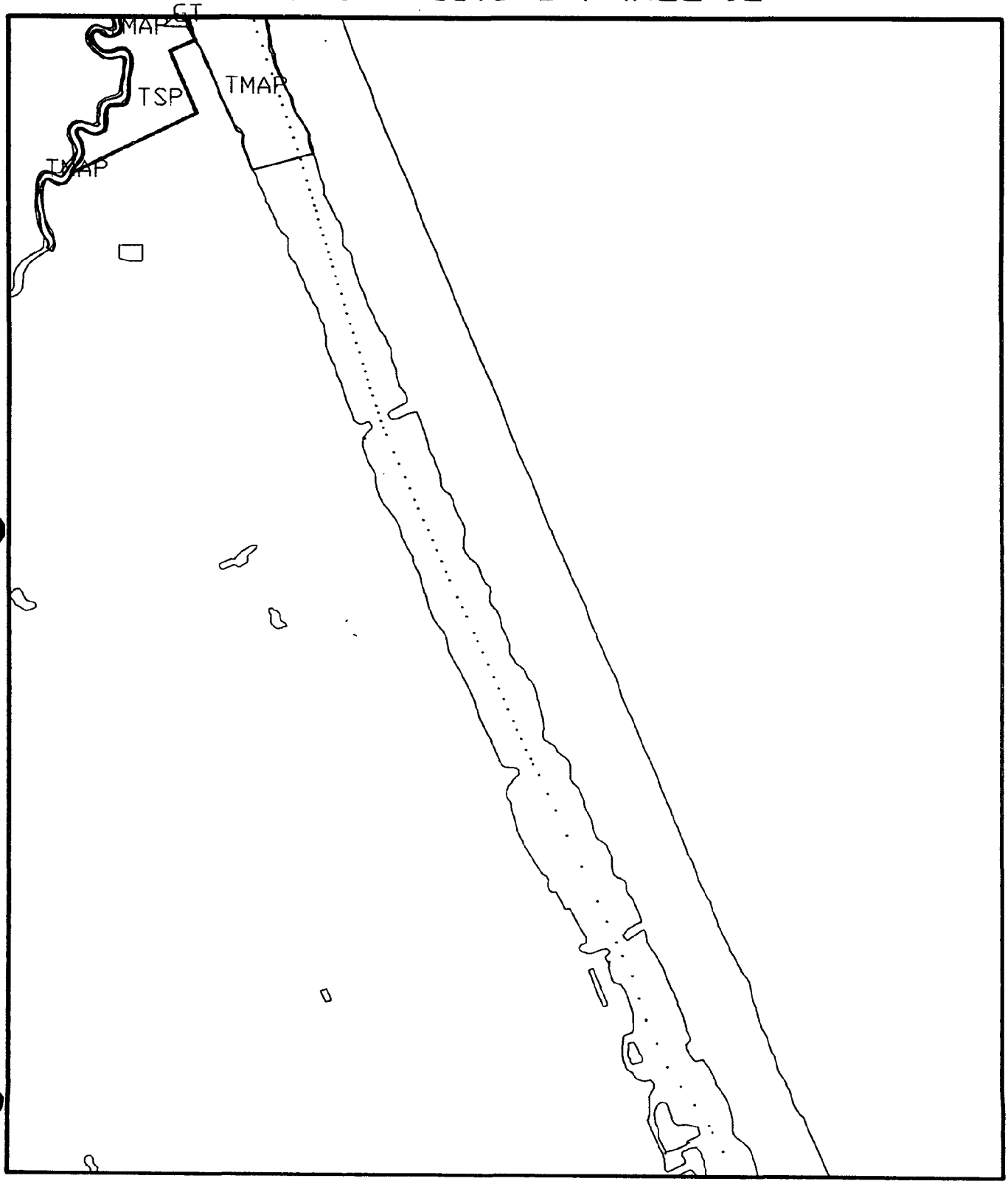


FIGURE 6
MARINA SITING PANEL 03

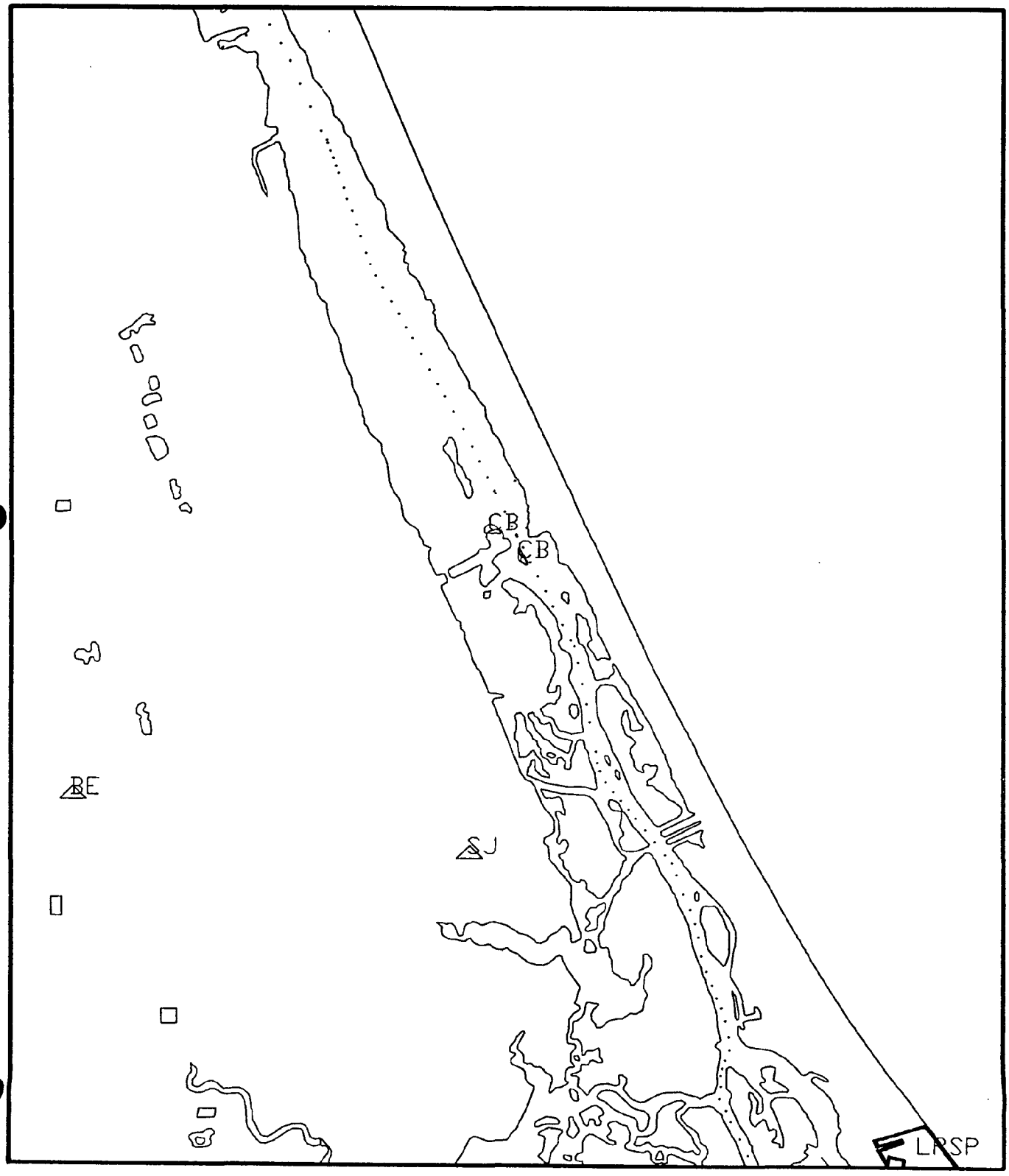
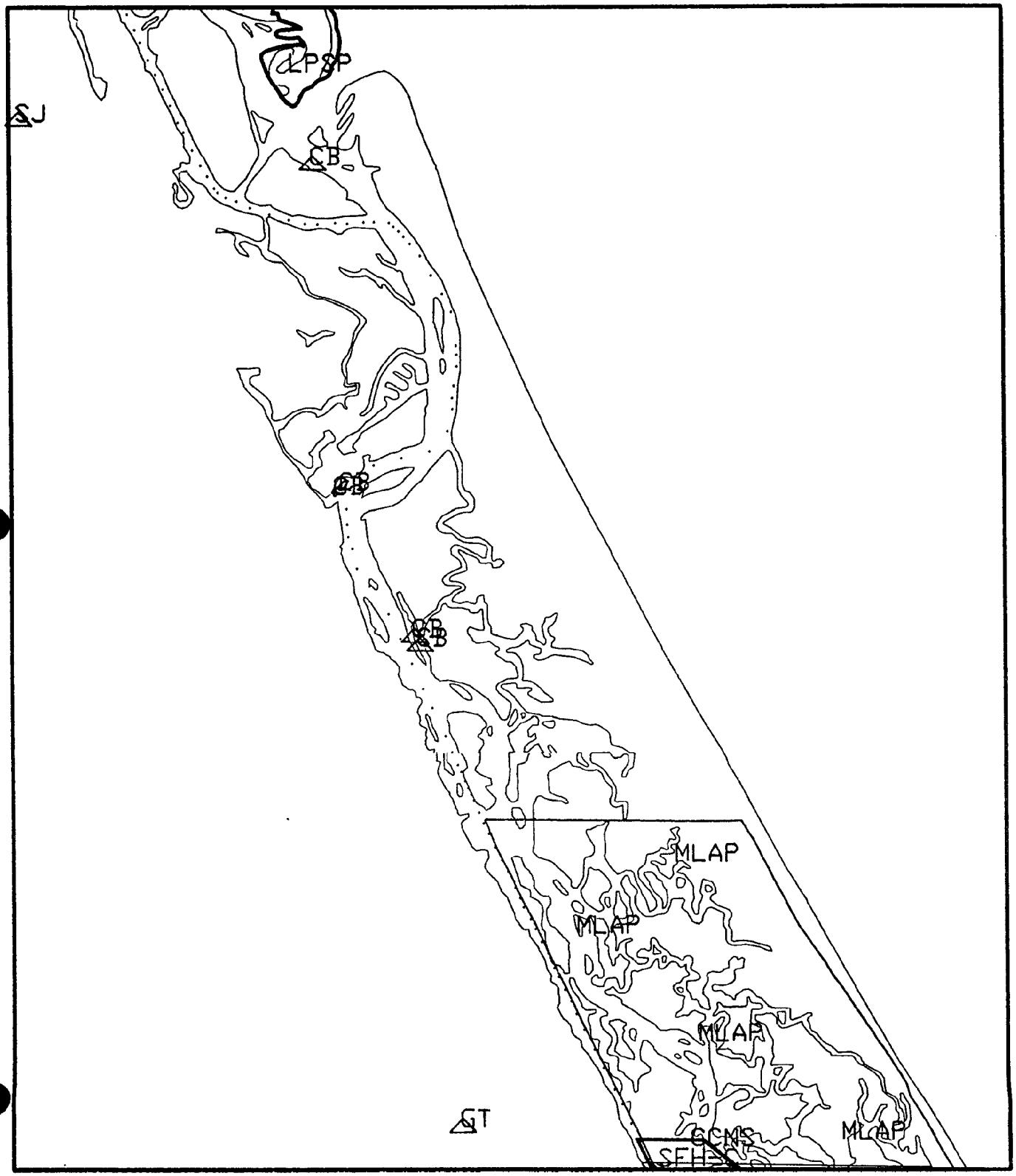


FIGURE 7
MARINA SITING PANEL 04



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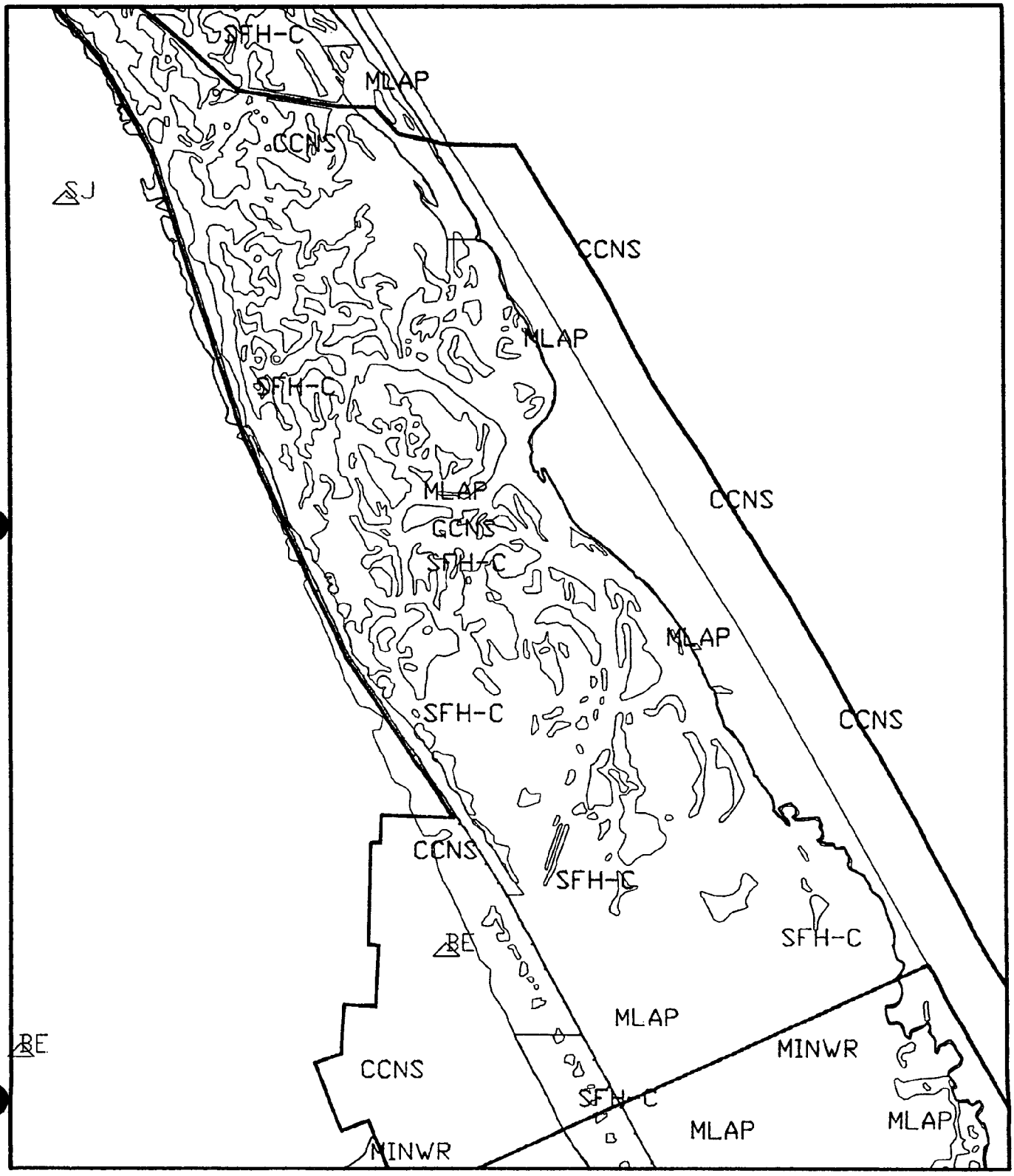
MARINA SITING PANEL 05



