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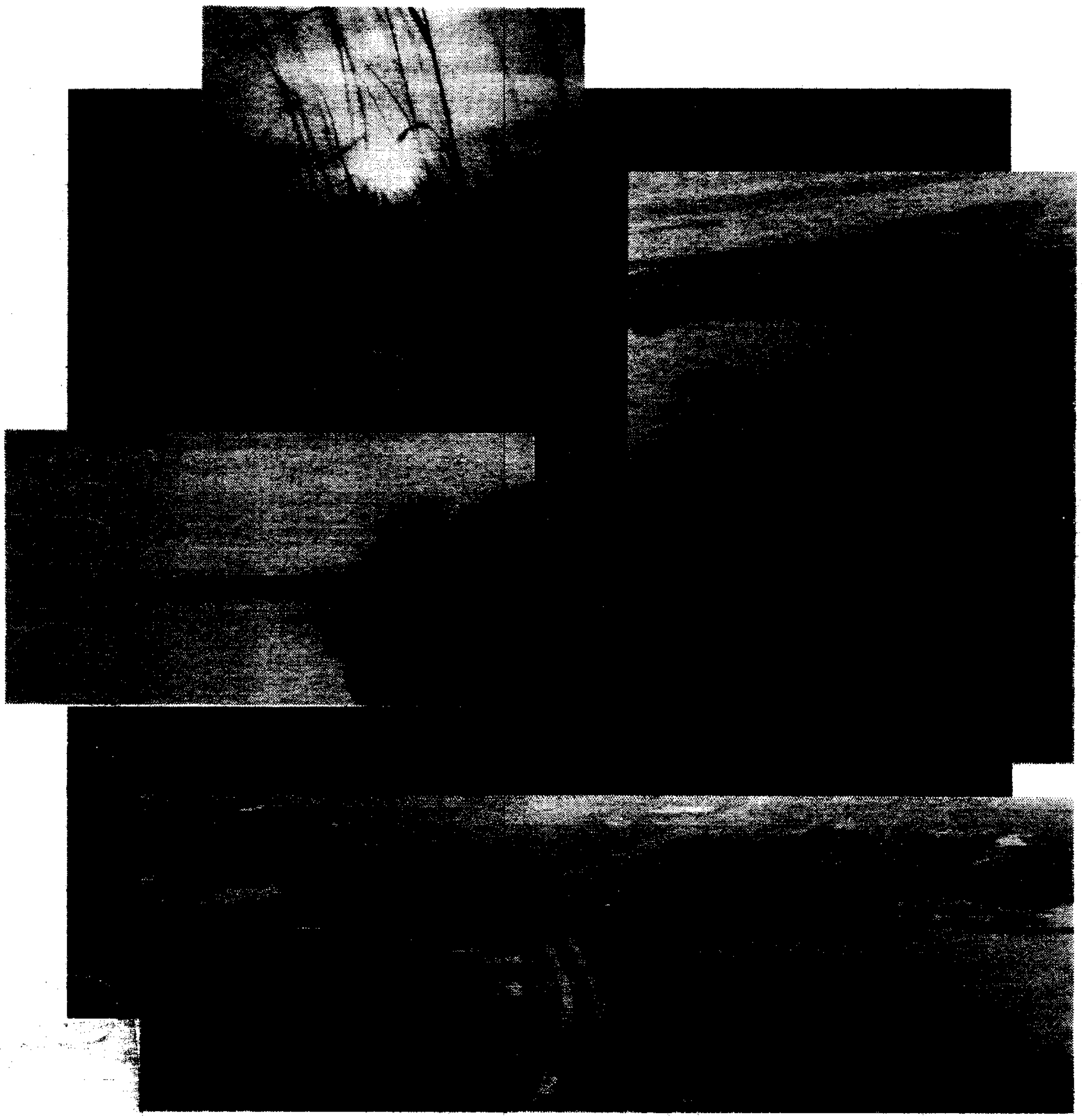
Task 3.15

FLORIDA

CM-124

Ecological Assessment, Classification and Management of Tampa Bay Tidal Creeks



tampa bay regional planning council

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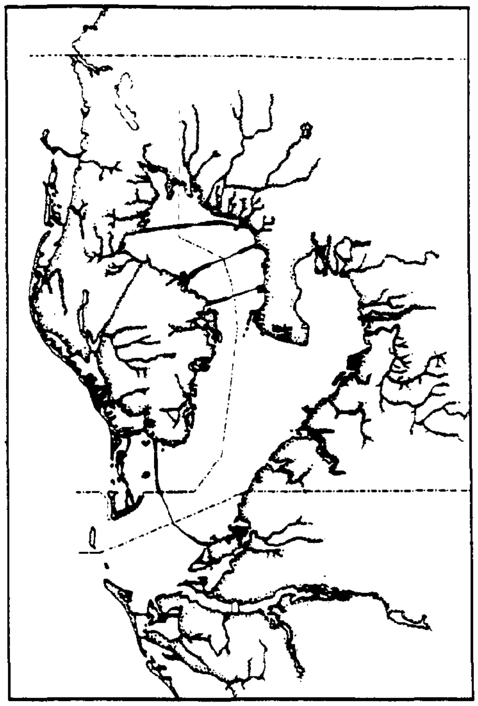
Ecological Assessment, Classification and Management of Tampa Bay Tidal Creeks



September 18, 1986

Tampa Bay Regional Planning Council
9455 Koger Boulevard
St. Petersburg, Florida 33702

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INTRODUCTION

Tampa Bay is one of the largest estuaries in the world (400 square miles) with 1.5 million people now living in the three counties bordering its shores. This represents a 45 percent population increase since 1970. Rapid urban and industrial development have radically changed the character and ecology of Tampa Bay and adjacent estuarine systems. For example, recent studies have indicated that 44 percent of the original 25,000 acres of mangroves and marshes have been destroyed, and 81 percent of the original 76,500 acres of seagrasses have disappeared. Many of the tidal tributaries entering Tampa Bay have been filed, diverted, hardened, channelized, or otherwise modified by point and non-point source discharges. This habitat loss has resulted in declining populations of commercially valuable fish and shellfish, including a complete collapse of such fisheries as those for scallops and oysters, and major declines for bait shrimp, red drum, and spotted sea trout.

In addition, the provision of adequate quantities of freshwater to Tampa Bay is critical to its function as a productive estuary. The water must be provided at ecologically relevant times, and be relatively free of contaminants. At present, every river and many minor tributaries flowing to Tampa Bay are either dammed, tapped for cooling water, or have modified draining patterns. Development pressures and demands for potable water are immense and increasing, meaning that the basic estuarine character of Tampa Bay is endangered.

Minor tributaries, or tidal creeks, flowing to Tampa Bay vary greatly in condition. Historical and anecdotal evidence exist to show that these streams were immensely productive estuarine zones. Modern data on relatively pristine tidal creeks support this view. Although little is known regarding the ecological condition of the majority of the minor tributaries entering Tampa Bay, the following conclusions are relevant to the study and management of these systems:

- Tidal creeks provide critically important habitat for the majority of economically important species of fish found in the Gulf coastal waters

- A comprehensive study or summary statement has never been accomplished for the condition of rivers and creeks flowing to Tampa Bay, or of their individual management problems

- The various tributaries of Tampa Bay are naturally and culturally different, and each has unique problems as well as problems common to other streams

- Eventual management of each tidal creek as an ecological unit will have to involve several levels of government and authority

- Although several streams among those considered are highly stressed, more are natural or are still restorable

- Population growth threatens all bay tributaries and unless actions are taken before 1990 more streams will be irrevocably stressed by the year 2000.

This study was funded by the Florida Department of Environmental Regulation (FDER) Coastal Zone Management Program with direction to undertake an ecological assessment of selected minor tributaries entering Tampa Bay. The purpose of this funding was to develop a cooperative resource management/restoration plan for each tributary and its associated watershed. The ecological assessment, classification and management study is an outgrowth of, and is consistent with, The Future of Tampa Bay (TBRPC, 1984) a comprehensive management plan for Tampa Bay, as well as the ongoing Council study entitled the Tampa Bay Regional Habitat Restoration and Management Study.

A total of 44 minor tributaries within the Tampa Bay Region were classified by condition based upon a review of available land use, habitat and water quality data in the tidal segment of each creek. Each tidal tributary was subjectively classified into natural, restorable or stressed condition. A summary of conditions within each tidal creek is included in Table 1 (Page 68).

Following a literature review and classification of all tidal creeks, one representative tributary from each county was chosen for the ecological assessment. Selected tidal tributaries included:

- Allen Creek in Pinellas County
- Delaney Creek in Hillsborough County
- Frog Creek in Manatee County.

The selected tidal creeks were studied with respect to hydrographic features, biology and chemistry, and physical and chemical alterations. Allen Creek represented a minor tributary through a largely urbanized area with the major land use being residential and commercial. Delaney Creek represented a system through an industrialized, urban, and agricultural area with rapid urbanization taking place. Frog Creek was selected because it is representative of a system through an agricultural-rural watershed with little alteration in the estuarine portion of the creek. The ecological assessment was completed through contract services with Environmental Science and Engineering, Inc.

A series of public workshops were held using the information derived from the environmental assessment to develop a management/restoration plan for each selected tributary. In addition, the management/restoration plan (framework found in Table 64, Pages 116 and 117) was further applied to each condition (natural, stressed and restorable) as a test for consistency.

The final product is a detailed restoration and management plan for three minor tributaries in the Tampa Bay watershed and one general application. It is the intent of the Council to implement all elements of the four plans wherever feasible during Developments of Regional Impact (DRI's) and Intergovernmental Coordination and Review (IC&R) reviews and through coordination with the DNR gill-net license fee habitat restoration program, as well as local government initiatives. The efforts of the Council's Agency on Bay Management will also be critical in implementing the findings and recommendations of this project.

1.0 IDENTIFICATION AND CLASSIFICATION OF MINOR TRIBUTARIES

1.1 The Importance of Tidal Creeks

Tributaries maintain the estuarine character of Tampa Bay. The importance of rivers and lesser streams to estuaries has been documented by studies throughout the world. Tributaries channel and deliver freshwater and food sources to the estuary system. In addition, the rivers and streams provide crucial habitat, protective cover, and feeding grounds for the early life history stages of marine and estuarine life forms.

The importance of freshwater flow into the bay is often overlooked. More than 60 years of marine research (Gunter 1961, 1967) has shown conclusively that low salinity estuarine water combined with the physical protection and energy sources supplied by marine plants constitutes the primary nursery habitat for most of the commercially and recreationally important fish and shellfish species in the Gulf of Mexico (Lewis and Estevez, 1986).

In addition, freshwater must be allowed to enter the estuary naturally and during ecologically relevant times in quantities necessary to lower salinities within vegetated habitats. The discharge of freshwater directly into unvegetated areas will reduce salinities without permitting the life forms to utilize the lowered salinities for critical habitat. Lewis and Estevez (1986), hypothesize that the tidal brackish to tidal freshwater marshes dominated by black needlerush mixed with freshwater plants located in the upper portions of tidal creeks and streams such as Double Branch Creek and the Alafia, Little Manatee, Manatee and Braden Rivers ultimately will be identified as some of this critical nursery habitat.

A major component of critical habitat is its wetland system. In addition to the habitat function, wetlands promote:

Environmental Quality
- Maintenance of Water Quality
  - o Pollution Filtration
  - o Sediment Removal
  - o Oxygen Production
  - o Nutrient Recycling

o Chemical and Nutrient Absorption

- Aquatic Productivity
- Microclimate Regulation

Socio-Economic Values

- Flood Control
- Wave Damage Protection
- Erosion Control
- Groundwater Recharge and Water Supply
- Timber and Other Natural Products
- Energy Source (Peat)
- Livestock Grazing
- Fishing and Shellfishing
- Hunting and Trapping
- Recreation
- Aesthetics
- Education and Scientific Research

Isolated and flood plain wetlands within tributary watersheds may temporarily store runoff or slow the flow of water downstream (Figure 1). Potentially this will reduce floodpeaks and the frequency of flooding to downstream areas.

Wetlands can improve, to varying degrees, the quality of water that flows over and through them. This function is accomplished by temporary or permanently retaining pollutants, such as suspended solids, excess nutrients, toxic chemicals, and disease-causing micro-organisms (OTA, 1984). Some pollutants that are trapped in wetlands may be converted by biochemical processes to less harmful forms. Some pollutants may remain buried; others may be taken up by wetland plants and either recycled within the wetland or transported from it. By temporarily delaying the release of nutrients until the fall, wetlands may help prevent excessive algae growth in open-water areas in the spring, when nutrient availability from other sources is typically high. Wetlands can retain nutrients on a net annual basis and have been used successfully for secondary treatment of sewage effluents.

The wetland vegetation systems significantly can reduce shoreline erosion created by large waves and coastal flooding. Acting as baffles, roots and leaves bind and stabilize the sediments. This characteristic is documented by reports of some coastal marshes surviving the destructive scouring forces of coastal storms and hurricanes in the Gulf States.

Coastal marshes and wetlands achieve some of the highest rates of plant productivity of any natural ecosystem (Figure 2). Although direct grazing of wetland plants is generally limited, their major food value is reached upon death when plants fragment to form detritus. This detritus forms the base of an aquatic food web which supports higher consumers, like commercial fishes (Figure 3). This relationship is especially well documented for coastal areas. Organisms, like shrimp, snails, clams, worms, killifish and mullet, eat detritus or graze upon the bacteria, fungi, diatoms and protozoa growing on its surfaces (Crow and MacDonald, 1979; de la Cruz, 1979). Many of these animals are the predominant food for commercial and recreational fishes. Thus wetlands can be regarded as the farmlands of the aquatic environment where great volumes of food are produced annually.

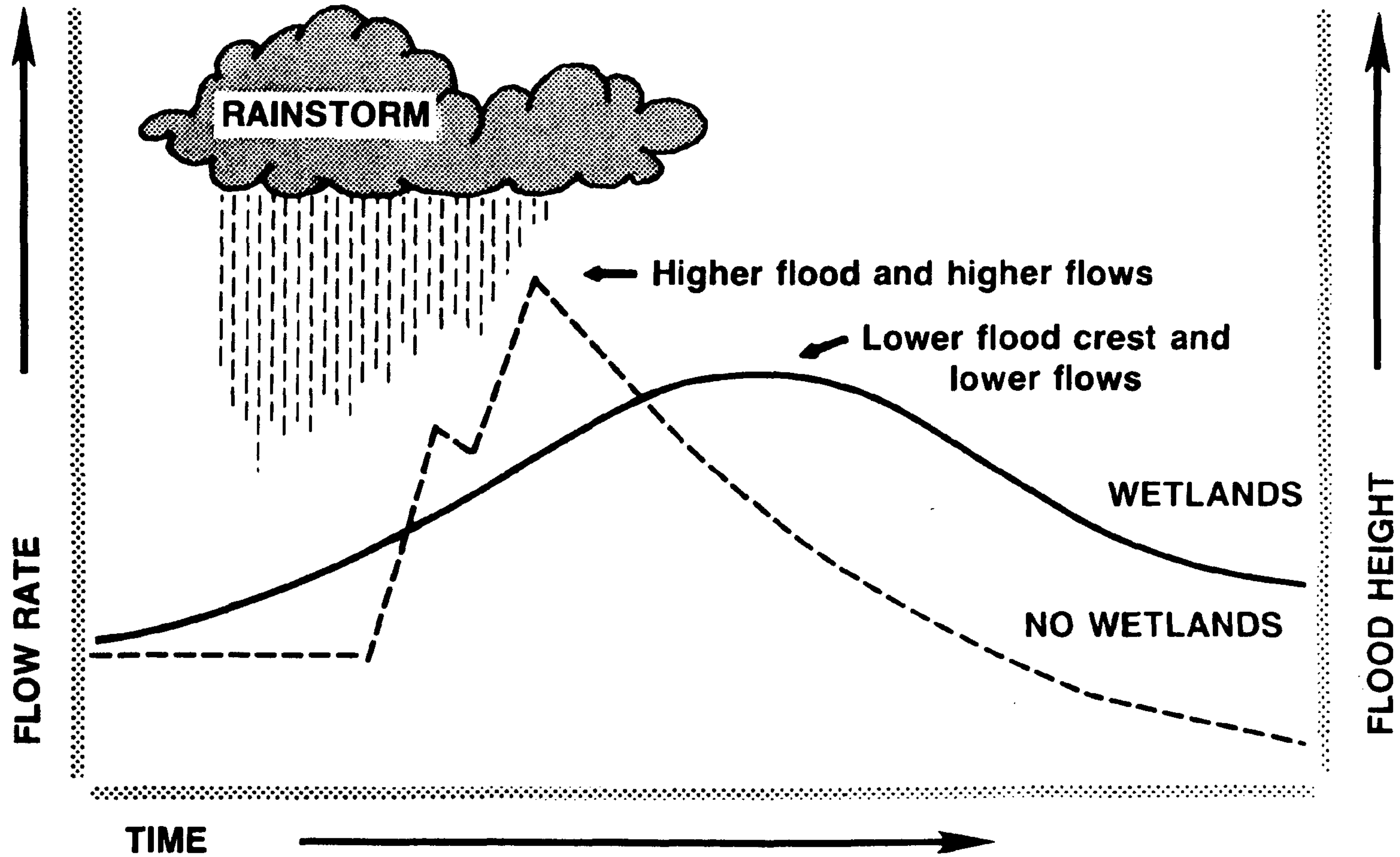


Figure 1. Wetland value in reducing flood crests and flow rates after rainstorms (adapted from Kusler, 1983)

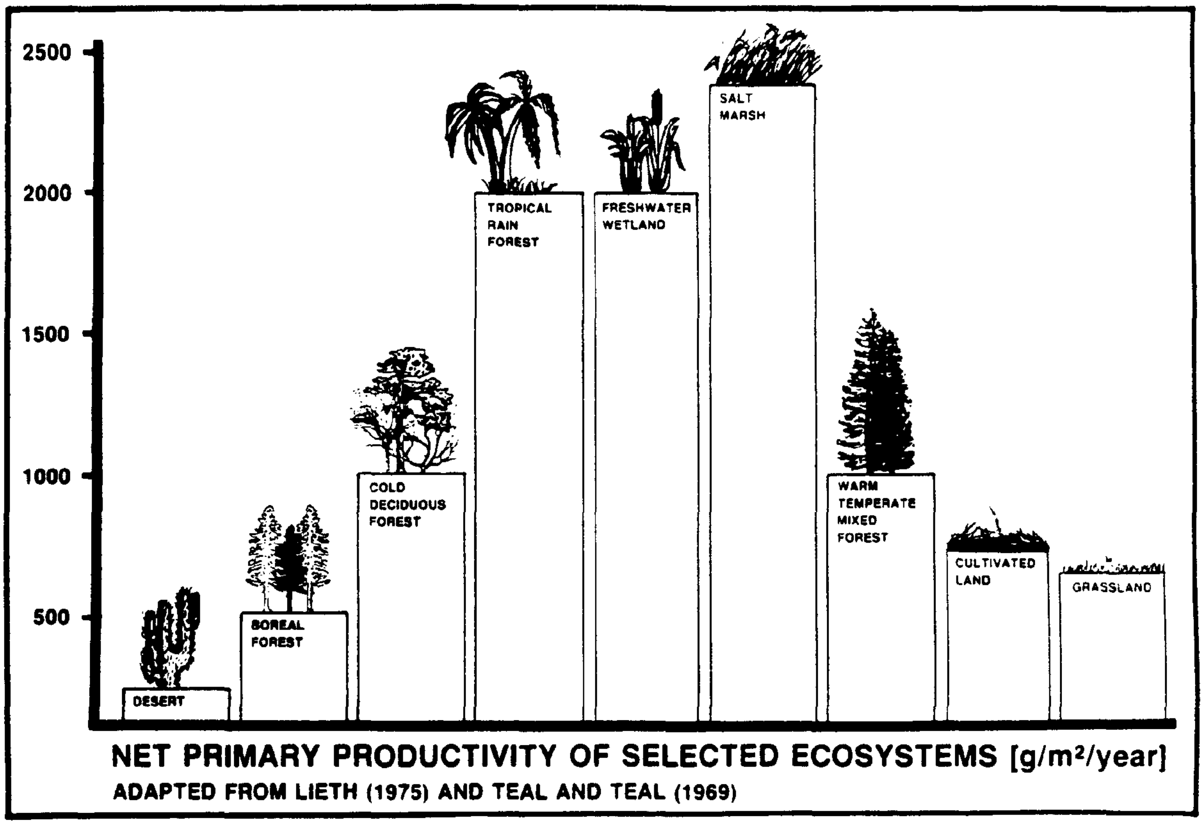


Figure 2. Relative productivity of wetland ecosystems in relation to others (Newton, 1981, in Tiner, 1984)

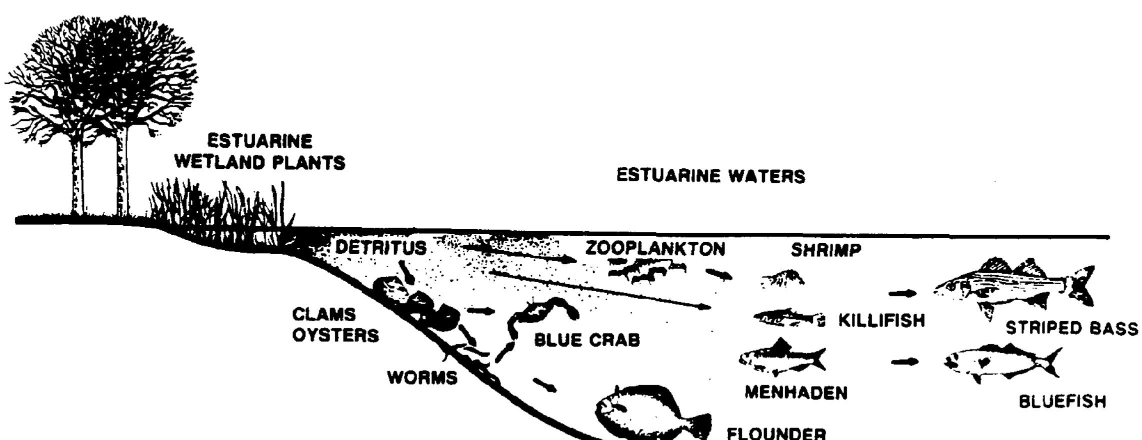


Figure 3. Simplified food pathways from estuarine wetland vegetation to commercial and recreational fishes (Tiner, 1984)

Tidal creeks function as critical habitat by providing protective cover, feeding and breeding grounds for many commercially important species of fish and wildlife. In understanding the role of tributaries as fishery habitat it is important to first understand the life history of those species of concern. Figures 4-7 illustrate the life history of snook, tarpon, redfish, and pink shrimp in relation to which habitats are utilized. Several things are apparent from these figures as described by Lewis, et al. 1985. First, all of the species are near-shore oceanic spawners. Secondly, all use a multitude of habitats throughout their life cycle (i.e., none spend their entire lives in mangroves). Thirdly, all of the species show a preference for a low salinity nursery habitat that often includes marshes or mangroves at the upper limit of tidal influence in tidal freshwater streams.

Gilmore et al. (1983), identified peripheral tidal freshwater streams draining into salt marshes as the prime nursery habitat for snook in the Indian River. Figure 8 represents monthly length frequency distribution for 1167 snook (Centropomus undecimalis) and habitat types where collection occurred. Figure 9 identifies juvenile snook migration and their association with various habitats and subsequent changes in food items consumed.

Gilmore et al. (1983) reiterated the opinion of Marshal (1958), "in that loss of habitat and general degradation of water quality has undoubtedly had a more permanent and therefore greater effect on reducing snook population than the fishery." Lewis et al. (1985) further described the complex use of several habitats during a life cycle as a "habitat mosaic."

> "Like a puzzle it is only functional when all the pieces are present. If only one of the key habitats is altered or removed, it can effectively stop the cycle and reduce or eliminate the recruitment of juveniles to the adult population, and thus reduce the available harvestable adult population. This fact and the general ignorance of the complexity of the life histories of these species has led to an overemphasis on certain management practices (e.g. bag limits for snook) while others are largely ignored (e.g. protection of tidal freshwater stream habitats)."

The loss of nursery habitat is reflected by a decrease in the harvestable adult population. Figure 10 identifies the decreasing trend in Florida landings of shrimp over 30 years. Figure 11 portrays the Florida landings of commercial marine products over the same time period. The direct value of the trend is reflected by an increase in the monetary value of commercial marine landings (Figure 12), for the same time frame as dictated by supply and demand. Figure 13 identifies the value of harvested species in 1977. Future demand on harvestable species will continue to pressure remaining stocks and may lead to the increase in foreign imports of saltwater fishery products.

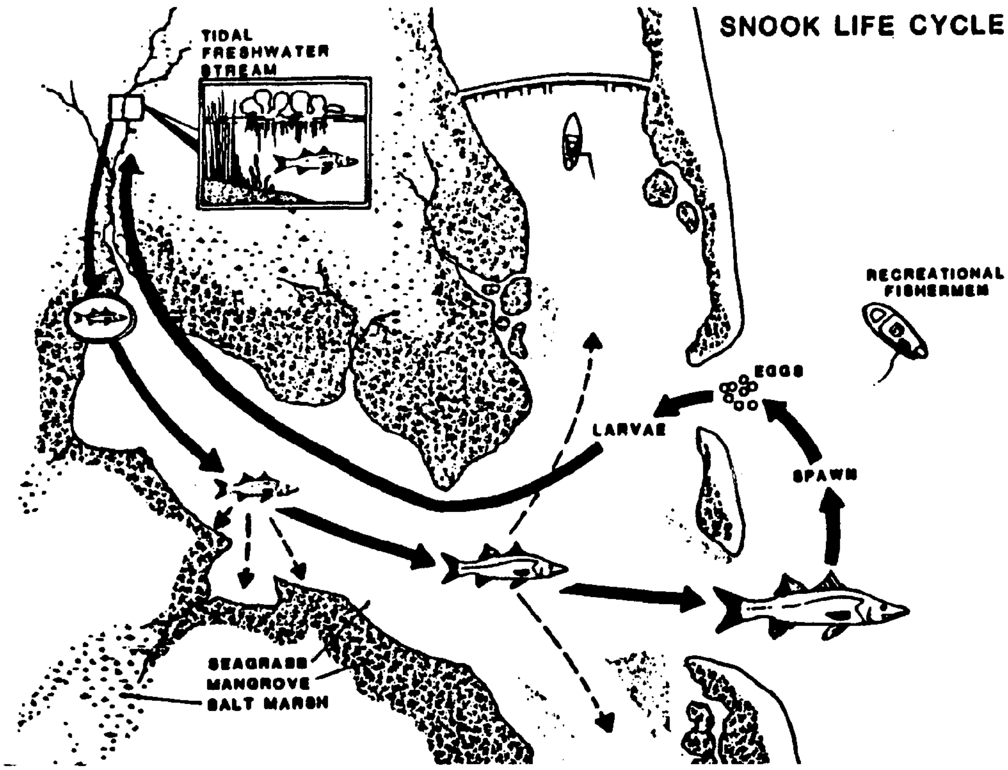


Figure 4. Life cycle of the snook (<u>Centropomus</u> <u>undecimalis</u>) (Lewis, et. al., 1985)

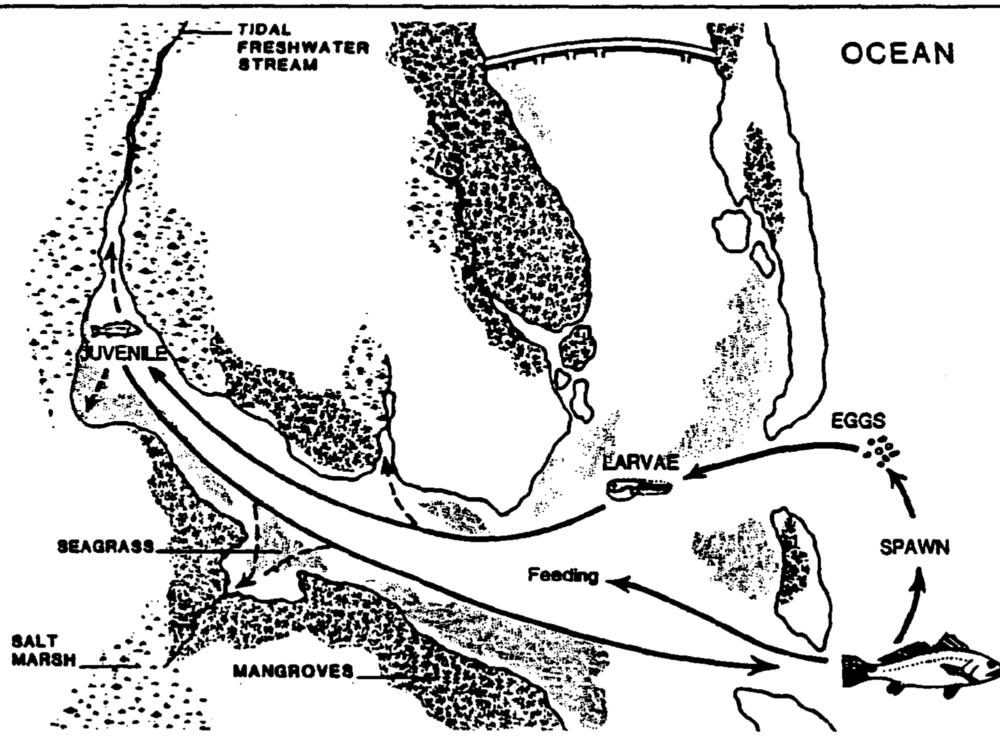


Figure 5. Life cycle of the redfish (<u>Sciaenops</u> <u>ocellatus</u>) (Lewis, et. al., 1985)

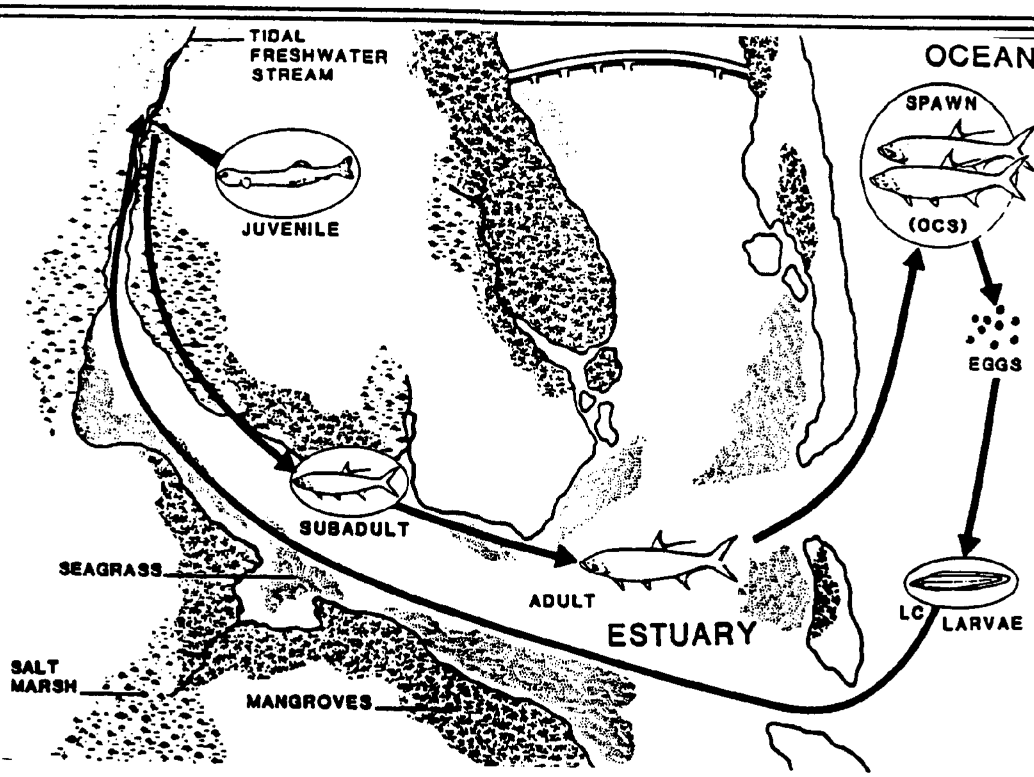


Figure 6. Life cycle of the tarpon (Megalops atlantica)
(Lewis, et. al., 1985)

OCS OUTER CONTINENTAL SHELF

LC LEPTOCEPHALUS

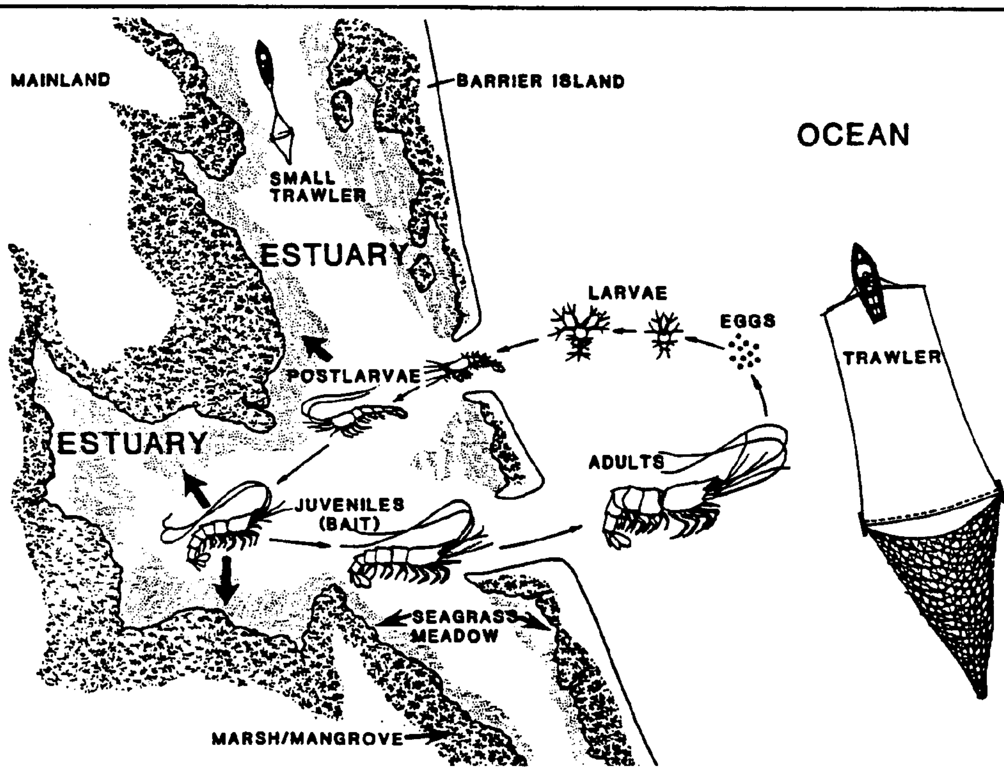


Figure 7. Life cycle of the pink shrimp (Lewis, et. al., 1985)

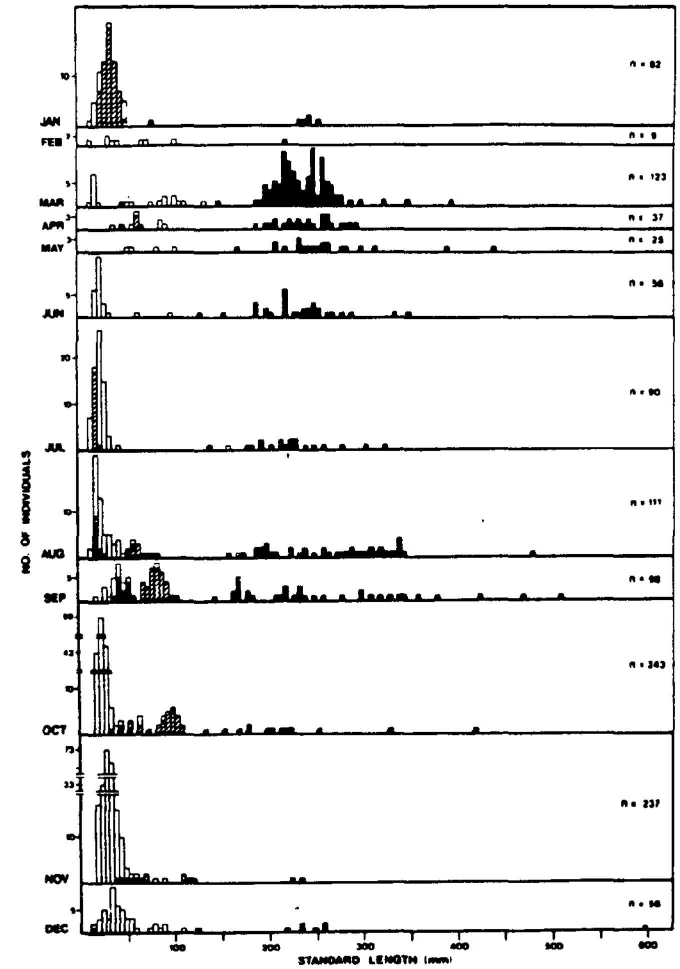


Figure 8. Monthly length frequency distribution for 1167 *Centropomus undecimalis* for which length measurements were taken, 1974-1980. ■ = seagrass beds; □ = fresh water; ▩ = marsh **(Gilmore, et. al., 1983)**

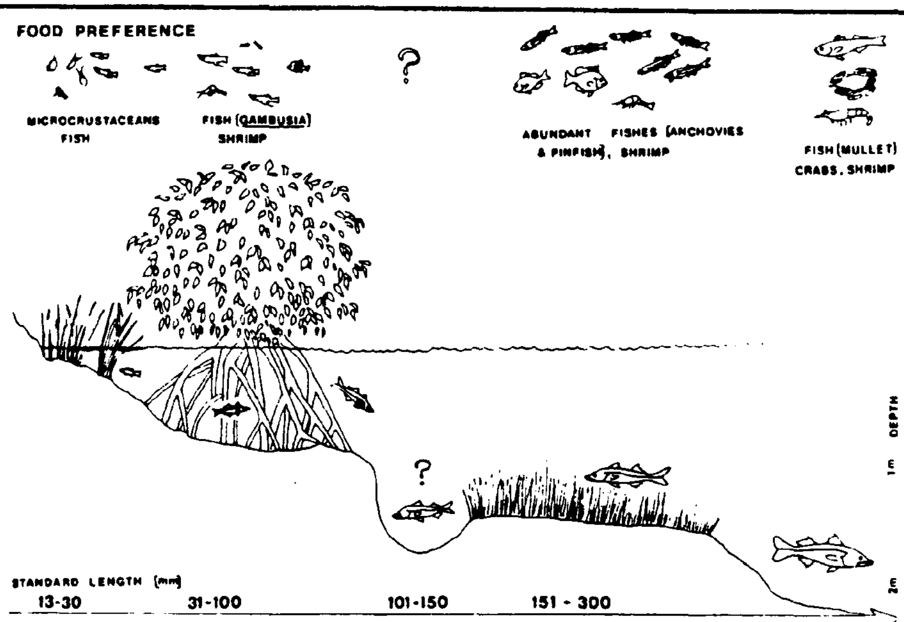


Figure 9. Schematic representation of juvenile snook migration and association with various habitats and subsequent changes in food items consumed. **(Gilmore, et. al., 1983)**

Figure 10. Florida landings of shrimp, 1952-1982 (Lewis,et. al., 1985)

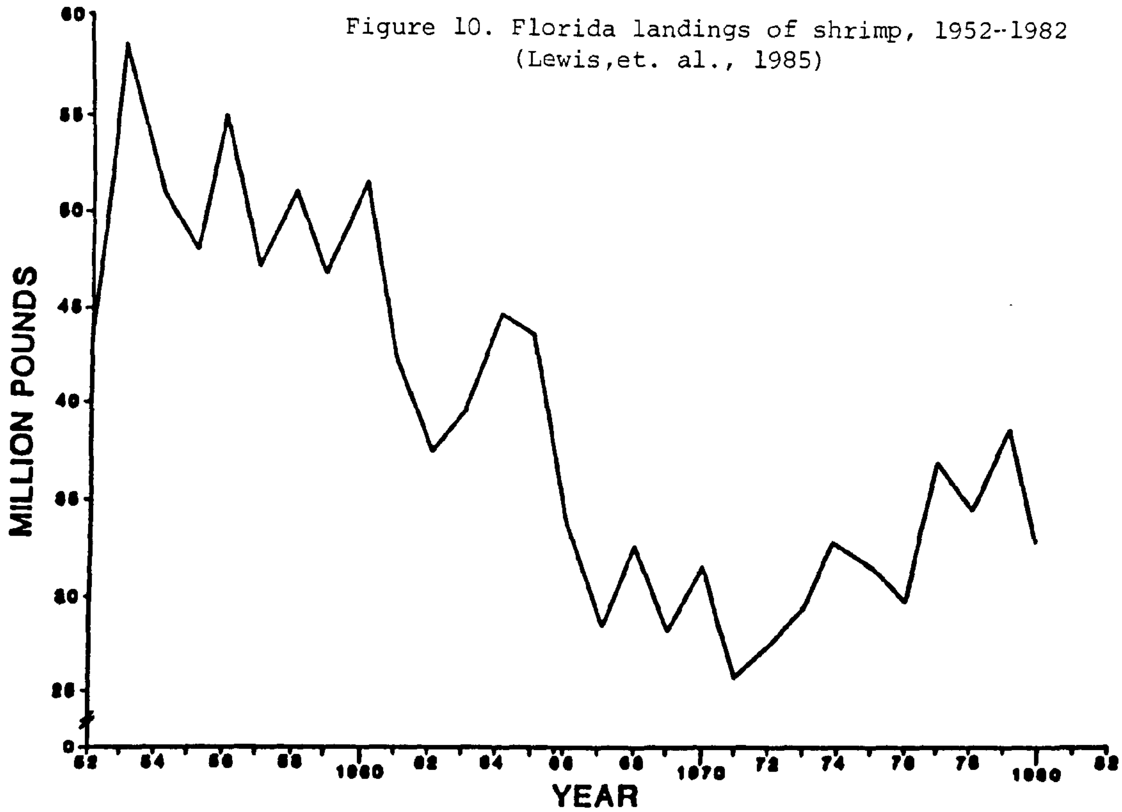


Figure 11. Florida landings of commercial marine products, 1952-1982 (Lewis, et. al., 1985)

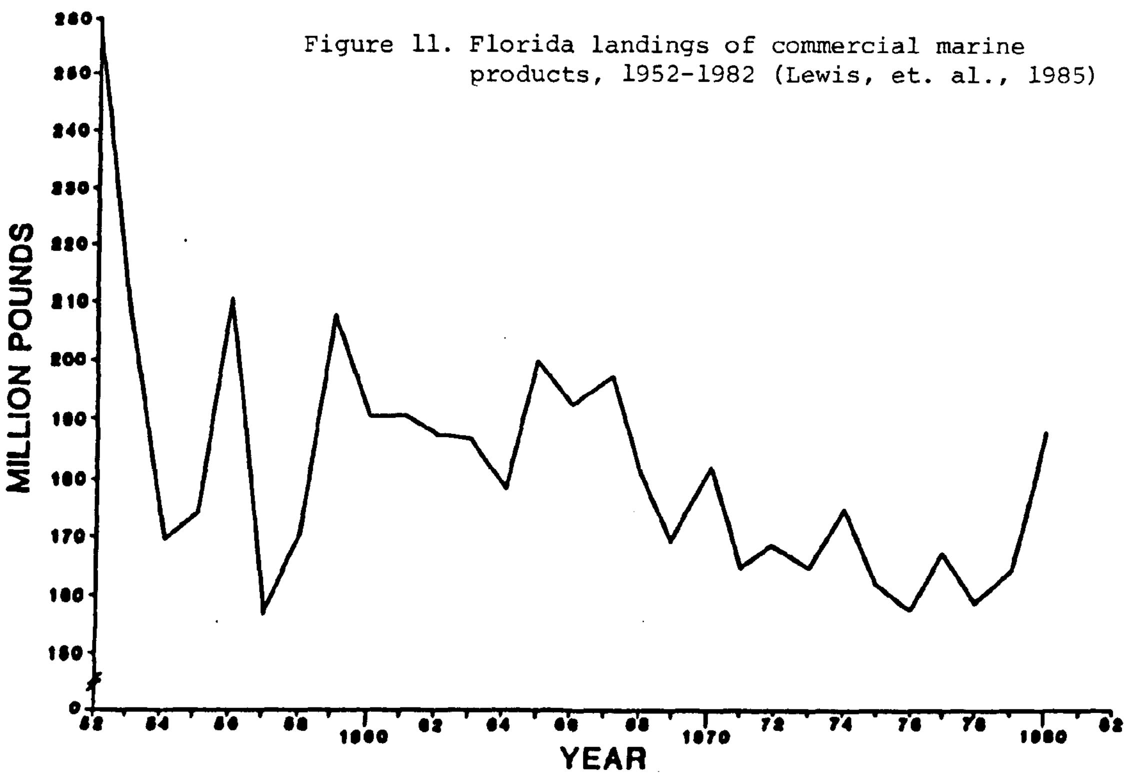


Figure 12. Value of Florida commercial marine landings, 1952-1982 (Lewis, et. al., 1985)

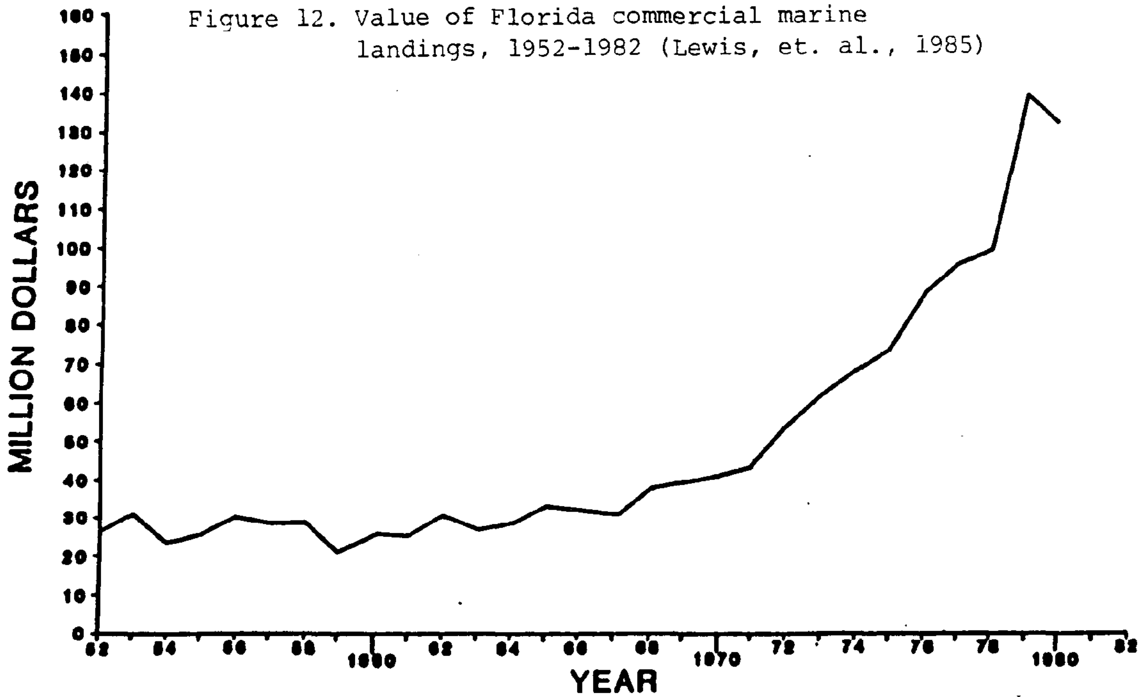
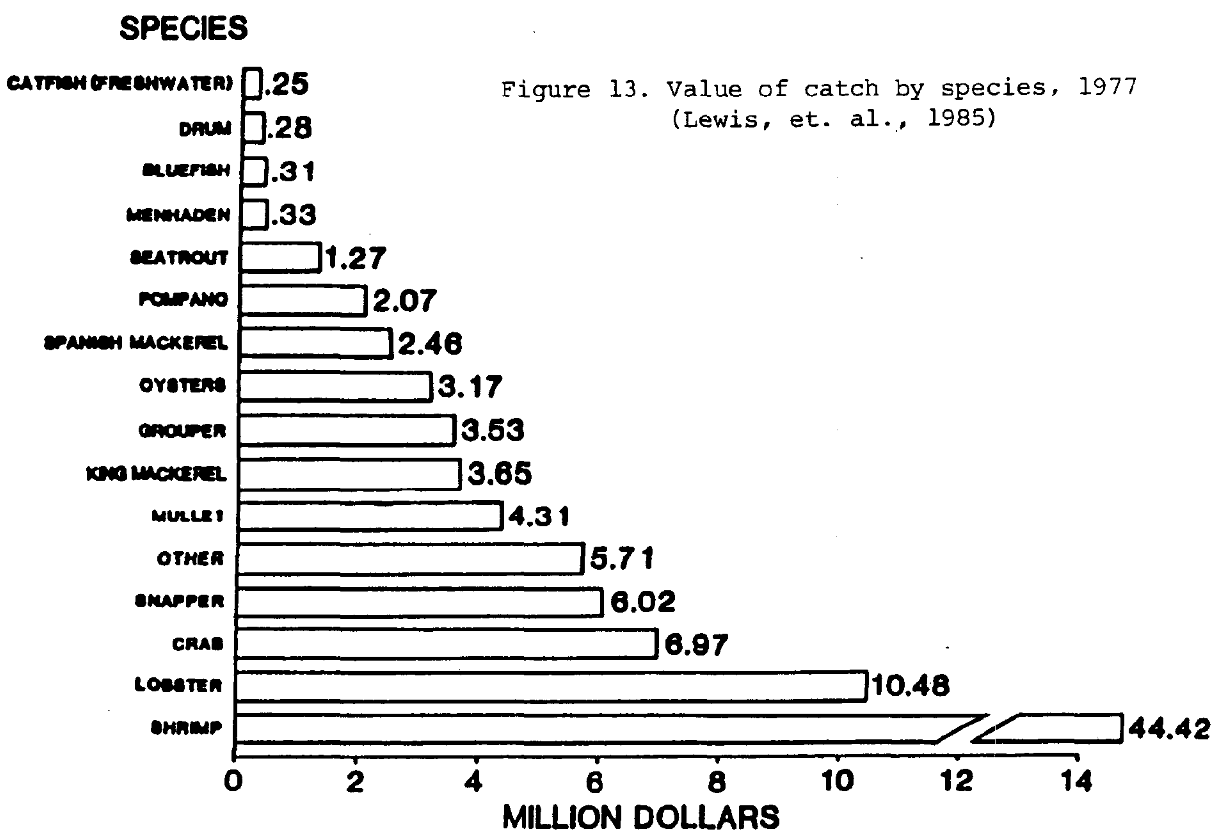


Figure 13. Value of catch by species, 1977 (Lewis, et. al., 1985)



In order to reverse this unappealing trend, it is vital to improve juvenile stock populations by managing the critical habitat necessary for the maintenance of the species. Management or restoration of the tidal tributaries to Tampa Bay can prevent further degradation to the nursery area critical for adult fish and shellfish populations. Rivers and tidal creeks are vulnerable to numerous impacts which also become evident downstream in terms of decreased estuarine productivity. Examples include hydroperiod alterations through excess drainage or impoundments; loss of corridor by damming; changes to stream loads by increasing runoff or discharging pollutants, and diverting or preventing flows; increased relief and habitat losses through dredging and filling; and contamination through disposal of toxic materials. As rivers and creeks deteriorate, their ability to buffer cultural shocks to the estuary are lost.

Rivers and creeks flowing into Tampa Bay vary greatly in condition. While basic information on tidal tributaries is lacking, enough exists to allow important ones to be classified by their overall condition from a management point of view. The type of classification to be used includes natural, restorable, and stressed. "Creeks" are defined as small streams of the Pamlico Terrace in which tidal prisms are equal to or larger than average discharge. Figure 14 identifies the classified minor tributaries and location within the Tampa Bay Region. All classifications are based on conditions within the tidal segment of each stream. For the purposes of this report, the extent of tidal influence is determined by the transition of brackish to freshwater vegetation communities. Land use adjacent to each creek is identified to further characterize condition and potential impacts.

Linear creek length is calculated using a Charvoz planimeter averaging three replicate measurements. Creek characterization is based upon historical literature, aerial photography and 1:24,000 quadrangles.

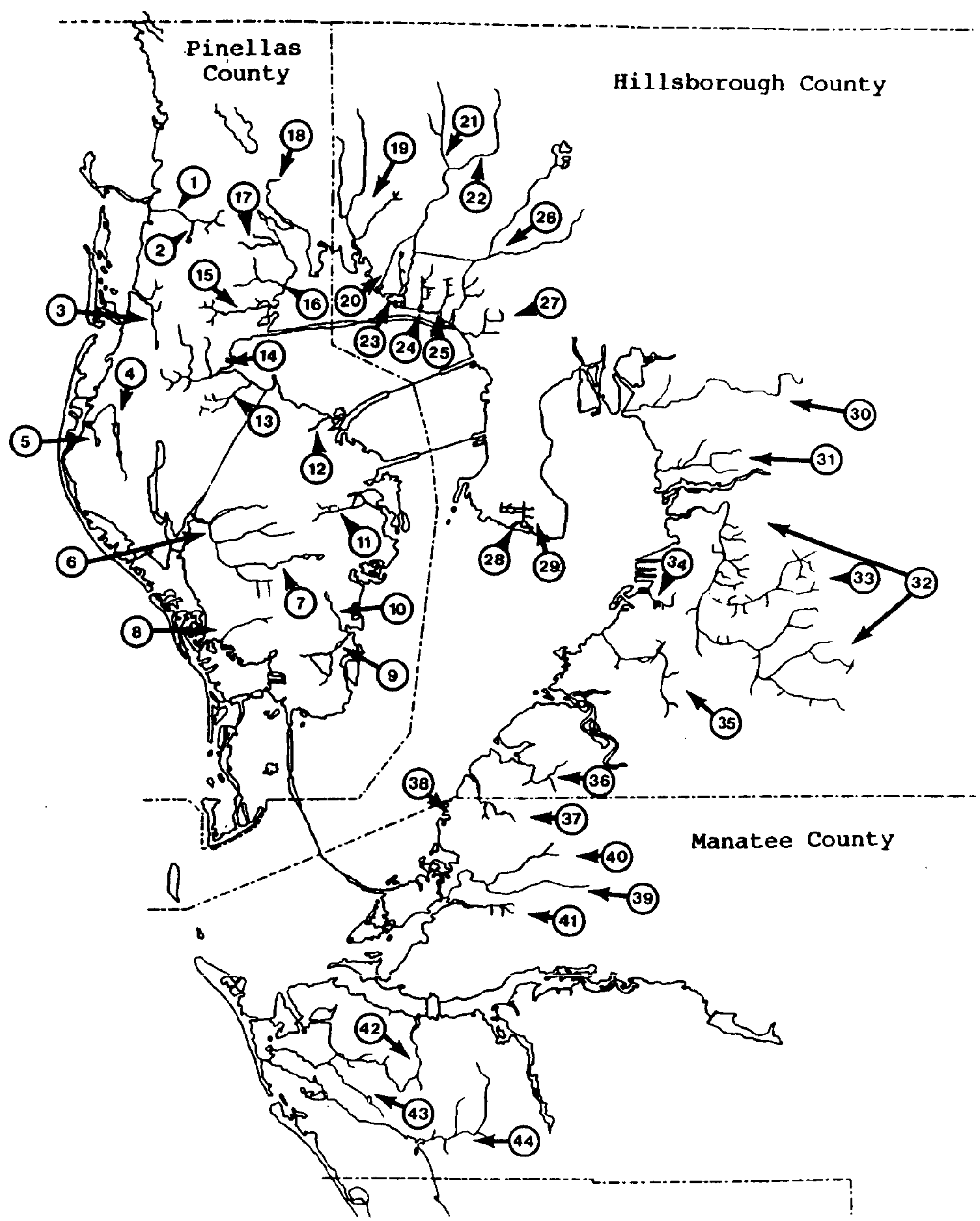
1.2 Curlew Creek and Jerry Branch

Just north of the City of Dunedin, in Pinellas County, and draining into St. Joseph's Sound lies Curlew Creek (Figure 15). Curlew Creek travels approximately four miles with a channel slope ranging from about 60 feet/mile (ft/mi) at the headwaters to less than five ft/mi near the mouth. Flow at the creeks mouth is estimated at 20 cubic feet per second (cfs) (Cherry et al. 1970).

The mouth of Curlew Creek has been hardened and channelized by residential development. Boating access is available to adjacent residential units but is limited by shoaling of the creek upstream. The middle and upper segments contain a forested floodplain with adjacent areas being predominantly urban residential with intermixed agricultural use and open space.

Jerry Branch bisects Curlew Creek at the confluence. The branch travels approximately 2.4 miles from Lake Jerry to Curlew Creek and has a south to north alignment. Jerry Branch is channelized for flooding control and is surrounded by residential development with smaller parcels of open space. Adjacent to the perimeter of Jerry's Lake are orchards, freshwater marsh systems and forested areas.

Figure 14. Location of classified minor tidal tributaries in the Tampa Bay region



Pinellas County

1. Curlew Creek
2. Jerry Branch
3. Stevenson Creek
4. McKay Creek
5. Church Creek
6. Joe's Creek
7. St. Joe's Creek
8. Bears Creek
9. Salt Creek
10. Booker Creek
11. Tinney Creek
12. Grassy Creek
13. Long Branch Creek
14. Allen's Creek
15. Alligator Creek
16. Mullet Creek
17. Bishop Creek
18. Moccasin Creek

Hillsborough County

19. Double Branch Creek
20. Channel A
21. Rocky Creek
22. Brushy Creek
23. Dick Creek
24. Woods Creek
25. Peppermound Creek
26. Sweetwater Creek
27. Fish Creek
28. Coon Hammock Creek
29. Broad Creek
30. Delaney Creek
31. Archie Creek
32. Bullfrog Creek
33. Little Bullfrog Creek
34. Newman Branch
35. Wolf Branch
36. Cockroach Creek
37. Piney Point Creek

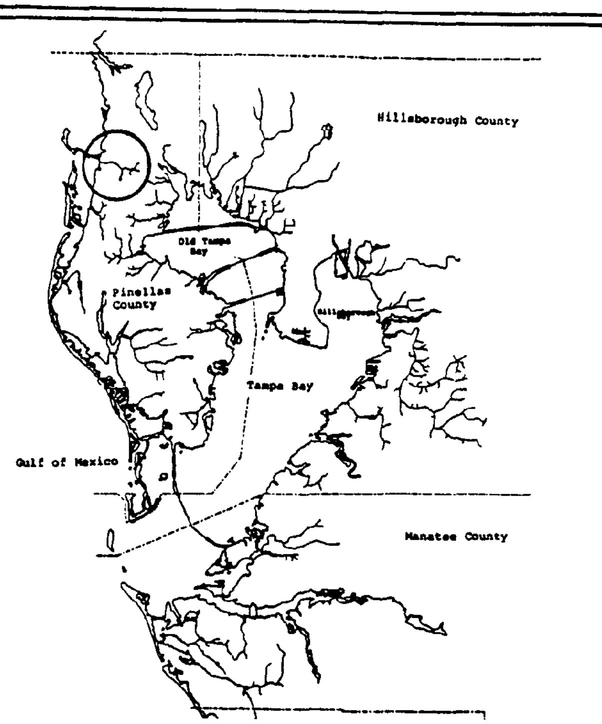
Manatee County

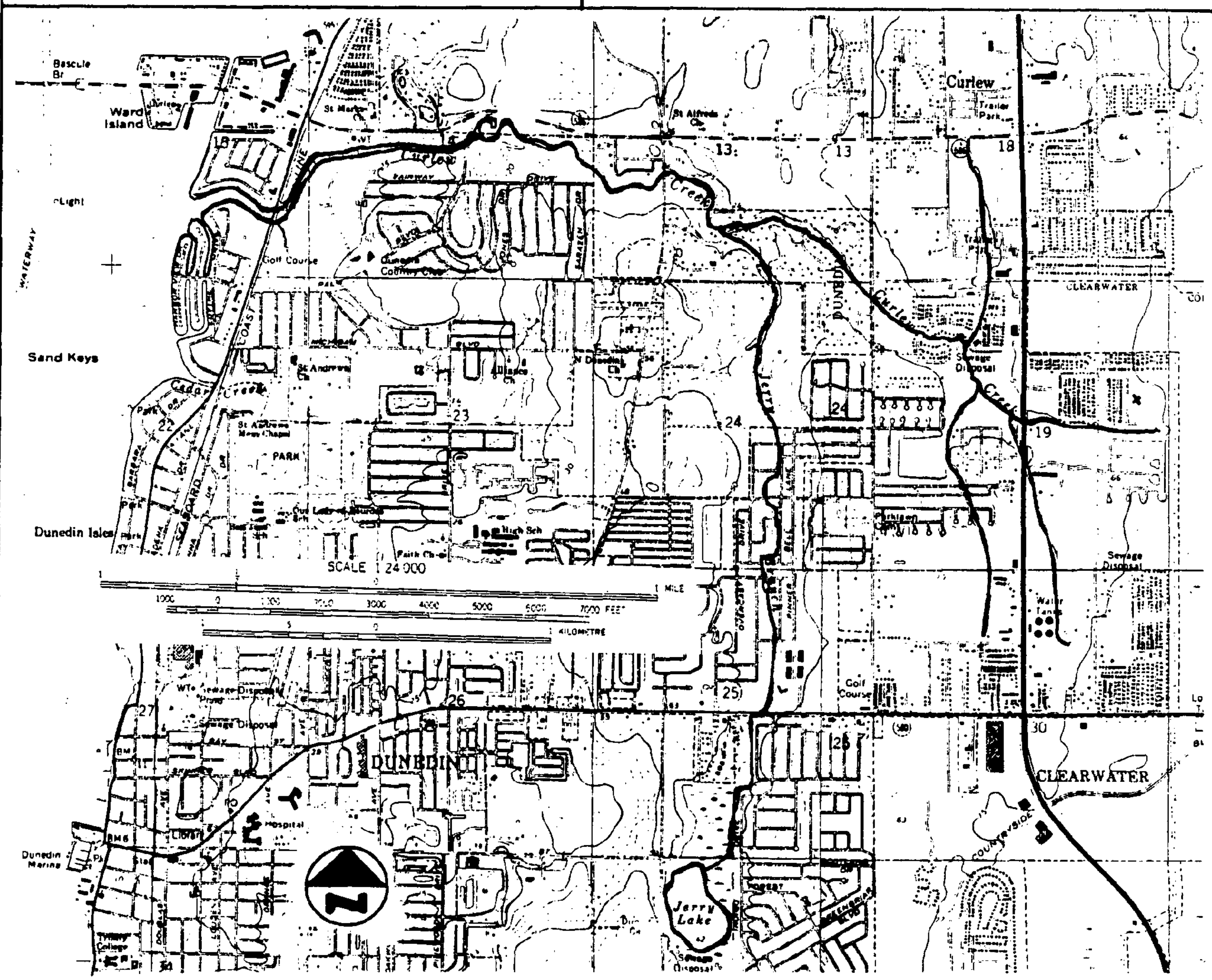
38. Redfish and Little Redfish Creek
39. Frog Creek
40. Cabbage Slough
41. McMullen Creek
42. Wares Creek
43. Palma Sola Creek
44. Bowles Creek

Figure 15.

Curlew Creek and Jerry Branch

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





Water quality in Curlew Creek is influenced by six point source discharges and by non-point source stormwater runoff. The largest point source is Greenbriar Service Corporation which discharges 38.1 milligrams per liter (mg/l) of 5-day biochemical oxygen demand (BOD-5) (ESE, 1977). Dissolved oxygen concentrations exceed 6.6 mg/l downstream from point source discharges (Schomer et al. 1984).

Point source discharge and stormwater runoff continue to moderately impact water quality within Curlew Creek and Jerry Branch. The tidally influenced portion of Curlew Creek is hardened and channelized for development with little potential for restoration. Therefore Curlew Creek is characterized as a stressed tidal tributary.

1.3 Stevenson Creek

Entering Clearwater Harbor north of Clearwater is Stevenson Creek (Figure 16). The area northeast of Clearwater drains south through an unnamed creek that empties into Stevenson Creek 0.6 miles upstream from its mouth. The eek travels to the north and northwest for approximately four miles to the mouth. The lower segment is tidally influenced and flow at the mouth averages 20 cfs (Cherry et al. 1970 in Schomer et al. 1984).

The mouth of Stevenson Creek contains small tidal marsh areas but is dominated by residential development. Several golf courses and a school are located in the middle segment. The majority of the upper segment is dominated by urban development from the City of Clearwater.

The Clearwater-Marshall Street Municipal Wastewater Treatment Plant is permitted to discharge 10 million gallons per day (MGD) treated effluent into Stevenson Creek. In addition, the non-point source pollutants entering the creek from adjacent urban development categorize Stevenson Creek as a stressed tidal tributary.

1.4 McKay Creek and Church Creek

McKay Creek enters Clearwater Harbor just north of the Narrows (Figure 17). McKay Creek travels north for approximately 4.7 miles, then travels an additional 1.7 miles southwest to the mouth of the harbor. Church Creek is approximately 1.6 miles in length and travels north to its confluence at the mouth of McKay Creek. Flow at the mouth of McKay Creek is estimated at 5 cfs (Cherry et al. 1970 in Schomer et al. 1984).