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MARINA SITING PANEL 06

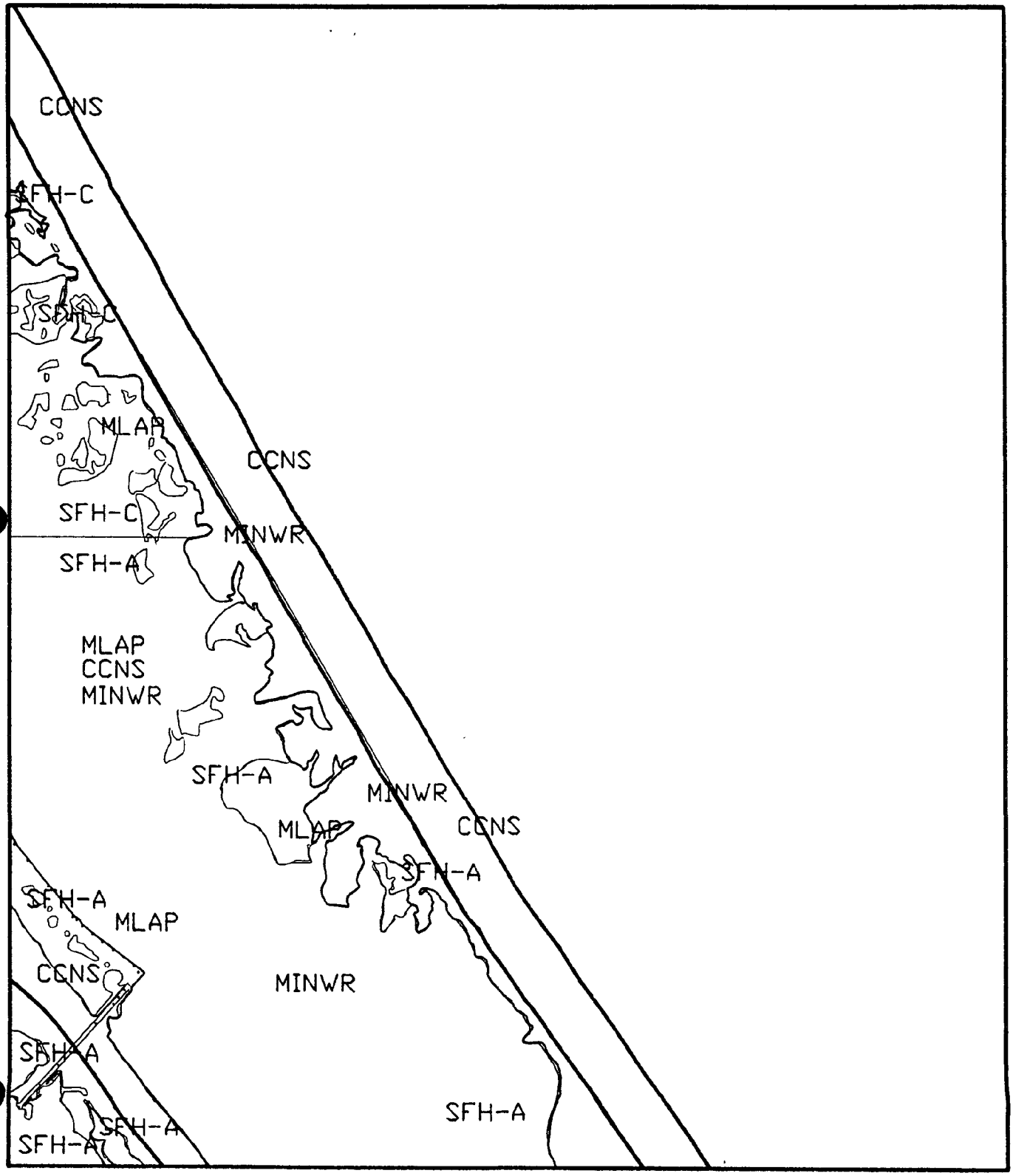
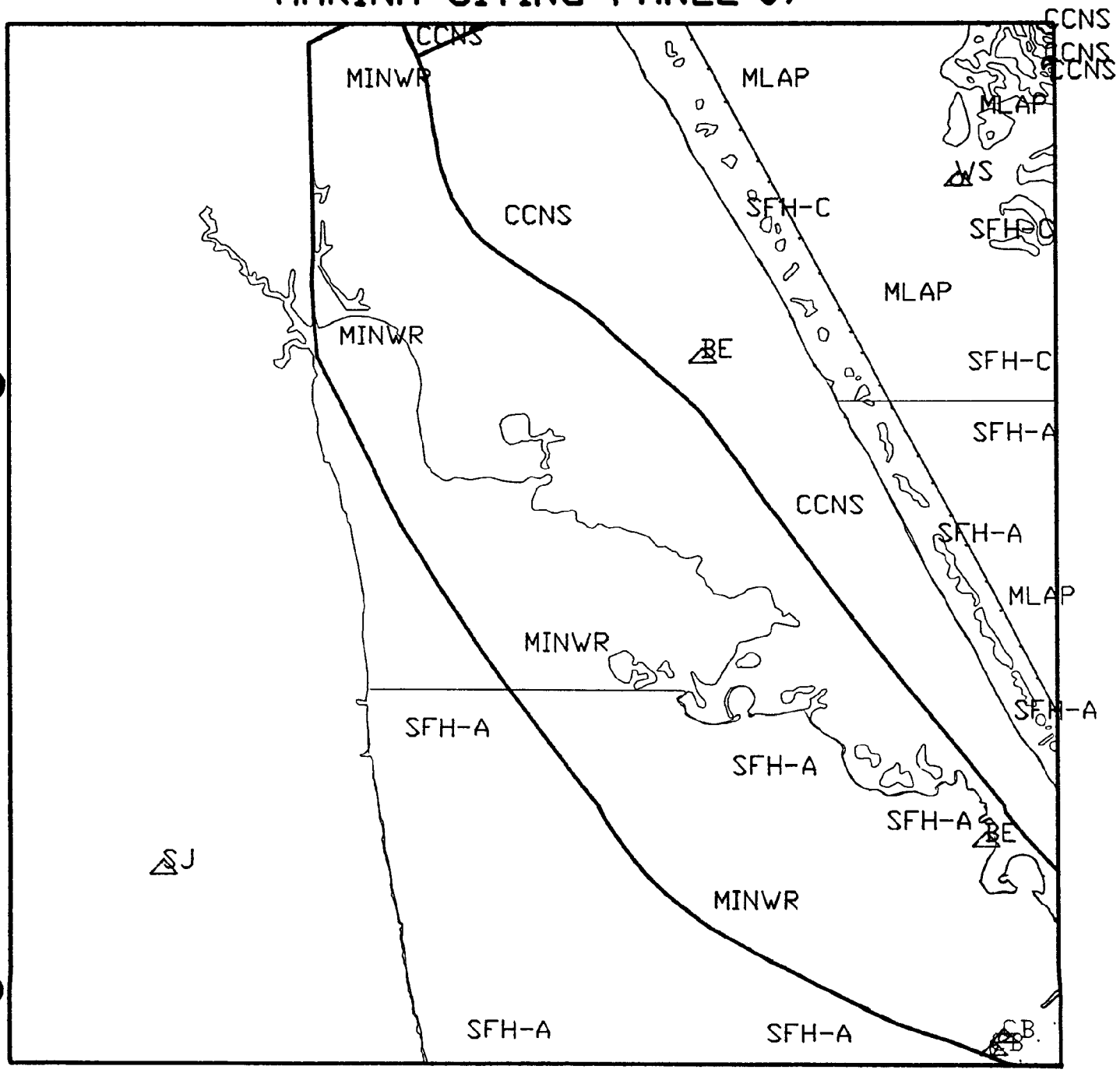