The mouth of McKay Creek has been hardened by residential finger fill development. Adjacent residential development continues to encroach on McKay Creek along its length upstream to Taylor Lake. Between Taylor Lake water reservoir and Walsingham Reservoir the land use is moderately undeveloped with some historic agricultural activity.

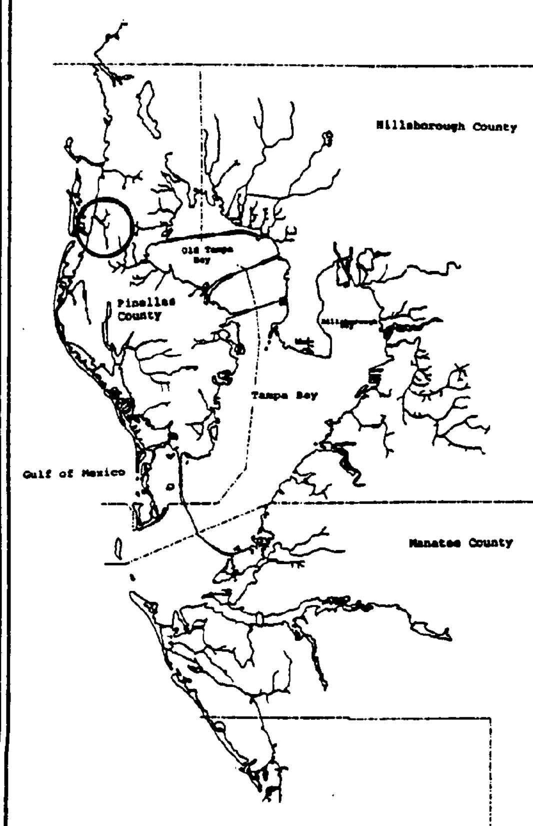
The headwaters of McKay Creek contain a contiguous freshwater marsh system and borrow pits then dissipating into a residential development.

Church Creek contains a tidal marsh at the confluence with McKay Creek. Church Creek is moderately impacted by golf courses, a cemetery and low density residential usage.

Figure 16.

Stevenson Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



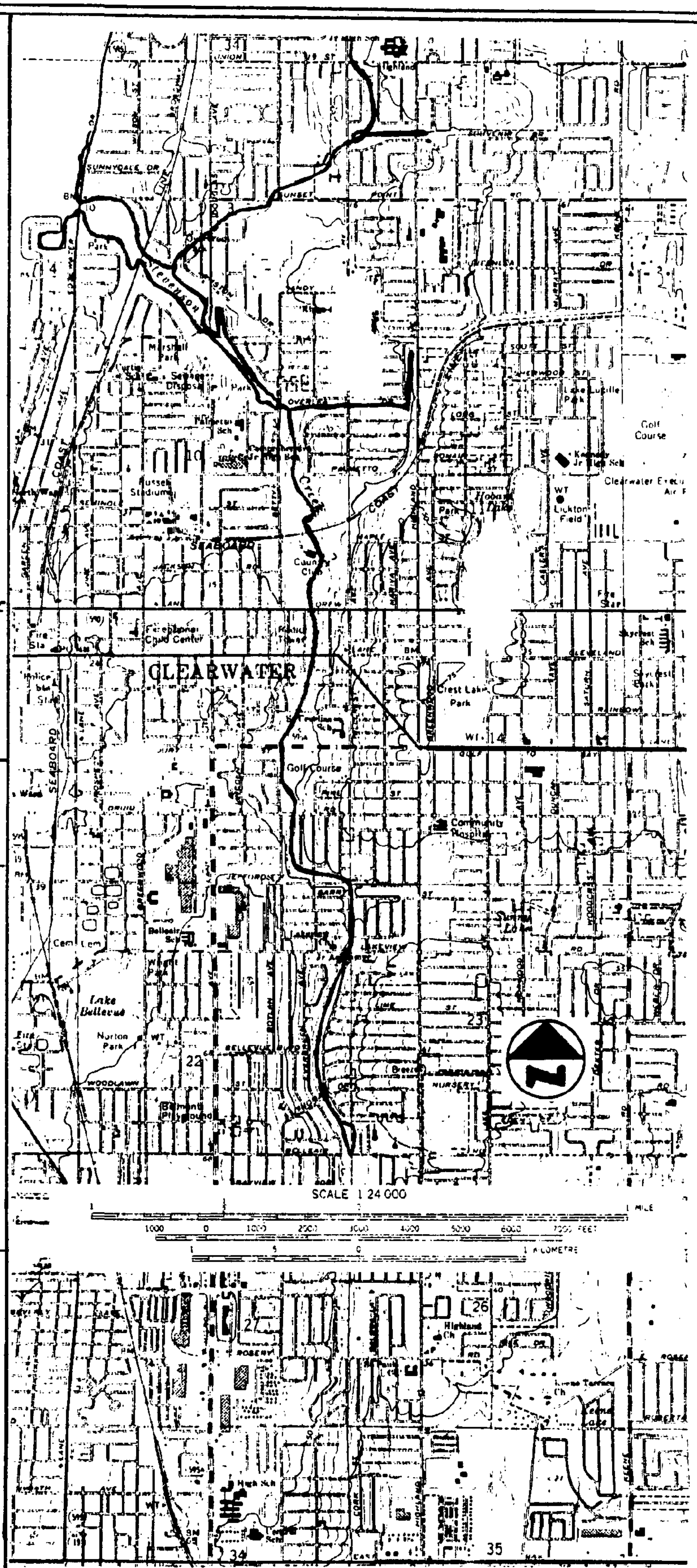
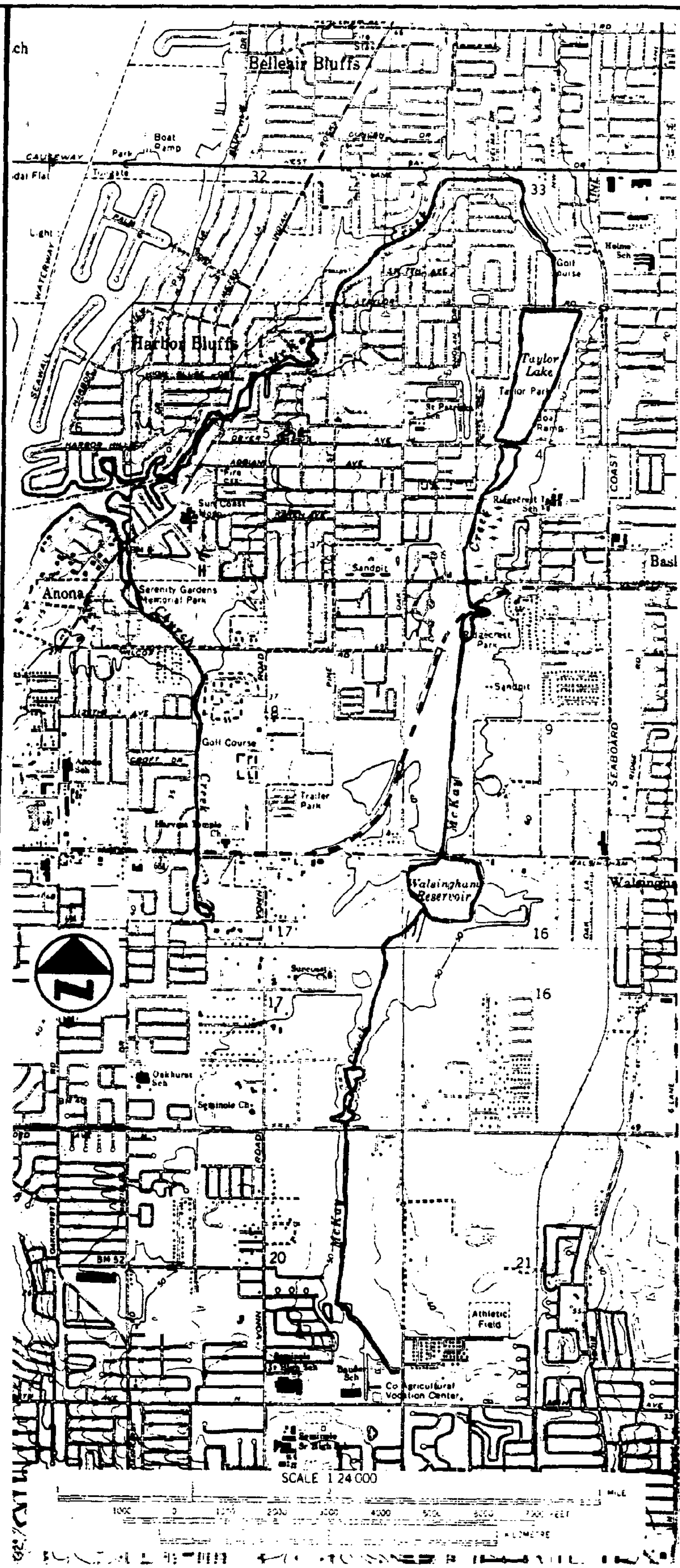
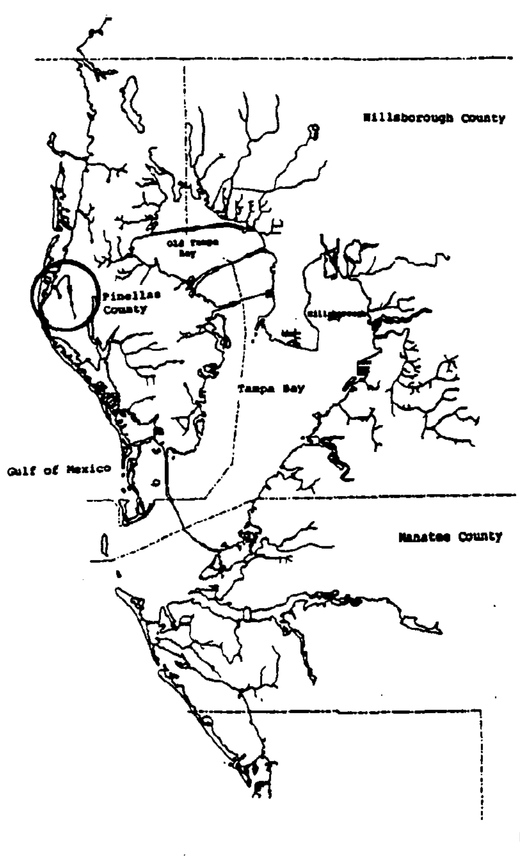


Figure 17.

McKay Creek and Church Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





The tidal segments of McKay and Church Creek contain a mix of natural marsh systems isolated by residential development. The middle and upper portions of each creek are moderate to lightly developed with freshwater flows being controlled in McKay Creek by the two reservoirs. Future improvements to wastewater treatment plant effluent (McKay Creek Sewage Treatment Plant) discharged into the Narrows and Clearwater Harbor, better management of non-point source (stormwater) pollutants and control of piecemeal development may improve McKay Creek to a restorable condition. Currently McKay and Church Creeks are stressed tidal tributaries due to the encroachment of urbanization.

1.5 Joe´s Creek and St. Joe´s Creek

Joe´s Creek outfalls into the Cross Bayou Canal which in turn flows into Boca Ciega Bay in southwest Pinellas County (Figure 18). Joe´s Creek has three branches with St. Joe´s Creek being the longest travelling a total of approximately 6.6 miles. The tributaries travel westerly to meet Joe´s Creek which travels northwest to intersect with the Cross Bayou Canal.

The mouth of Joe´s Creek is contiguous with one of the largest tidal marsh systems still existing in Boca Ciega Bay. The northern branch travels approximately two miles through a mixture of residential and light industrial development. This branch is channelized and drains the southern portion of Pinellas Park. The junction with the middle tributary delineates the beginning of St. Joe´s Creek. The middle tributary of Joe´s Creek is channelized and is dominated by residential use with some parcels in industrial use and open space.

The St. Joe´s Creek basin is composed of residential development with commercial and industrial areas to the east in the watershed. The eastern segment lies within the St. Petersburg - Lealman urbanized area of Pinellas County. The southern tributary to St. Joe´s Creek is characterized by criss-crossed drainage canals supporting the heavy residential development of the Tyrone area, including the commercial Tyrone Square Mall.

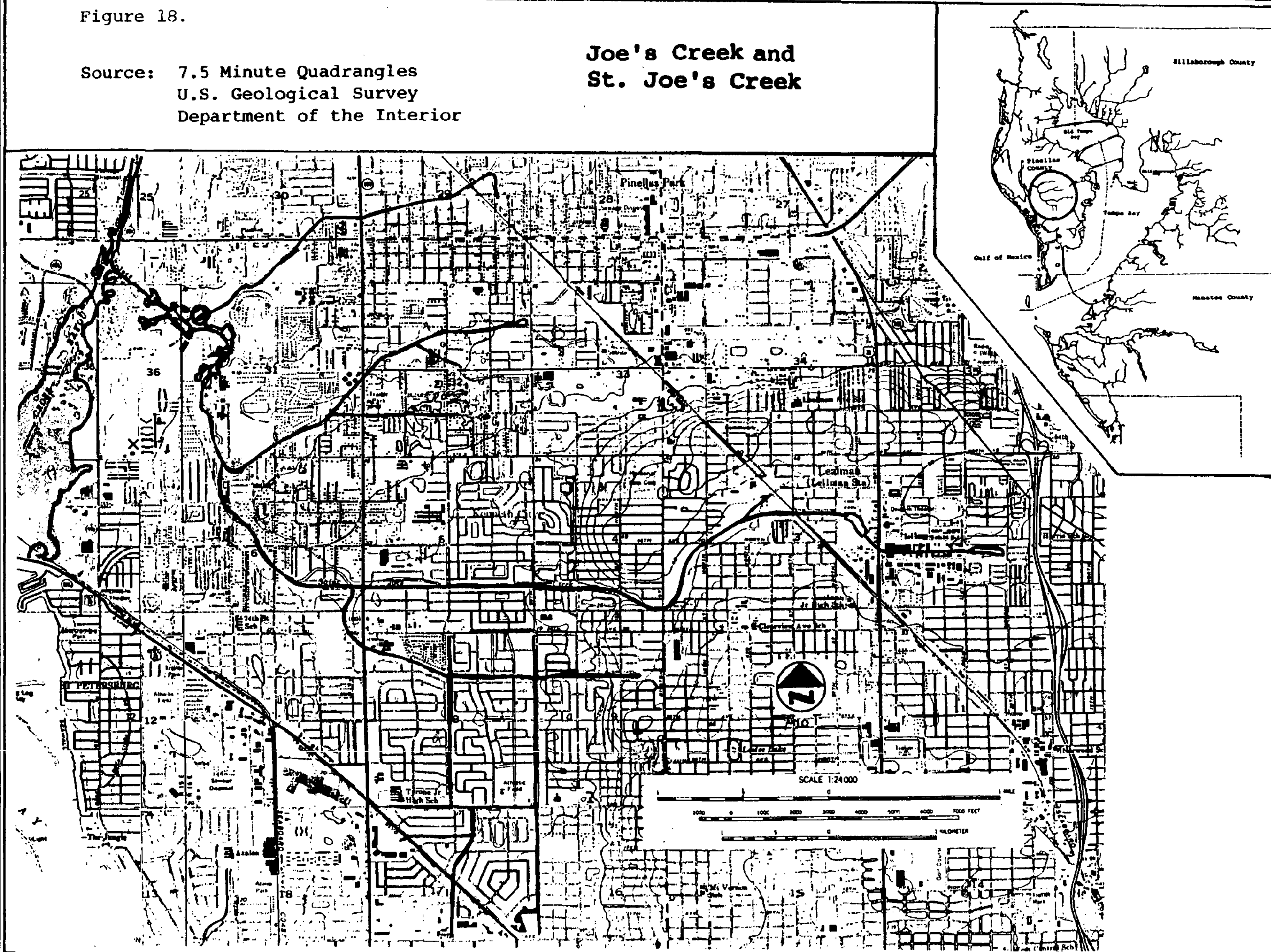
Tributaries to Boca Ciega Bay have been modified into underground storm-sewers or open ditches (Lopez and Michaelis, 1979). The upper reach of Joe´s Creek is 67 percent storm-sewered and 33 percent open ditches. Background water quality in the creeks is fair and does not reflect the poor water quality of stormwater that flows to Boca Ciega Bay through these tributaries (Schomer, et al. 1984), such as Joe´s Creek. In addition, Joe´s Creek receives industrial discharges from Dixie Plating Inc. and municipal wastewater discharges from the South Cross Bayou Plant, permitted at 28.5 MGD (CDM, 1983).

The mouth of Joe´s Creek is in relatively good condition, however the tidal marsh system cannot assimilate all of the pollutants created by the urbanized drainage basin. Joe´s Creek and St. Joe´s Creek are stressed tidal tributaries and further development will require better management to prevent additional degradation.

Figure 18.

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior

Joe's Creek and St. Joe's Creek



1.6 Bear Creek

Bear Creek travels southwesterly to southern Boca Ciega Bay on the west side of the South Pasadena area (Figure 19). Bear Creek is approximately 2.7 miles in length with the majority of the drainage area being residential.

Bear Creek has been channelized to provide flood control. Stormwater from this creek exhibits high concentrations of total coliforms ($6.8 \times 10_5$ Counts/100 ml), lead [128 micrograms per liter (ug/l)], and zinc (83 ug/l) (Schomer et al. 1984). Poor water quality and loss of natural alignment has characterized Bear Creek as a stressed tidal tributary.

1.7 Salt Creek

Salt Creek drains the lower southeastern Pinellas County peninsula and flows into Bayboro Harbor, an urbanized embayment (Figure 20). Salt Creek receives the outflow from Lake Maggiore. Between Lake Maggiore and Bayboro Harbor, Salt Creek is approximately 1.5 miles in length.

Lake Maggiore, based on water quality data, is considered as one of the ten worst lakes in Florida. The lake is characterized by poor light penetration (0.3 m secchi depth), and high concentrations of chlorophyll-a (158 ug/l), total nitrogen (4.45 mg/l) and total phosphorous (0.28 mg/l) (Schomer et al. 1984). The lake margin consists of approximately two-thirds freshwater marsh and one-third residential development.

The shoreline of Salt Creek has been hardened at Bayboro Harbor and contains industrial development from seafood processing, boat facilities, and electrical power generation facilities. The middle segment to Lake Maggiore is dominated by residential usage with Bartlett Park being located in the center. Urbanized Salt Creek is classified as a stressed tidal tributary.

1.8 Booker Creek

Booker Creek drains into Bayboro Harbor in St. Petersburg (Figure 21). The creek runs southeast and is 1.9 miles in length. Booker Creek drains the majority of downtown St. Petersburg and the major highway and arterial roads of Interstate 275.

Base flow in Booker Creek, 1.5 miles upstream of the mouth, averages 1.0 cfs. Under base flow conditions the creek is turbid [140 jackson turbidity units (JTU)] and high in nutrients [total phosphate (TP)-0.25 mg/l, total nitrogen (TN)-2.0 mg/l] (Schomer et al. 1984).

Booker Creek is a stressed tidal tributary, characterized by poor water quality and an urbanized drainage area.

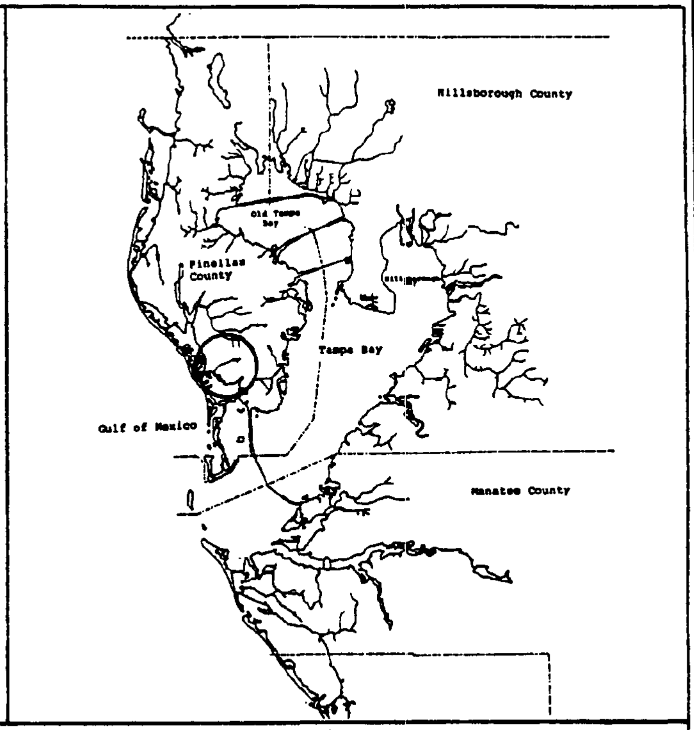
1.9 Tinney Creek

Tinney Creek historically provided drainage from Sawgrass Lake to Riviera Bay in Pinellas County (Figure 22). Currently Tinney Creek has been rerouted in large open drainage ditches into Riviera Bay. Portions of the creek still retain a different alignment than the ditch. Tinney Creek is

Figure 19.

Bear Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



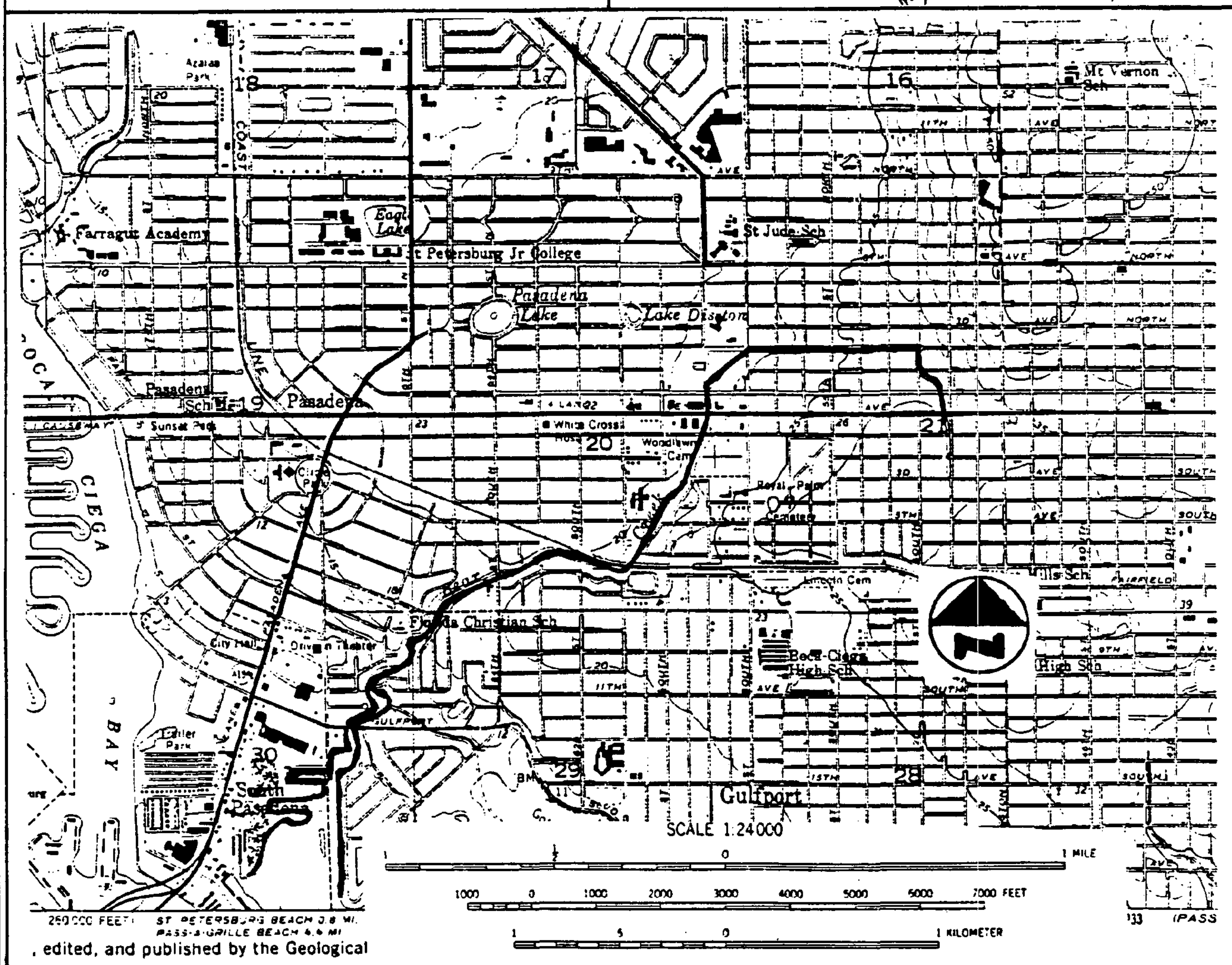
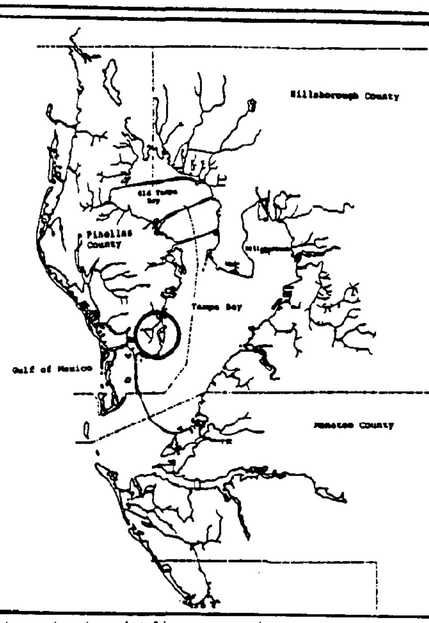


Figure 20.

Salt Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



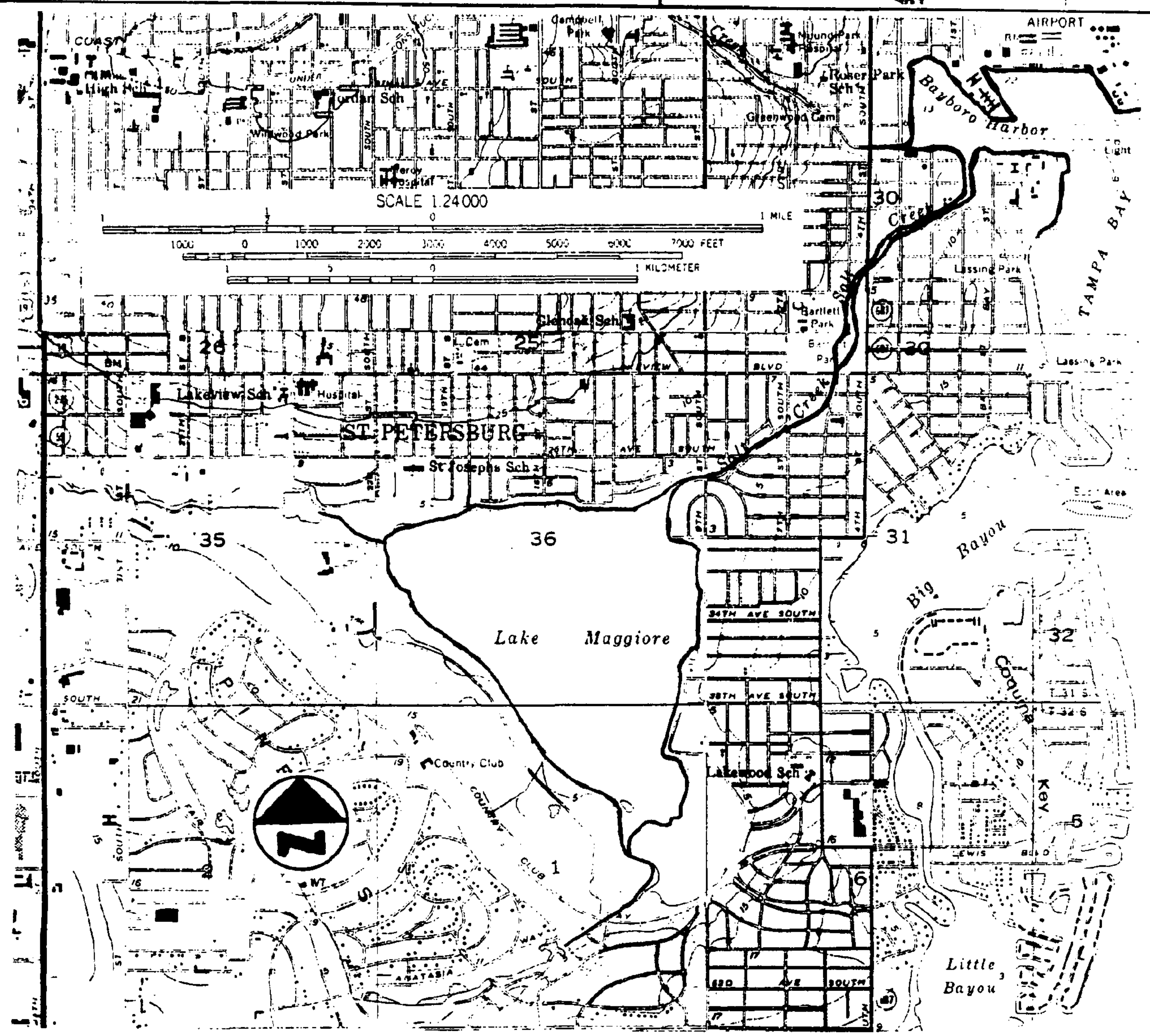
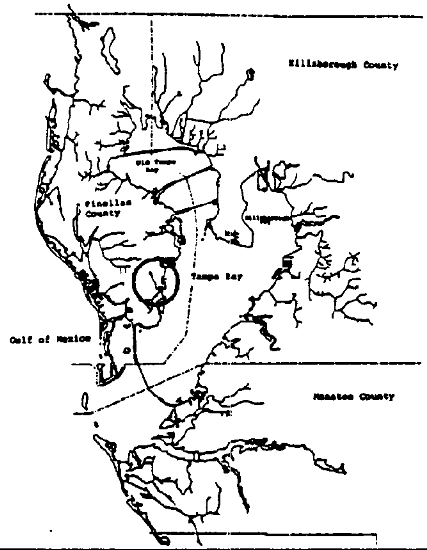


Figure 21.