FIGURE 10
MARINA SITING PANEL 07



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MARINA SITING PANEL 08

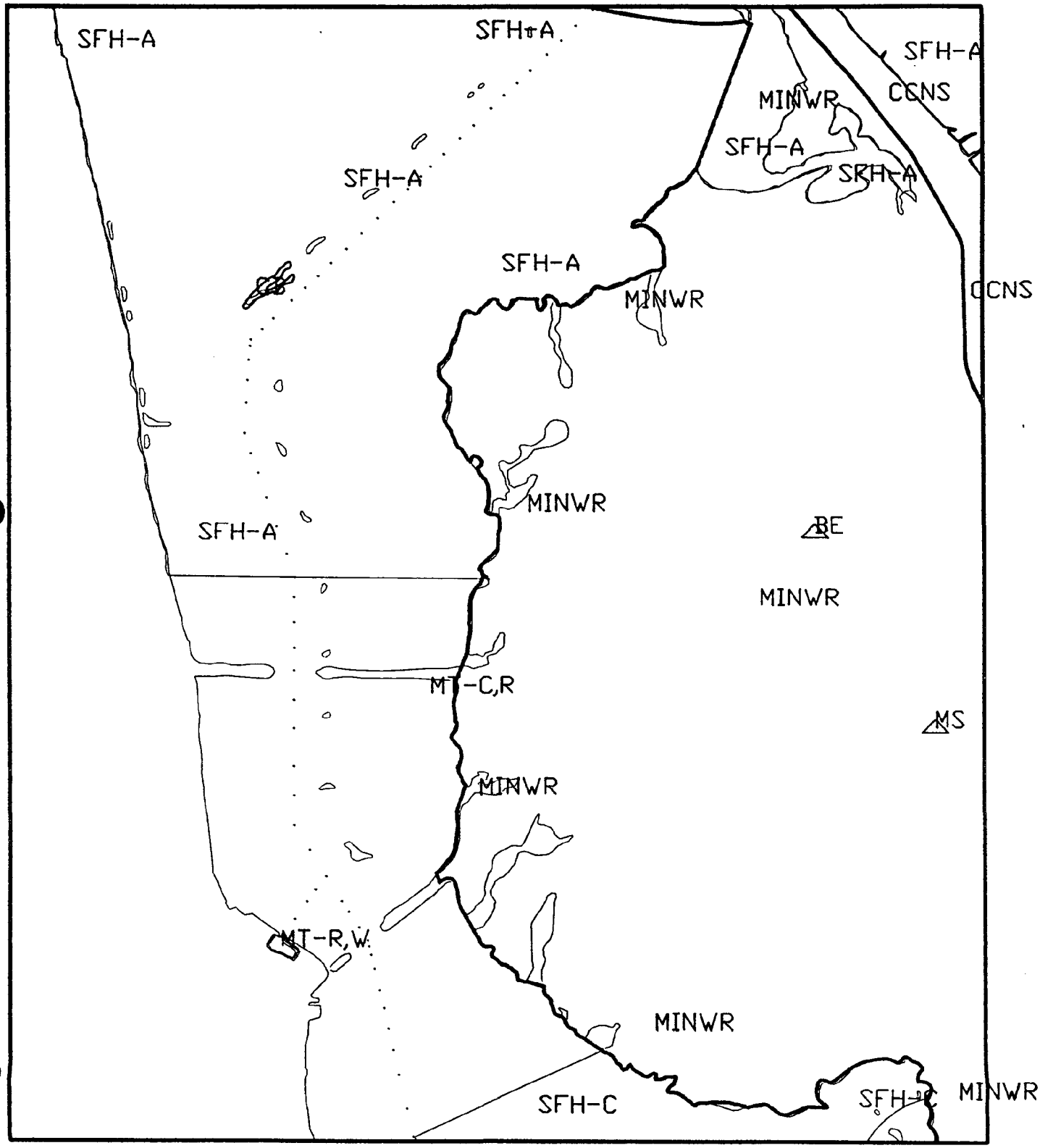


FIGURE 12
MARINA SITING PANEL 09

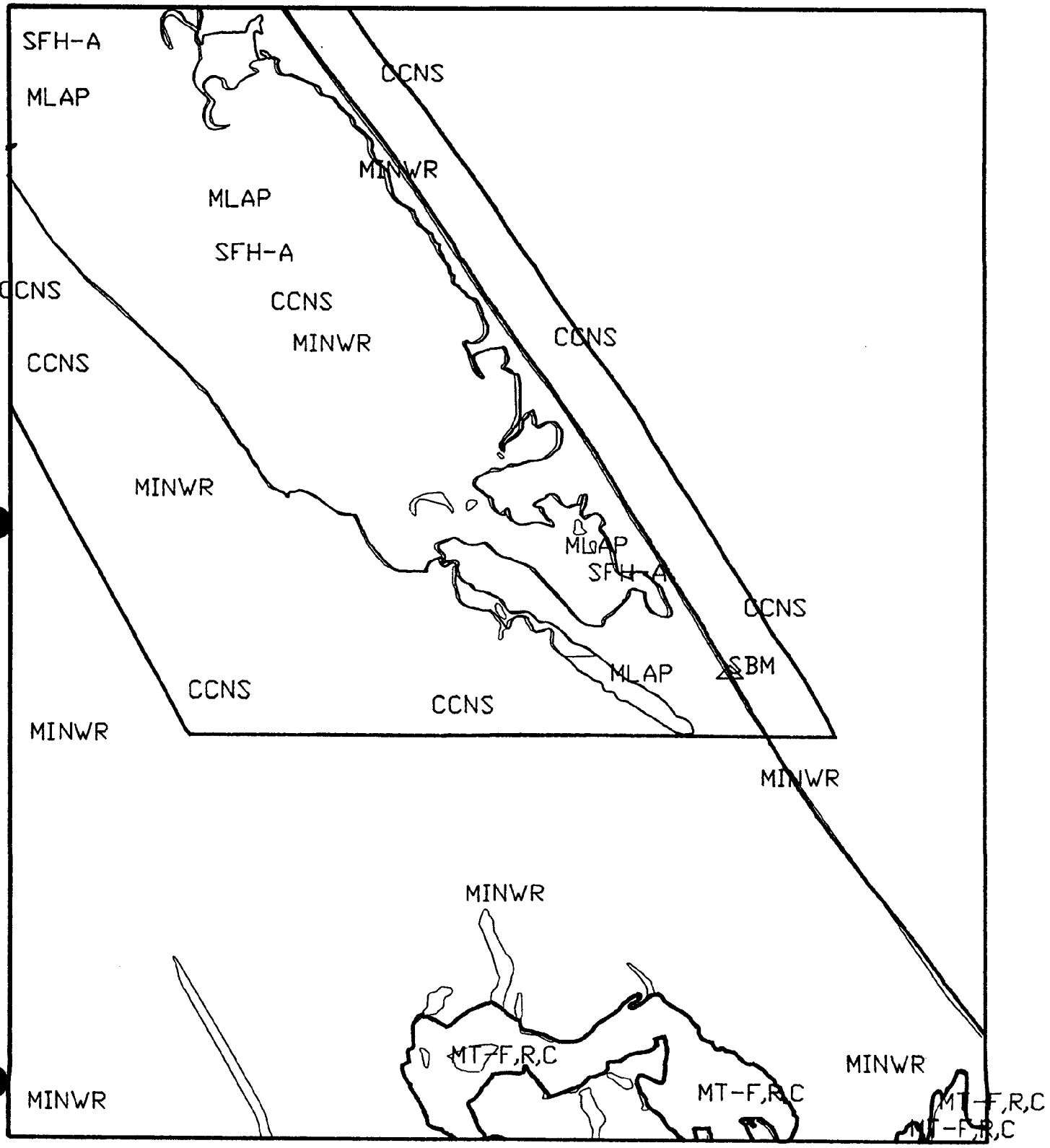


FIGURE 13
MARINA SITING PANEL 10

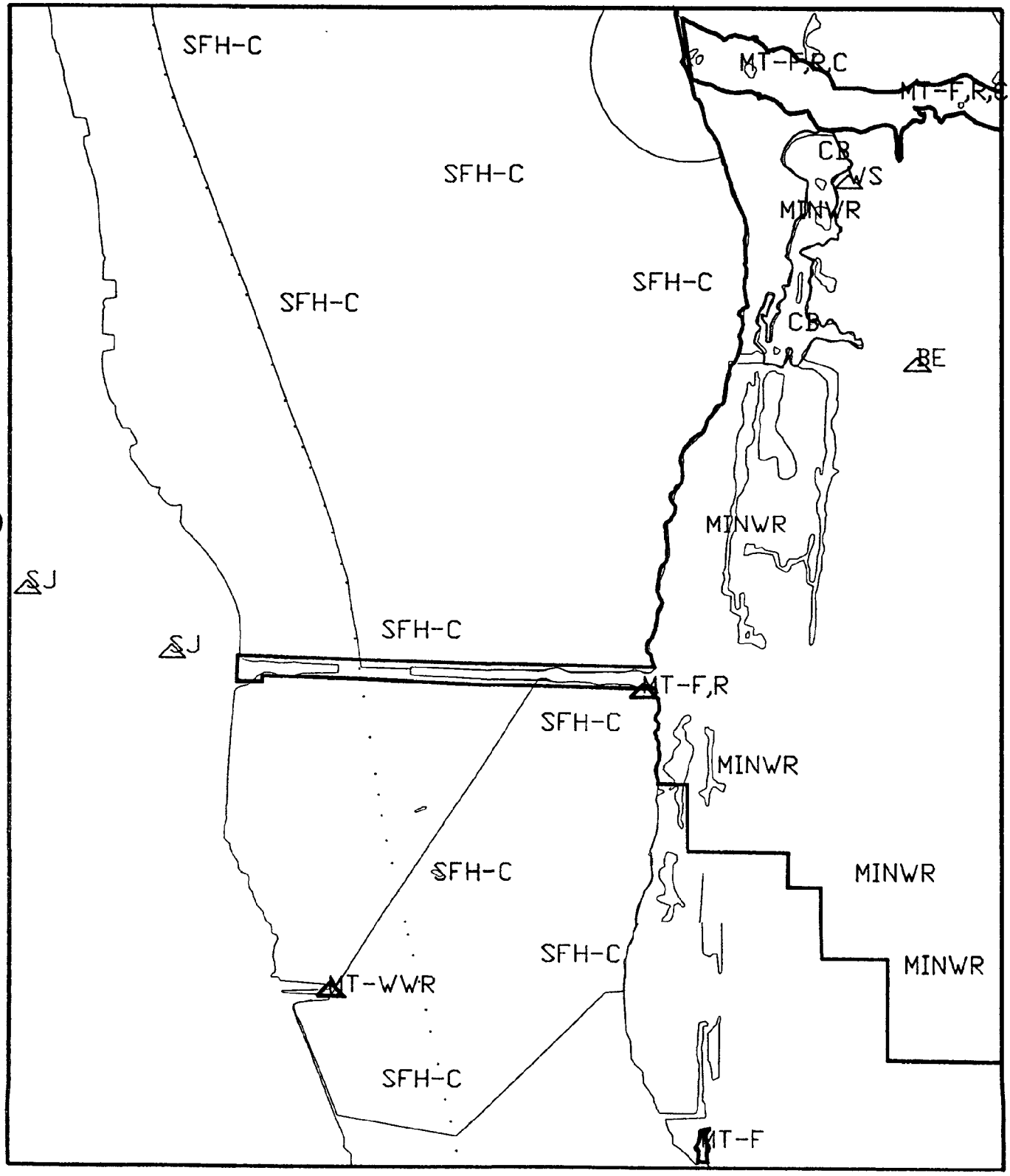


FIGURE 14
MARINA SITING PANEL 11

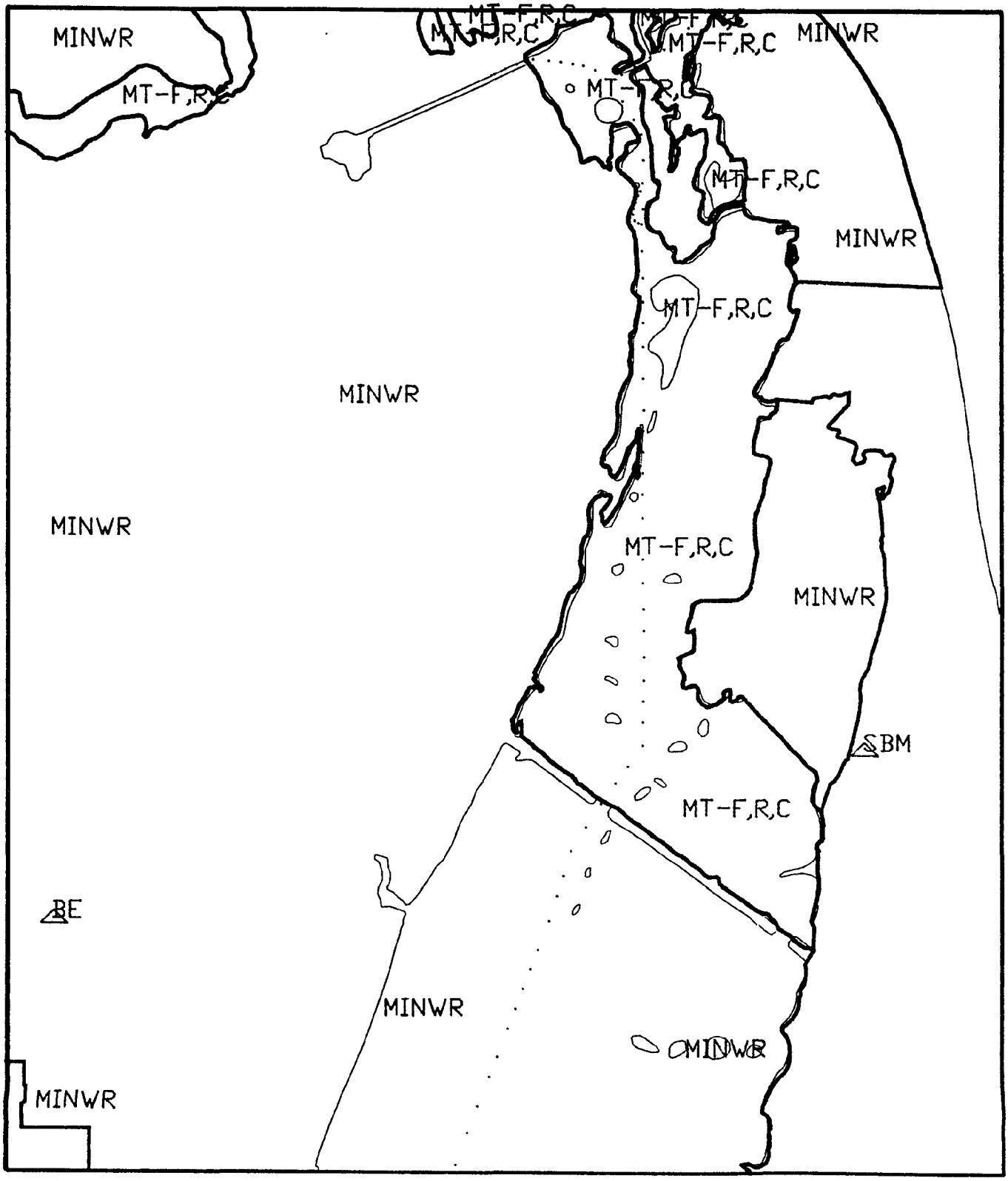


FIGURE 15
MARINA SITING PANEL 12

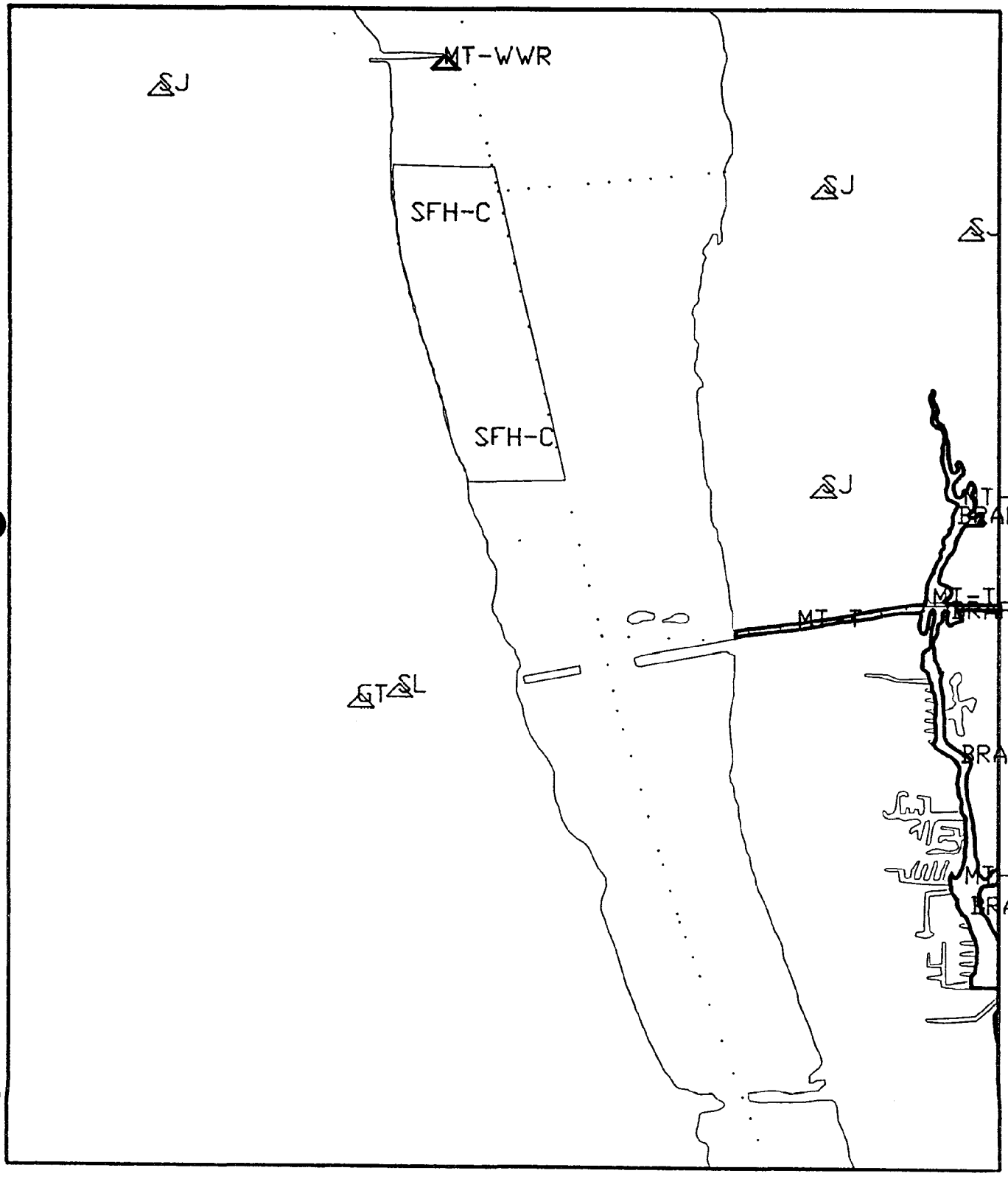


FIGURE 16
MARINA SITING PANEL 13

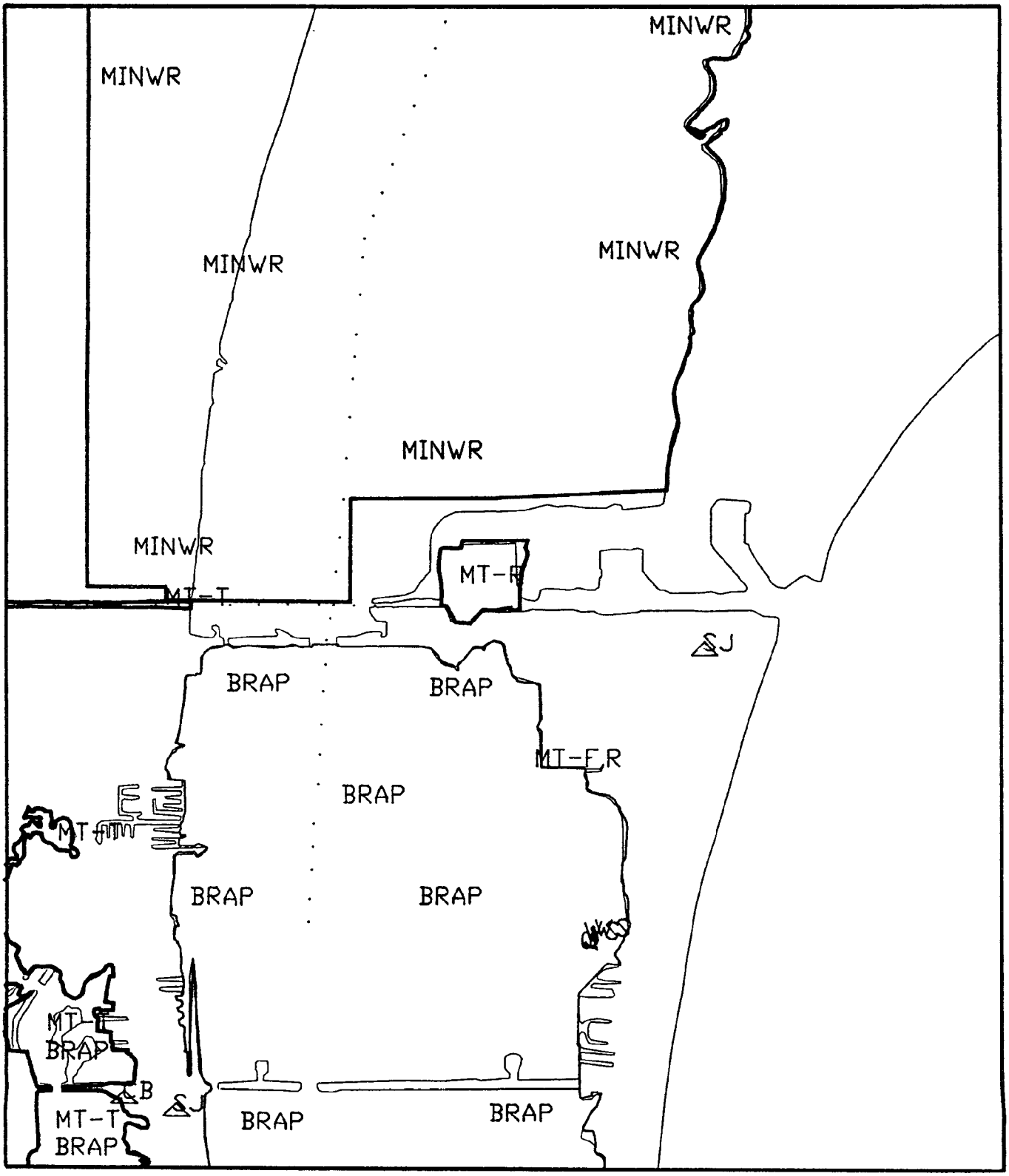


FIGURE 17
MARINA SITING PANEL 14

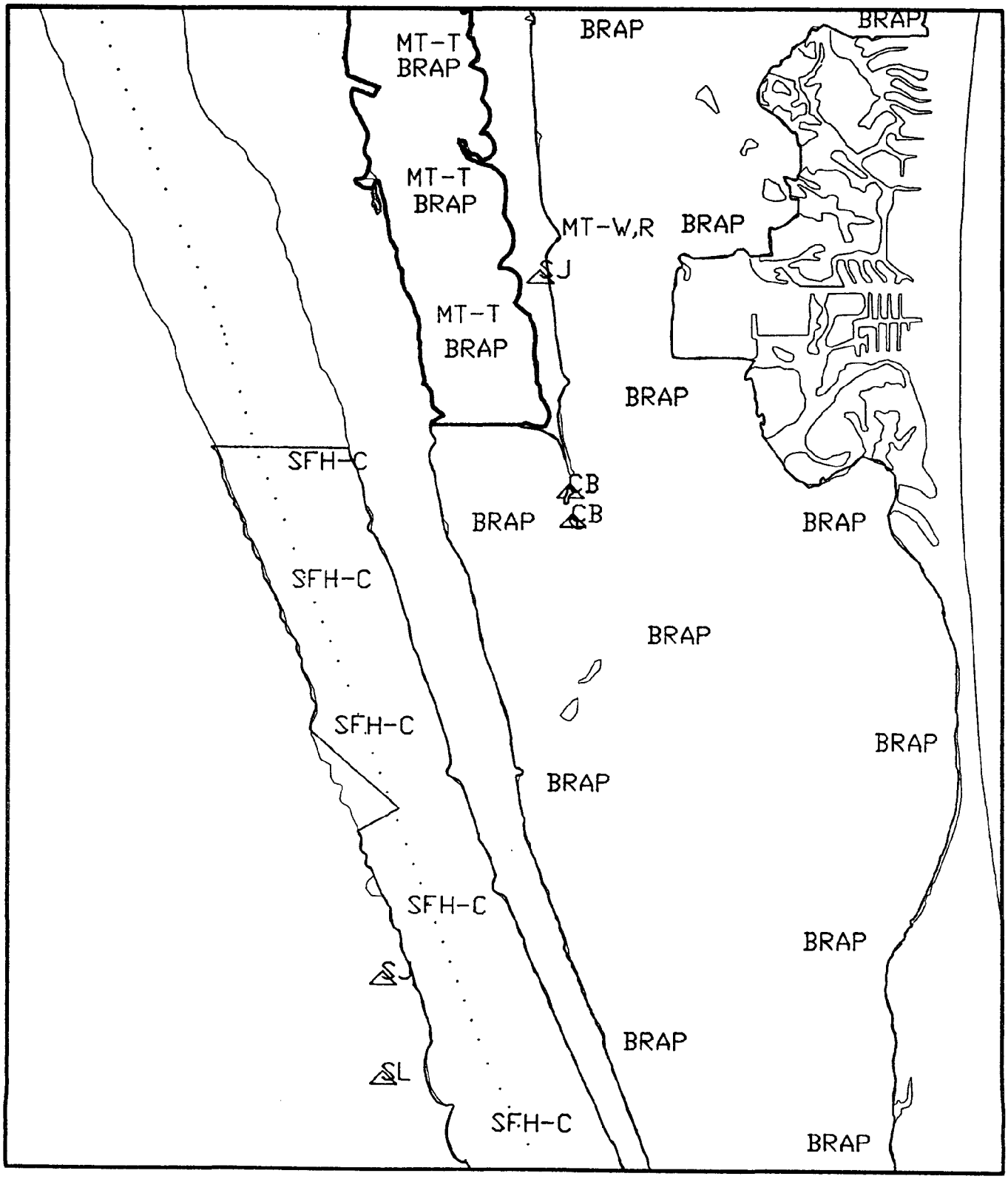


FIGURE 18
MARINA SITING PANEL 15

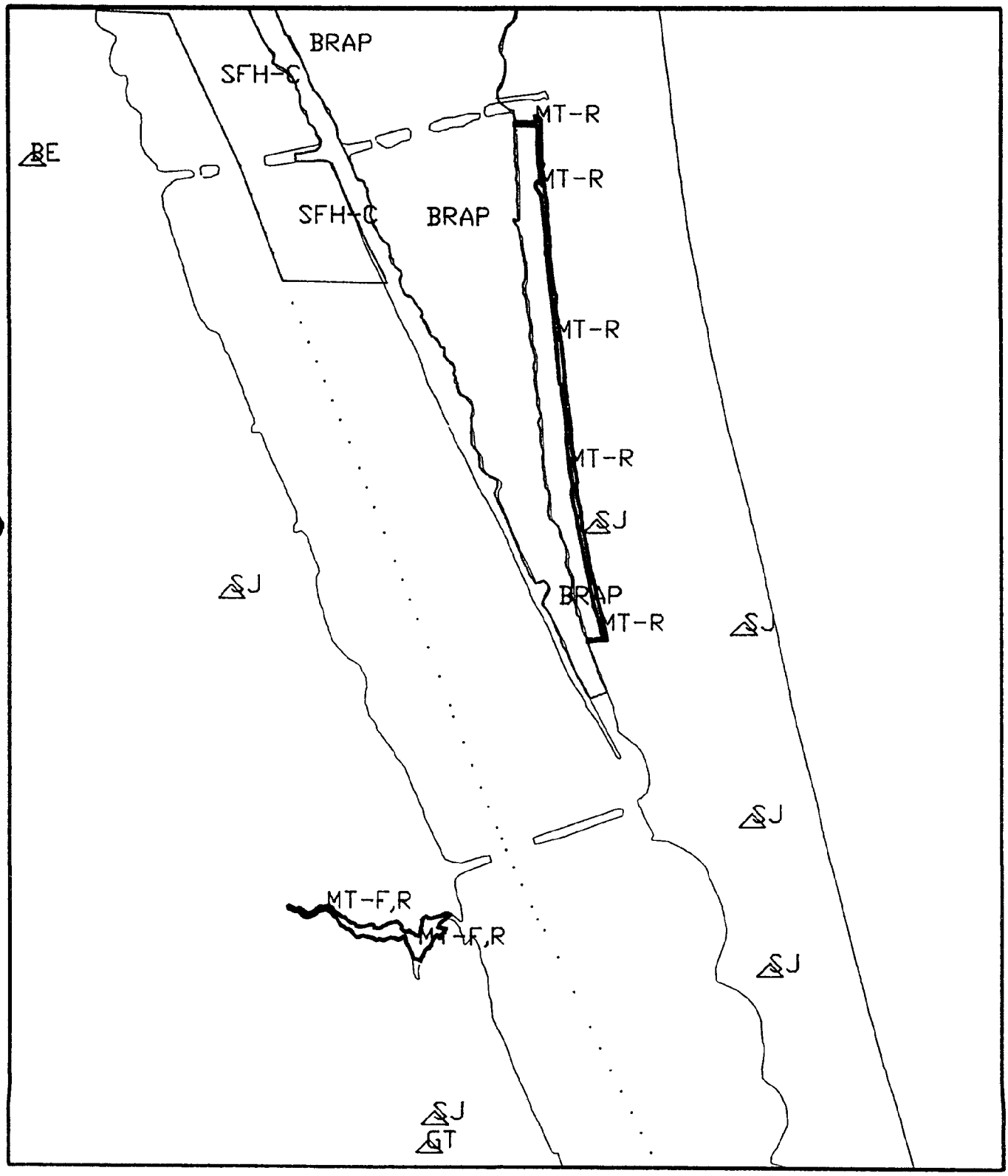


FIGURE 19
MARINA SITING PANEL 16

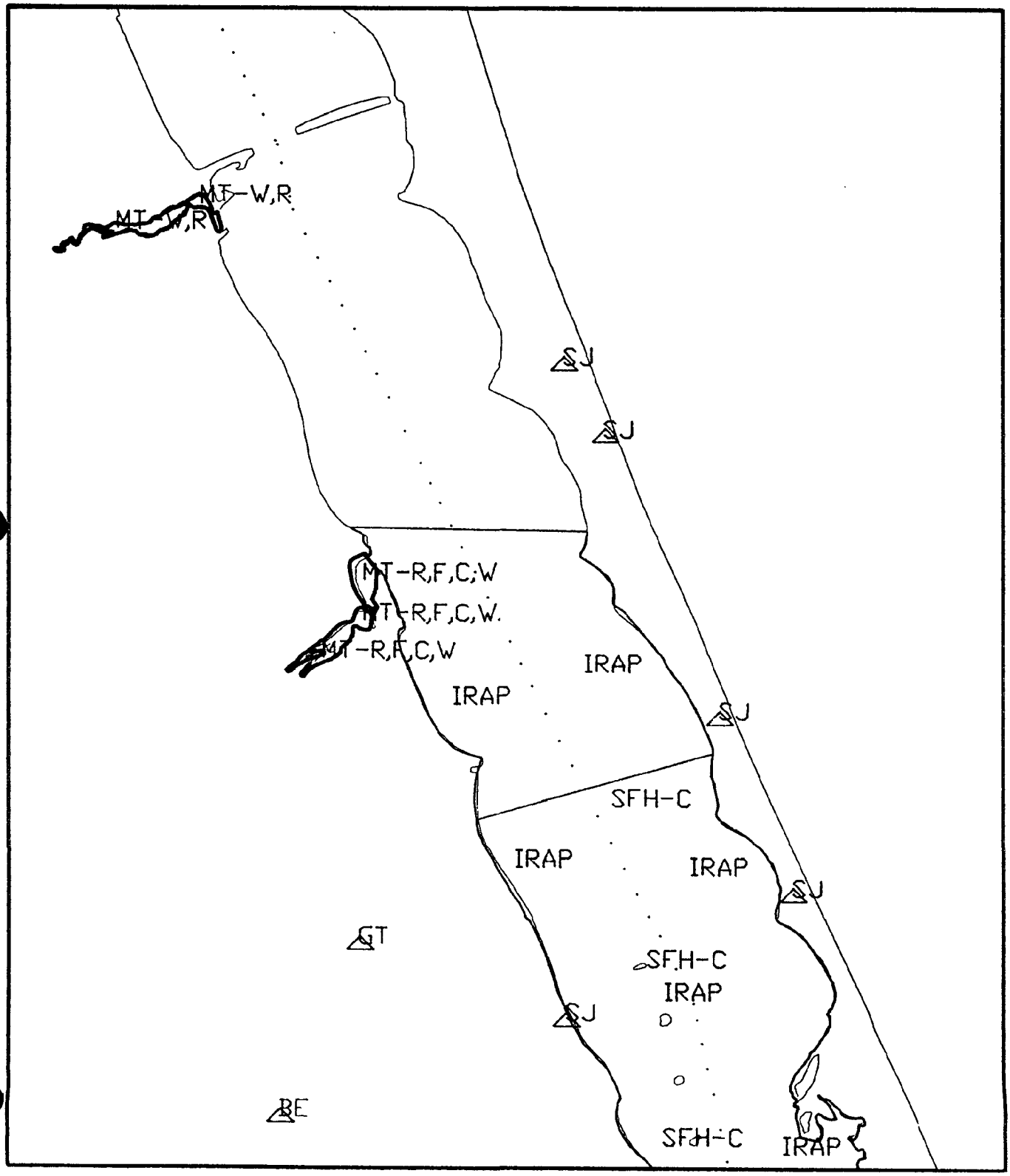
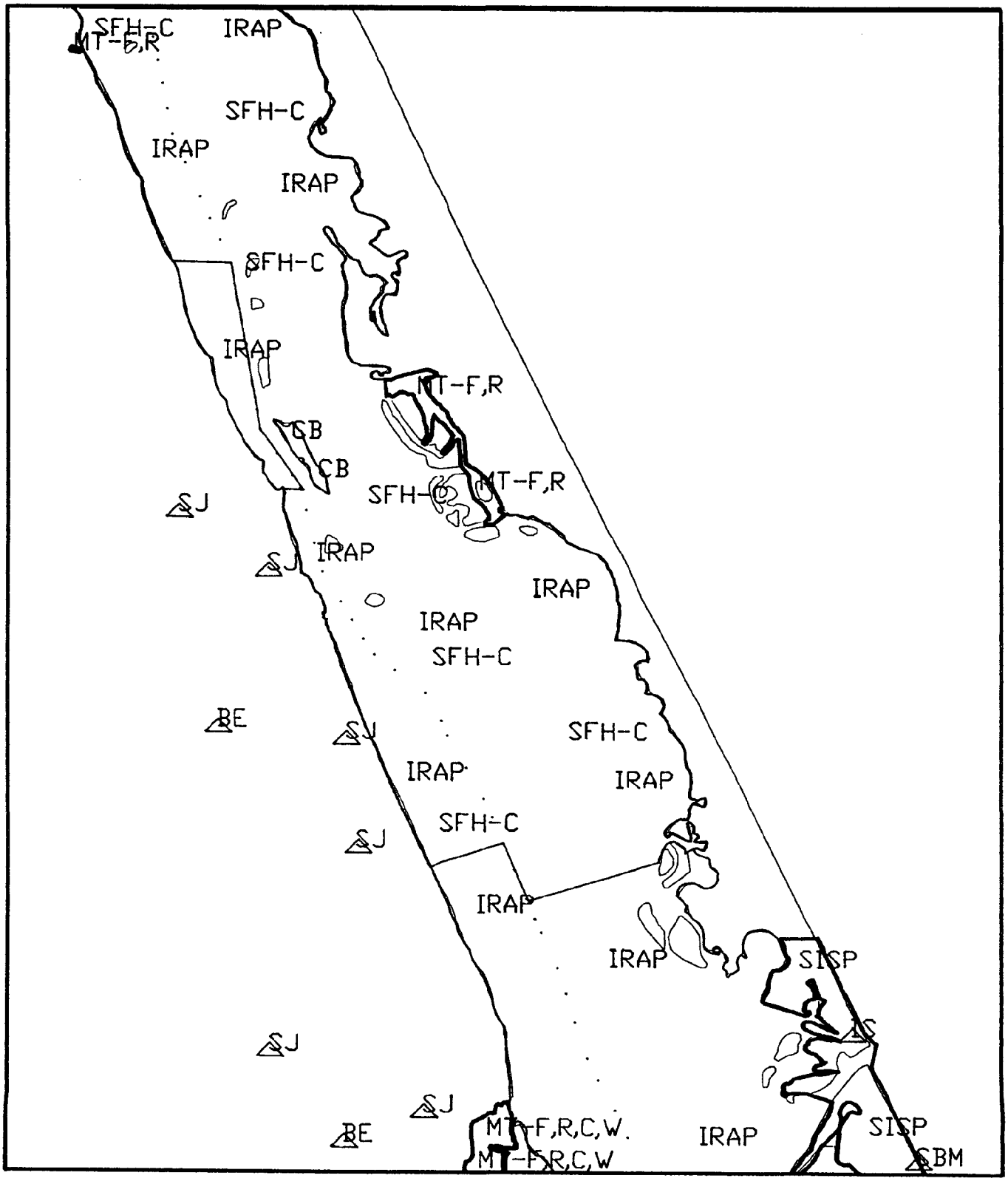
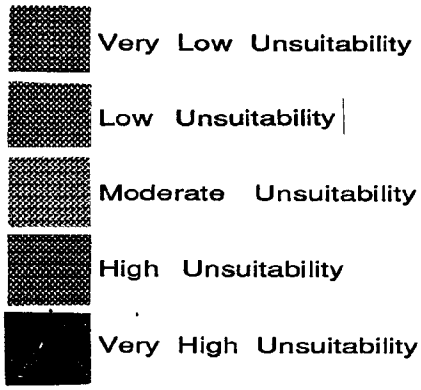


FIGURE 20
MARINA SITING PANEL 17



LEGEND
FIGURES 21 - 37

MARINA SITING UNSUITABILITY SCALE



FINAL01E.GIS SCALE = 1:63360

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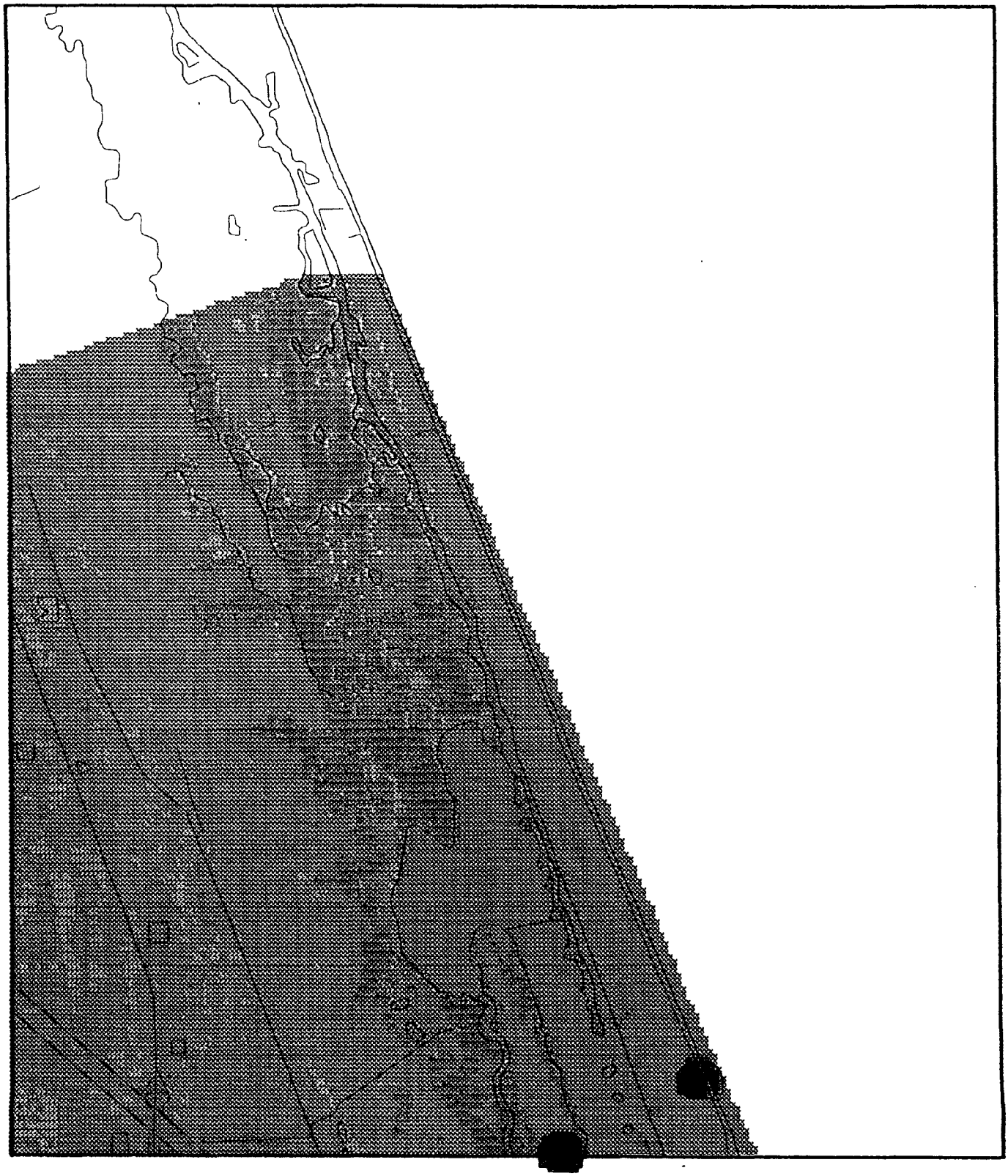