Booker Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



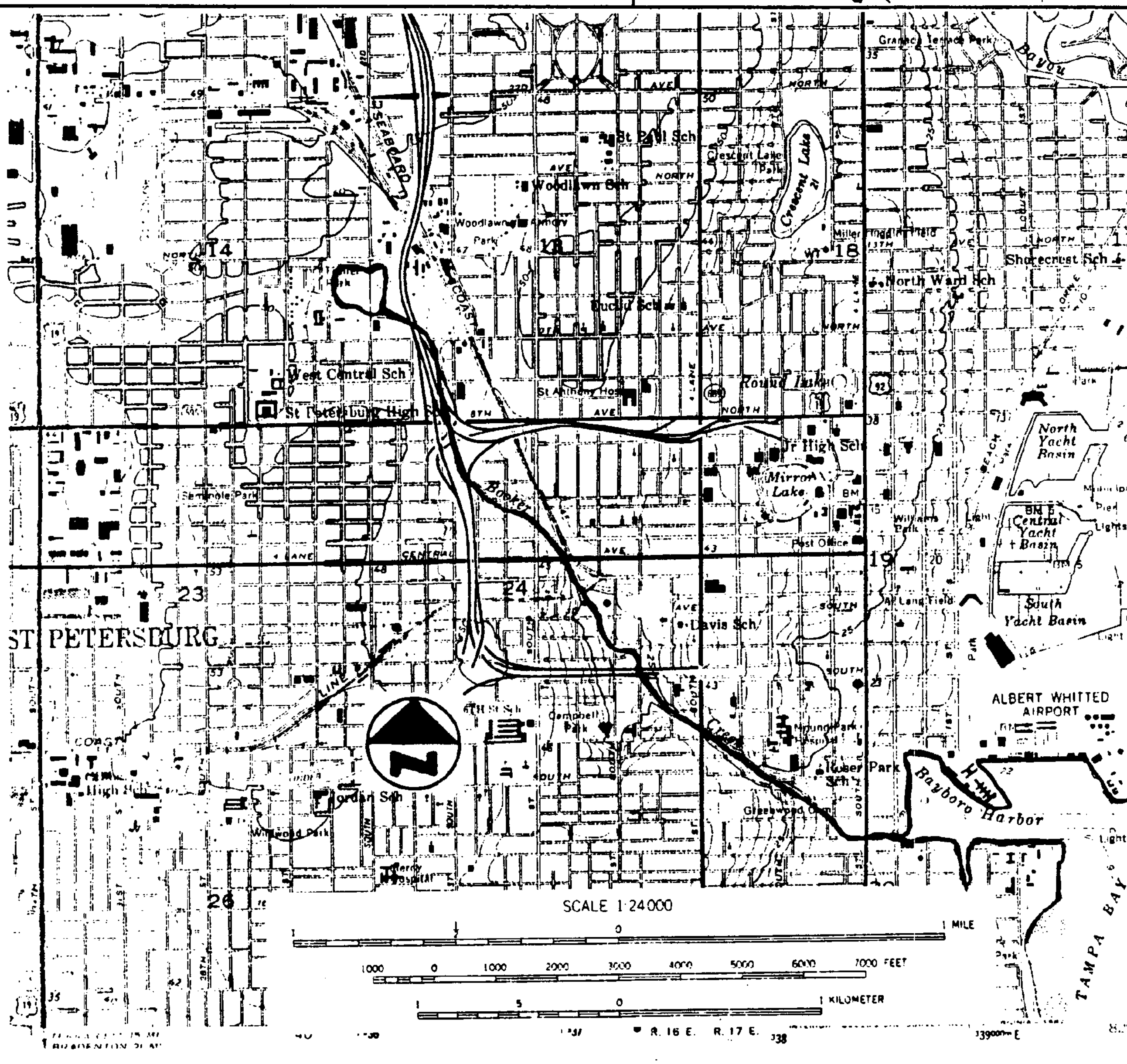
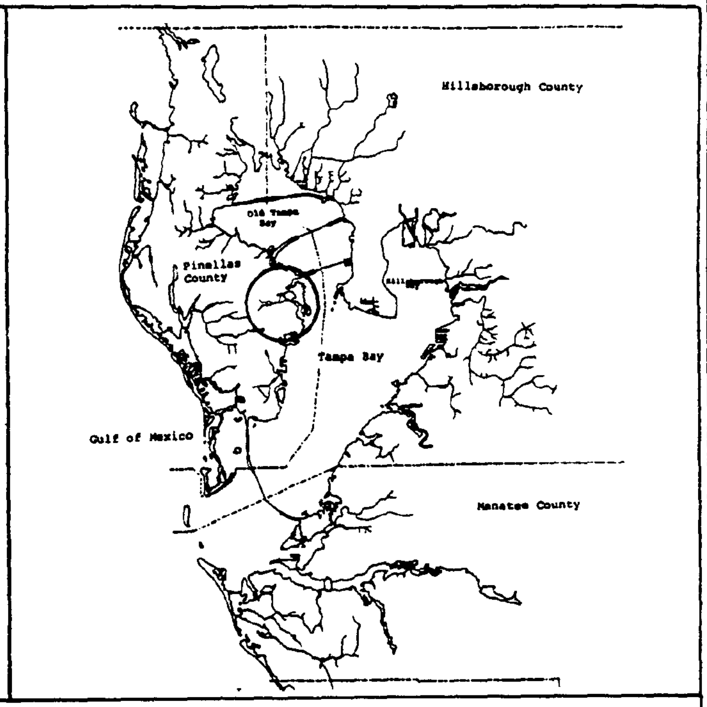
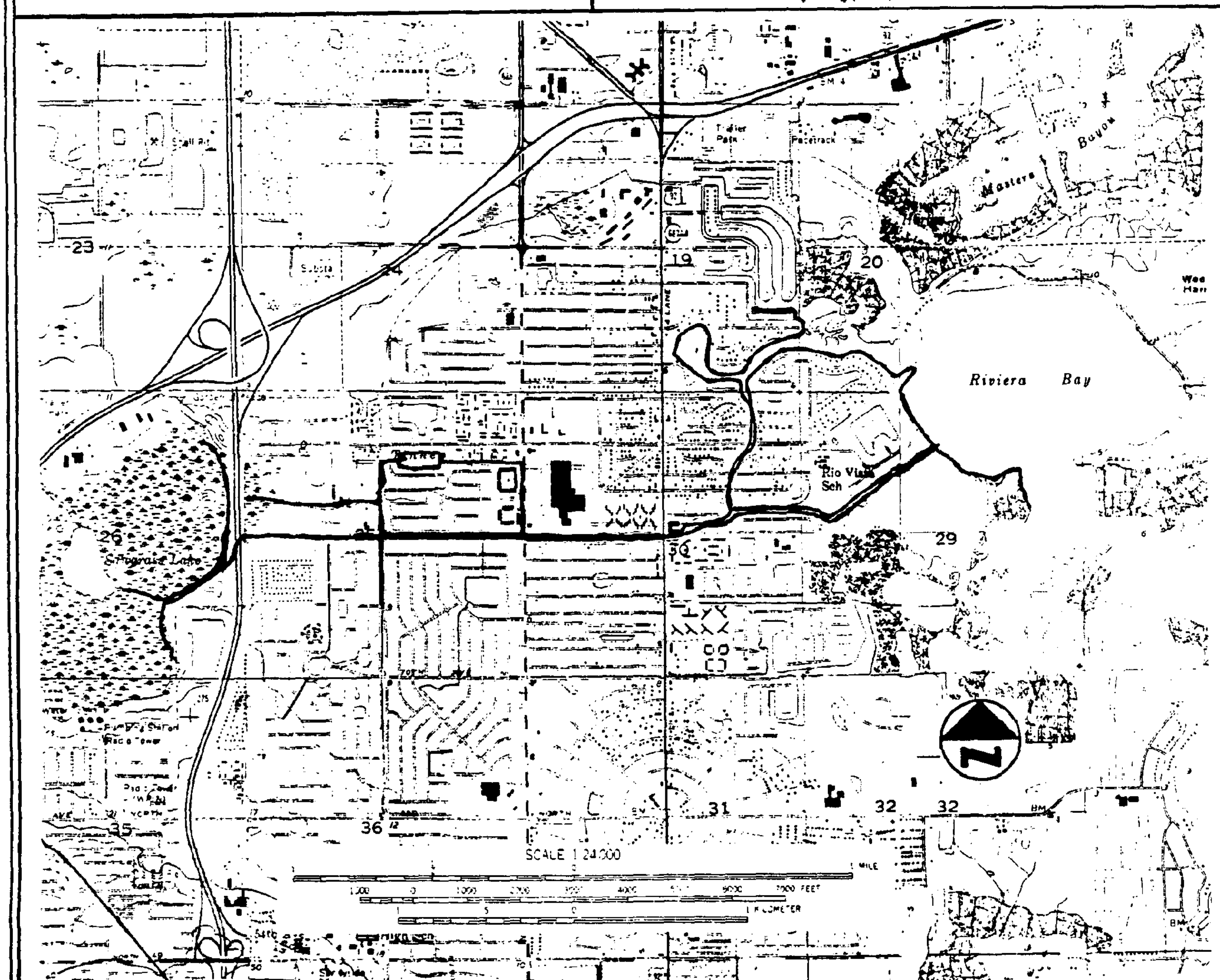


Figure 22.

Tinney Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





2.7 miles in length and outfalls into the finger fills located on Riviera Bay.

The shoreline of Tinney Creek has been hardened for residential finger fill development at the mouth. Many adjacent areas within Riviera Bay and Weedon Island contain large expanses of mangrove marsh. The middle segment is surrounded by residential and commercial development. The upper segment has been impacted by the excavation of borrow pits during the construction of Interstate 275 and still receives stormwater drainage from the Interstate.

Sawgrass Lake drains eastern Pinellas Park and northwestern St. Petersburg. The majority of the lake's drainage area is urban (70 percent). The lake itself is surrounded primarily by a red-maple swamp and to a lesser extent a mixed-oak ridge (Rochow, 1979, 1982). Nutrient loading to the lake was ranked fourth highest for lakes in Florida, but concentrations within the lake varied considerably, possibly caused by the dense mats of water hyacinth (Eichnornia crassipes) that completely cover the lake surface, assimilating nutrients into their biomass (Dooris, 1979). Dissolved oxygen concentrations below the hyacinth mat decrease sharply to near zero (Schomer et al. 1984).

The loss of natural channel alignment and function, and development pressures degrading water quality conditions within Sawgrass Lake, characterize Tinney Creek as a stressed tidal tributary.

1.10 Grassy Creek

Grassy Creek enters Old Tampa Bay adjacent to the north side of the Howard Frankland Bridge in Pinellas County (Figure 23). The creek runs through a mangrove marsh system and is connected with numerous mosquito ditches. The upper reaches receive sheet flow runoff from a golf course and apartment communities. Grassy Creek is approximately 0.84 mile in length and flows in an easterly direction.

The upper drainage basin is lightly developed, while the creek channel retains its natural alignment. Grassy Creek is characterized as a natural tidal tributary.

1.11 Long Branch Creek

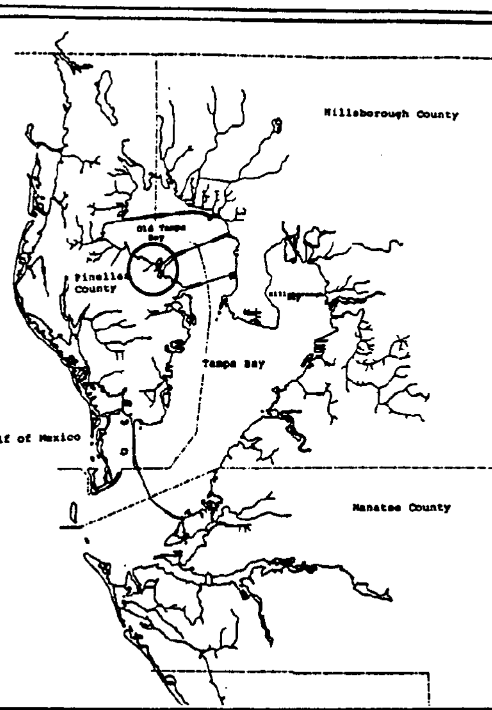
Long Branch Creek is located north of St. Petersburg-Clearwater Airport and flows into Old Tampa Bay between the Howard Frankland Bridge and the Courtney Campbell Causeway in Pinellas County (Figure 24). The longest segment is 3.4 miles in length and stream flow is toward the northeast.

The mouth of Long Branch meanders into Old Tampa Bay through a tidal marsh system adjacent to forested floodplain areas. Only light residential development and plots of agriculture exist in this lower segment. The middle segment is dominated by residential and commercial development and drains U.S. 19. Both upper branches (north and south) of Long Branch are surrounded by residential development and light commercial uses. The upper segments have been channelized for urban drainage.

Figure 23.

Grassy Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



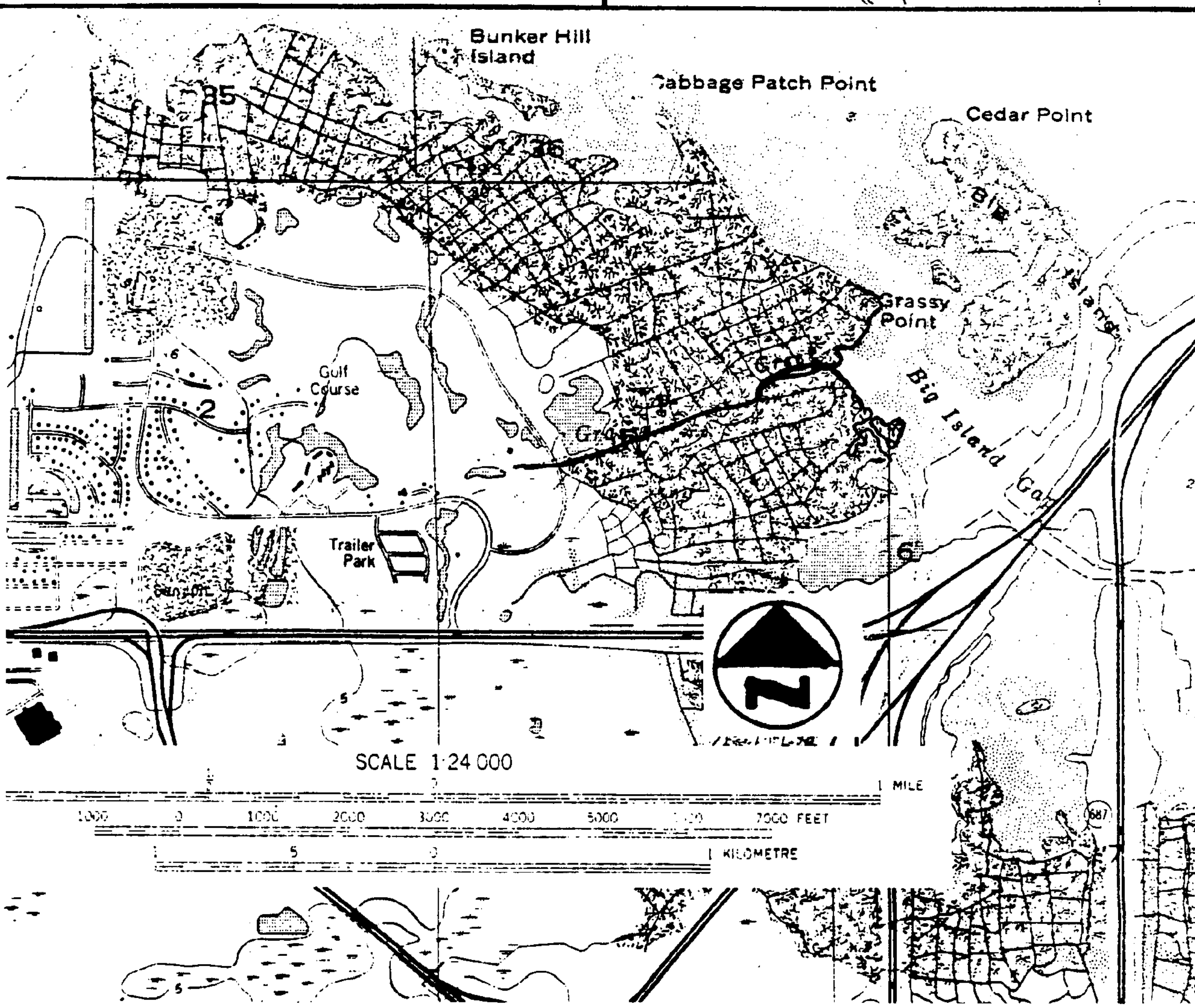
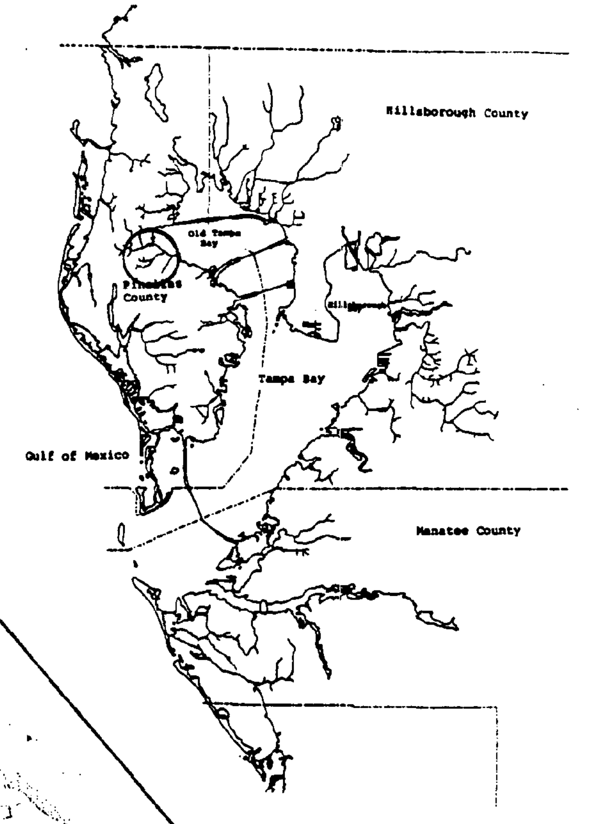
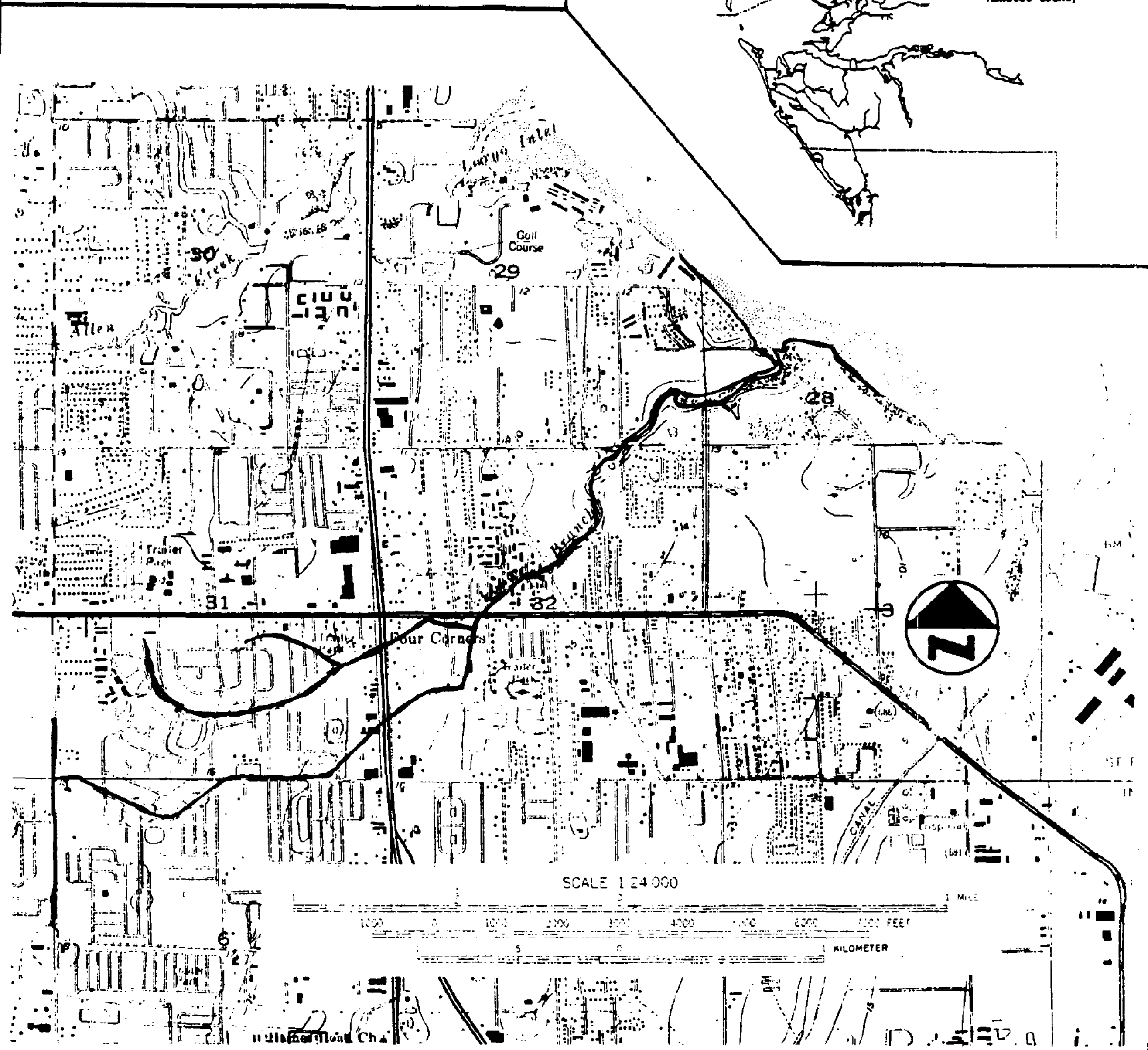


Figure 24.

Long Branch Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





The lower segment (tidally influenced area) of Long Branch remains in a relatively natural condition. Midway Services Corporation discharges 0.15 hundred gallons per day (HGD) of industrial effluent into Long Branch. Improved point and non-point source pollutant management practices and natural conditions at the mouth of Long Branch Creek characterize this tidal tributary as restorable.

1.12 Allen Creek

Allen Creek flows into Old Tampa Bay south of the Courtney Campbell Causeway in Pinellas County (Figure 25). Allen Creek is classified as a stressed tidal tributary to Tampa Bay. A detailed ecological assessment of Allen Creek is included in the following section of this report.

1.13 Alligator Creek

Alligator Creek flows into Old Tampa Bay via Alligator Lake, north of the Courtney Campbell Causeway in Pinellas County (Figure 26). The longest segment of Alligator Creek is approximately 4.4 miles in length and drains into Alligator Lake which is 0.66 mile long. The creek travels in an easterly direction into Old Tampa Bay.

Alligator Lake was formed by damming the tidal connection to Upper Tampa Bay under Spring Boulevard. Alligator Lake and the lower creek segment are surrounded by open forested areas, agriculture (groves) and light residential. The middle and upper segments are dendritic with light residential and agricultural areas. Many borrow pits intersect the branches, potentially providing areas for marsh creation. The extreme western segments lie within the City of Clearwater industrial/commercial areas.

Flow one mile upstream of Alligator Lake averages 8.0 cfs and ranges from 0.25 cfs to 628 cfs (Cherry et al. 1970; USGS, 1982 in Schomer et al. 1984).

High counts of coliforms, high concentrations of BOD and phosphate, and low dissolved oxygen levels have been recorded for Alligator Creek (ESE 1977). These conditions are repeated downstream in Alligator Lake where chlorophyll-a concentrations averaged 38 ug/l (Huber et al. 1983 in Schomer et al. 1984). Two point source discharges have been identified on Alligator Creek and include Aerosonics Corporation [Municipal at 7.5 thousand gallons per day (TGD)] (DER, 1983) and Boulevard 0.018 HGD (Schomer et al. 1984).

Alligator Creek has lost the intrinsic functions of a natural tidal tributary by the action of damming to create Alligator Lake. Removal of the dam and better management of point and non-point source discharges may upgrade Alligator Creek to the restorable category. However, Alligator Creek is characterized as a stressed tributary under existing conditions.

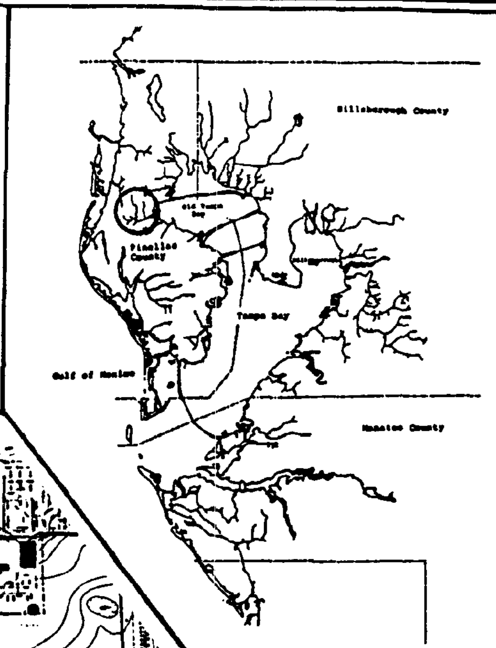
1.14 Mullet Creek

Mullet Creek is located in Pinellas County north of Courtney Campbell Causeway, and flows eastward into Old Tampa Bay (Figure 27). The longest branch is approximately 2.3 miles in length.

Figure 25.

Allen Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



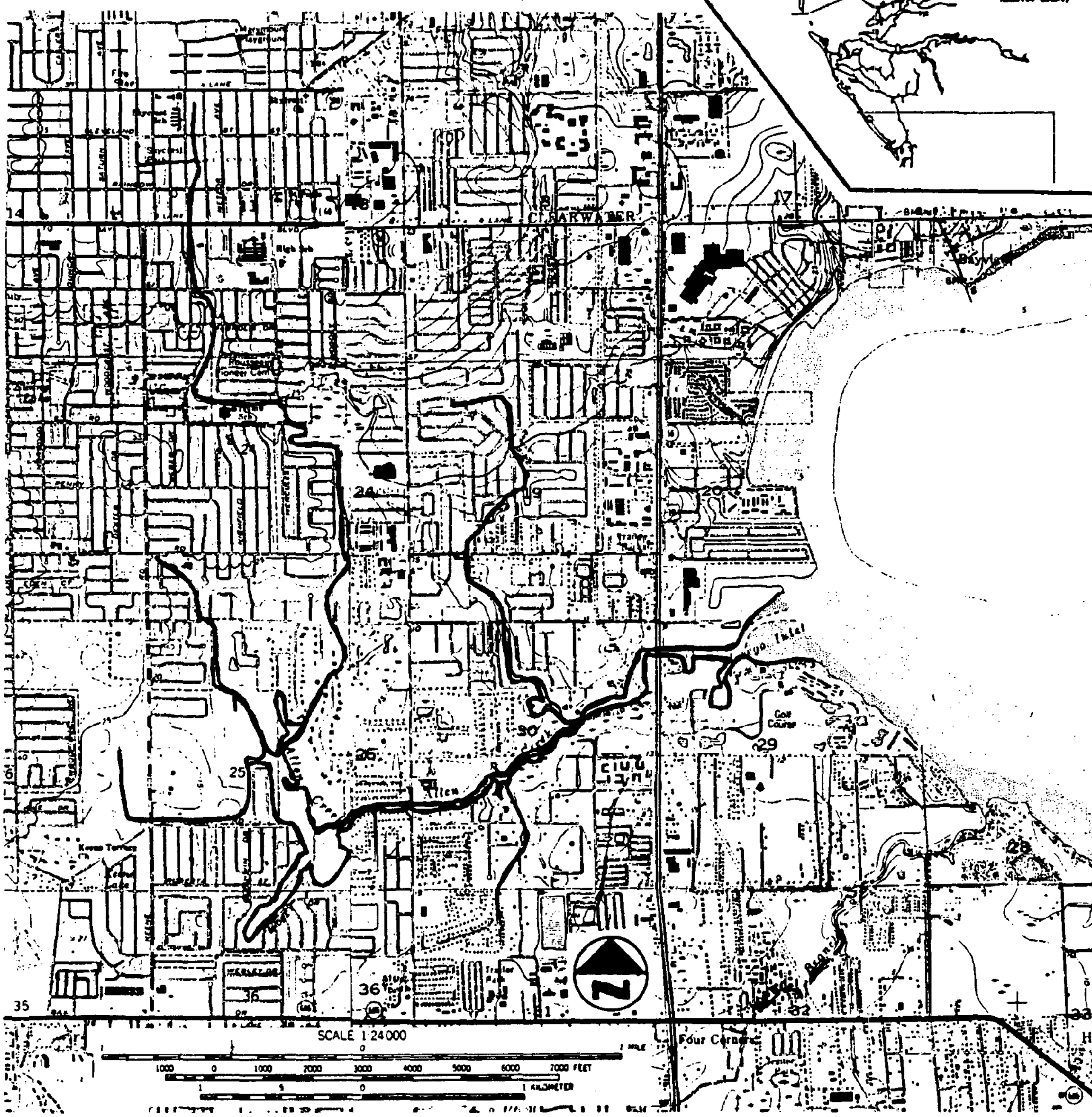
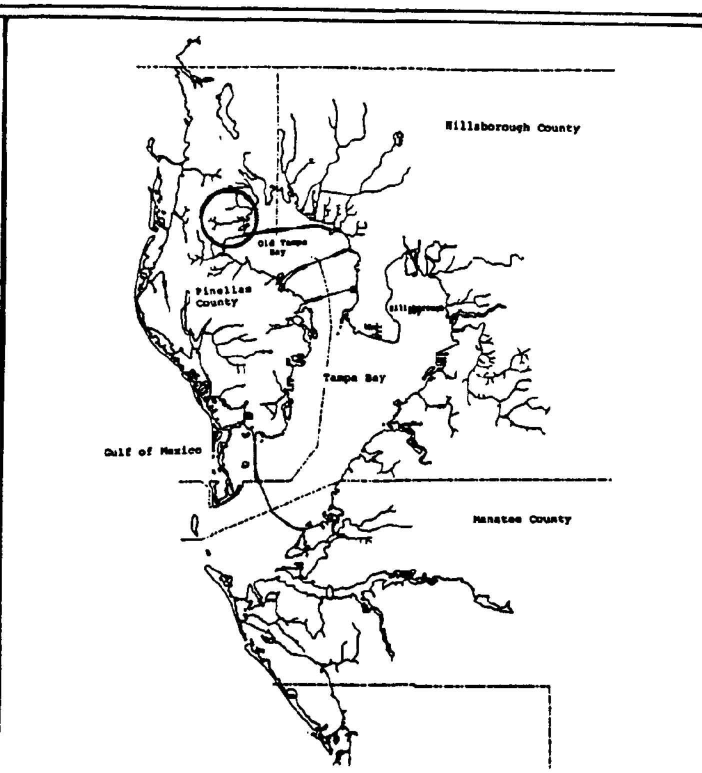


Figure 26.

Alligator Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



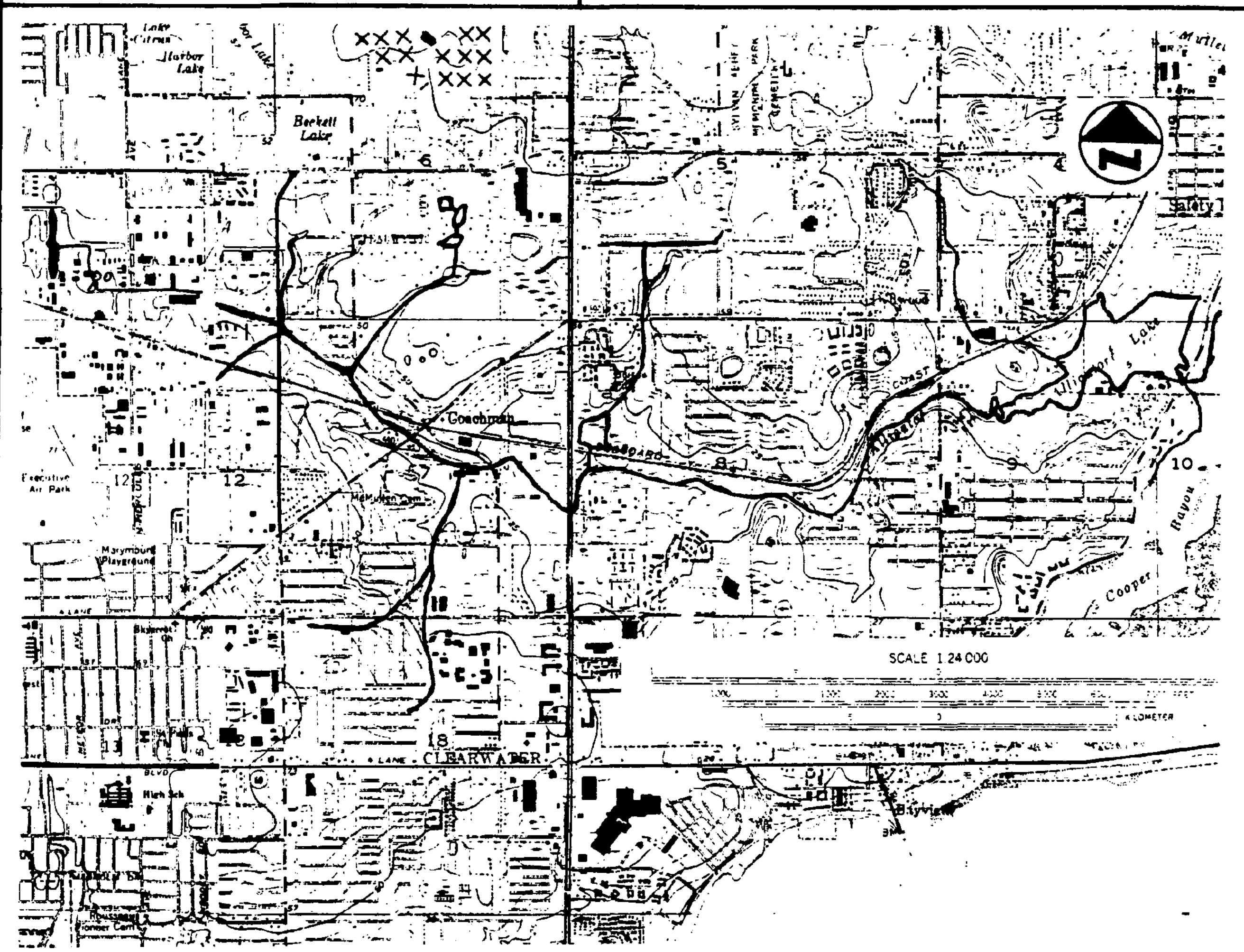
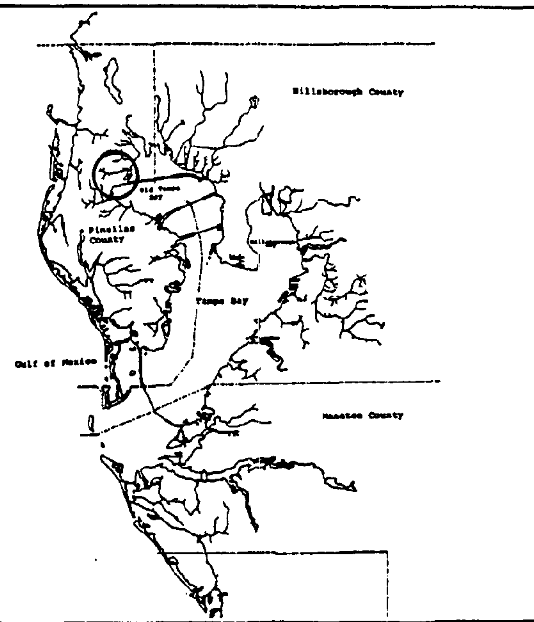
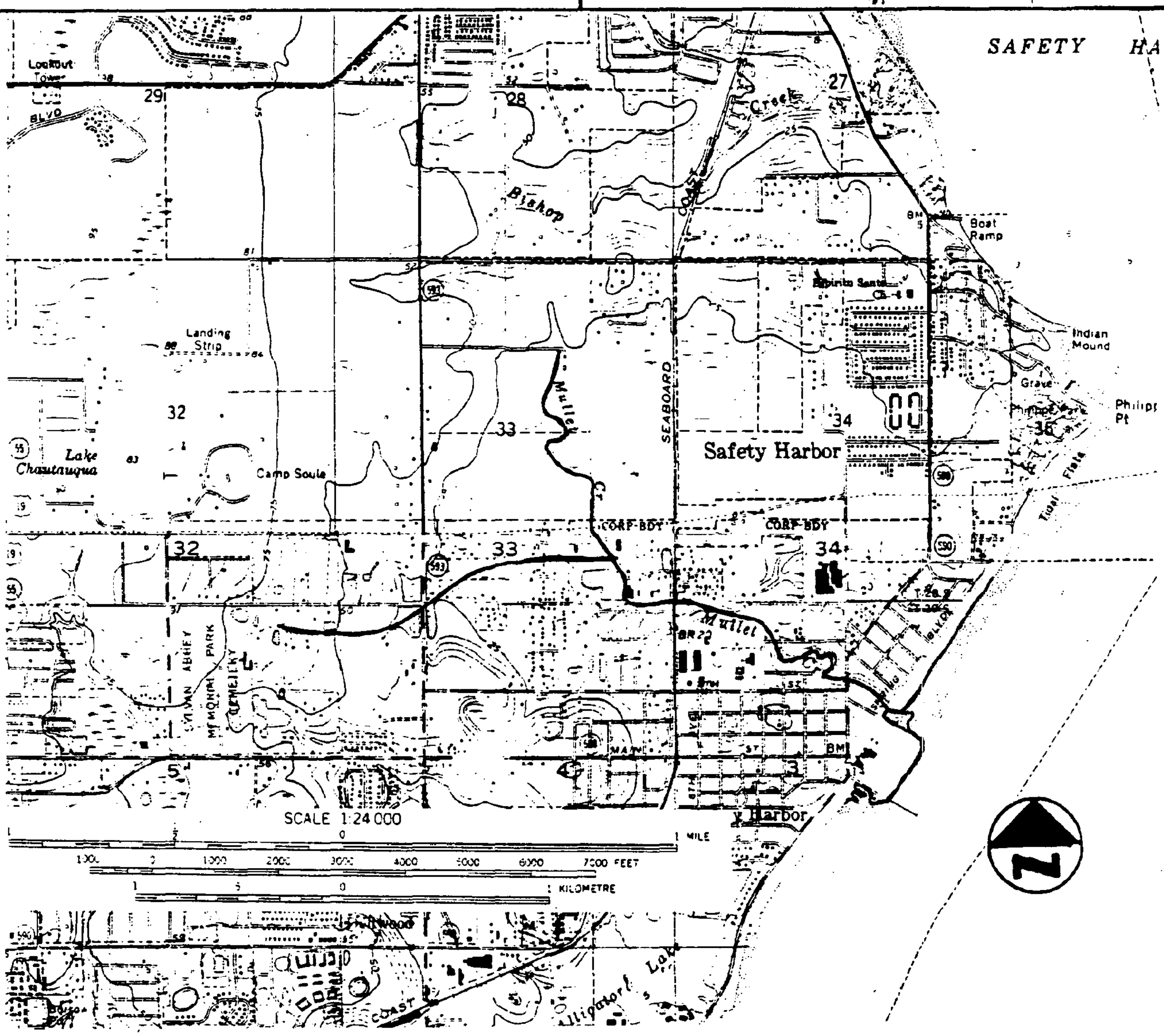


Figure 27.

Mullet Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





The mouth of Mullet Creek contains a small marsh limited by dredge and fill operations on either side for residential development. The middle segment contains a wooded overstory with low density residential and commercial development. The headwaters are predominately in open agricultural use (citrus and pasturelands).

Mullet Creek receives stormwater pollutants from agricultural usage (upper) and residential development (middle and lower). Safety Harbor Municipal Treatment Facility discharges 0.33 HGD into Mullet Creek (Schomer et al. 1984).

The natural tidal portion of Mullet Creek is limited by adjacent residential development. Existing open area in the upper drainage area and the potential for future water quality improvements classify Mullet Creek as a restorable tidal tributary.

1.15 Bishop Creek

In northern Pinellas County, draining into the western side of Safety Harbor in Old Tampa Bay, lies Bishop Creek (Figure 28). The creek drains toward the east-northeast for a distance of approximately 1.8 miles.

The mouth of Bishop Creek meanders through an extensive tidal marsh. The lower segment remains in a natural condition with a meandering alignment and wooded floodplain buffered from development. The middle segment has low intensity residential usage. The upper drainage area is mostly agricultural areas with some encroachment by residential development.

Bishop Creek receives some non-point source pollution from agricultural and residential development. The majority of the tidal segment remains in pristine condition and qualifies as a natural tidal tributary.

1.16 Moccasin Creek

Moccasin Creek enters Old Tampa Bay via the Upper Safety Harbor water body in northern Pinellas County (Figure 29). The creek travels in a southeast direction for a distance of 1.5 miles into Safety Harbor.

Moccasin Creek is a small tributary flowing to Old Tampa Bay through a minimally developed portion of Pinellas County. The mouth of the creek contains small fringe marsh areas with adjacent residential development. The middle and upper segments are adjacent to open pasturelands and the Harbor Palms residential development.

The headwaters of Moccasin Creek are adjacent to a wastewater treatment plant and industrial waste ponds. Additional potential pollution sources include agricultural and residential stormwater runoff. Due to minimal encroachment and pollution sources at present, Moccasin Creek is classified as a natural tidal tributary.

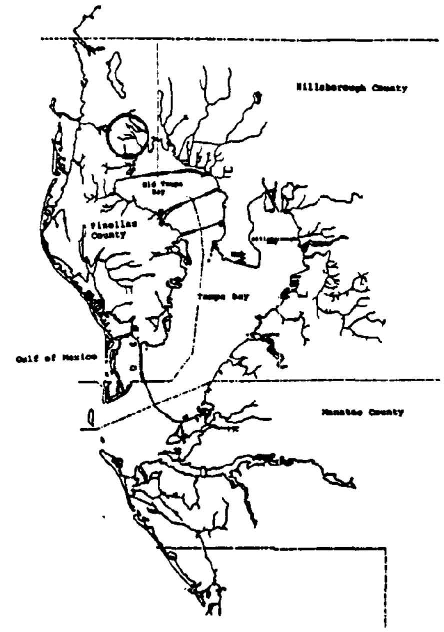
1.17 Double Branch Creek

In the extreme northwestern corner of Hillsborough County and flowing

Figure 28.

Bishop Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



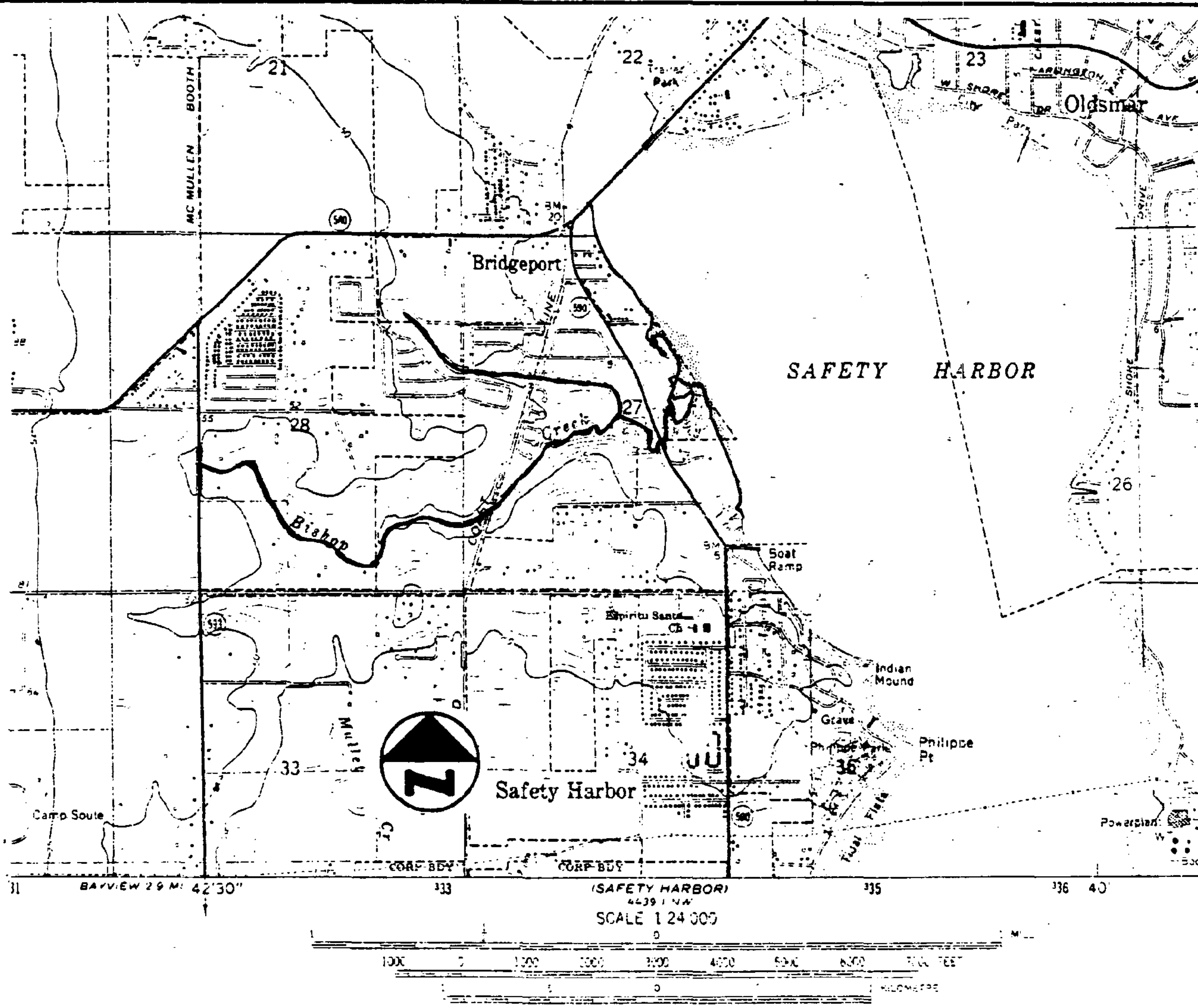
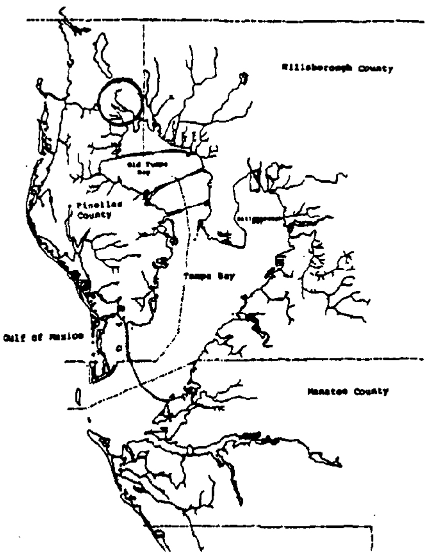
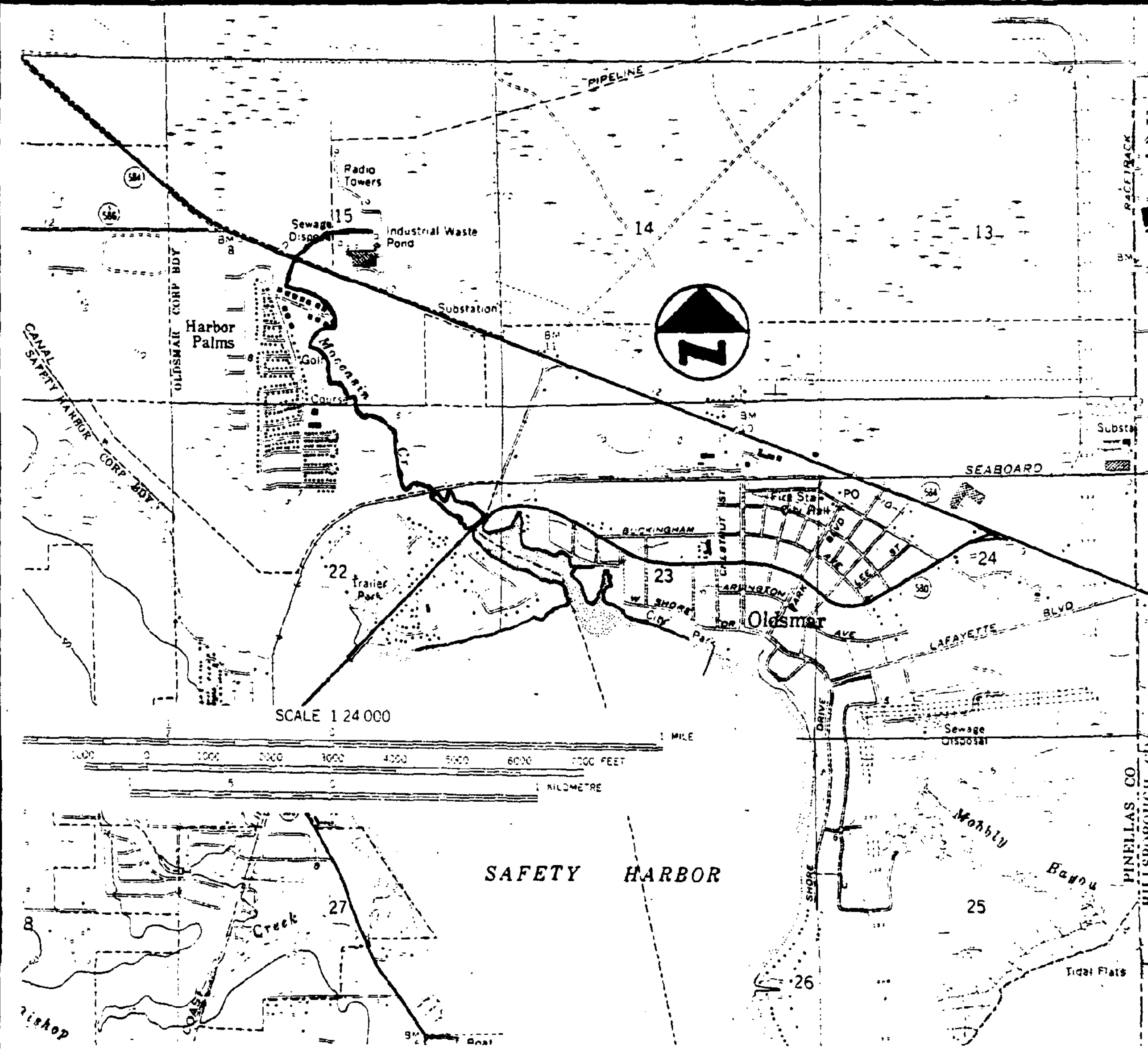


Figure 29.

Moccasin Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





southward into Old Tampa Bay lies Double Branch Creek (Figure 30). The creek drains 19 square miles and has an estimated discharge of 40 cfs (Simon, 1974). Double Branch Creek has three distinct branches, with the longest traveling 6.8 miles to its mouth in Double Branch Bay.

Double Branch Bay is dominated by mangrove islands and tidal marsh expanses. The lower segment meanders through additional tidally influenced marsh segments with minimal residential development.

The eastern branch is channelized with spoil banks deposited adjacent to the creek. Much of the drainage area contains cypress marshes and other freshwater herbaceous marshes that have been drained to maintain adjacent agricultural usage. Extensive drainage canals can be identified on Figure 30.

Between the eastern branch and the middle branch the creek meanders through residential development. The middle branch is longest and is also characterized by extensive wetland drainage for agricultural purposes.

The western branch travels through the Florida Downs Racetrack and supporting facilities. The upper segment is dominated by agricultural usage with associated enhanced wetland draining. The upper segment arises within a large cypress swamp.

Double Branch Creek is tidally influenced as observed in high salinities (12 ppt) measured at the Hillsborough Avenue Bridge (HCEPC, 1983). High nutrients, organics (TOC), and coliform levels peak in the wet season and are caused by urban stormwater (including runoff from the Florida Downs Racetrack) and pastureland runoff (HCEPC, 1983; Dooris and Dooris, 1984 in Schomer et al. 1984). Color, much higher in Double Branch Creek than other creeks to the east indicates the strong influences of wetland areas on the stream's water quality (HCEPC, 1983).

The extensive tidal marsh and low intensity usage of the drainage area classify Double Branch Creek as a natural tidal tributary.

1.18 Channel "A"

Channel "A", although not part of this study, is discussed for informational purposes. Constructed in 1966, Channel "A" is designed to provide flood relief for the Rocky Creek drainage basin. The channel travels southwest for a distance of approximately 4.1 miles from its confluence with Rocky Creek to Old Tampa Bay in Hillsborough County (Figure 31).

Channel "A" cuts through Cabbagehead Bayou - an extensive tidal marsh system. Spoil material has been piled alongside the channel and prevents natural freshwater distribution over the adjacent marsh areas. Channel "A" contains twice the chlorophyll-a concentration, very low nitrate levels (0.05 mg/l), and total nitrogen levels equal to those found in Rocky Creek (HCEPC, 1983; Dooris and Dooris, 1984 in Schomer et al. 1984). Channel "A", and to some extent Rocky Creek, exhibits some of the lowest color levels (18.8 platinum-cobalt units) reported from Hillsborough County. This reflects the urbanization and loss of wetlands that were once common in the drainage area (Schomer et al. 1984).

Figure 30.

Double Branch Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior

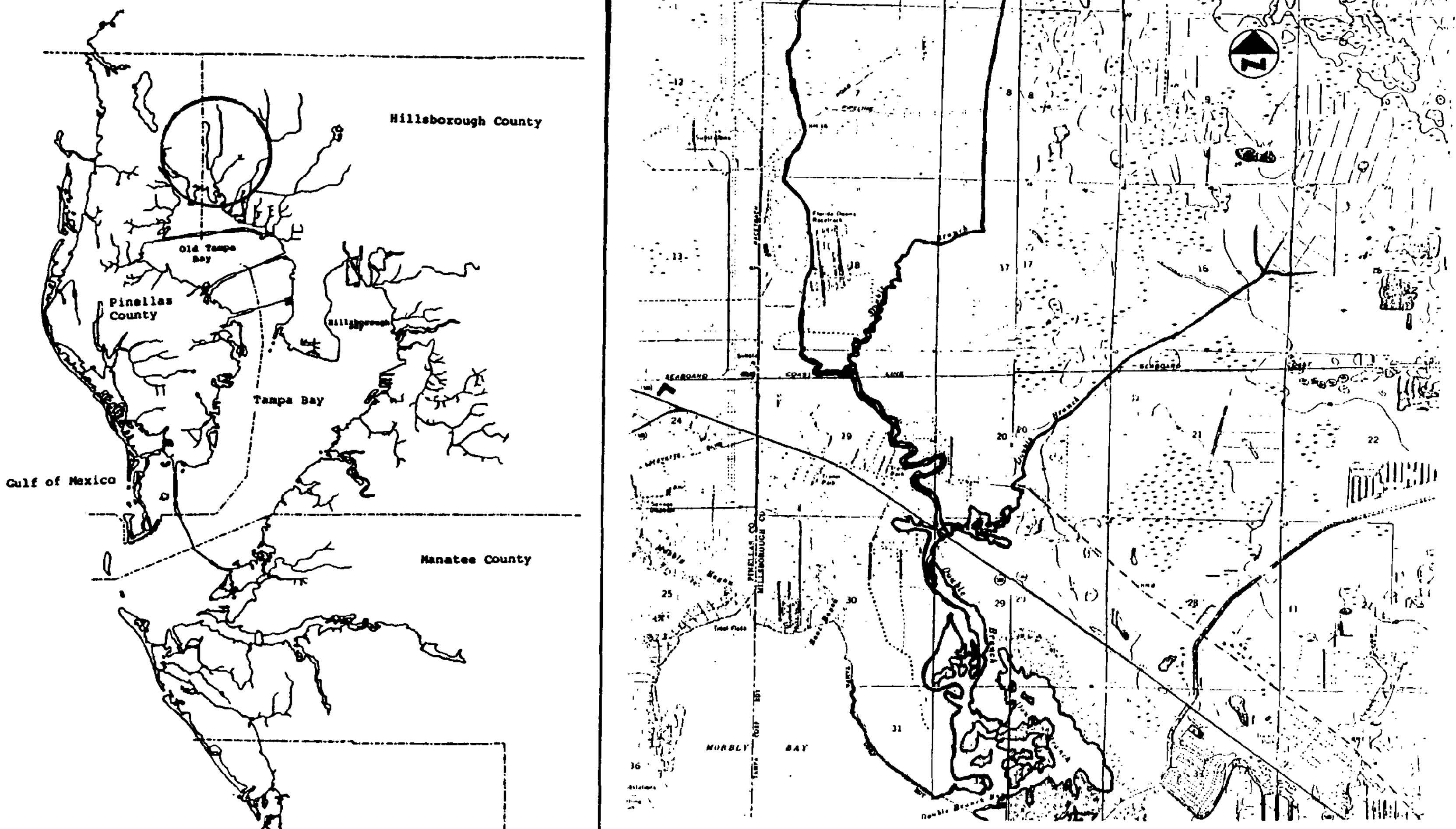
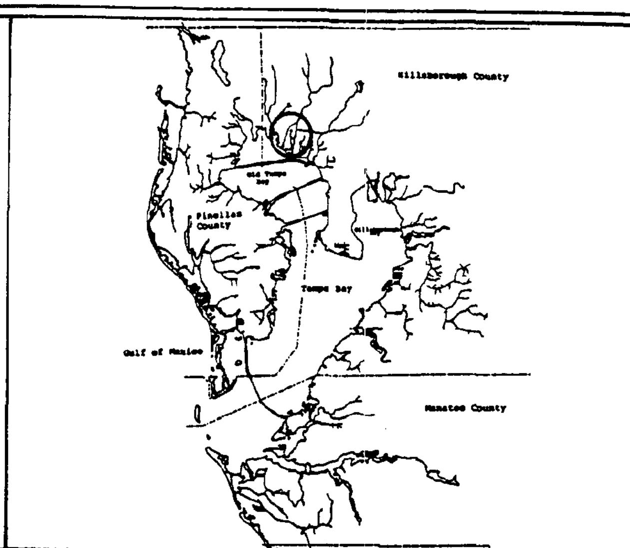
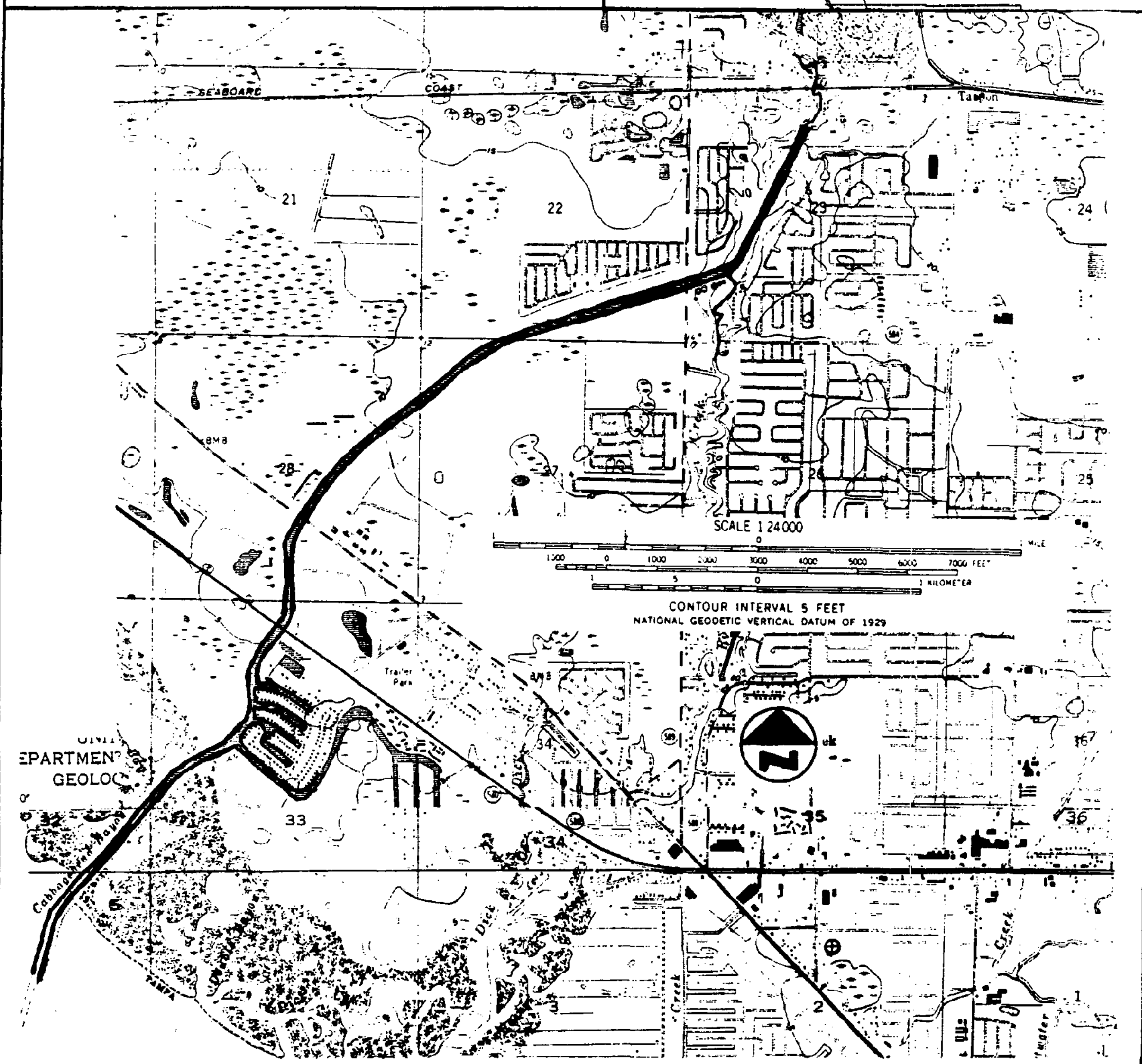


Figure 31.

Channel A

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





1.19 Rocky Creek and Brushy Creek

Located in northwestern Hillsborough County and traveling in a southerly direction into Old Tampa Bay lies Rocky Creek (Figure 32). The creek travels a distance of approximately 10.9 miles from Turkey Ford Lake to Old Tampa Bay and drains 45 square miles. Brushy Creek, the largest tributary of Rocky Creek, drains 11 square miles and is approximately 6.4 miles in length between Starvation Lake and its junction with Rocky Creek (Figure 32).

The mouth of Rocky Creek has been channelized through the extensive tidal marsh system on the northeastern fringe of Old Tampa Bay. Spoil material from channelization is placed on adjacent marsh areas. The meandering lower segment travels through intensive residential development and finger fill construction. The lower segment is connected to two drainways; Channel "G" travels eastward to Sweetwater Creek, and Channel "A". The floodplain north of Channel "A" maintains a meandering alignment with a forested canopy. Through this middle segment the land use is predominately residential and agricultural. The upper segment, north of the Brushy Creek confluence, is dominated by agricultural pasture land with numerous cypress swamps and other freshwater marsh systems being drained by artificial means.

The lower segment of Brushy Creek retains a forested floodplain surrounded by agricultural usage. The upper segment is encroached upon by channelization associated with residential development. The headwaters drain several lakes containing a cypress fringe.

The average annual flow 5.8 miles upstream of Rocky Creek's mouth is 35 cfs and ranges from 2,840 cfs to no flow (USGS, 1982). In the upper watershed the lake levels have been lowered in the past 20 years because of pumpage from several wellfields to the north (Schomer et al. 1984). River Oaks municipal wastewater treatment plant currently is permitted to discharge 4.6 MGD of treated effluent at the confluence of Rocky Creek and Channel "A". Because of increasing developmental pressures in this area, the treatment plant is currently being expanded in capacity to 12 MGD.

The condition of Rocky and Brushy Creeks have deteriorated due to rapid urbanization of the area. The mouth of Rocky Creek is channelized through the natural tidal marsh, preventing intrinsic assimilation of pollutants under existing conditions. Rocky Creek is characterized as a stressed tidal tributary to Old Tampa Bay.

1.20 Dick Creek

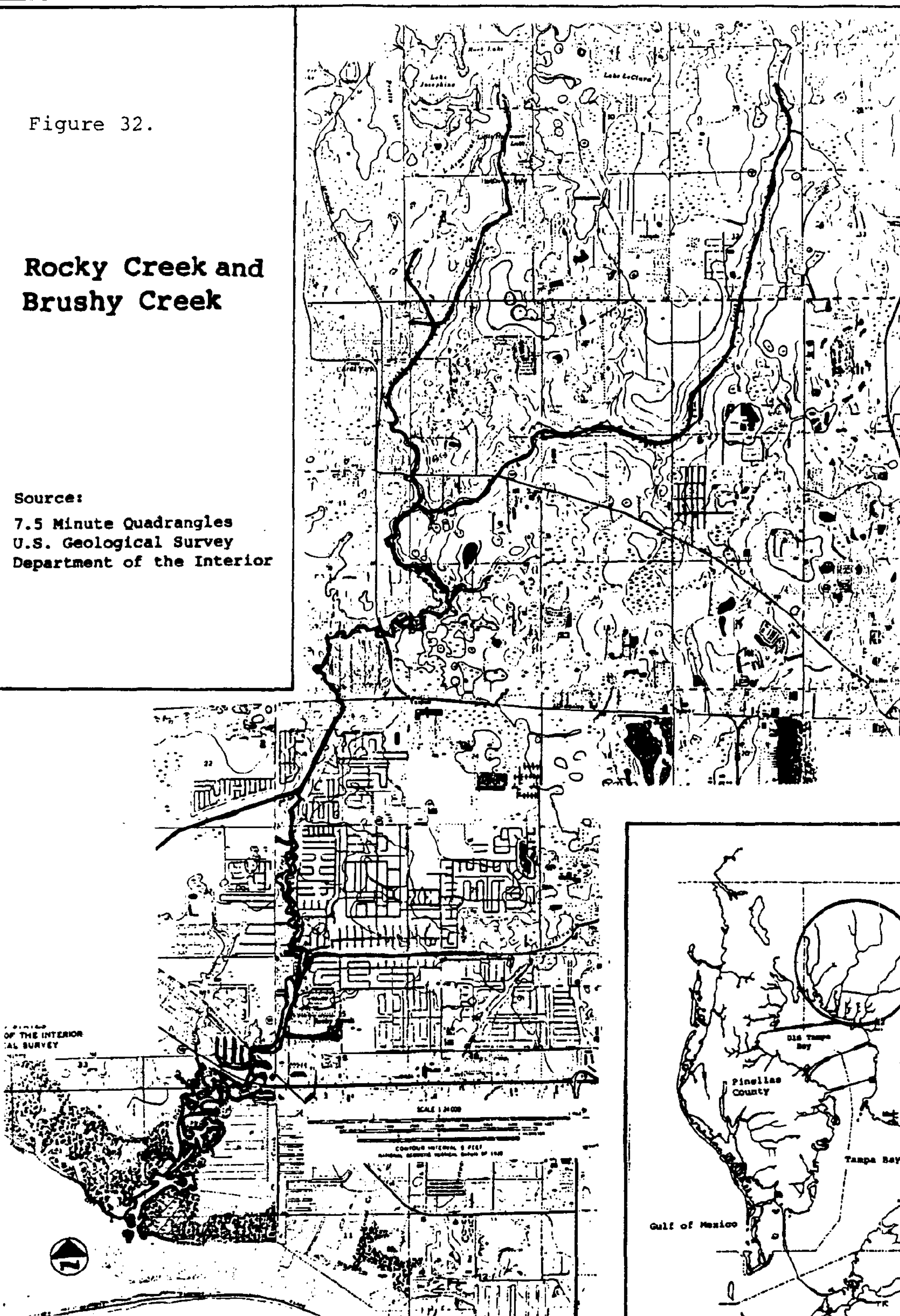
Dick Creek is located between Rocky Creek and Channel "A" and drains southward into Old Tampa Bay in Hillsborough County (Figure 33). Dick Creek shares partial channel alignment with Rocky Creek through the marsh and is approximately 1.6 miles in length.