FIGURE 22
MARINA SITING PANEL 02

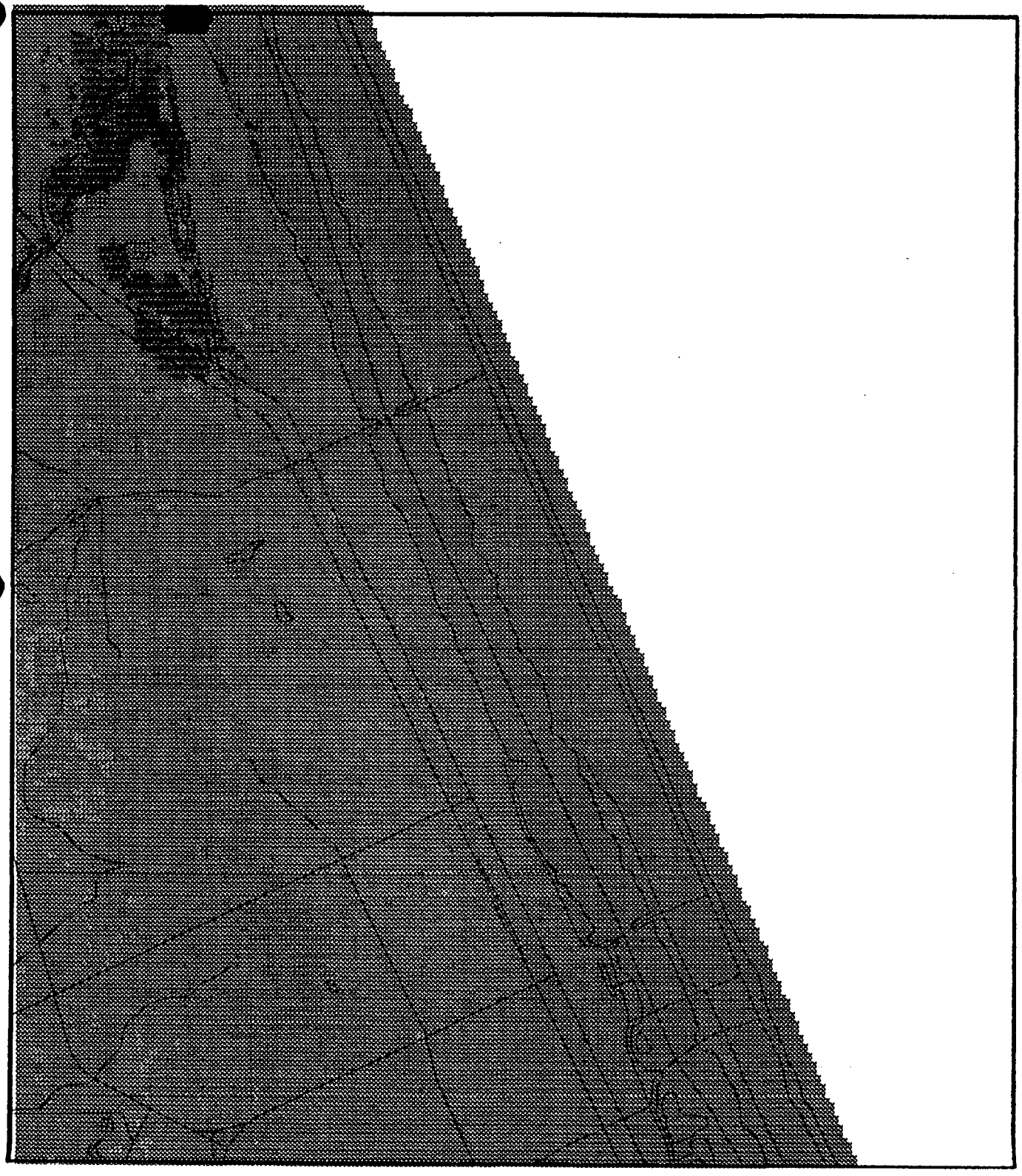


FIGURE 23
MARINA SITING PANEL 03

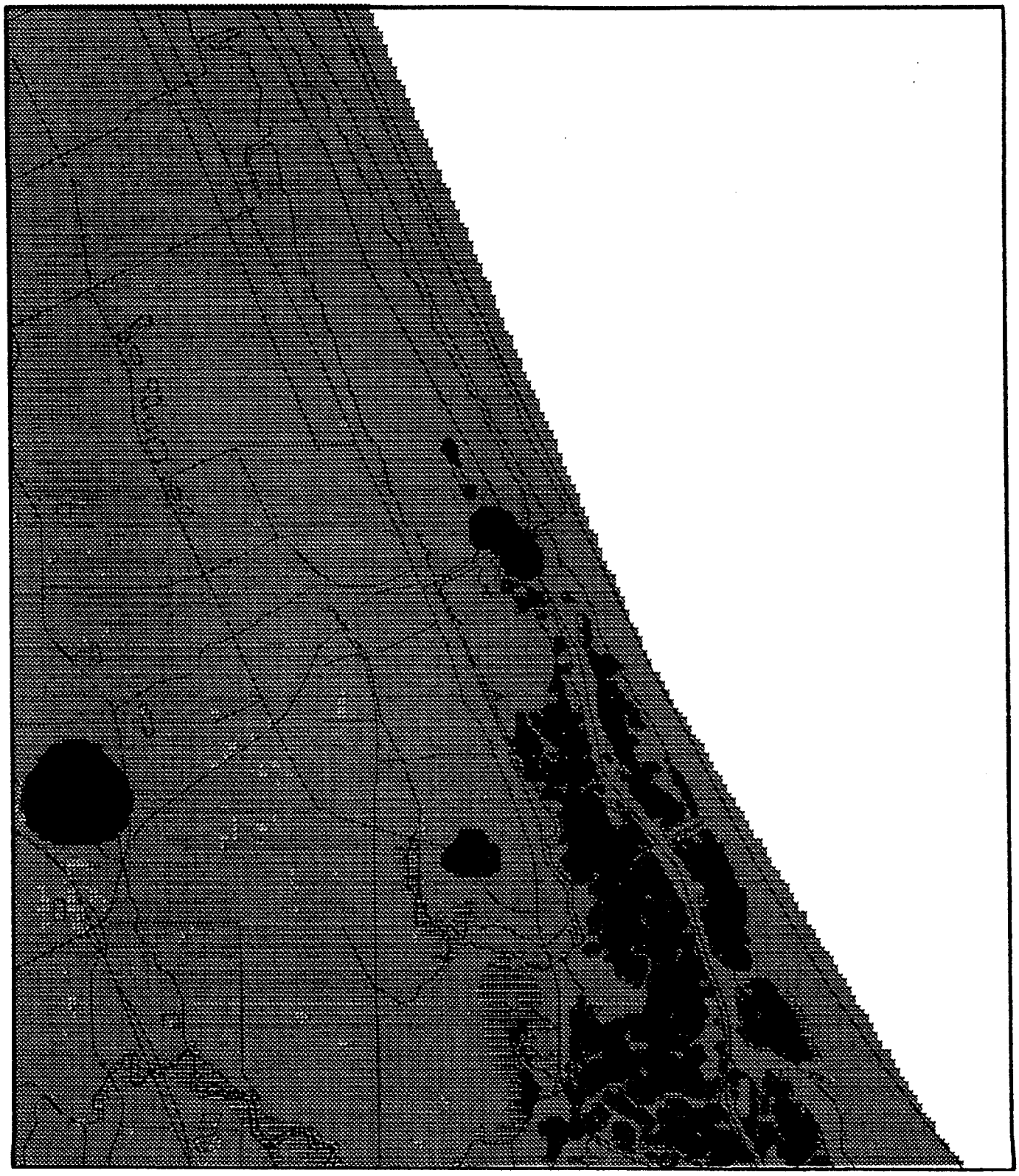


FIGURE 24
MARINA SITING PANEL 04

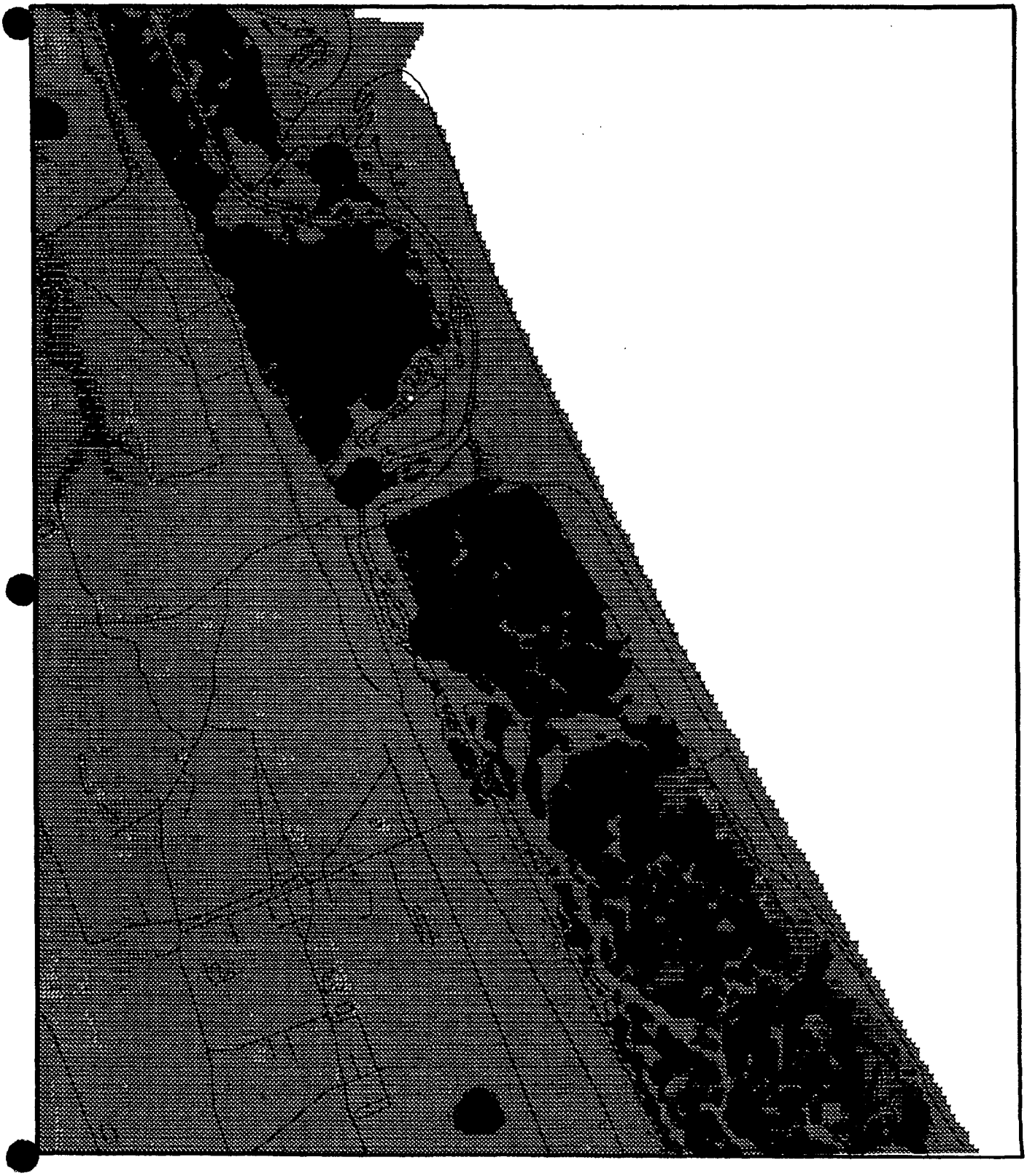


FIGURE 25
MARINA SITING PANEL 05

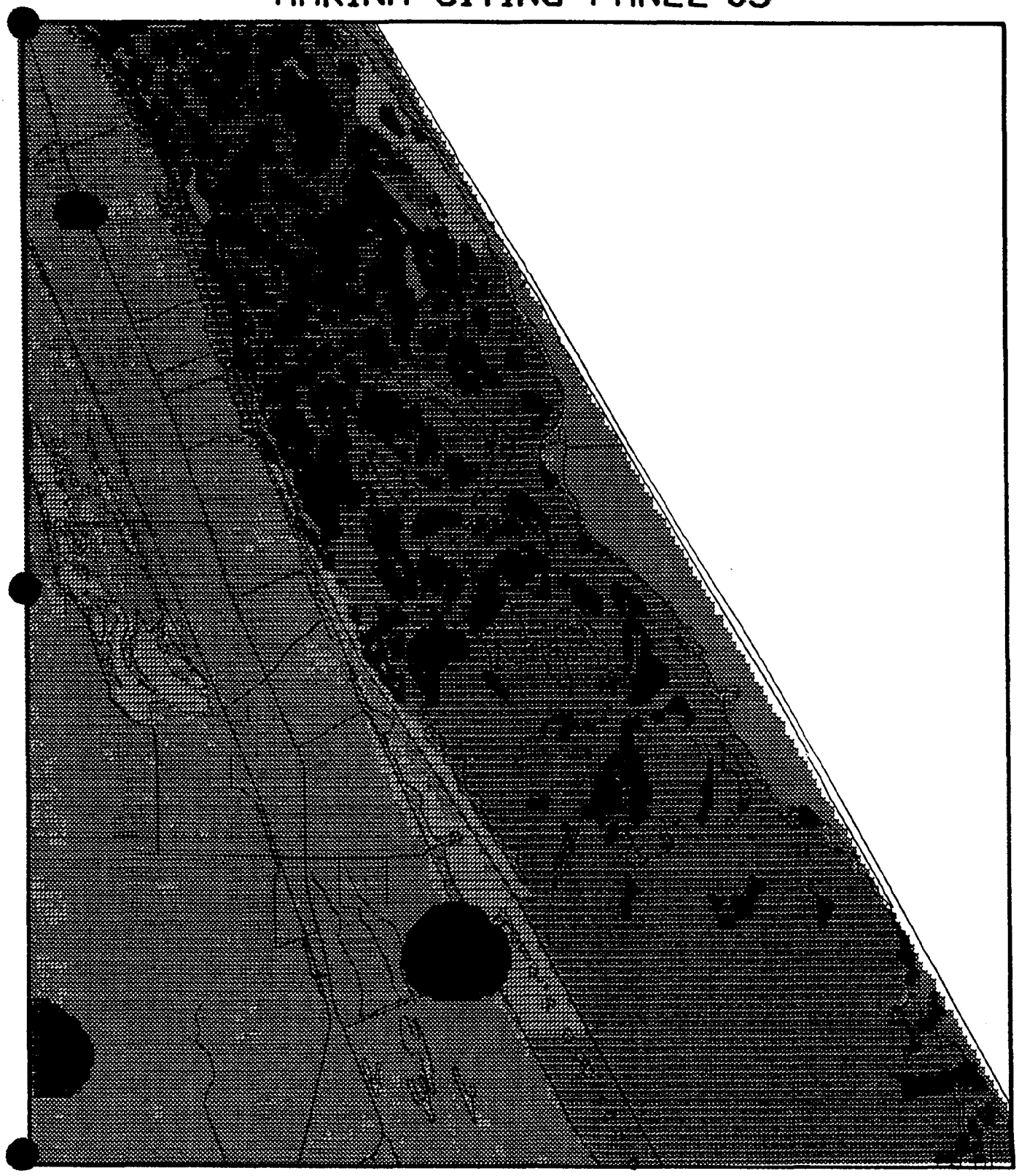


FIGURE 26
MARINA SITING PANEL 06

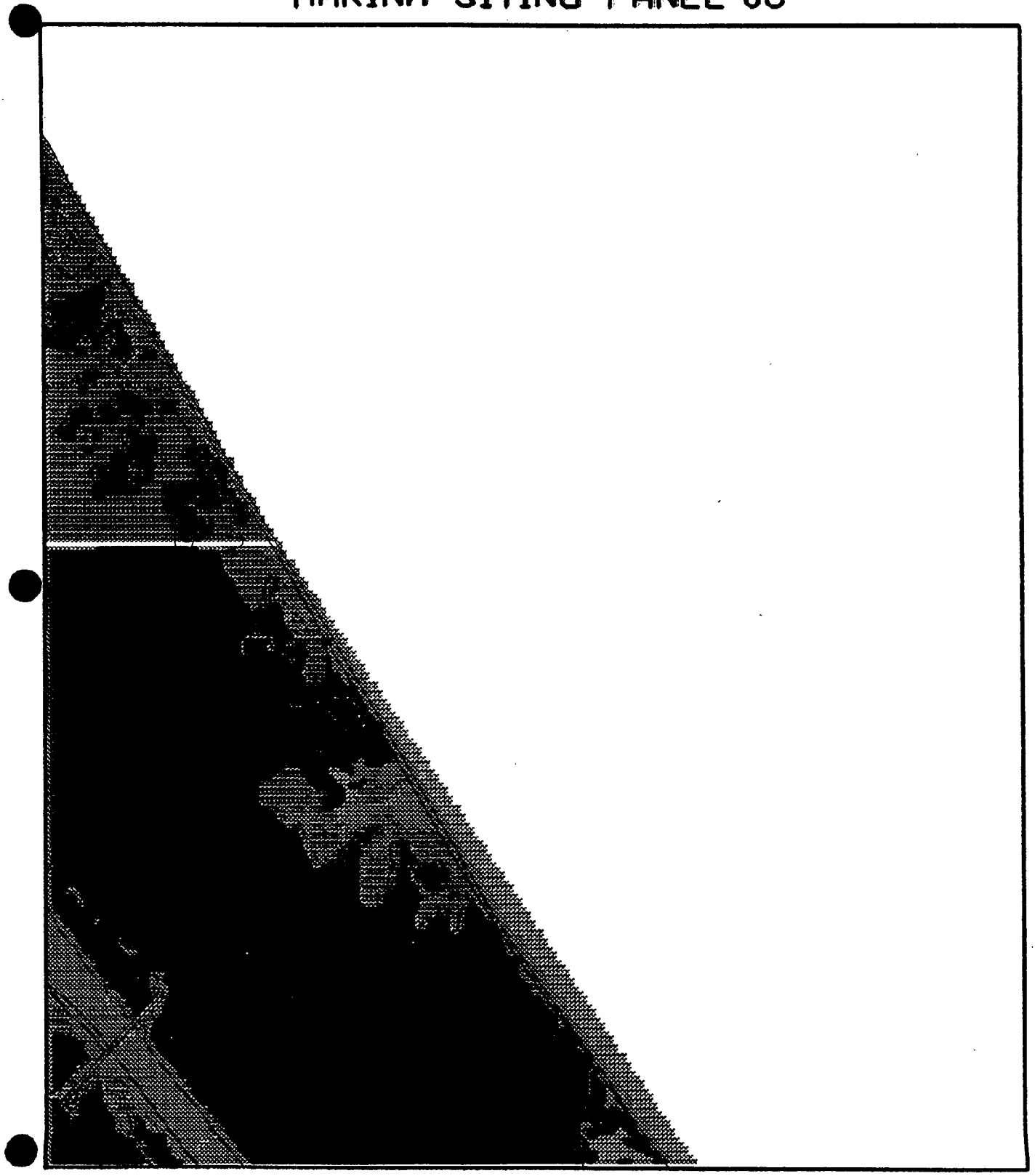


FIGURE 27
MARINA SITING PANEL 07

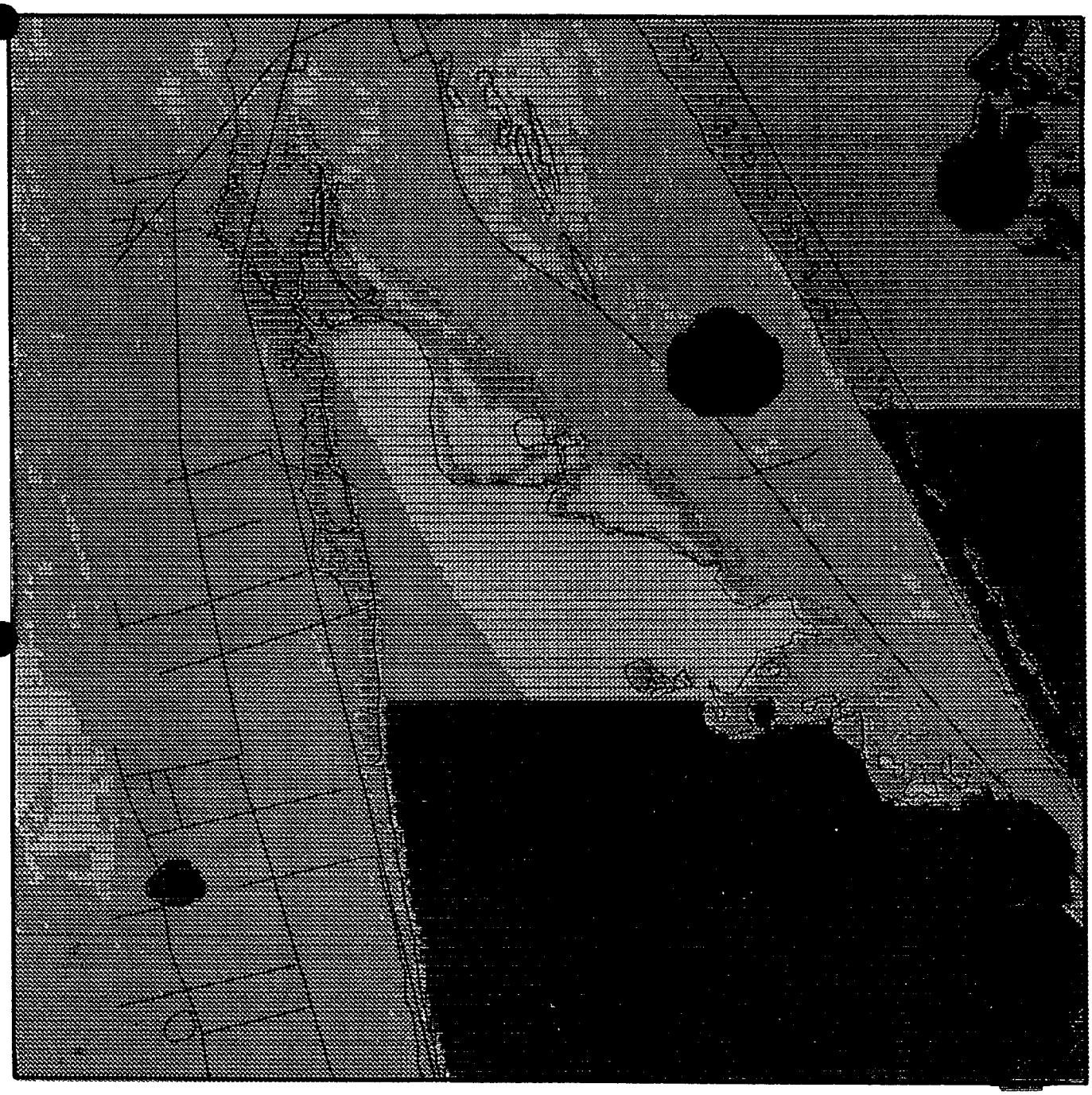


FIGURE 28
MARINA SITING PANEL 08

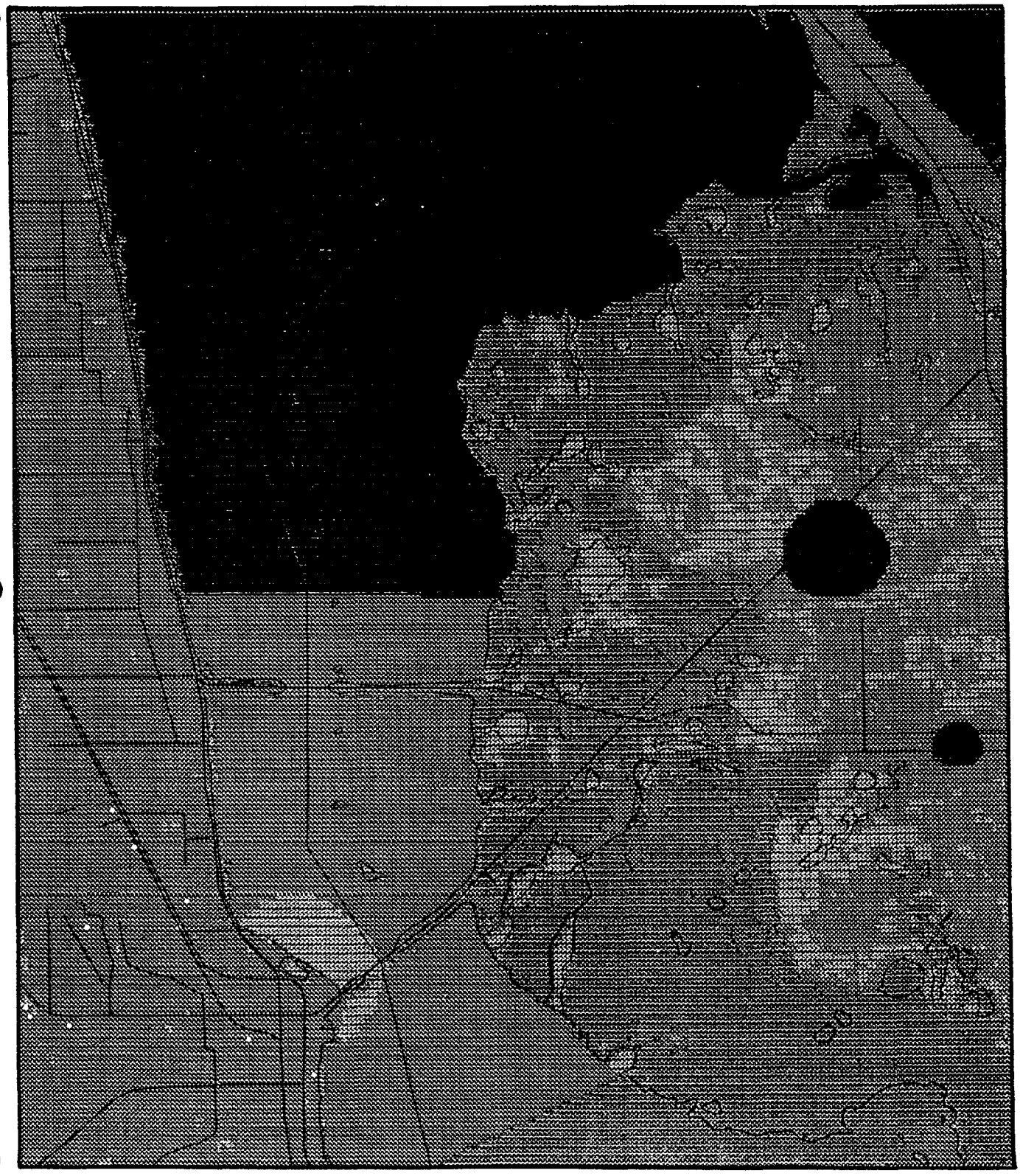


FIGURE 29
MARINA SITING PANEL 09

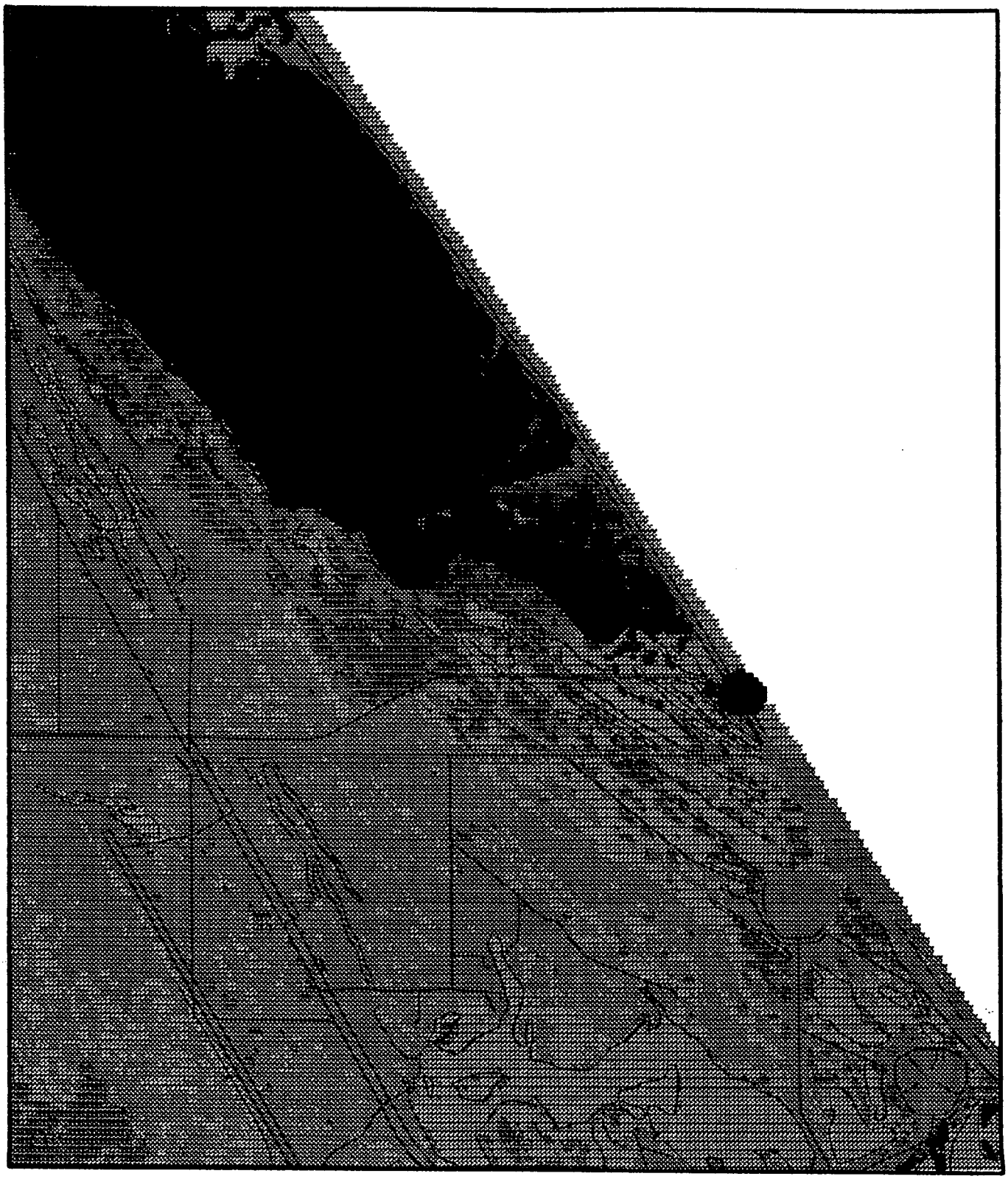


FIGURE 30
MARINA SITING PANEL 10

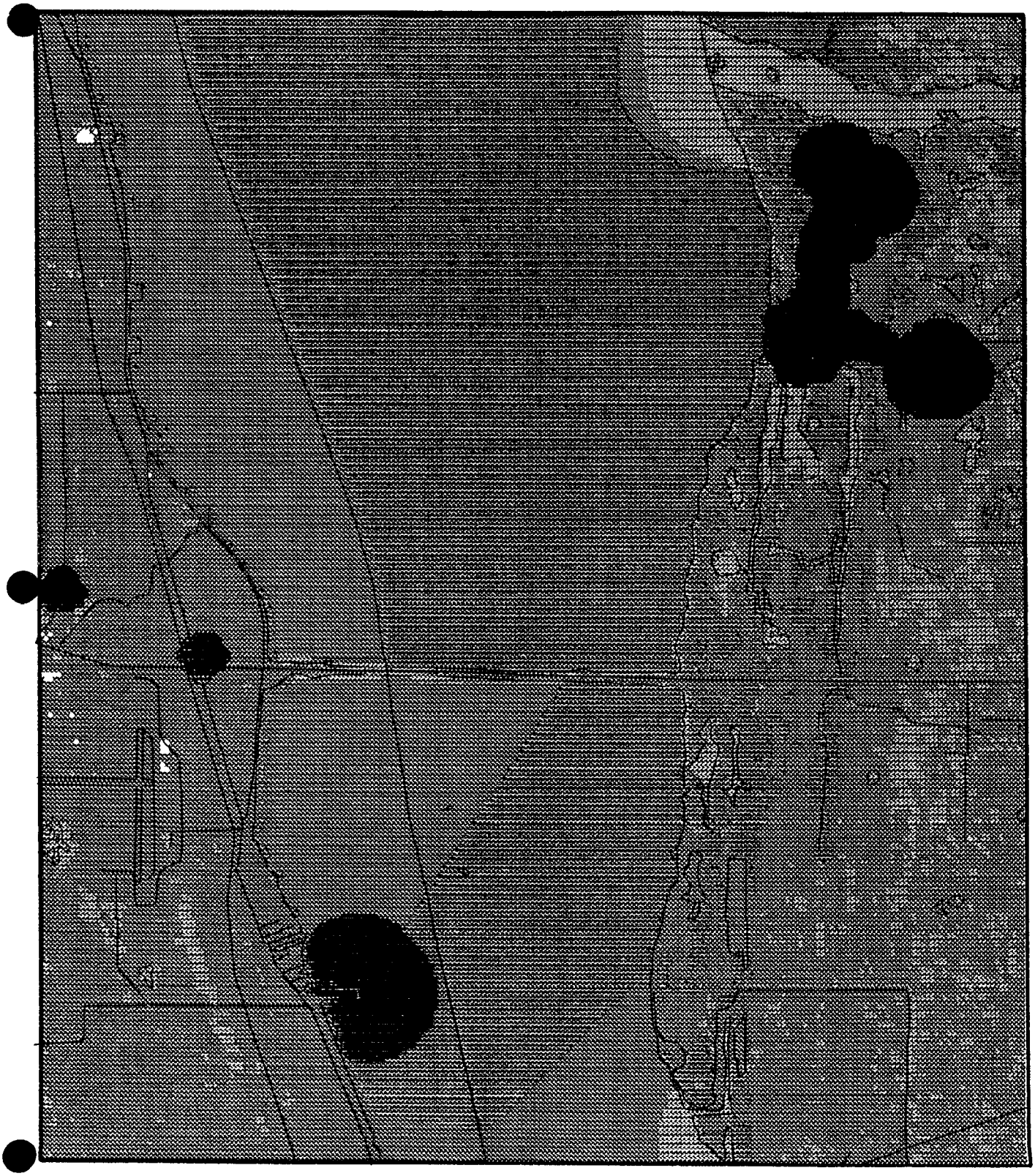


FIGURE 31
MARINA SITING PANEL 11

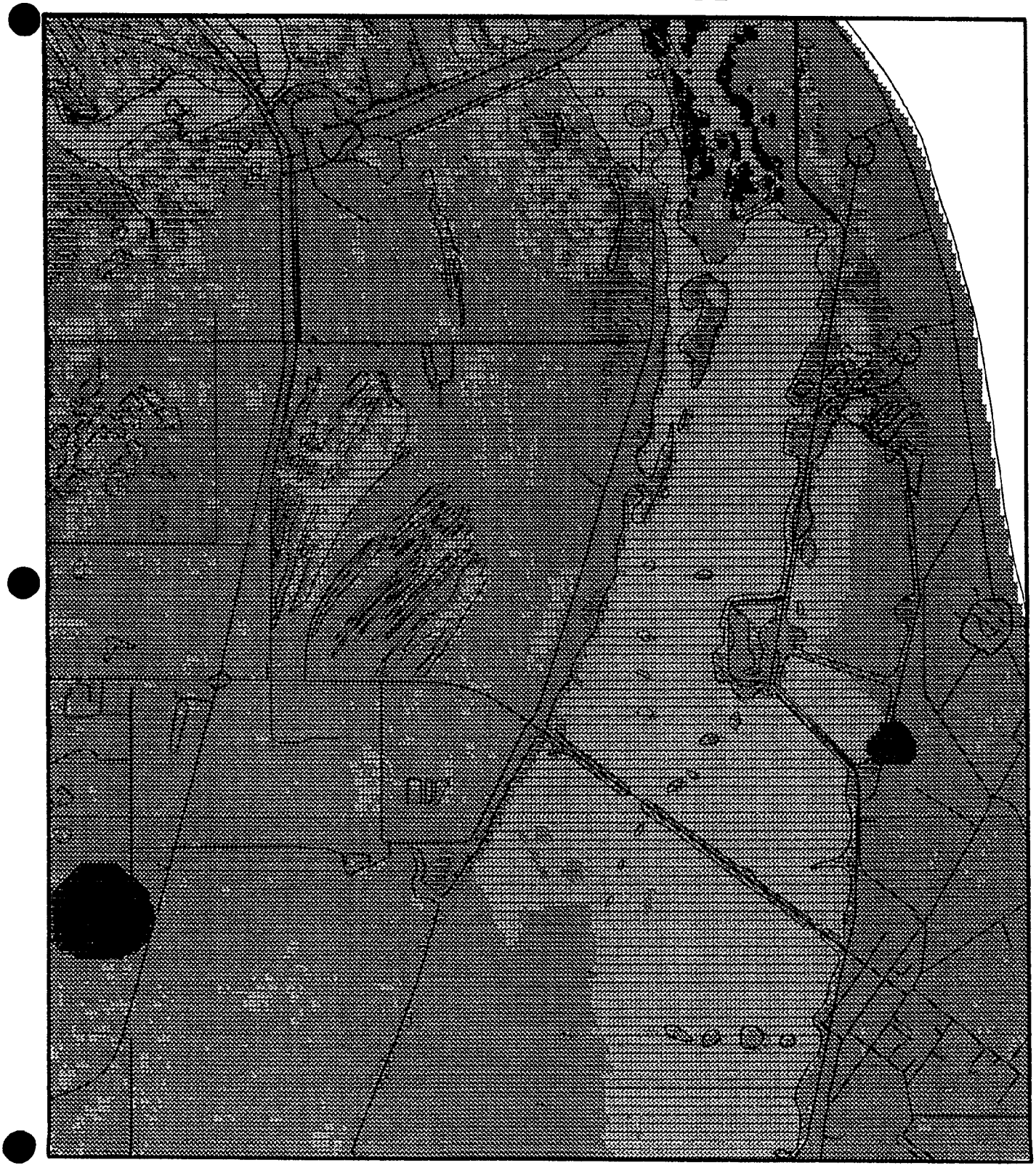


FIGURE 32
MARINA SITING PANEL 12

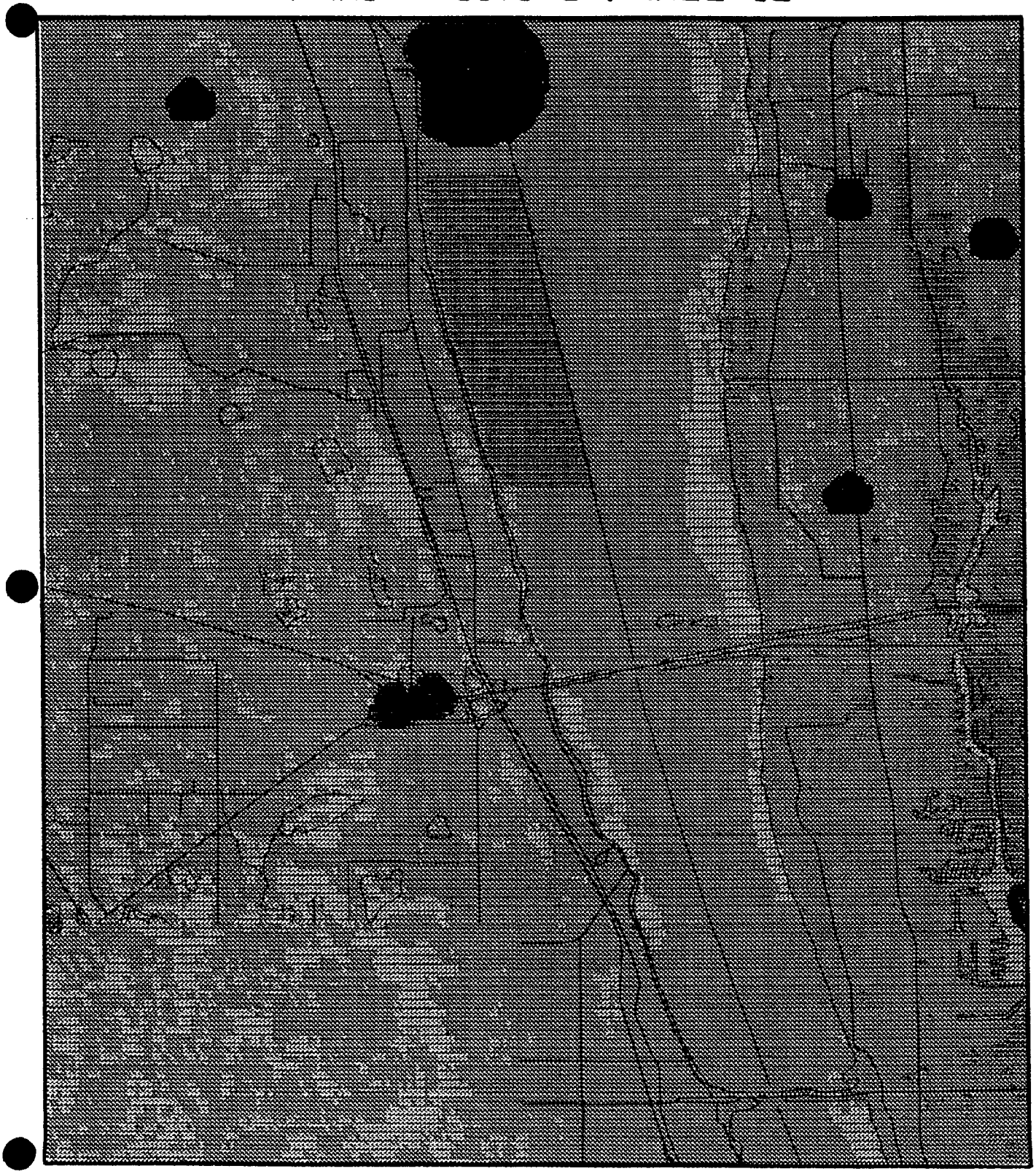


FIGURE 33
MARINA SITING PANEL 13

FIGURE 34
MARINA SITING PANEL 14

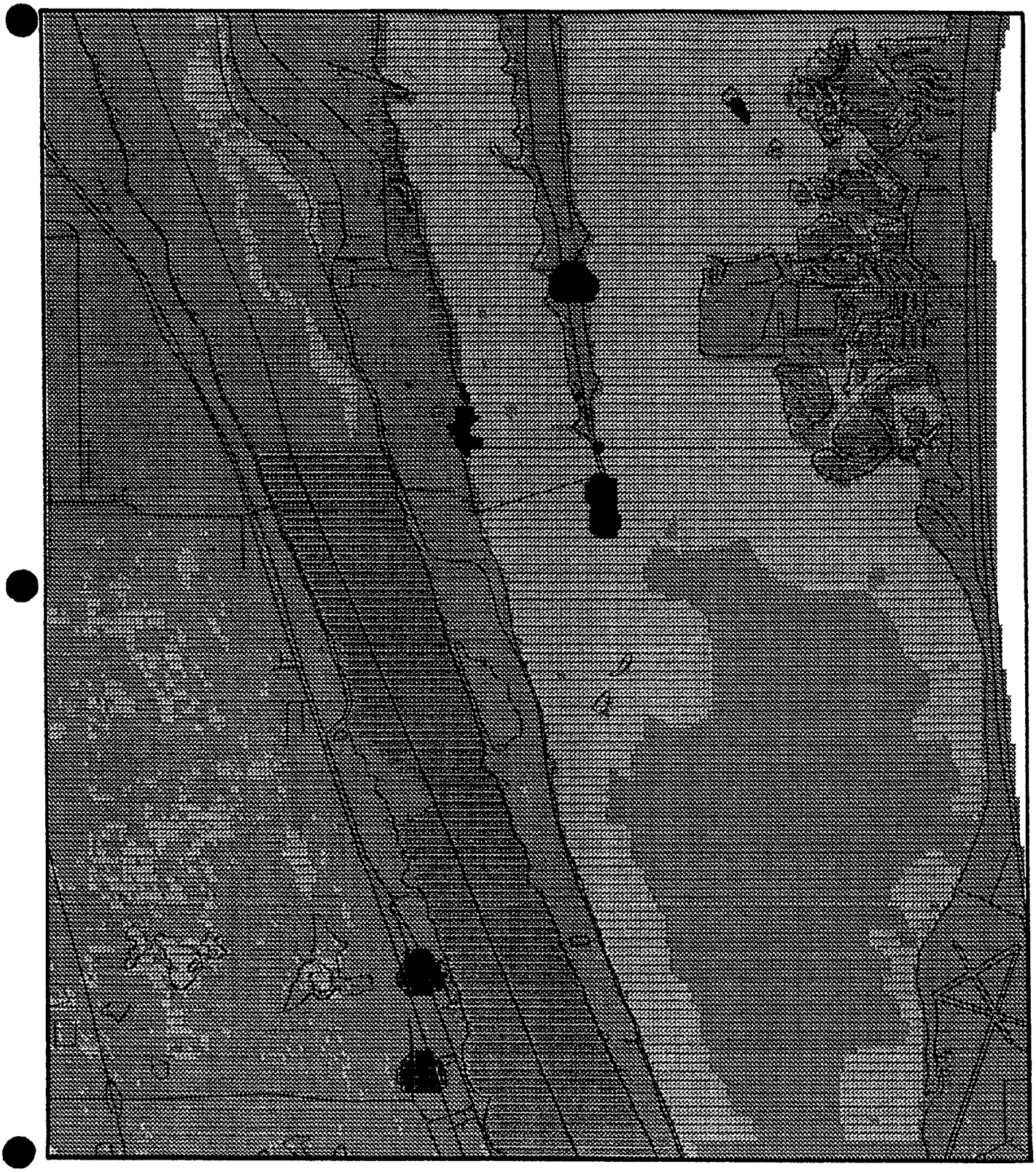


FIGURE 35
MARINA SITING PANEL 15

FIGURE 36
MARINA SITING PANEL 16

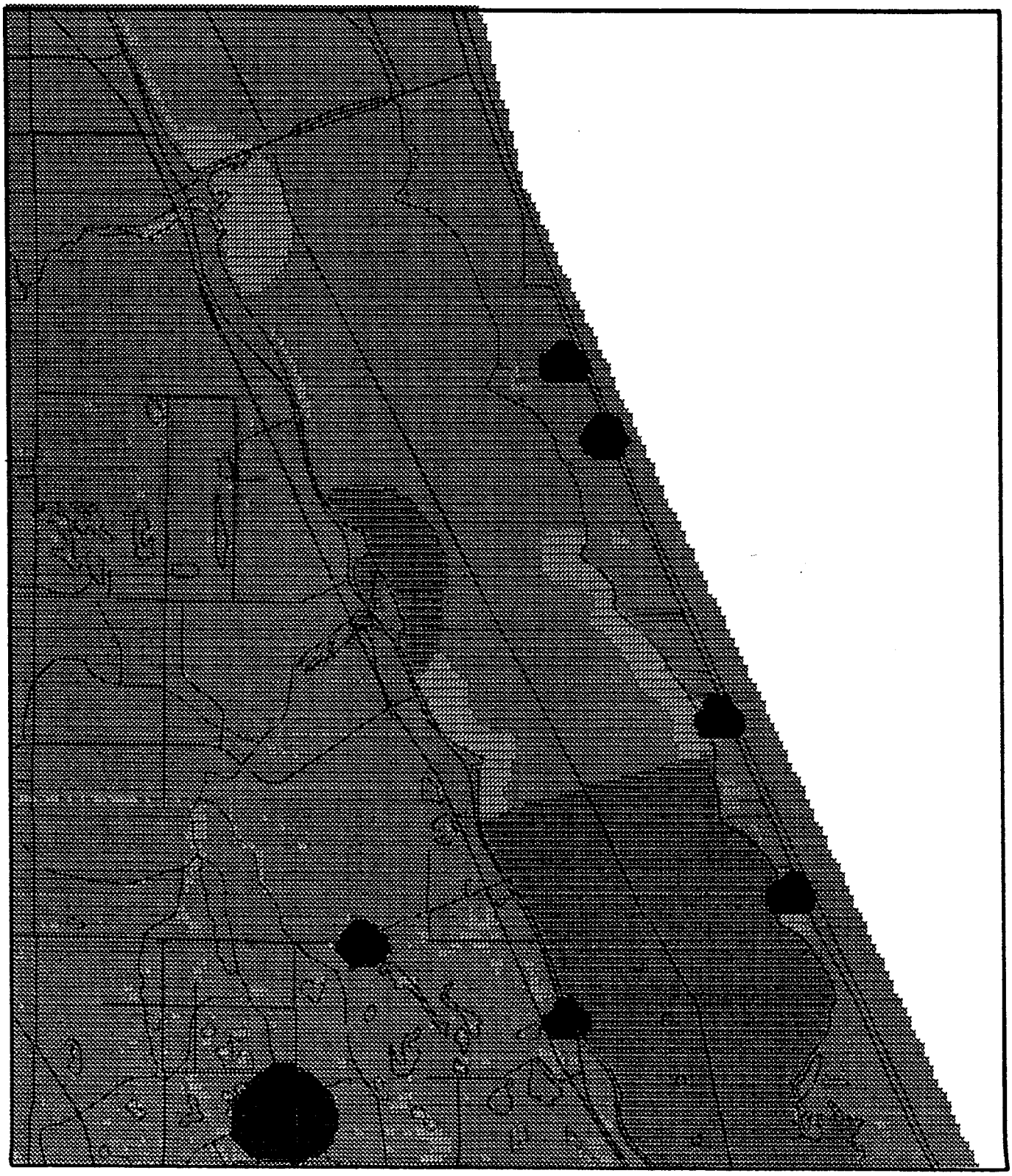
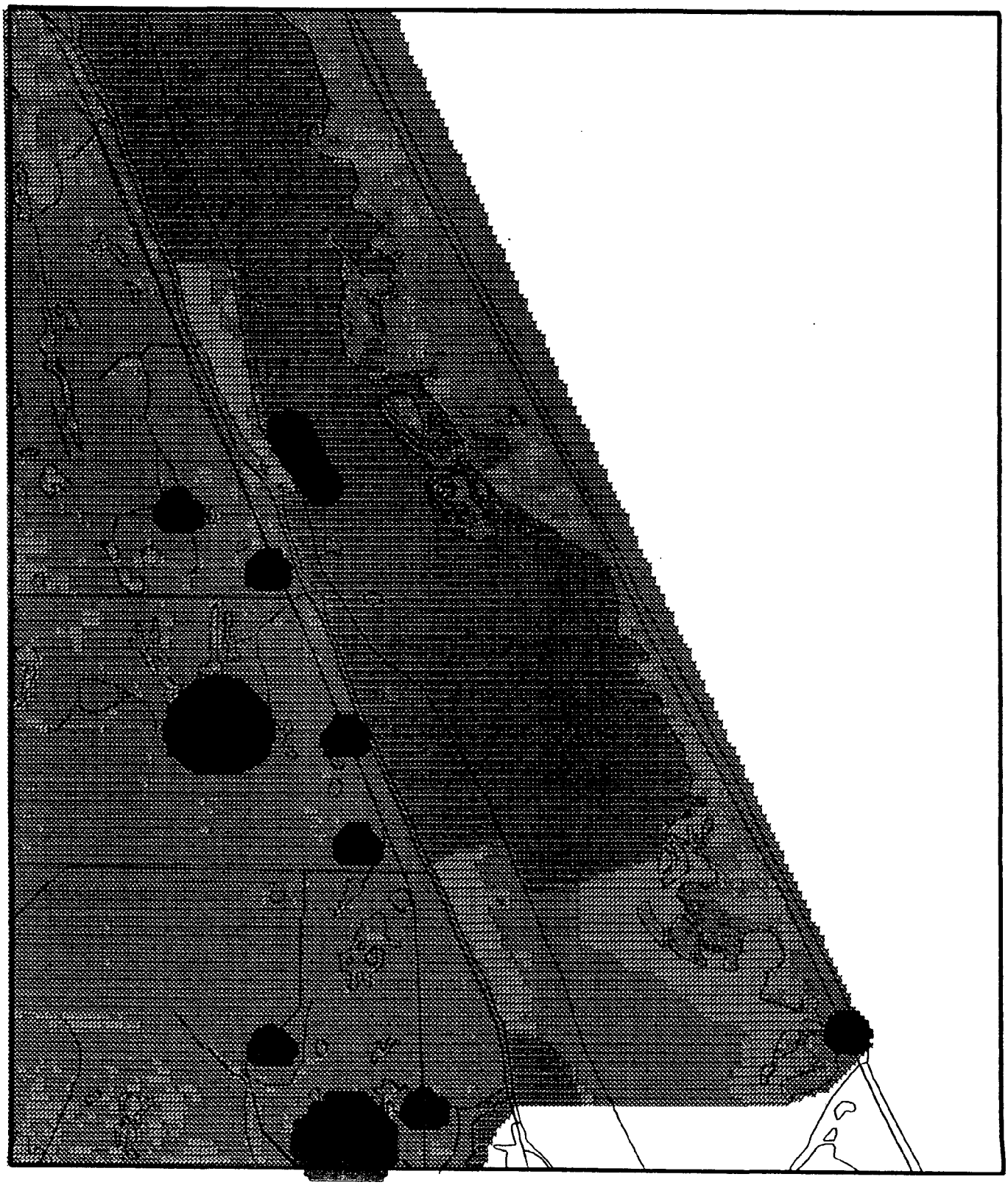


FIGURE 37
MARINA SITING PANEL 17



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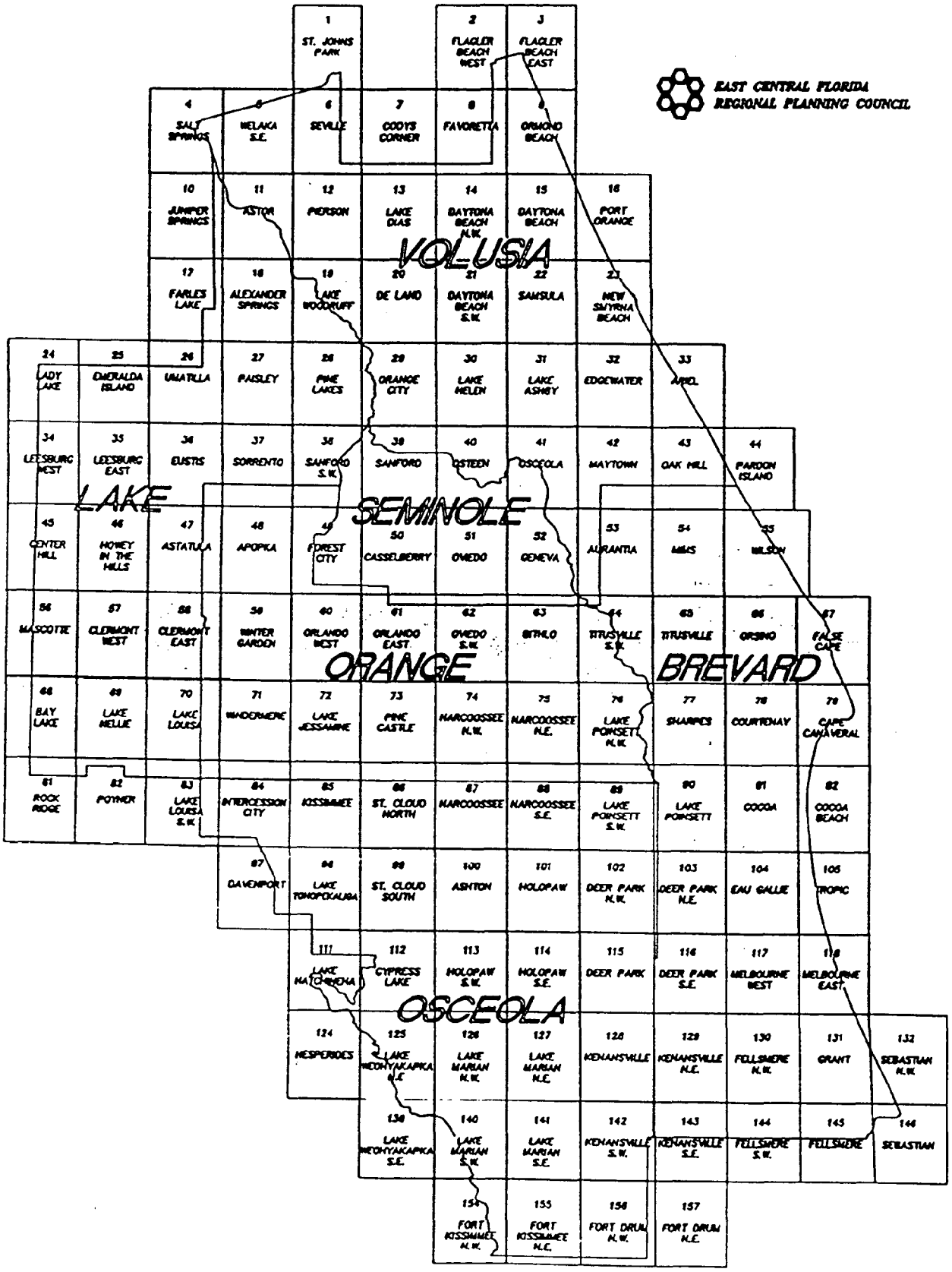
APPENDIX 1

Quadrangle Map Index For The ECFRPC Region


EAST CENTRAL FLORIDA
REGIONAL PLANNING COUNCIL
VOLUSIA
LAKE
SEMINOLE
ORANGE
BREVARD
OSCEOLA
1 ST. JOHNS PARK
2 FLAGLER BEACH WEST
3 FLAGLER BEACH EAST
4 SALT SPRINGS
5 WELAKA S.E.
6 SEVILLE
7 CODYS CORNER
8 FAVORETTA
9 ORMOND BEACH
10 JUNIPER SPRINGS
11 ASTOR
12 PIERSON
13 LAKE DIAS
14 DAYTONA BEACH N.W.
15 DAYTONA BEACH
16 PORT ORANGE
17 FARLES LAKE
18 ALEXANDER SPRINGS
19 LAKE WOODRUFF
20 DE LAND
21 DAYTONA BEACH S.W.
22 SAMSULA
23 NEW SMYRNA BEACH
24 LADY LAKE
25 EMERALDA ISLAND
26 UMATILLA
27 PAISLEY
28 PINE LAKES
29 ORANGE CITY
30 LAKE HELEN
31 LAKE ASHBY
32 EDGEWATER
33 APRIL
34 LEESBURG WEST
35 LEESBURG EAST
36 EUSTIS
37 SORRENTO
38 SANFORD S.W.
39 SANFORD
40 OSTEEN
41 OSCEOLA
42 MAYTOWN
43 OAK HILL
44 PARDON ISLAND
45 CENTER HILL
46 HONEY IN THE HILLS
47 ASTATULA
48 APOPKA
49 FOREST CITY
50 CASSELBERRY
51 OVIEDO
52 GENEVA
53 AURANTIA
54 MIMS
55 WILSON
56 MASCOTTE
57 CLERMONT WEST
58 CLERMONT EAST
59 WINTER GARDEN
60 ORLANDO WEST
61 ORLANDO EAST
62 OVIEDO S.W.
63 BITHLO
64 TITUSVILLE S.W.
65 TITUSVILLE
66 ORSINO
67 FALSE CAPE
68 BAY LAKE
69 LAKE NELLIE
70 LAKE LOUISA
71 WINDERMERE
72 LAKE JESSAMINE
73 PINE CASTLE
74 NARCOOSSEE N.W.
75 NARCOOSSEE N.E.
76 LAKE POINSETT N.W.
77 SHARPES
78 COURTENAY
79 CAPE CANAVERAL
81 ROCK RIDGE
82 POINER
83 LAKE LOUISA S.W.
84 INTERCESSION CITY
85 KISSIMMEE
86 ST. CLOUD NORTH
87 NARCOOSSEE
88 NARCOOSSEE S.E.
89 LAKE POINSETT S.W.
90 LAKE POINSETT
91 COCOA
92 COCOA BEACH
97 DAVENPORT
98 LAKE TOHOPEKALIGA
99 ST. CLOUD SOUTH
100 ASHTON
101 HOLOPAW
102 DEER PARK N.W.
103 DEER PARK N.E.
104 EAU GALLIE
105 TROPIC
111 LAKE HATCHINEHA
112 CYPRESS LAKE
113 HOLOPAW S.W.
114 HOLOPAW S.E.
115 DEER PARK
116 DEER PARK S.E.
117 MELBOURNE WEST
118 MELBOURNE EAST
124 HESPERIDES
125 LAKE MYRTLE N.E.
126 LAKE MARIAN N.W.
127 LAKE MARIAN N.E.
128 KENANSVILLE
129 KENANSVILLE N.E.
130 FELLSMERE N.W.
131 GRANT
132 SEBASTIAN N.W.
138 LAKE MYRTLE S.E.
140 LAKE MARIAN S.W.
141 LAKE MARIAN S.E.
142 KENANSVILLE S.W.
143 KENANSVILLE S.E.
144 FELLSMERE S.W.
145 FELLSMERE
146 SEBASTIAN
154 FORT KISSIMMEE N.W.
155 FORT KISSIMMEE N.E.
156 FORT DRUM N.W.
157 FORT DRUM N.E.

APPENDIX 2

Policies From The East Central Florida Comprehensive Regional Policy Plan Relevant To Marina Siting