The lower half of Dick Creek meanders through the extensive tidal marsh in the Bower Tract. In areas where Dick and Rocky Creeks share the same creek path, the alignment is channelized for flood prevention. The upper segment is encroached upon and channelized for residential development. Dick Creek

Figure 32.

Rocky Creek and Brushy Creek

Source:
7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



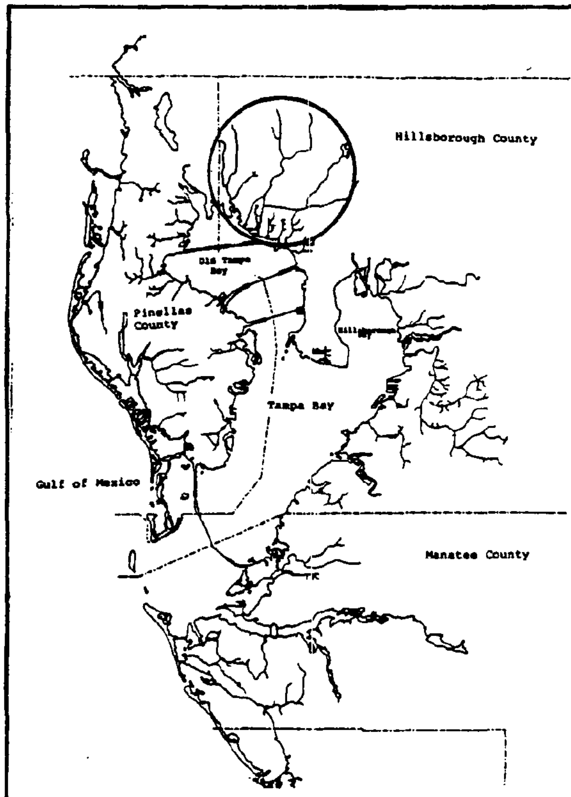
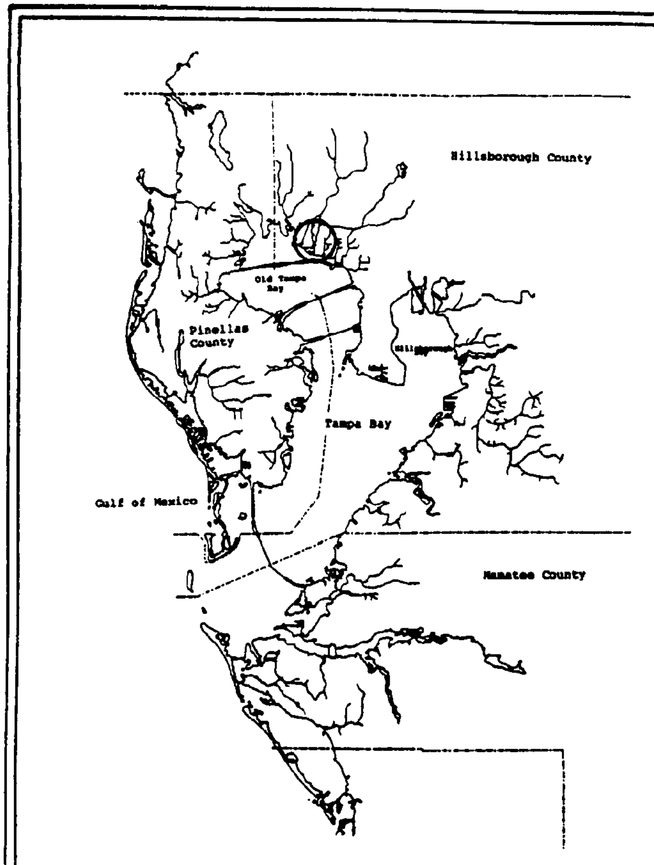
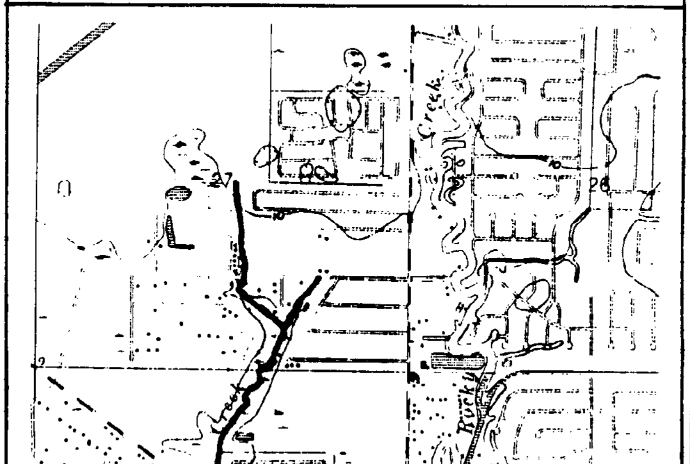
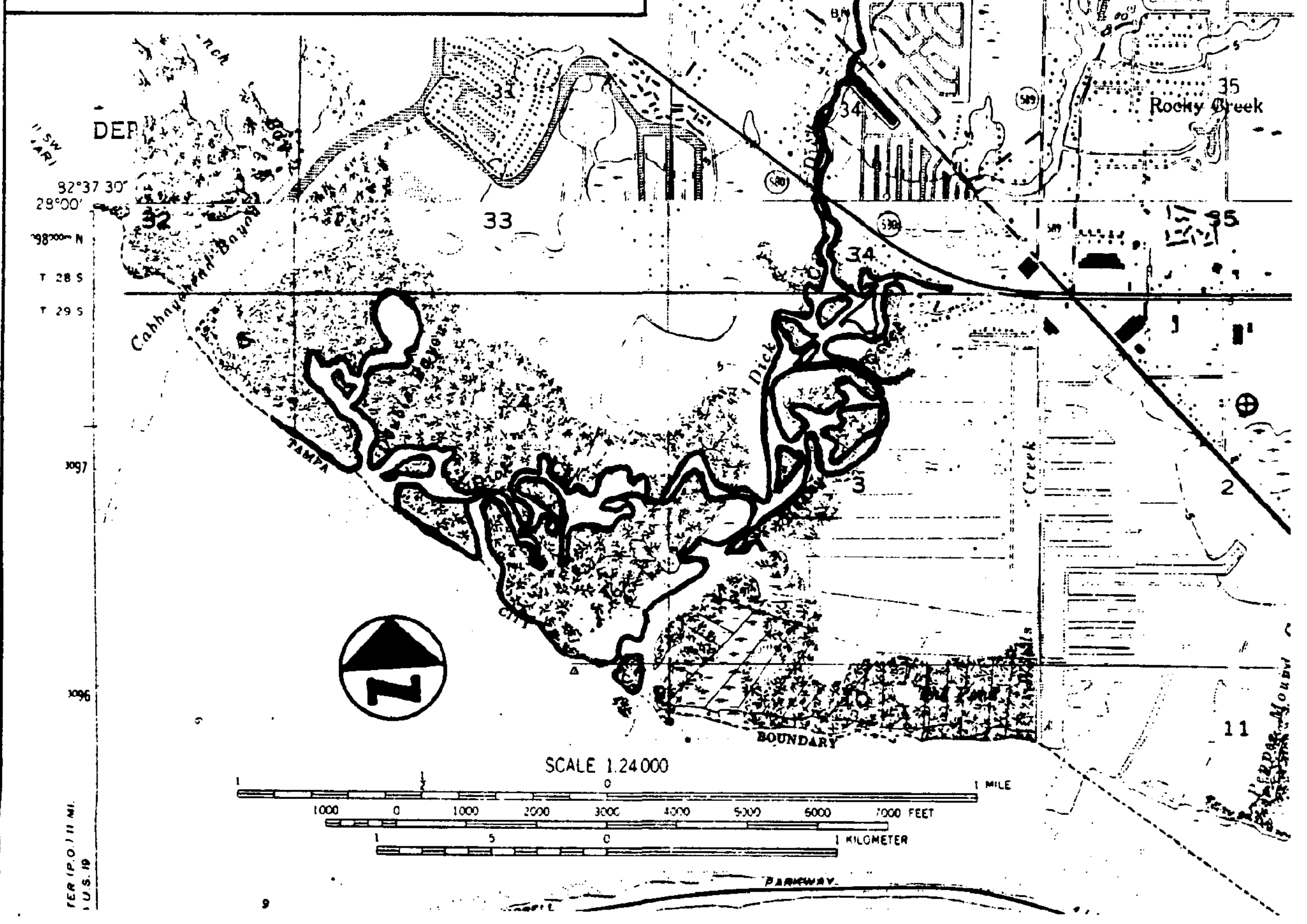


Figure 33.

Dick Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



is categorized as a restorable tidal tributary when considering the natural mouth and partially urbanized drainage area.

1.21 Woods Creek

Located in Hillsborough County between Rocky Creek and Sweetwater Creek is Woods Creek (Figure 34). Woods Creek is approximately 1.6 miles in length and flows south into Old Tampa Bay north of the Courtney Campbell Causeway.

The entire length of Woods Creek has been channelized for either residential development or drainage. On the west side of the creek mouth is a tidal marsh system with open areas at higher elevations to the north. The east side of Woods Creek contains extensive residential development created by dredge and fill construction of finger fills. The upper segment of the creek drains an industrial park area with small areas retaining a wooded overstory.

The extensive channelization and development of Woods Creek characterize the creek as a stressed tidal tributary.

1.22 Peppermound Creek

Located between Woods Creek and Sweetwater Creek in Hillsborough County is Peppermound Creek (Figure 35). The creek flows toward the south approximately 1.6 miles into Old Tampa Bay, north of the Courtney Campbell Causeway.

The mouth of Peppermound Creek is located within a tidal marsh. The tidal marsh retains the natural channel alignment even with urban development surrounding the area. The northern half of Peppermound Creek is dominated by intensive residential development. This segment of the creek has been channelized to minimize flooding of the residential area.

The southern (tidal) section of Peppermound Creek maintains a natural configuration. The segment within the residential areas potentially can be improved by better stormwater management practices to prevent water quality degradation within the tidally influenced portion. Considering these conditions, Peppermound Creek is categorized as a restorable tidal tributary.

1.23 Sweetwater Creek

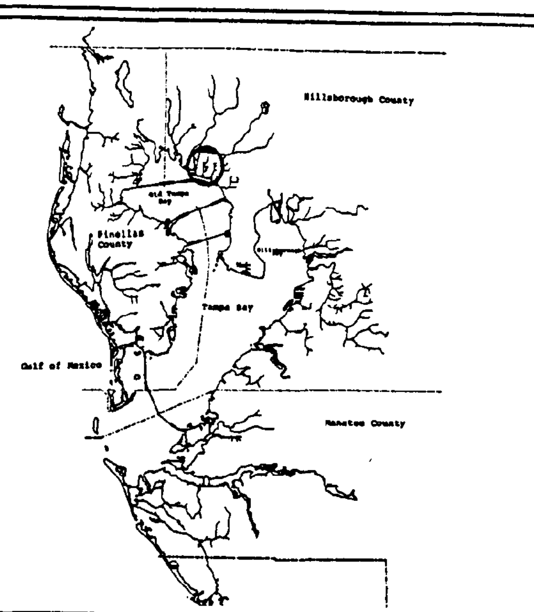
Sweetwater Creek enters Old Tampa Bay just north of Rocky Point in Hillsborough County (Figure 36). The creek flows in the southwest direction approximately 10.4 miles to Old Tampa Bay. Sweetwater Creek drops an average of 10 ft/mi in the middle reaches and one ft/mi near the creek's mouth (Schomer et al. 1984). The creek drains about 25 square miles and the basin consists primarily of urban uses (85 percent), with single family residential accounting for 61 percent of the land use (ESE, 1977).

The mouth of Sweetwater Creek was impacted by dredge and fill activities to create upland residential development in the early 1970's. A remnant marsh exists on the western side of the channelized mouth of the creek. Sweetwater Creek meanders through predominantly residential/commercial use

Figure 34.

Woods Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



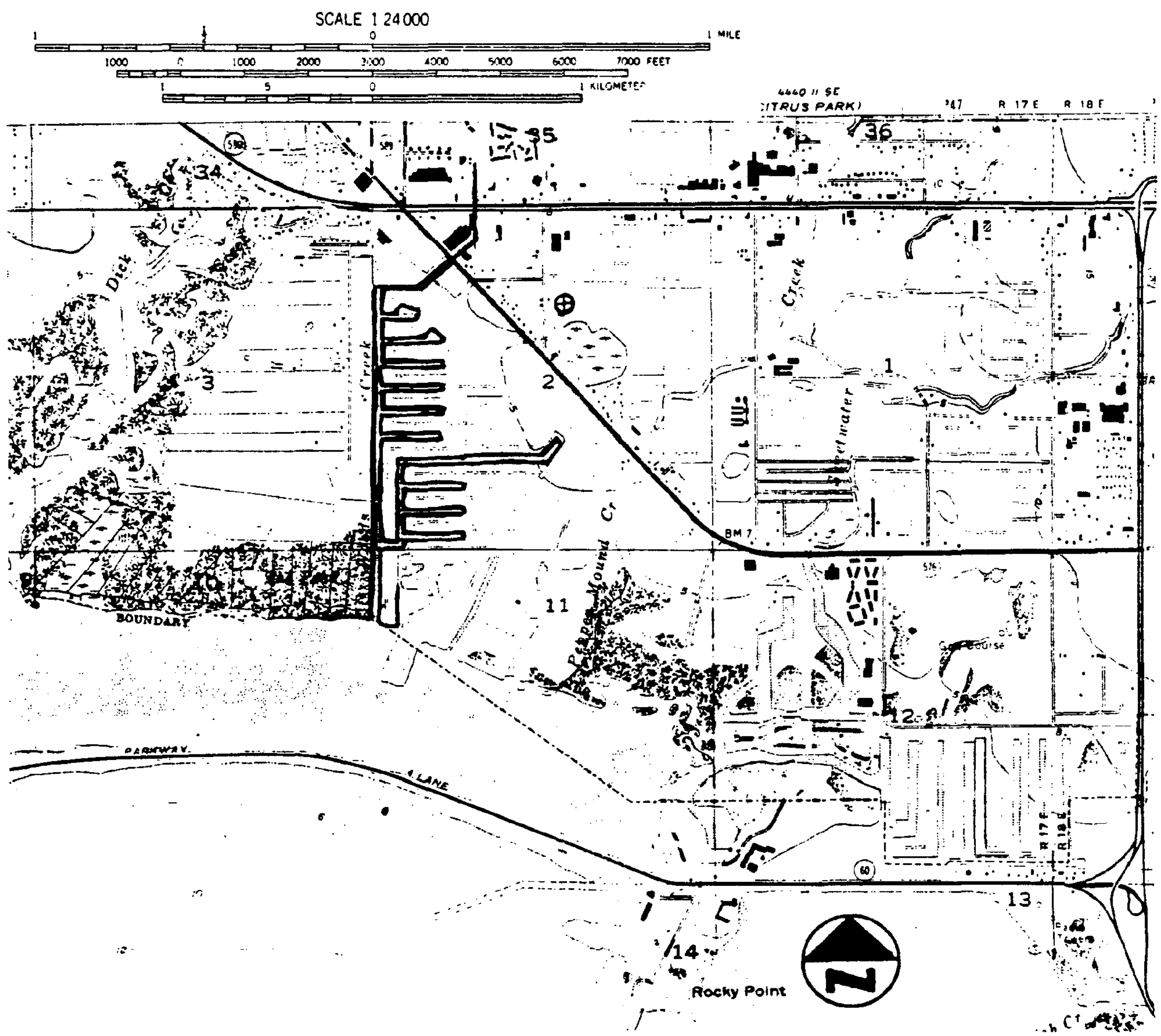
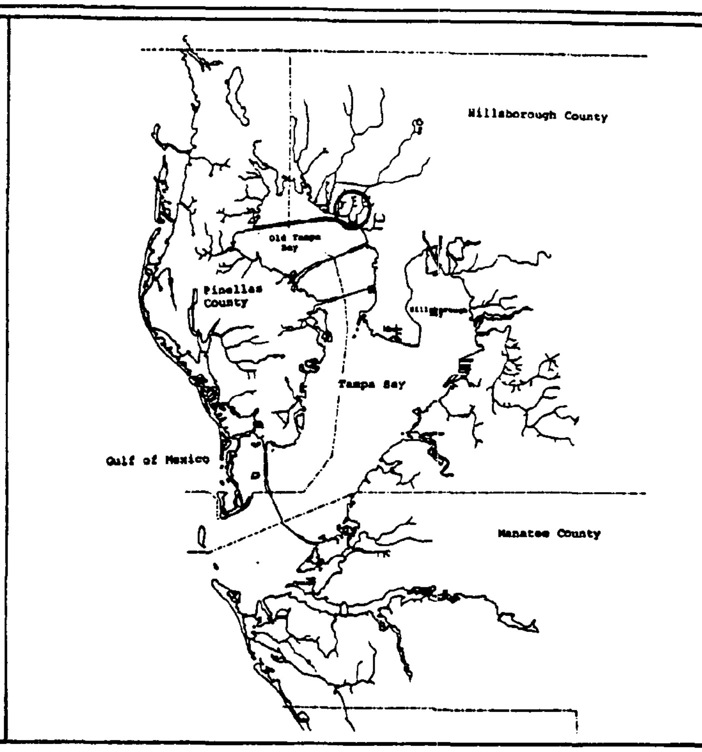


Figure 35.

Peppermound Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



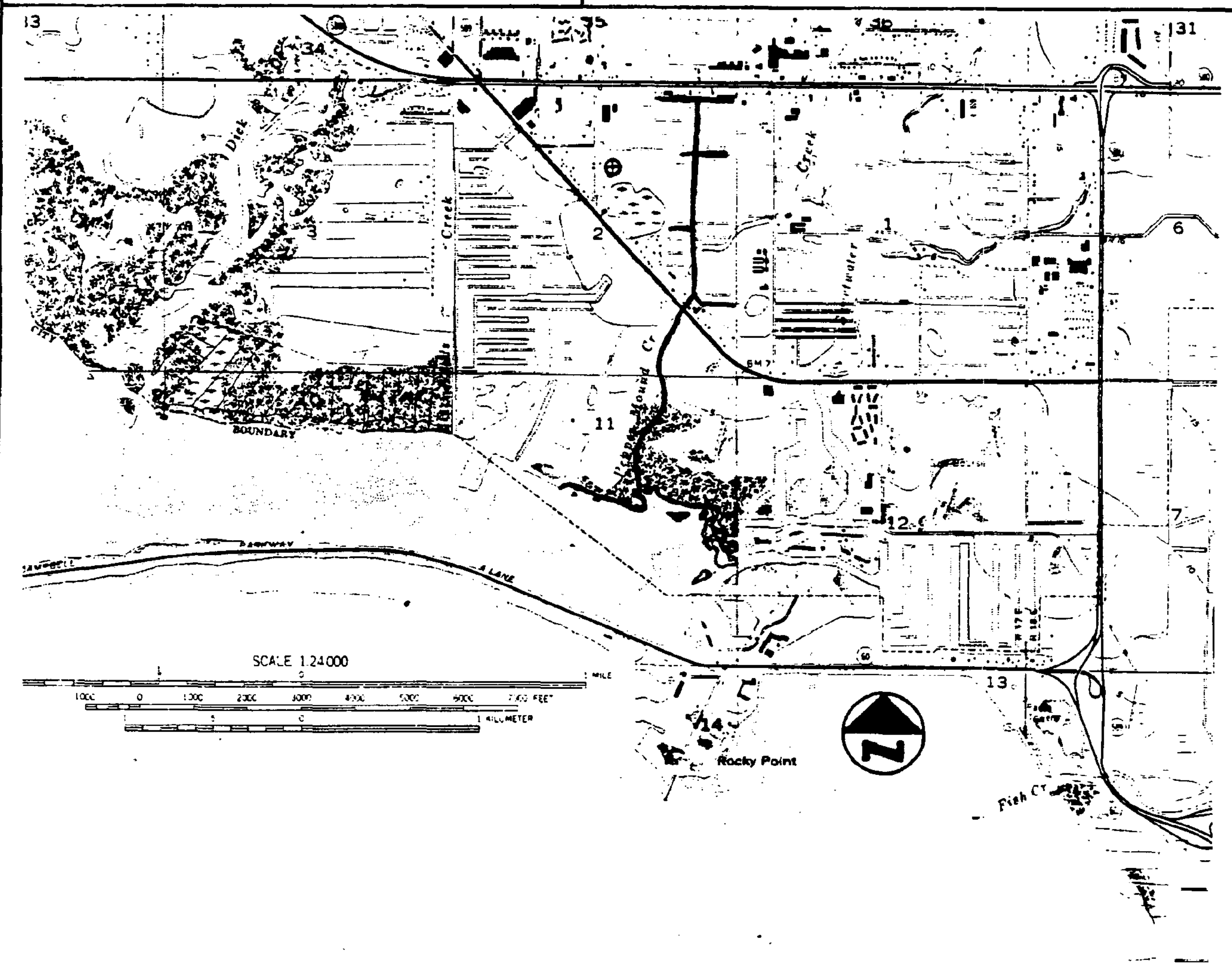
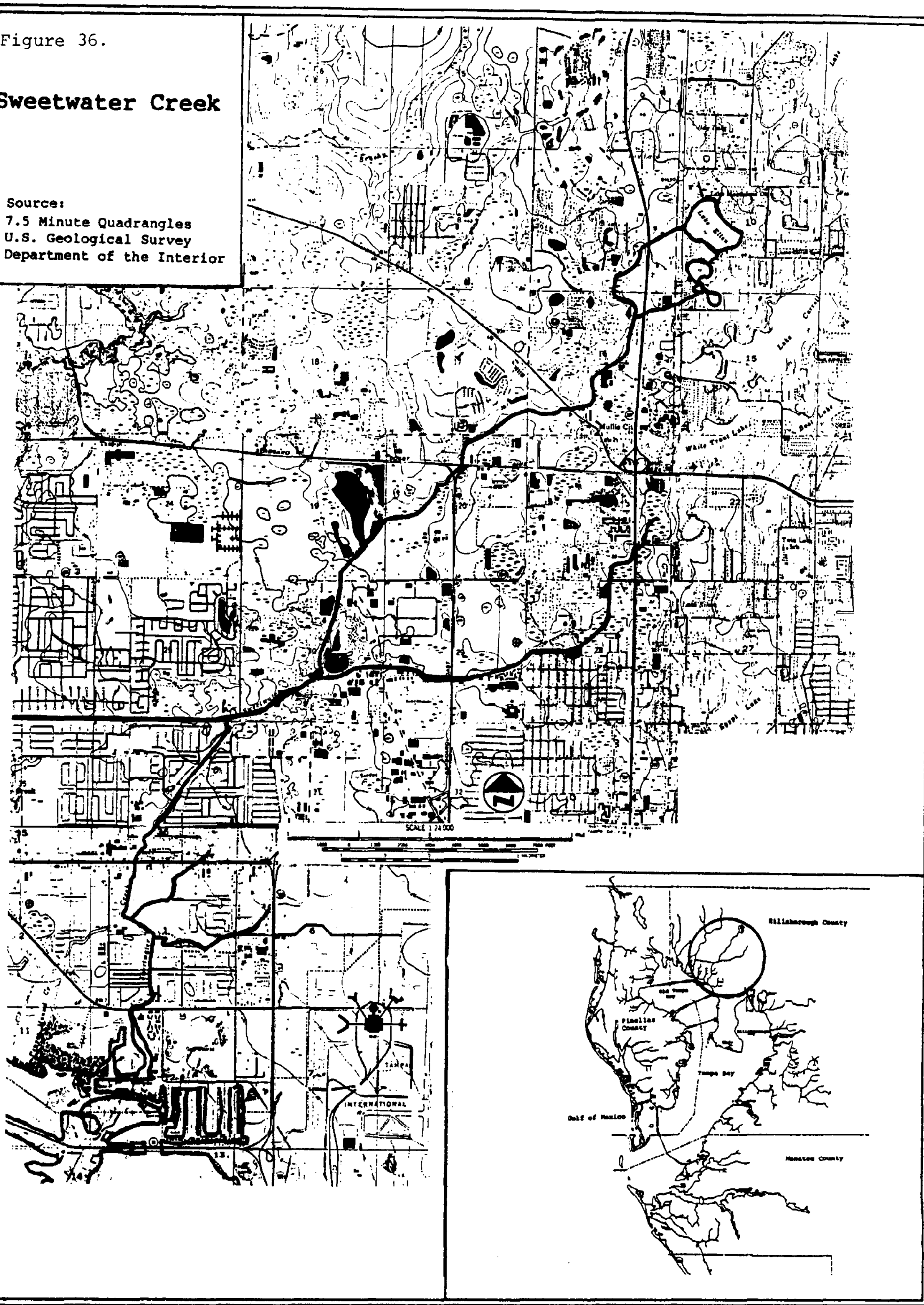


Figure 36.

Sweetwater Creek

Source:
7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



with small agricultural plots north to Channel "G". Channel "G" is a flood control channel between Sweetwater and Rocky Creeks. A cleared buffer area exists adjacent to Channel "G" with surrounding residential development.

The southern branch travels through mixed developments consisting of residential, commercial, industrial and agricultural usage. Scattered freshwater marshes exist along the alignment. The headwaters of the southern branch contain cypress systems and agricultural (grove) areas.

The basin of the northeast branch contains areas of industrial development, borrow pits, agricultural plots, and moderate density residential areas. The upper segment contains numerous cypress domes that have been encroached upon by residential units. The stream alignment is channelized between cypress and marsh systems to promote control of floodwaters.

Water quality data from upper Sweetwater Creek indicates poor conditions, as dissolved oxygen (DO) averages less than 3.0 mg/l and BOD-5 averages 6.0 mg/l (USACE, 1977). The drainage system receives heated or sewage effluent from eleven municipal or industrial facilities (Schomer et al. 1984).

In the tidal portion of the creek DO, BOD-5, and nutrient concentrations indicate seriously degraded conditions (ESE, 1977). Throughout the creek fecal coliform counts are the highest reported in Hillsborough County. In 1981, eight percent of the samples showed a fecal coliform/fecal streptococcus ratio in excess of 4.0, suggesting human waste contamination.

The Sweetwater Creek drainage area is dominated by urban development and associated water quality problems. In addition, the lower (tidal) segment has lost a majority of its natural condition to channelization and other dredging and filling activities. Consideration of these factors identifies Sweetwater Creek as a stressed tidal tributary.

1.24 Fish Creek

Located within Hillsborough County and discharging into Old Tampa Bay south of the Courtney Campbell Causeway is Fish Creek (Figure 37). The creek is approximately 2.3 miles in length with the lower segment oriented in an east to west direction.

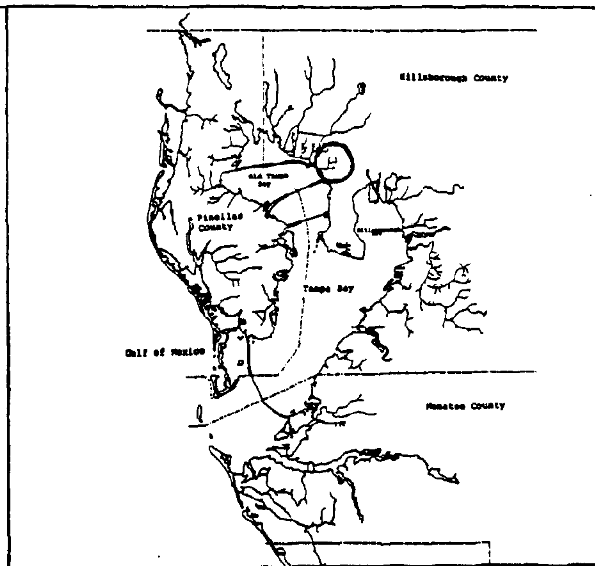
The mouth of Fish Creek is surrounded by a tidal marsh system. However, the creek has been channelized placing spoil piles within marsh areas adjacent to the creek. The lower segment is used for drainage of the highway interchange of State Road 60, Eisenhower Boulevard, and Tampa Airport access roads. The majority of the middle and upper segments have been realigned to serve as drainage ditches for Tampa International Airport.

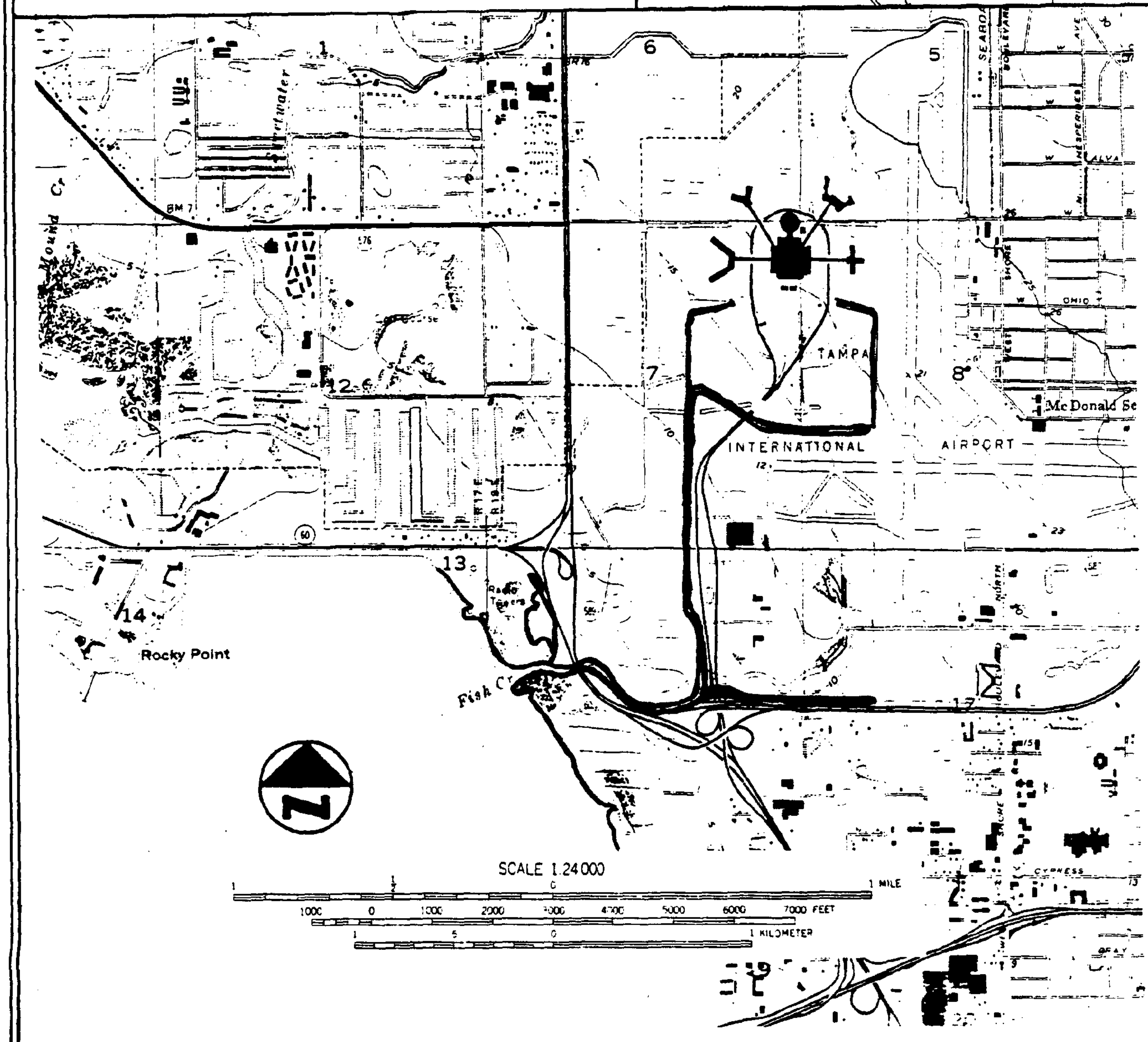
The potential for restoration exists within Fish Creek. The drainage area for Tampa International Airport potentially can be restored to a meandering marsh and still provide retention and treatment for the airport runoff. The same restoration can be applied for Fish Creek along the roadway alignments. Spoil mounds at the creek mouth can be lowered to the adjacent marsh elevation to increase potential marsh acreage and promote inundation of adjacent marsh systems. Therefore, Fish Creek is categorized as a restorable tidal tributary to Old Tampa Bay.

Figure 37.