Milon, W.J. and P.H. Riddle. 1983. Employment and Sales Characteristics of Florida's Recreational Boating Industry: Florida Sea Grant Publication SGR-52.

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POLICY 40.1: Proposed activities which would destroy or degrade the function of coastal wetlands or deepwater habitat should not be permitted except where such activities are clearly in the public interest and there is no practical alternative which reduces or avoids impacts to wetlands. Unavoidable losses of viable wetlands should be mitigated through the demonstrably successful restoration, creation or (where no other alternative is feasible) preservation of wetlands whose functional values are at least comparable to those of the wetlands lost. Wetlands mitigation should occur within the same watershed as the proposed impact to ensure that there is no net loss of wetland functional values within the drainage basin where the loss is to occur. Creation of new wetlands as mitigation should avoid impacts to ecologically valuable uplands including, but not limited to, bird nesting colonies, migratory wildlife corridors and rare or endangered ecosystems.

MEASURE: The percentage of coastal wetland acreage remaining after 1987.

POLICY 40.2: An estuarine shoreline buffer zone should be established and maintained within which no development activity shall occur, except that required for reasonable access. The size of the buffer zone will be set at the discretion of the authority having jurisdiciton. The following criteria should apply in the implementation of this policy:

1. The shoreline buffer zone shall begin at the upland limit of any wetland habitat.

2. The buffer zone should include canopy, understory and groundcover consisting of preserved existing vegetation or planted native species.