Fish Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





1.25 Broad Creek and Coon Hammock Creek

Broad and Coon Hammock Creeks are located on the extreme southern tip of the Interbay Peninsula within Hillsborough County. Broad Creek is the longest and travels 2.5 miles in a southward direction to Tampa Bay. Coon Hammock Creek is a branch of Broad Creek and travels one-half mile through a mangrove/tidal marsh system (Figure 38).

The lower segment and mouth of Broad Creek meander through the extensive tidal marsh system south of MacDill Air Force Base. The middle and upper sections have been channelized and ditched to provide drainage for the Air Force Base. Many dredged channels have side-cast spoil on adjacent tidally influenced marshes.

The drainage ditches of MacDill Air Force Base potentially can be restored to natural conditions and continue to provide flood control. The natural conditions prevalent at the mouth of Broad Creek and surrounding Coon Hammock Creek characterize both as in restorable condition.

1.26 Delaney Creek

Delaney Creek is located within Hillsborough County and flows toward the west into Hillsborough Bay (Figure 39). A detailed ecological assessment of Delaney Creek is included in the following section of this report. Delaney Creek is classified as a stressed tidal tributary to Tampa Bay.

1.27 Archie Creek

Flowing into Hillsborough Bay just north of the Alafia River is Archie Creek. The creek travels approximately 4.9 miles toward the west into Hillsborough Bay (Figure 40).

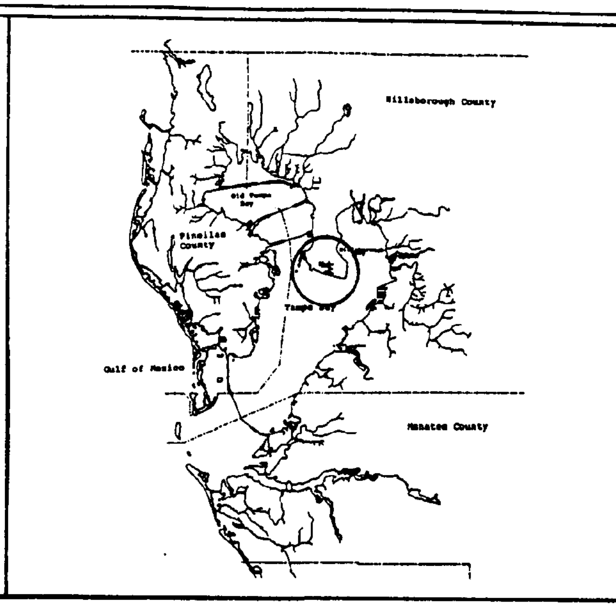
The mouth of Archie Creek is located within a moderate sized <u>Juncus</u> and <u>Spartina</u> tidal marsh. The lateral extent of the existing marsh is limited by a channelized drainage canal to the north, and the Gardinier, Inc. gypsum stack to the south. The creek maintains a meandering alignment through the marsh to the Seaboard Coast railroad line. At this point the creek is rerouted around Gardinier's cooling ponds, and channelized in the upper reaches for agricultural drainage. The majority of the drainage area consists of agricultural usage. Areas of industrial development exist in the lower sections and residential development is encroaching upon the upper drainage area.

Water quality within Archie Creek is affected by agricultural runoff, industrial discharges and the Progress Village municipal wastewater treatment plant effluent discharge. Improved management practices for stormwater and effluent limitations potentially can improve water quality conditions. The tidally influenced portion maintains a healthy marsh community and categorizes Archie Creek as a restorable tidal tributary.

Figure 38.

Broad Creek and Coon Hammock Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



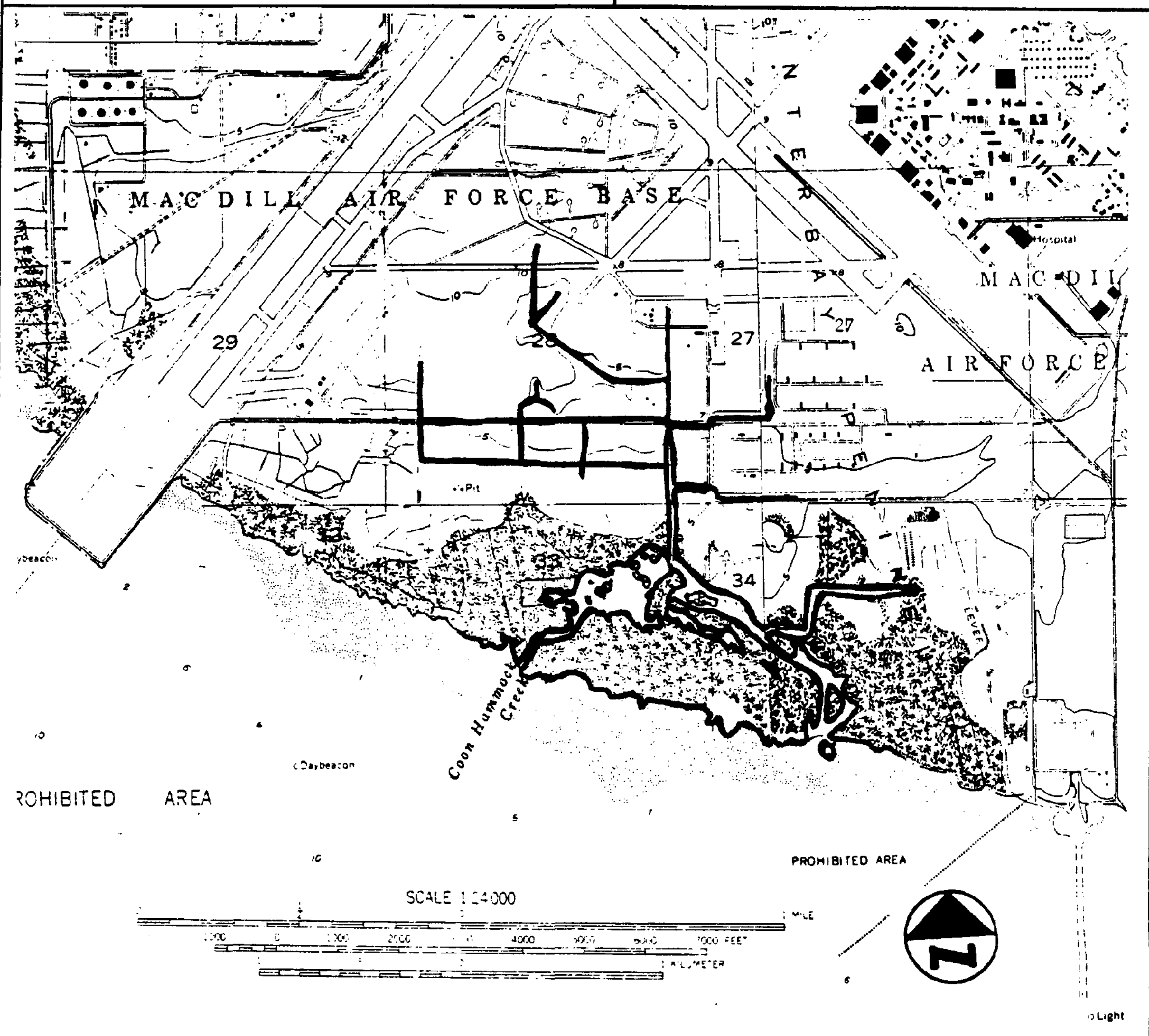
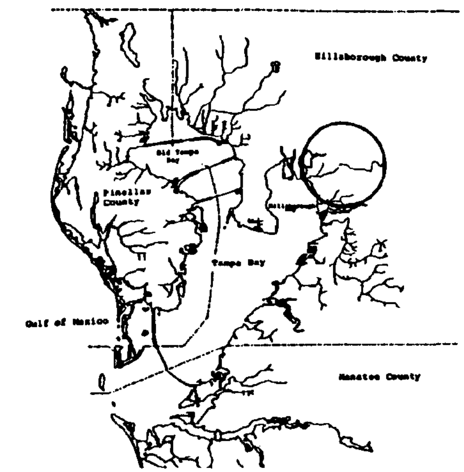


Figure 39.

Delaney Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



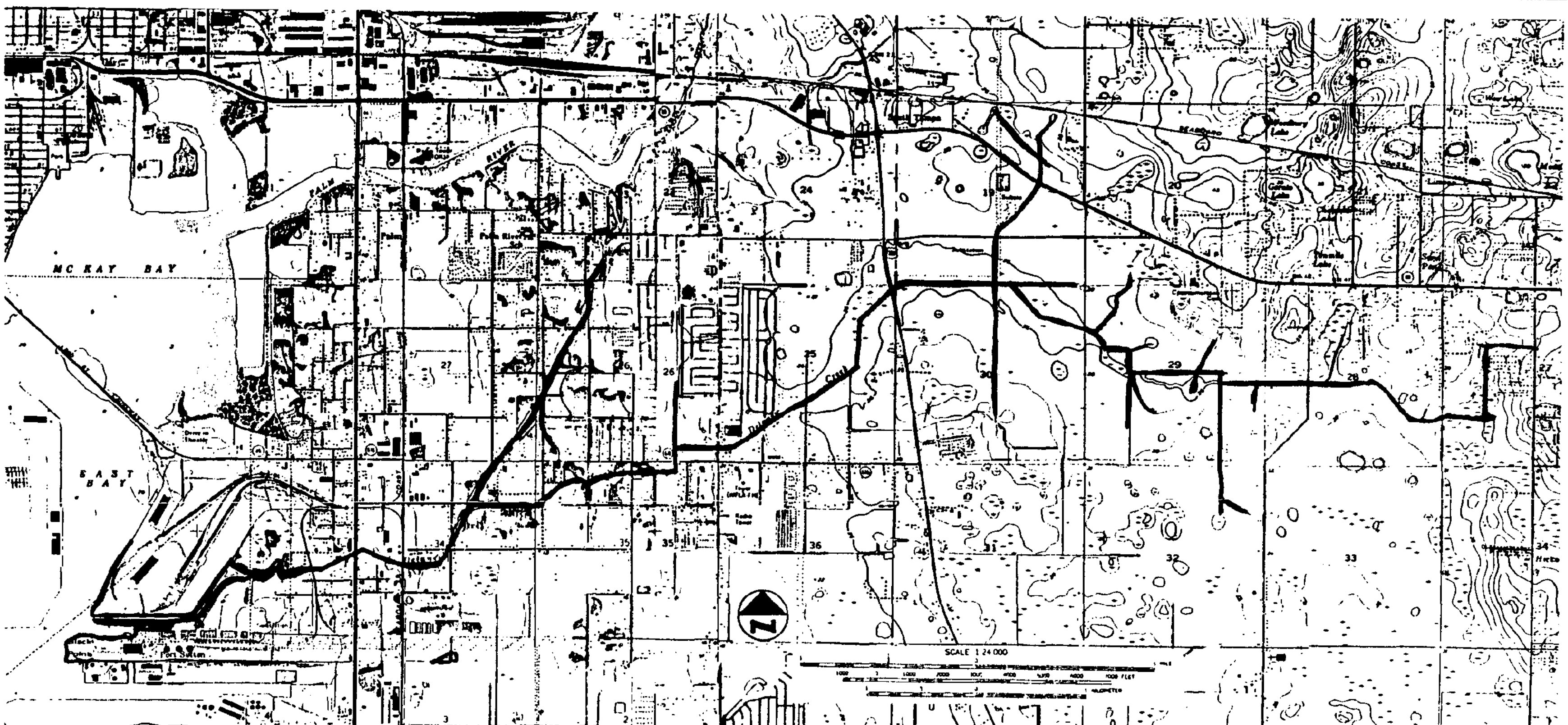
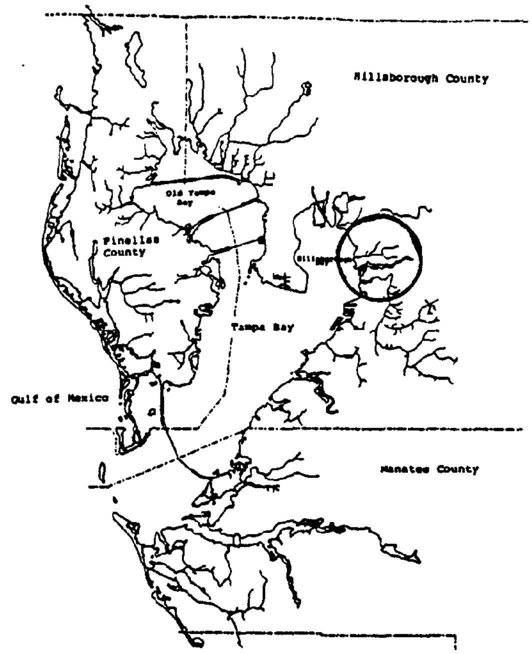
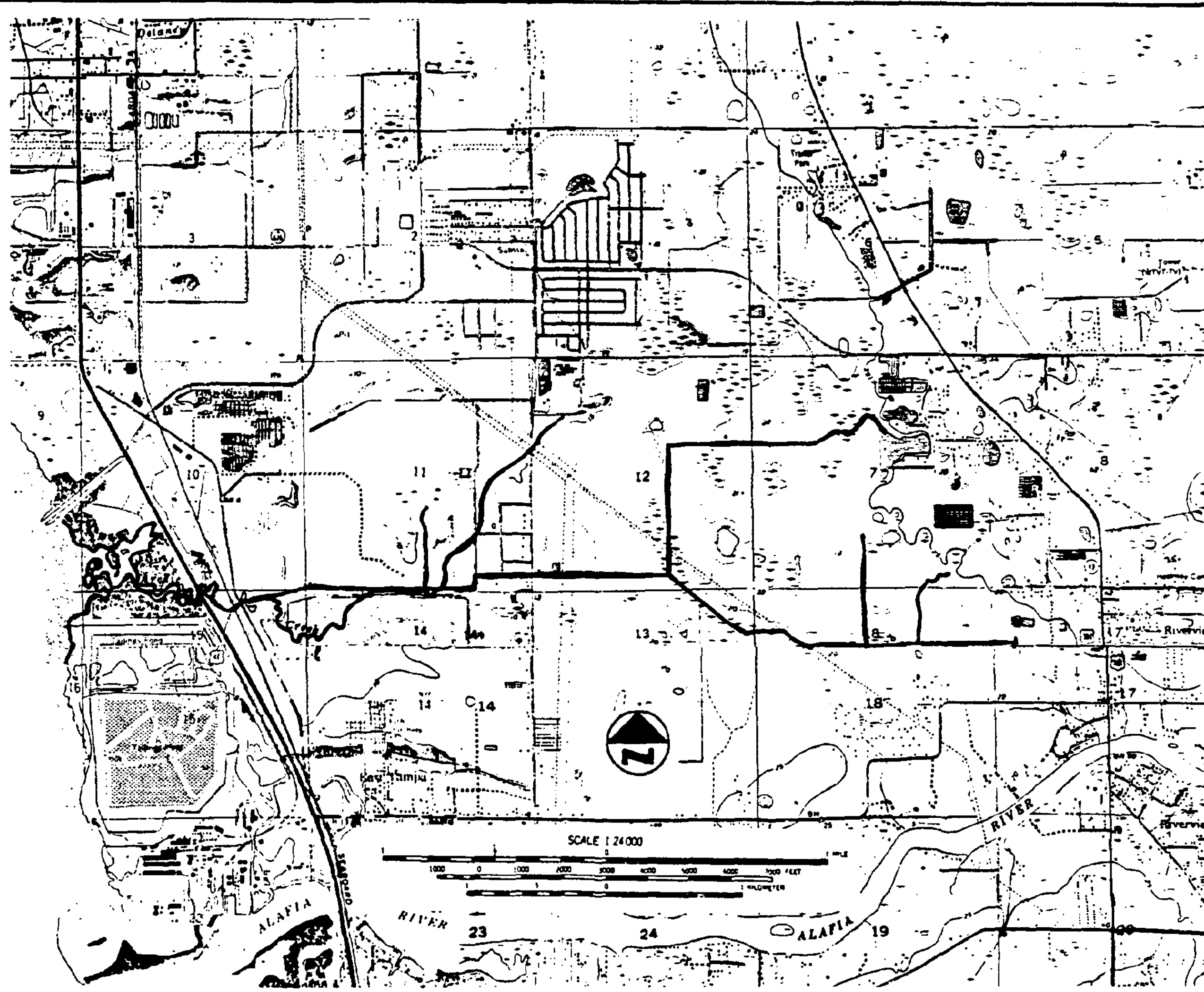


Figure 40.

Archie Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





1.28 Bullfrog Creek and Little Bullfrog Creek

Bullfrog Creek discharges into Hillsborough Bay about one mile south of the Alafia River in Hillsborough County (Figure 41). The drainage basin is about 40 square miles and the creek flows in a northwest direction approximately 17.5 miles to Hillsborough Bay.

The mouth of Bullfrog Creek meanders through an extensive tidal marsh containing mangrove islands. Upstream of the marsh, the creek maintains the meandering alignment through low density residential areas, agricultural plots and tropical fish farms. The middle segment maintains a natural path with a wooded overstory. The creek is dominated by agriculture and open pasture on either side of the creek floodplain. The creek is dendritic with the majority of the branches traveling toward the east, the largest of which is Little Bullfrog Creek (Figure 41).

Little Bullfrog Creek branches off about middle length of Bullfrog Creek. Little Bullfrog drains toward the west through agricultural (tomato fields) areas, open pastures, and forested areas. The upper segment is connected to many freshwater marshes for agricultural drainage.

Bullfrog Creek flows south from the Little Bullfrog Creek confluence and maintains a forested floodplain surrounded predominantly by tomato farms. The upper dendritic branches travel through intensive agricultural development and channelized through marsh systems to facilitate drainage. The small town of Wimauma lies within the drainage area near the extreme southern branch of Bullfrog Creek.

The Bullfrog Creek channel ranges from 30 ft. to 195 ft. wide and 2 ft. to 6 ft. deep, narrowing upstream of US 41. Flow measured 8.5 miles upstream of the bay averages 35.4 cfs and ranges from 2,360 cfs to no flow (Mycyk et al. 1983 in Schomer et al. 1984). Land use within the drainage area is primarily agricultural (75 percent) with some residential single family development. Two privately-owned wastewater treatment plants discharge approximately 0.01 MGD of effluent into the creek (Priede-Sedgwick, Inc., 1980). Nutrient levels are moderate and occasional problems with instream sludge build-up, apparently from fish pond drainage, have caused increases in BOD and high levels of coliforms (ESE, 1977; HCEPC, 1982; Mycyk et al. 1983 in Schomer et al. 1984).

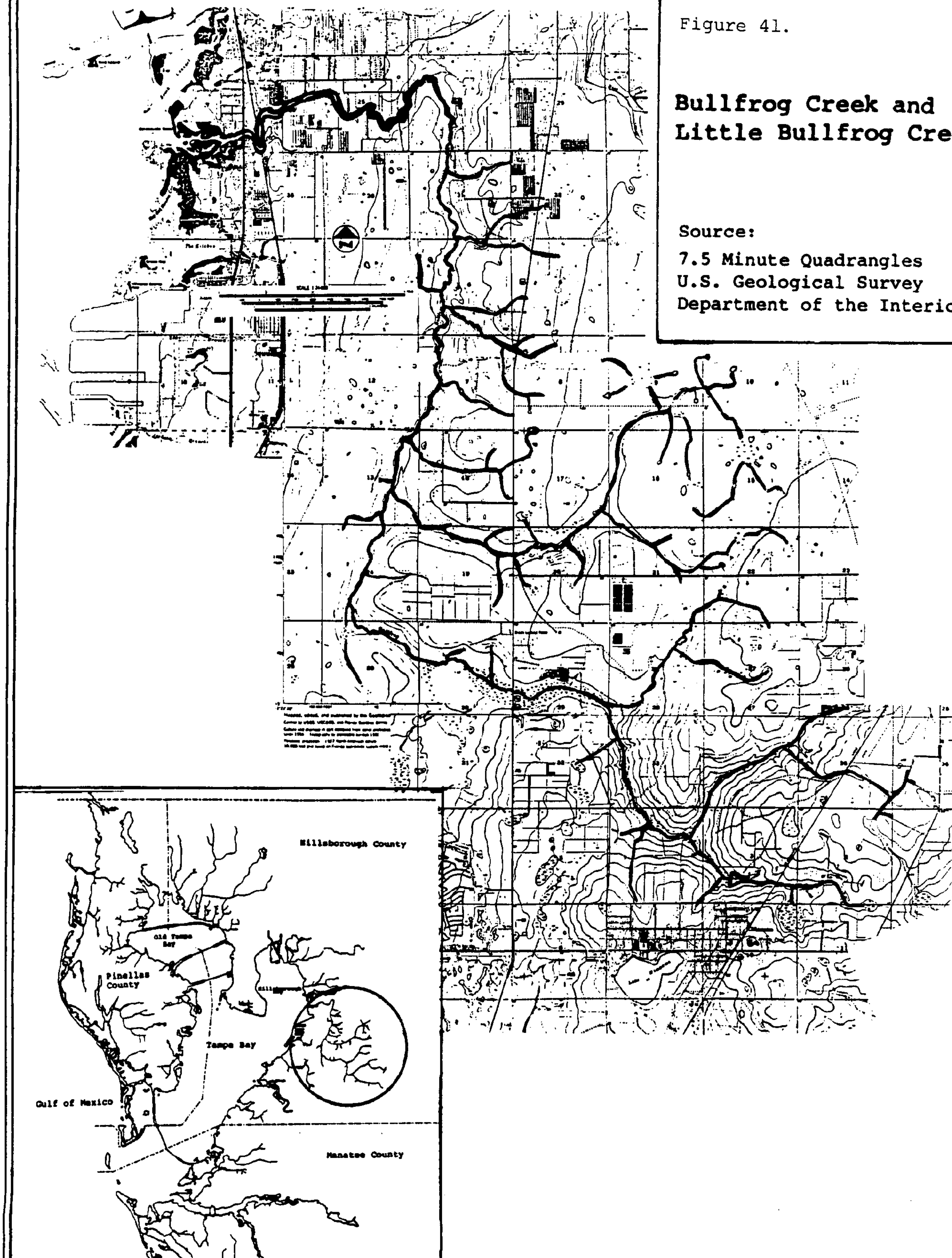
The middle and upper reaches of Bullfrog Creek have experienced moderate habitat loss through piecemeal development (TBRPC, 1985). Water quality impacts appear to be associated primarily from non-point sources (agricultural) with some influence from point sources (fish ponds, treated effluent). However, the lower segment contains natural tidal marsh areas with some adjacent encroachment by development. With the opportunity for creek improvements through better management, Bullfrog Creek categorized as a restorable tidal tributary.

Figure 41.

Bullfrog Creek and Little Bullfrog Creek

Source:

7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



1.29 Newman Branch

Newman Branch is a small tidal tributary entering Tampa Bay between Big Bend to the north and Apollo Beach to the south, in Hillsborough County (Figure 42). The creek travels approximately 2.5 miles toward the northwest into middle Tampa Bay.

The mouth of Newman Branch is channelized through a tidal marsh. The marsh is isolated from other natural systems by Tampa Electric Company's Big Bend facility and Apollo Beach dredge and fill developments. The Tampa Electric Company's Big Bend plant discharges thermal effluent cooling water near the mouth of Newman Branch. The lower segment retains a meandering alignment with adjacent tidal marsh to the trailer park (Figure 42). The trailer park is excavated from the creek channel and adjacent uplands to create a finger fill development. The upper segment retains some remnant marsh systems while being channelized to provide drainage for Seaboard Coast Railroad and U.S. Highway 41.

Development adjacent to Newman Branch is expected to accelerate in the future. Possible channel realignment and improved management practices potentially can improve the creek's status. Due to historical development and channelization, Newman Branch is characterized as a stressed tidal tributary to Tampa Bay.

1.30 Wolf Branch

Located between Apollo Beach and the Little Manatee River in Hillsborough County is Wolf Branch (Figure 43). The creek flows in a northeasterly direction for approximately 6.5 miles into middle Tampa Bay.

The mouth of Wolf Branch meanders through an extensive tidal marsh containing mangrove islands and fringe. The lower segment travels through a marsh that is diked to prevent salt water intrusion into agricultural areas. The middle segment is channelized through agricultural (predominantly tomato farms) development and is channelized along the Seaboard Coast Line Railroad. The upper section is dominated by agricultural use surrounding the forested floodplain of Wolf Branch. The headwaters of the creek drain several large freshwater wetlands.

The natural conditions at the mouth of Wolf Branch are quickly displaced by ditching and other agricultural impacts upstream. Better stormwater runoff practices and reconditioning of channelized areas potentially can improve the creek system. Wolf Branch is categorized as a restorable tidal tributary.

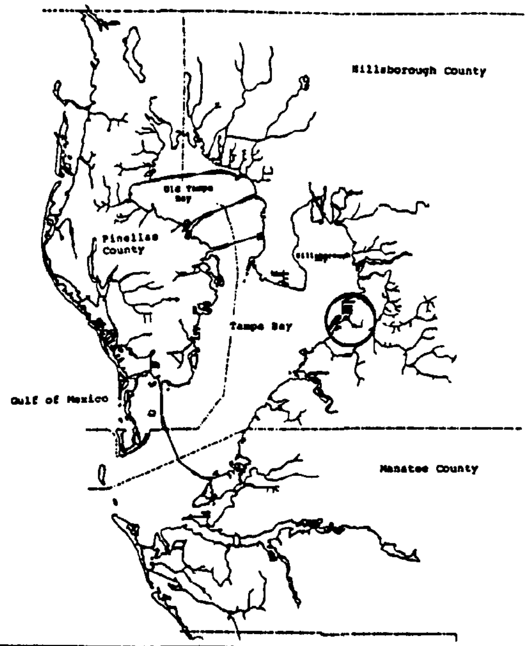
1.31 Cockroach Creek

Cockroach Creek is located in the southwestern corner of Hillsborough County (Figure 44). The creek travels approximately 2.5 miles toward the northwest into Cockroach Bay. Cockroach Bay is an extensive mangrove embayment of Tampa Bay, and is classified as a Class I Aquatic Preserve.

The lower segment of the creek is diked to prevent flooding of adjacent agricultural areas. The middle and upper segments are dominated by agricultural and pasture lands with some single-family residential usage.

Figure 42.

Newman Branch



Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior

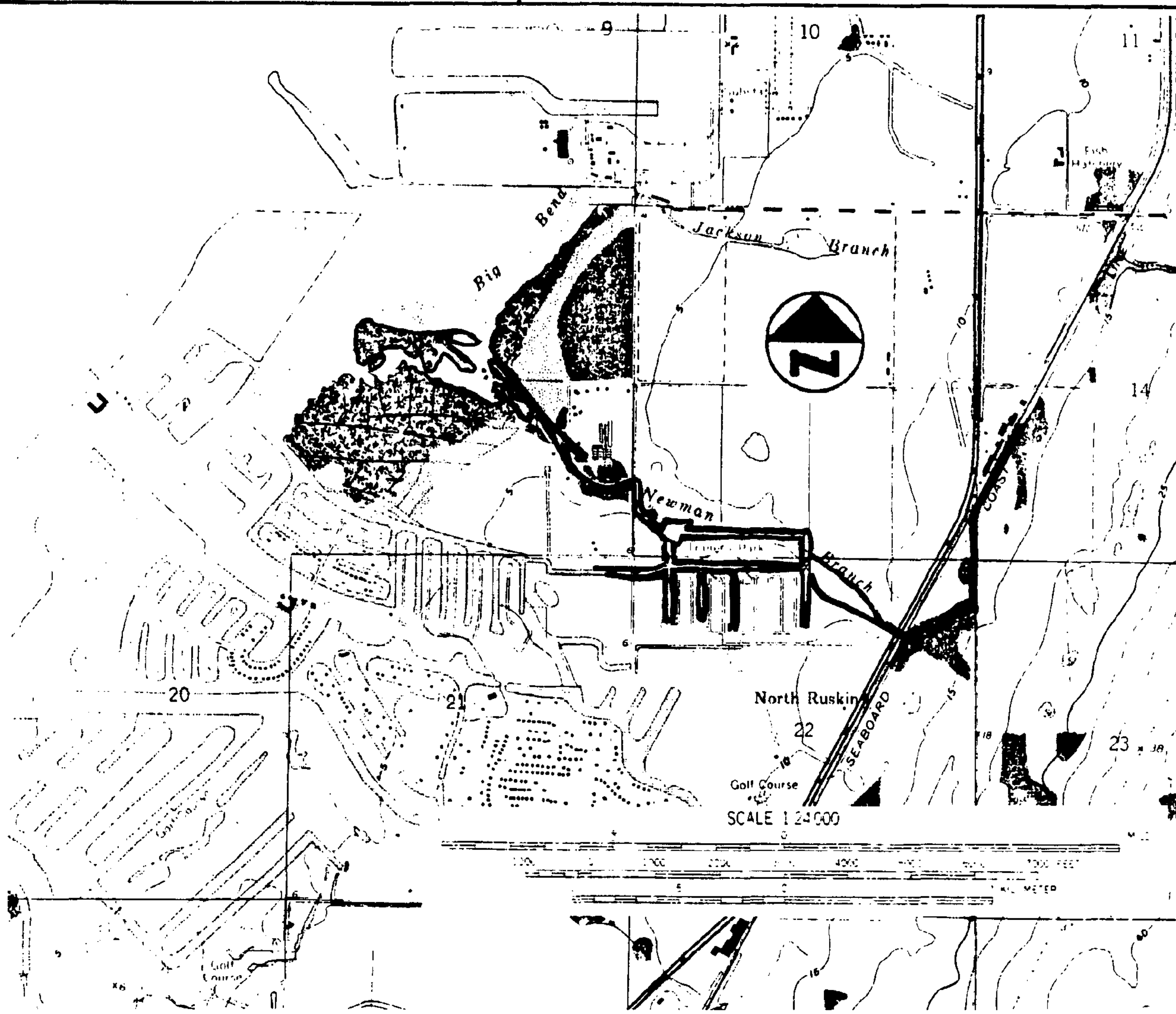
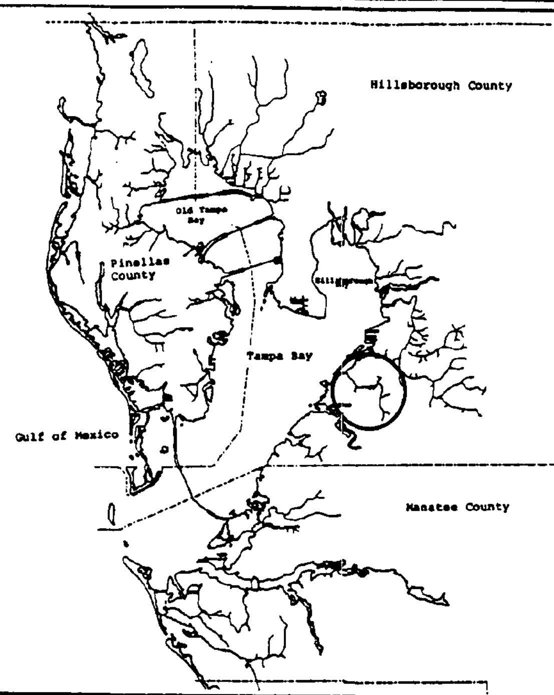


Figure 43.