3. No development should be permitted in the buffer zone with the exception of docks, pervious walkways, elevated walkways, or other means necessary to provide access.

4. No more than 20 percent or 25 feet, whichever is greater, of any shoreline should be altered in order to provide necessary access. The remaining shoreline wetlands and buffer zone should remain in their natural states.

5. The upland extent of the buffer zone should be sufficient to provide a transition area which can substantially reduce the impact to wetlands and estuarine waters from development activity.

MEASURE: Establishment of estuarine shoreline buffer zones of sufficient size to efficiently reduce the impact to the estuarine wetlands and waters.

POLICY 40.3: The introduction of noxious exotic species shall be prohibited within the region. Noxious exotic species should be prohibited for use in landscaping. Additionally, exotic species shall be removed during construction, with the action only pertaining to the areas which are to be disturbed. Noxious exotic species include, but are not limited to, the following:

Causarina cunninghamiana	(Beefwood)
Causarina glauca	(Scaly-bark Beefwood)
Causarina equisetifolia	(Australian Pine)
Dioscorea bulbifera	(Devil's Potato or Air Potato)
Melaleuca quinquenervia	(Punk Tree or Cajeput)
Rincinus communis	(Castor Bean)
Sansevieria hyacinthoides	(African Bowstring)
Schinus terebinthifolius	(Brazilian Pepper)

MEASURE: A diminishment of noxious exotic species in landscaping.

POLICY 40:4: Land clearing, filling, excavation, and alteration in the coastal zone shall proceed only when adequate soil erosion safeguards are implemented. Land clearing ordinances developed in response to this policy should address premature clearing of land prior to issuance of a building permit and methods of combatting unconfined emissions such as seeding, mulching, and wetting of disturbed areas prior to construction.

MEASURE: The number of land clearing ordinances that ensure prevention of erosion prior to and during construction.

POLICY 40.5: The natural processes inherent to coastal sand beaches fronting the Atlantic Ocean shall be allowed to proceed uninterrupted by human activities. The following criteria shall apply in the implementation of this policy:

1. Structural methods of erosion control shall be prohibited except where necessary for public navigation and public access.

2. Reconstruction of existing hard erosion control structures shall be prohibited except where such reconstruction is not contrary to the public interest or where failure to reconstruct would result in the loss of abutting property.

3. Non-structural methods of erosion control such as planting of natural dune vegetation and beach re-nourishment shall be encouraged.

MEASURES: The proportion of projects in which structural methods are used for erosion control.

The number of hard erosion control structures which are reconstructed.

POLICY 40.6: Structural development along sand beaches fronting the Atlantic Ocean shall not adversely affect the coastal beach and dune system. The following criteria shall apply in the implementation of this policy:

1. Beach setbacks shall be established to protect and preserve the coastal beach and dune systems fronting the Atlantic Ocean.

2. Structures shall be prohibited within the established setback except where overriding public interest is apparent, or the structures are necessary for reasonable access and are elevated above the existing dune vegetation.

MEASURE: The number of ordinances which establish beach setbacks.

POLICY 40.7: Dredge and fill activities shall be minimized to ensure the least possible adverse environmental, social and economic impacts to the region estuaries.

MEASURE: Number of dredge and fill permits issued.

POLICY 40.8: Developments that are feasible only through creation of land by dredging and filling of areas below mean high water shall be prohibited except where overiding public interest can be demonstrated.

MEASURE: The amount of submerged bottom land which is developed.

POLICY 40.9: Marinas shall be located in areas where maximum physical advantage exists, where the least dredging and maintenance are required, and where marine resources will not be adversely affected. The following criteria shall apply in the implementation of this policy:

1. Marinas proposed for the region's estuaries shall demonstrate that they have sufficient upland areas to accommodate all needed utilities and marina support facilities.

2. Docking facilities shall only be approved which require minimal or no dredging and/or filling to provide access by canal, channel, or road. This restriction shall also apply to widening and/or deepening any existing canal or channel, but not to regular maintenance dredging and filling to meet depth standards of existing canals or channels. Preference shall be given to marina sites with existing channels. In the event that dredging is required, the mooring areas and the navigation access channels shall not be dredged to depths greater than those necessary to prevent prop dredging. Any required dredging shall utilize appropriate construction techniques and materials to comply with state water quality standards (e.g., turbidity screens, hydraulic dredges, properly sized and isolated spoil deposition area to control spoil dewatering).

3. Marina basins shall only be approved when the locations have existing adequate depths to accommodate the proposed boat use. A minimum of four feet below mean low water shall be required. Greater depths shall be required for those facilities designed or capable of accommodating boats having greater than a three-foot draft.

4. Marinas shall not be permitted in areas where approved or conditionally approved shellfish harvesting would be severely impacted and/or significant sections closed to shellfish harvesting.

5. Marinas shall not be permitted in areas of the regions estuaries which have been determined by FDNR and USFWS to be critical to the survival of the endangered manatee. These areas can include but are not limited to manatee sanctuaries, feeding areas or areas which have been identified in FDNR or USFWS manatee recovery plans.

6. New marina facilities shall be designed to maximize the water quality benefits of existing water circulation and shall not adversely affect existing circulation patterns. Improvement of circulation shall be a preferred consideration when expanding or upgrading existing facilities. However, any buffer zone established by FDNR's Shellfish Environmental Assessment Section shall be maintained.

MEASURE: The proportion of marinas sited which are in conformance with the criteria developed through this policy.

POLICY 40.10: Present and future marina facilities shall not degrade water quality in the estuaries of the region. The following criteria shall apply in the implementation of this policy:

1. When new facilities are developed, non-water-dependent structures (such as bait and tackle shops, restaurants, etc.) shall be situated on suitable uplands.

2. New or expanded facilities shall utilize dry storage to the fullest possible extent.

3. Marinas containing live-aboards shall be inspected to ensure proper operation of marine sanitation devices.

INVOLVED AGENCIES

The following public and private agencies may have responsibilities in the implementation of strategies developed under this regional issue:

Federal:
U.S. Fish & Wildlife Service
U.S. Army Corps of Engineers
National Marine Fisheries Services
National Park Service
U.S. Geological Survey
National Oceanic & Atmospheric Agency/OCZM
Soil Conservation Service

State:
Florida Department of Environmental Regulation
Florida Department of Natural Resources
Florida Department of Health & Rehabilitative Services
Florida Game and Fresh Water Fish Commission
Marine Fisheries Commission
Florida Department of Transportation
University System
Florida Sea Grant Extension Service
Florida Department of Agriculture & Consumer Services

Regional:
East Central Florida Regional Planning Council
St. Johns River Water Management District
South Florida Water Management District
Florida Inland Navigation District

Local:
Local Governments
Melbourne-Tillman Drainage District
Sebastian Drainage District
Fellsmere Water Control District
Ponce Inlet Port Authority
Canaveral Port Authority
Sebastian Inlet District

Private:
Environmental interest groups
Scientific organizations
Fishing and sports organizations/Organized Fisherman of Fla.
Educational institutions

REGIONALLY SIGNIFICANT RESOURCES/FACILITIES

Please refer to the list in Regional Issue 40.

REFERENCES

Please refer to the list in Regional Issue 40.

POLICY 41.1: No dredging or filling shall be performed within designated estuarine waters, except for those occasions when there is an overriding public benefit. The criteria applicable in the implementation of this policy shall include, but are not be limited to, the following:

1. Designated estuarine waters shall be defined to include, at a minimum, Aquatic Preserves, Outstanding Florida Waters, marine sanctuaries and Class II waters.

2. The following activities may be considered sufficiently within the public's interest to justify minimum dredging and filling:

   a. Such minimum dredging and filling as may be authorized for public navigation projects;

   b. Such minimum dredging and filling as needed for the maintenance of existing marinas, piers, and docks and their attendant navigational channels;

c. Such minimum dredging which may be necessary and desirable to enhance the water quality of the estuary or the public health in general;

d. Maintenance dredging as may be required for existing navigational channels; and

e. Reasonable improvements as may be necessary for public utility installation or maintenance.

3. No dredging shall occur seaward of mean high water for the purpose of providing fill for any area landward of mean high water.

4. No excavation of minerals shall occur.

MEASURE: The number of permits issued for dredging or filling within estuarine waters which are not consistent with the identified criteria.

POLICY 41.2: Activities within an estuarine basin that will adversely impact seagrass beds and other valuable submerged aquatic vegetation shall be prohibited, unless an overriding public benefit can be shown and adequate mitigation and monitoring measures are included. The following criteria apply in the implementation of this policy:

1. Grassbeds and other submerged habitat deemed valuable by FDER and FDNR will be subject to protection regardless of their size.

2. Proposed activities in an estuarine basin whose public interest benefits could be considered to justify alterations or adverse impacts shall, at a minimum, meet one or more of the following criteria:

   a. The activity is necessary to prevent or eliminate a public hazard; and

   b. The activity would provide direct public benefits which would exceed those lost to the public.

3. Unavoidable impacts to grassbeds and other valuable submerged habitat may be mitigated through any means which will result in no net loss of grassbeds or other estuarine habitat. The method utilized (transplant, creation, etc.) will be determined in conjunction with the USFWS, FDNR, and FDER. The ratio for mitigation will be no less than 2:1.

4. Mitigation shall take place within the limits of an area stipulated by FDNR.

5. If seagrass mitigation is determined by FDER, FDR and USFWS not to be feasible other types of wetland vegetation may be substituted if deemed appropriate by FDER, FDNR and USFWS.

6. Agencies responsible for permitting activities having the potential to impact grassbeds and submerged habitats shall participate in an interagency conflict resolution process to ensure that permit applicants are not given conflicting or inconsistent permit conditions by different agencies for applications undergoing simultaneous review. This policy does not preclude permitting agencies from establishing additional or more stringent conditions to permits applied for, subsequent to the applicant's receipt of a permit from another agency.

MEASURES: The difference in the amount of grassbeds and other submerged habitat from one period to another.

Turbidity change in the estuarine system.

The existence of mitigative guidelines by FDER consistent with the policy approaches of FDNR and USFWS.

POLICY 41.3: Mosquito control practices that require habitat modification or manipulation should be avoided unless there is no reasonable alternative and failure to conduct such practices would result in a threat to public health. The following criteria shall apply in the implementation of this policy:

1. To the maximum extent possible, existing privately-owned mosquito control impoundments shall be managed for both pest control and fisheries habitat.

2. Impounding as a management practice should be a technique of last resort and only initiated after a thorough and exhaustive search has been made of alternative courses of action.

3. This does not preclude habitat modification which may be necessary for the reintroduction of existing impoundments into the estuarime system.

MEASURES: The change over time in the amount of land currently used for mosquito control impoundments.

The type and number of practices utilized in the region for mosquito control.

POLICY 41.4: Industrial marinas and port facilities shall be limited to areas of the coastal zone which are outside estuarine waters.

MEASURE: Absence of industrial marinas and port facilities inside the region's estuaries.

POLICY 41.5: The West Indian manatee shall be afforded protection from boating activities which may have an adverse impact upon the species. The following criteria apply in the implementation of this policy:

1. Marina operators shall undertake the following manatee protection measures in areas of manatee visitation within marina basins:

   a. Implement and maintain a manatee public awareness program (in consultation with FDNR) which will include the posting of signs to advise boat users that manatees are an endangered species which frequent the waters of the region's estuaries and lagoons and the provision of manatee literature at conspicuous locations;

   b. Declare the waters in and around marinas as "idle speed" zones; and

   c. Install floating display flags at entrance channels to warn boaters when manatees are known to be in the area.

   d. Post telephone number(s) to report on injured manatee.

2. Local manatee protection plans shall be included as part of the coastal zone element of the local comprehensive plan and be coordinated by adjacent jurisdictions. The plan should, at a minimum:

   a. Assess the occurrence of manatee activity within the jurisdiction;

   b. Document the number of manatee accidents and deaths;

   c. Identify manatee habitats;

   d. Determine the potential for adverse impacts to the manatee population from various activities (boating, etc.) and identify the level of protection necessary to ensure least possible interference; and

   e. Recommend local mitigative actions to be undertaken in support of the regional policy.

MEASURES: Reduction in the number of manatee deaths by boats and other activities.

Number of manatee protection plans developed.

MacClintock, L., R.F. Whitcomb, and B.L. Whitcomb. 1977. Island biogeography and "habitat islands" of eastern forest. II. Evidence for the value of corridors and minimization of isolation in preservation of biotic diversity. American Birds, 31(1):6-12.

Martin, R.A. 1974. Fossil mammals from the Coleman IIa fauna, Sumter County. In: Pleistocene mammals of Florida. University Presses of Florida, Gainesville, Florida. pp. 35-99.

Peroni, P.A. and W.G. Abrahamson. 1985. Vegetation loss on the southern Lake Wales Ridge. The Palmetto. 5(3):6-7.

Pritchard, P.C.H. (series editor). 1978. Rare and Endangered Biota of Florida. Volumes I - VI. University Presses of Florida. Gainesville, Florida.

Simberloff, D. 1982. Big advantages of small refuges. Natural History, 91(4):6-14.

_____ and J. Cox. 1986. Consequences of conservation corridors. Unpublished manuscript.

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Veno, P.A. 1976. Successional relationships of five Florida plant communities. Ecology, 57:498-508.

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Webb, S.D. 1974. Chronology of Florida Pleistocene mammals. In: Pleistocene Mammals of Florida. University Presses of Florida. Gainesville, Florida. pp. 5-34.

Whitcomb, R.F. 1977. Island biogeography and "habitat islands" of eastern forest. I. Introduction. American Birds, 31(1):3-5.

POLICY 43.1: Proposed activities which would destroy or degrade the function of wetlands or deepwater habitat shall not be permitted except where such activities are not contrary to the public interest and there is no practical alternative which reduces or avoids impacts to wetlands or deepwater habitat. Unavoidable losses of viable wetlands should be mitigated through the demonstrably successful restoration, creation or (where no other alternative is feasible) preservation of wetlands whose functional values are at least comparable to those of the wetlands lost. Wetlands mitigation should occur within the same watershed as the proposed impact to ensure that there is no net loss of wetland functional values within the drainage basin where the loss is to occur. Creation of new wetlands as mitigation should avoid impacts to ecologically valuable uplands including, but not limited to, bird nesting colonies, migratory wildlife corridors and rare or endangered ecosystems.

MEASURE: The percentage of wetland acreage remaining after 1987.

POLICY 43.2: Land use planning, development approvals and assignments of priorities for environmental preservation and protection programs should include consideration of the status of rare or endangered ecosystems as identified in State or regional lists or inventories. Natural community types assigned a State Element Rank of S1 or S2 by the Florida Natural Areas Inventory should be considered as rare or endangered until more quantitative inventories based on actual habitat acreage are available from the FGFWFC, RPC or other appropriate source.

MEASURES: The proportion of State, regional and local government agencies which have implemented policies or programs for considering the status of rare or endangered ecosystems in the preparation of land use plans, public acquisition programs and in development approval processes.

POLICY 43.3: Ecologically viable portions of natural upland plant communities, including but not limited to rare or endangered ecosystems, present on proposed urban development sites should be preserved and maintained in their original state, to the greatest extent practicable, within the open space requirements mandated by local governments. Both urban and agricultural landowners should be provided with economic incentives to conserve native uplands, including rare or endangered ecosystems, on their property, where appropriate.

MEASURE: The proportion of agricultural and urban development properties on which natural native uplands are conserved.

POLICY 43.4: Public conservation land acquisition programs should give the greatest consideration permissible by law to the selection of lands which appear on lists or inventories of rare or endangered ecosystems, but for which public use and recreation may not be appropriate.

MEASURES: The proportion of the acreage proposed for purchase on the acquisition priority lists of public conservation lands acquisition programs which is for rare or endangered ecosystems.

POLICY 43.5: The identification of habitat corridors which serve as biological connections between existing managed areas (i.e, parks, preserves, private conservation lands) should be given high priority by the FGFWFC, FDNR, FNAI and/or RPC. Once identified, public conservation land acquisition programs should give consideration to the acquisition of property where such connections are economically feasible and consistent with the ecological and/or species management objectives of the managed areas thereby connected. Property owners should be provided with economic incentives by State and local governments to participate voluntarily (e.g., in the form of conservation easements or transfers/purchases of development rights) in the formation of a habitat corridor system in order to minimize the amount of public acquisition necessary to safeguard habitat corridors.

MEASURE: The proportion of managed areas for which potential habitat corridors have been identified, and the proportion of identified corridors which have been established.

POLICY 43.6: Habitat corridors identified as important to the movement of non-avian wildlife by the FGFWFC, FDNR, FNAI and/or RPC should be protected, to the greatest extent practicable, from disturbances which would render the corridors unusable or dangerous to the species which frequent them. All levels of government should give consideration to the protection of such corridors in their comprehensive planning and development approval processes. Transportation agencies at all levels of government should avoid construction or improvement of transportation facilities which would adversely impact habitat corridors, and should mitigate unavoidable crossings through provision of appropriate "wildlife underpasses."

MEASURES: The proportion of local, regional and state government agencies which have adopted policies, procedures or programs for protecting habitat corridors.

MacClintock, L., R.F. Whitcomb, and B.L. Whitcomb. 1977. Island biogeography and "habitat islands" of eastern forest. II. Evidence for the value of corridors and minimization of isolation in preservation of biotic diversity. American Birds, 31(1):6-12.

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Whitcomb, R.F. 1977. Island biogeography and "habitat islands" of eastern forest. I. Introduction. American Birds, 31(1):3-5.

POLICY 44.1: Planning and approval of development projects shall avoid adverse impacts to species listed as endangered, threatened or species of special concern to the greatest extent practicable. Where suitable habitat on a project site is utilized by a listed species, a management plan designed to minimize harm to the species and its habitat should be prepared by the developer and adherence to the plan made a condition of development approval. Management plans should be reviewed and approved by the appropriate State agency (FGFWFC for upland and freshwater species, FDNR for marine species) prior to their approval by local governments.

MEASURE: The proportion of development sites utilized by listed species for which management plans are implemented.

POLICY 44.2: All levels of government shall support the protection of critical habitat for endangered and threatened species to the maximum extent feasible. "Critical habitat" shall include those habitat types, or specific geographical locations, which are designated as such by the USFWS, NMFS, FGFWFC, FDNR, FDACS, or the RPC. The RPC shall serve as a data clearinghouse for information on critical habitat designations and shall provide this information to local governments and the general public.

MEASURES: The proportion of state, regional and local government agencies which provide meaningful support to the protection of designated critical habitats.