Wolf Branch

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



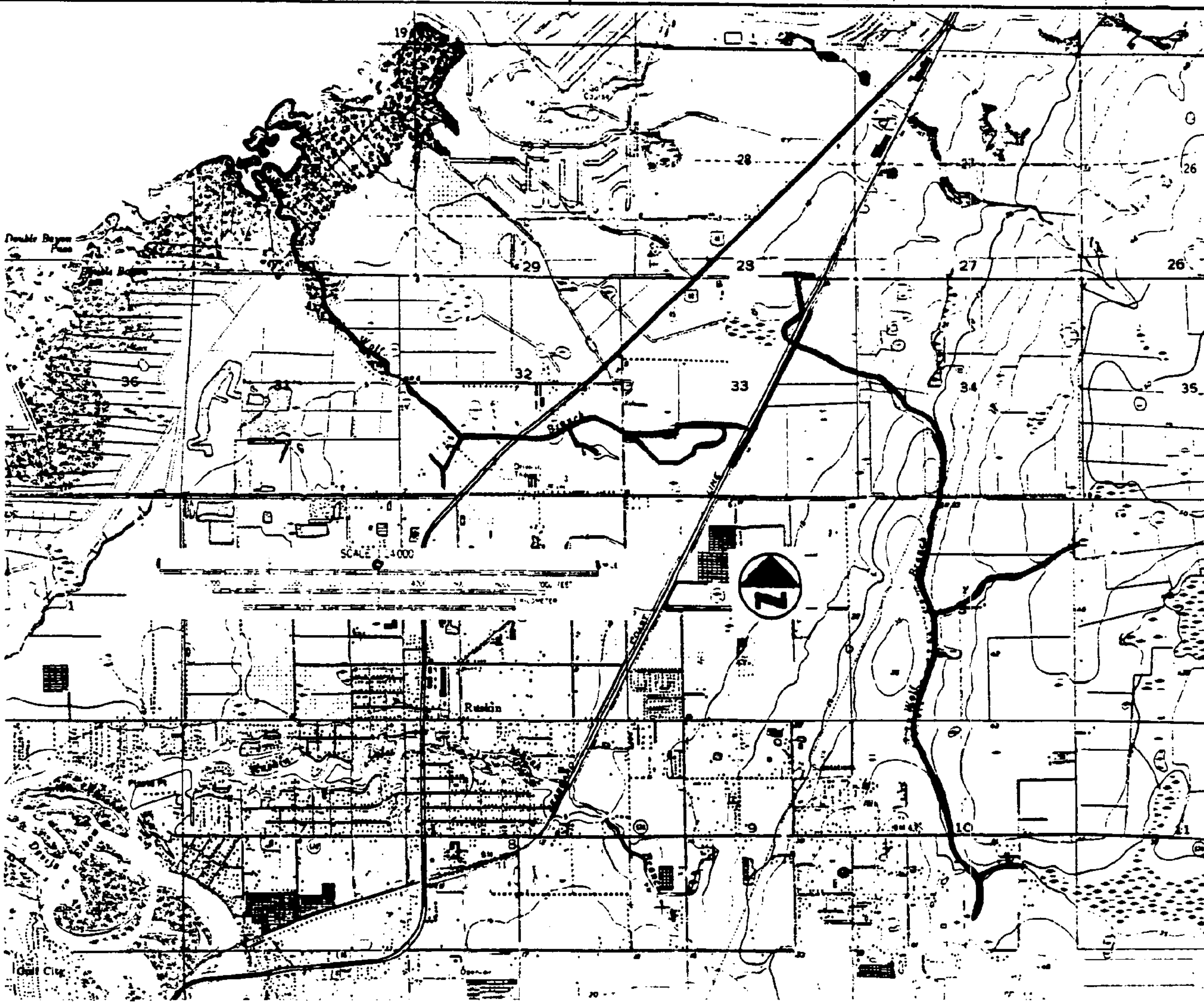
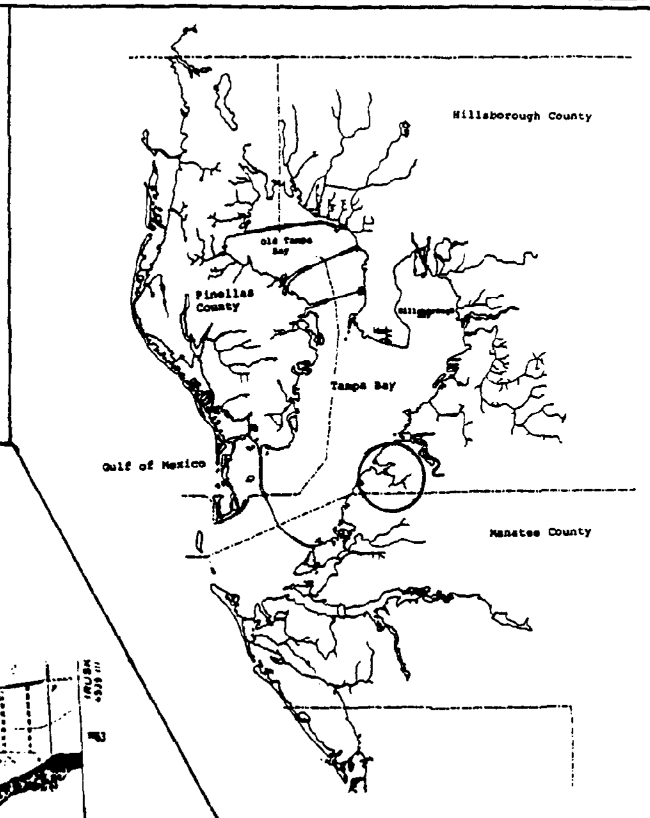
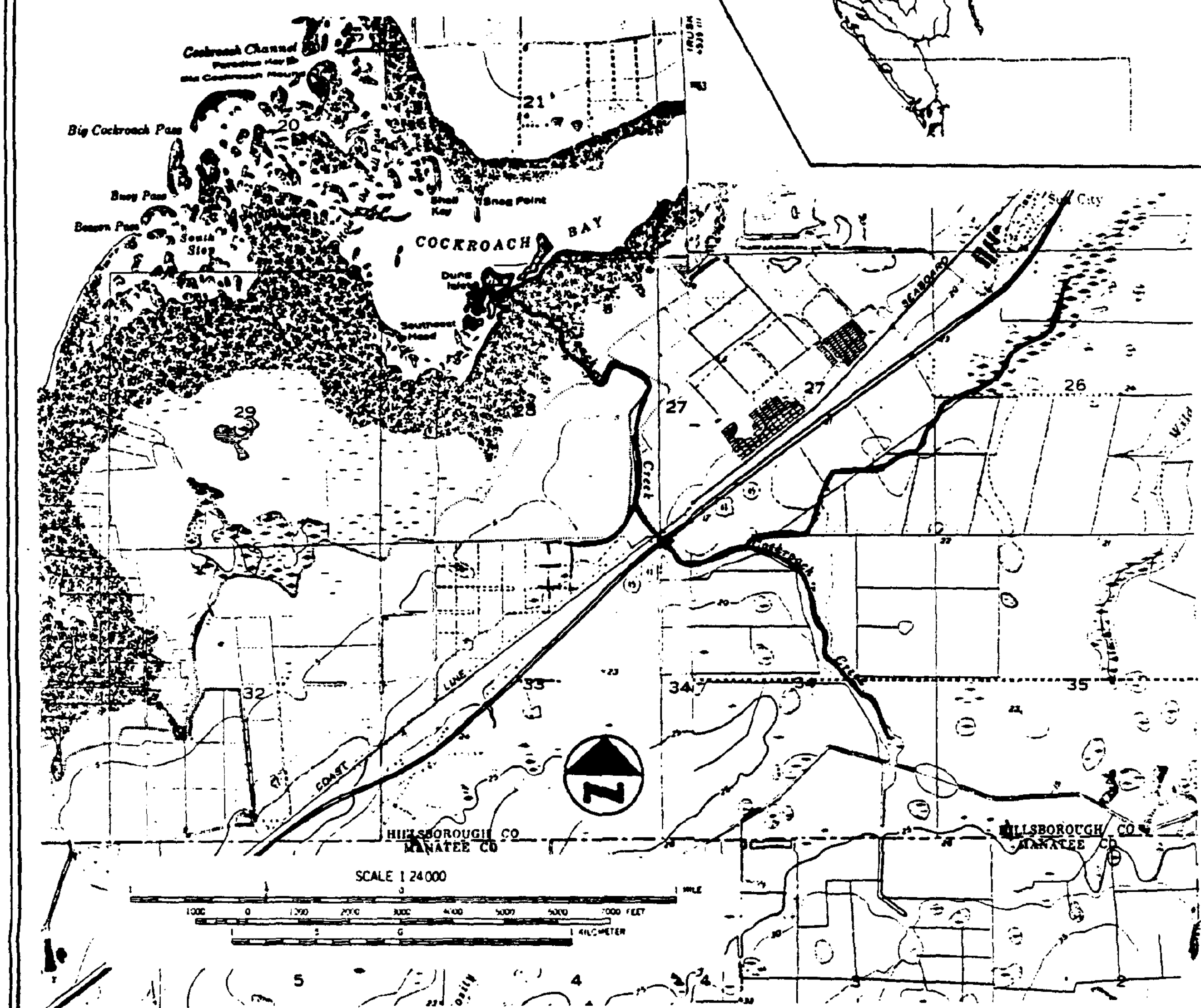


Figure 44.

Cockroach Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





The headwaters are ditched between wetlands to facilitate drainage of stormwater.

The tidal portion of Cockroach Creek remains in relatively good condition with slight agricultural and residential impacts. Cockroach Creek is characterized as a natural tidal tributary to Tampa Bay.

1.32 Piney Point Creek

Piney Point Creek flows into Tampa Bay at the extreme southwestern corner of Hillsborough County (Figure 45). The creek flows from the southeast direction from Manatee County for approximately 2.7 miles to Moody Point in Hillsborough County.

The mouth of Piney Point Creek flows through an extensive tidal marsh into the bay. The marsh is limited by agricultural development on all upland sides by the use of dikes. The middle and upper sections travel through agricultural and improved pasture development. Some industrial development is located in the middle segment and includes the Amax and Piney Point Inc. plants. The headwaters drain wetlands located within agricultural areas.

The tidally influenced portions of Piney Point Creek remain in relatively pristine condition. The watershed contains some industrial activity but is dominated by agricultural practices. Piney Point Creek is classified as a natural tidal tributary.

1.33 Redfish and Little Redfish Creeks

Located adjacent to the southern property line of Port Manatee in Manatee County are Redfish and Little Redfish Creek (Figure 46). Both creeks are located within extensive tidal marsh systems between Bishop Harbor and Port Manatee. During ship channel excavation for Port Manatee in 1969, the Hendry Corporation illegally filled 71 acres of the marsh. The mouth of Redfish Creek was buried in the process and portions of Little Redfish Creek have silted in from the spoil material.

Upland of the marsh system is the industrial development of Port Manatee and Amax Phosphate's slime ponds and gypsum stack. Surrounding the industry, the drainage area also contains large groves and other agricultural uses.

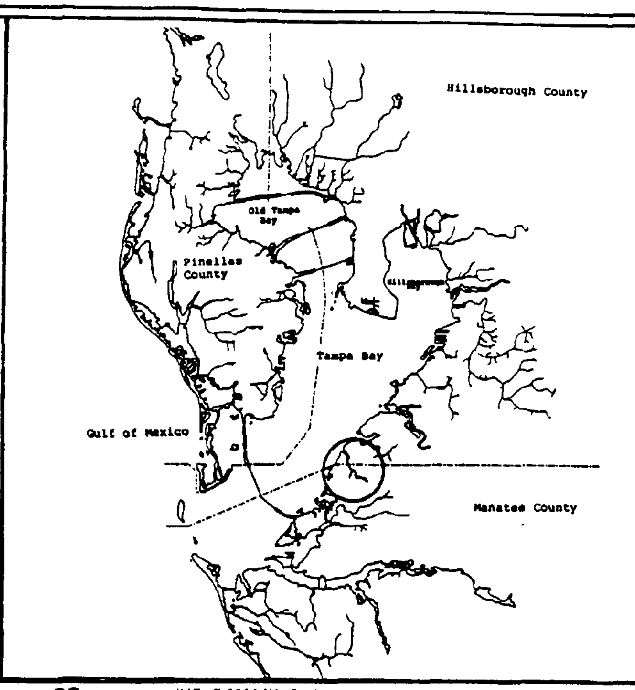
Redfish Creek is currently under private ownership. Restoration of the tidal portion would require transfer of ownership, reconnection of upland drainage areas with Tampa Bay, and lowering surrounding elevations for tidal marsh re-creation. The actual restoration of Redfish Creek appears bleak and it is currently classified as a stressed tidal tributary.

Little Redfish Creek is categorized as a natural tidal tributary to Tampa Bay in The Future of Tampa Bay (TBRPC, 1984). Additional enhancement is possible to improve existing conditions by the removal of silt deposits in an effort to restore the habitat value.

Figure 45.

Piney Point Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



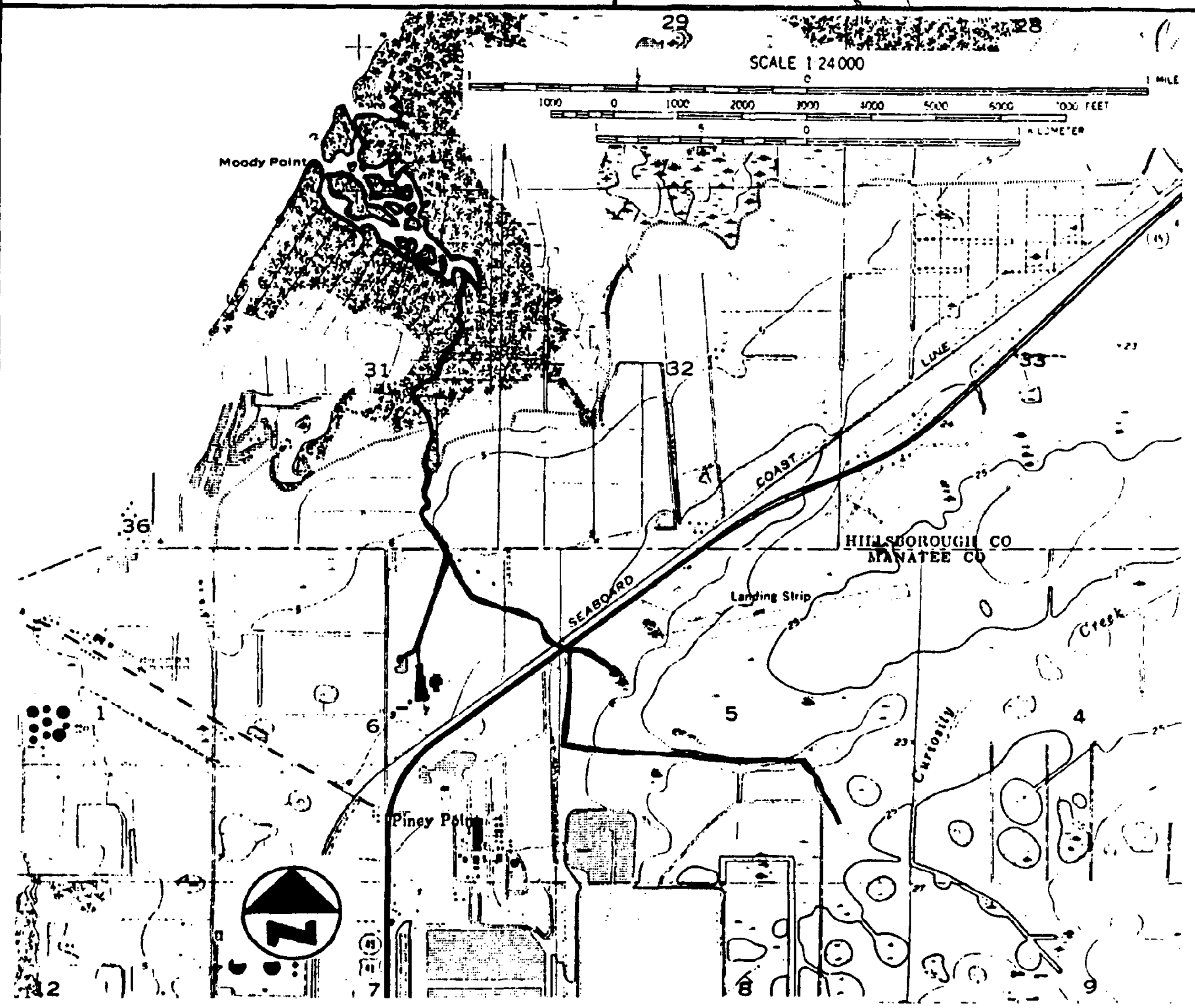
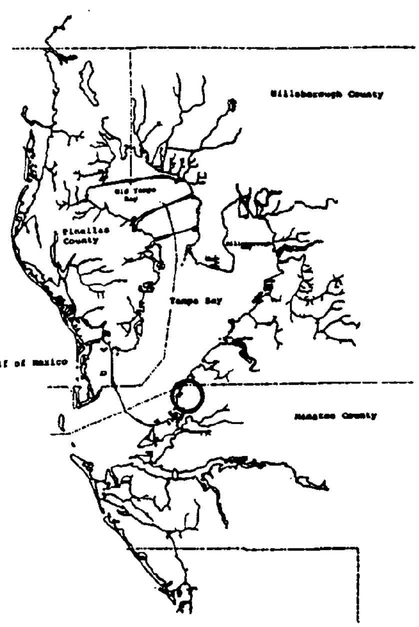


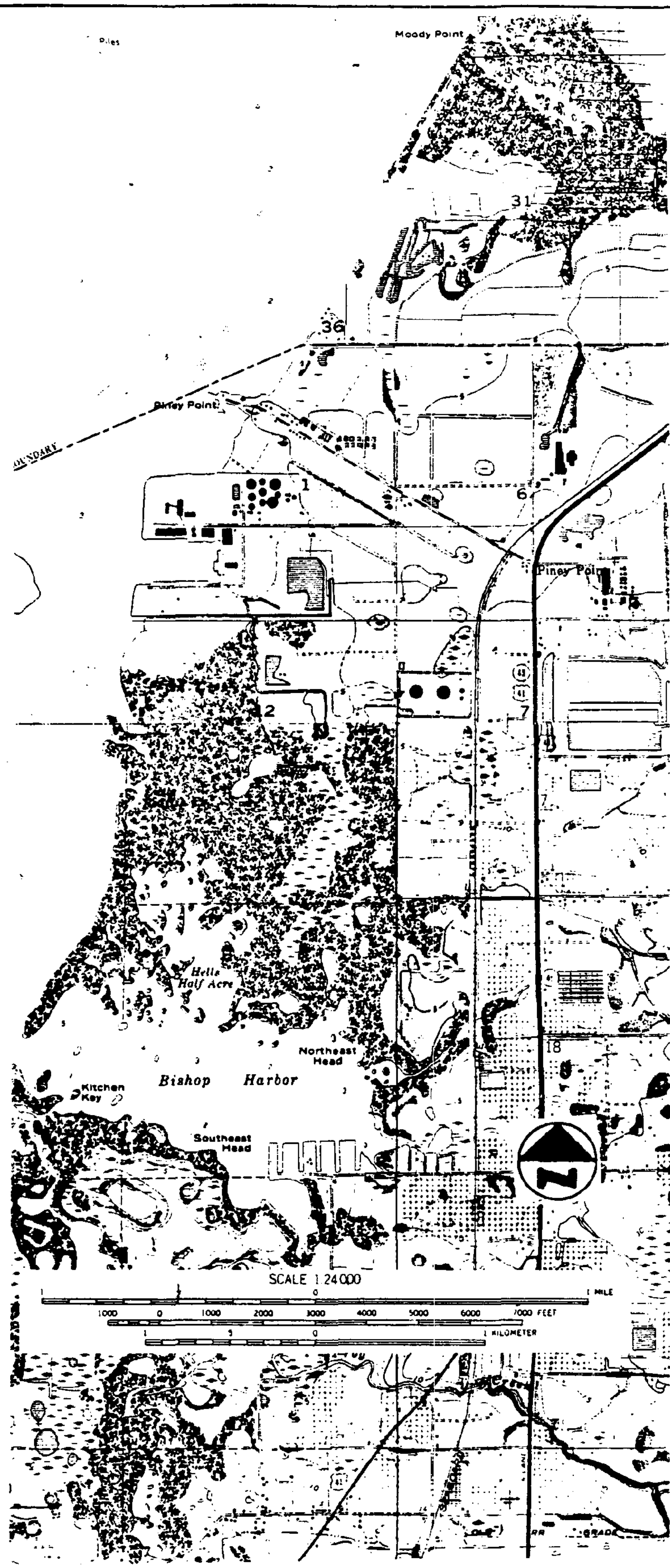
Figure 46.

Redfish and Little Redfish Creek

Source:

7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





1.34 Frog Creek and Cabbage Slough

Frog Creek, with Cabbage Slough, enters Tampa Bay via Terra Ceia Bay in Manatee County (Figure 47). A detailed ecological assessment of Frog Creek is included in the following section of this report. Frog Creek with Cabbage Slough is classified as a natural tidal tributary to Tampa Bay.

1.35 McMullen Creek

Flowing into Terra Ceia Bay south of Frog Creek in Manatee County is McMullen Creek (Figure 48). The creek travels approximately 3.8 miles from the headwaters, toward the west, to its mouth.

A small, tidally influenced marsh exists at the mouth of McMullen Creek. The small town of Rubonia occupies the northern side of the mouth. The lower and middle segments have a wide channel with large adjacent marsh systems. The upper section is dominated by agricultural development and wetland drainage.

The lack of encroachment into the floodplain of the creek categorizes McMullen Creek as a natural tidal tributary.

1.36 Wares Creek

Located within Manatee County, Wares Creek connects Palma Sola Bay and the Manatee River. Wares Creek travels approximately 9.4 miles between the two larger bodies of water (Figure 49).

At the northern end, Wares Creek intersects the Manatee River in downtown Bradenton. The north-south alignment of the creek (Figure 49) is dominated by the Bradenton urban environment consisting of residential and commercial usage with some areas of industrial development. Wares Creek is channelized over the majority of its length and serves as an urban drainage system.

The east-west alignment travels through some open areas (agricultural, open pastures) but is dominated by residential urban development. The mouth of Wares Creek into Palma Sola Bay is surrounded and has been hardened for residential lots. Wares Creek is considered a stressed tidal tributary.

1.37 Palma Sola Creek

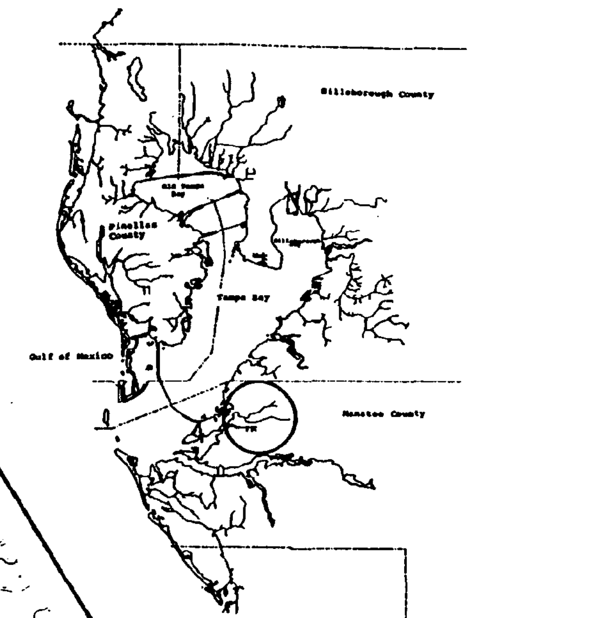
Palma Sola Creek parallels Sarasota Bay and outfalls into Palma Sola Bay in Manatee County (Figure 50). The creek is poorly defined and flows from near Sarasota Bay northwestward for approximately 4.1 miles to Palma Sola Bay.

The mouth of the creek contains some forested wetlands and maintains its natural alignment to the vicinity of a trailer park (Figure 50). The creek is rerouted around the trailer park and between residential development. The remainder of the drainage area is dominated by agricultural usage surrounding the elongated marsh system that makes up Palma Sola Creek. A large borrow area exists within the marsh. The creek loses its definition

Figure 47.

Frog Creek and Cabbage Slough

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



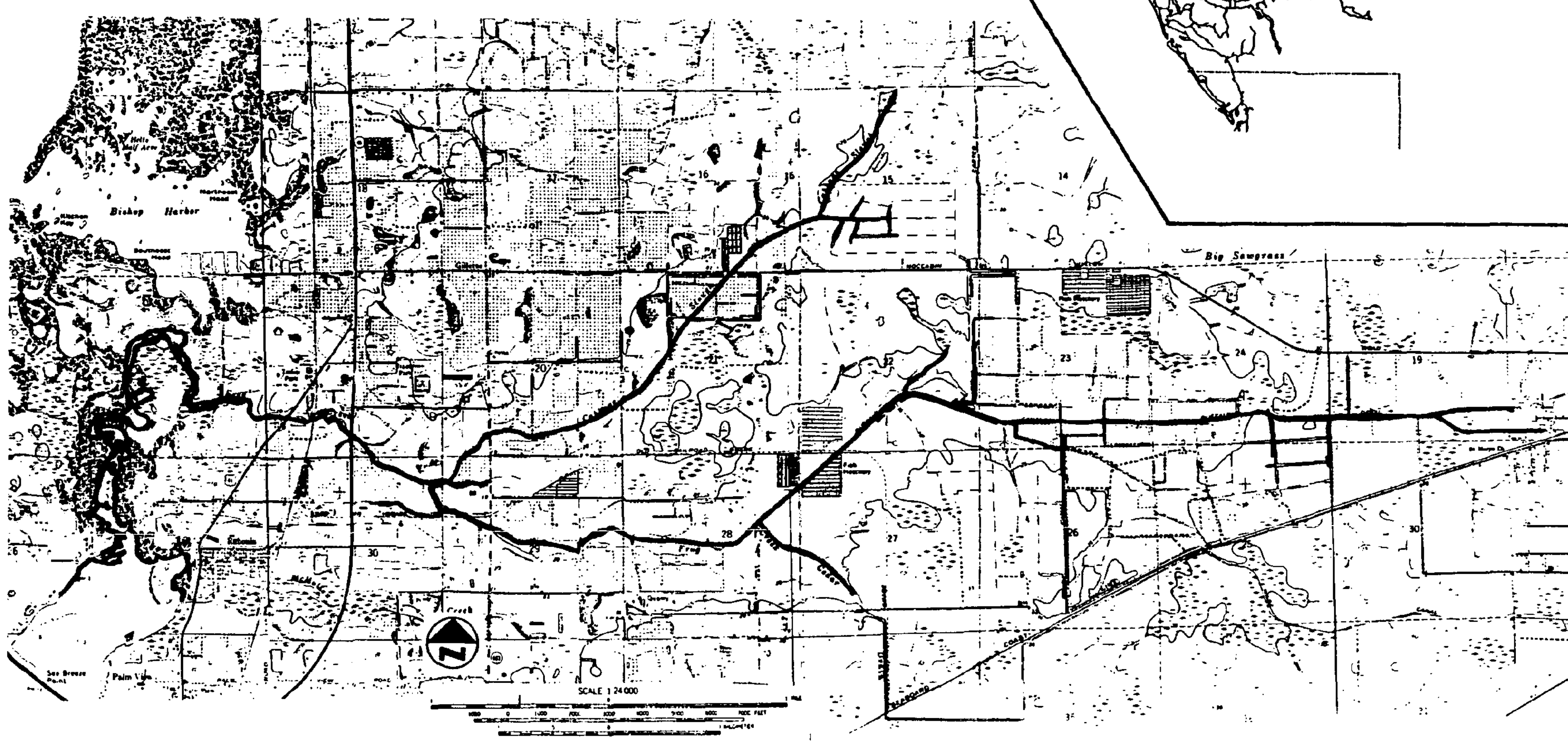
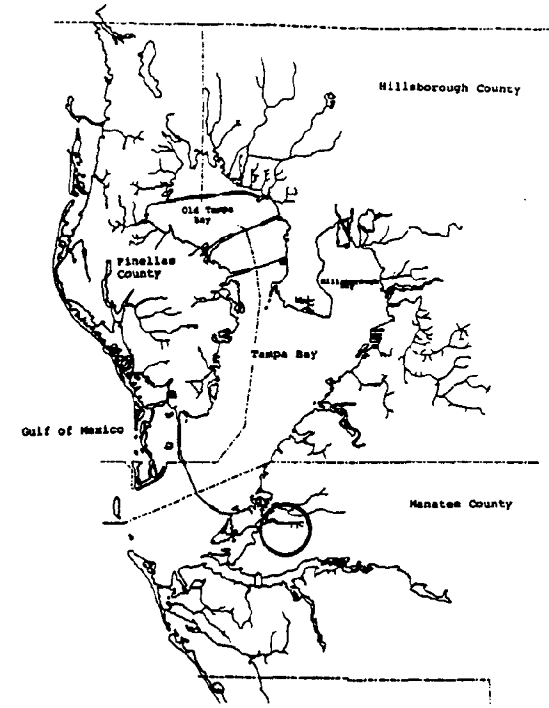


Figure 48.

McMullen Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



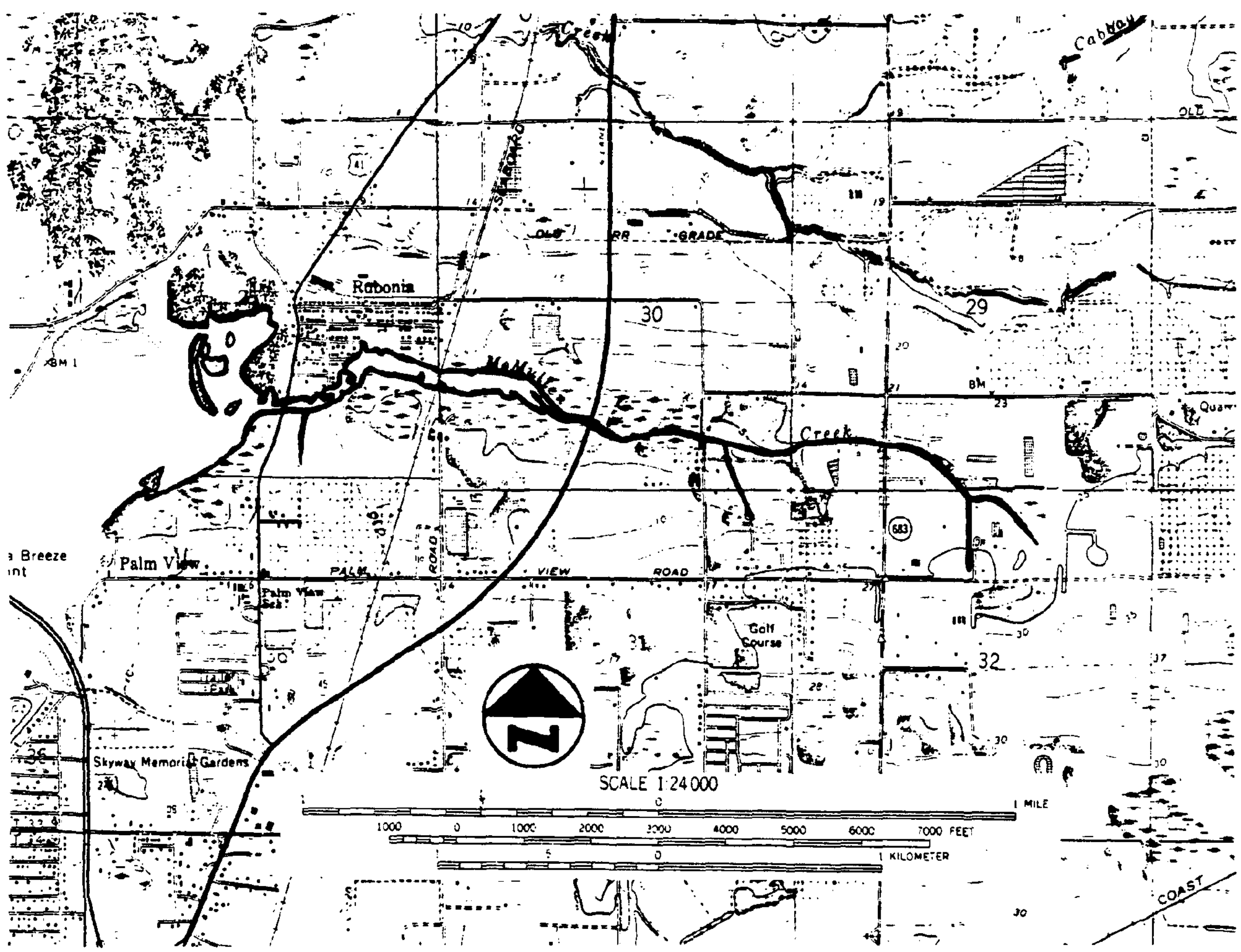
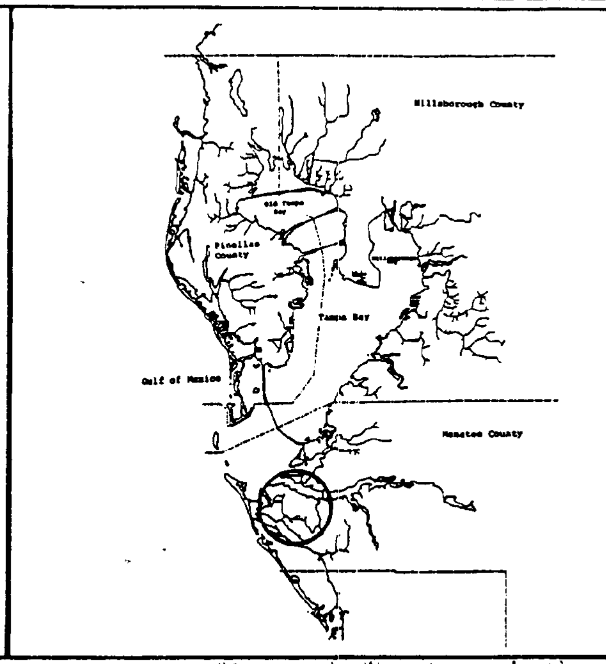


Figure 49.

Wares Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior



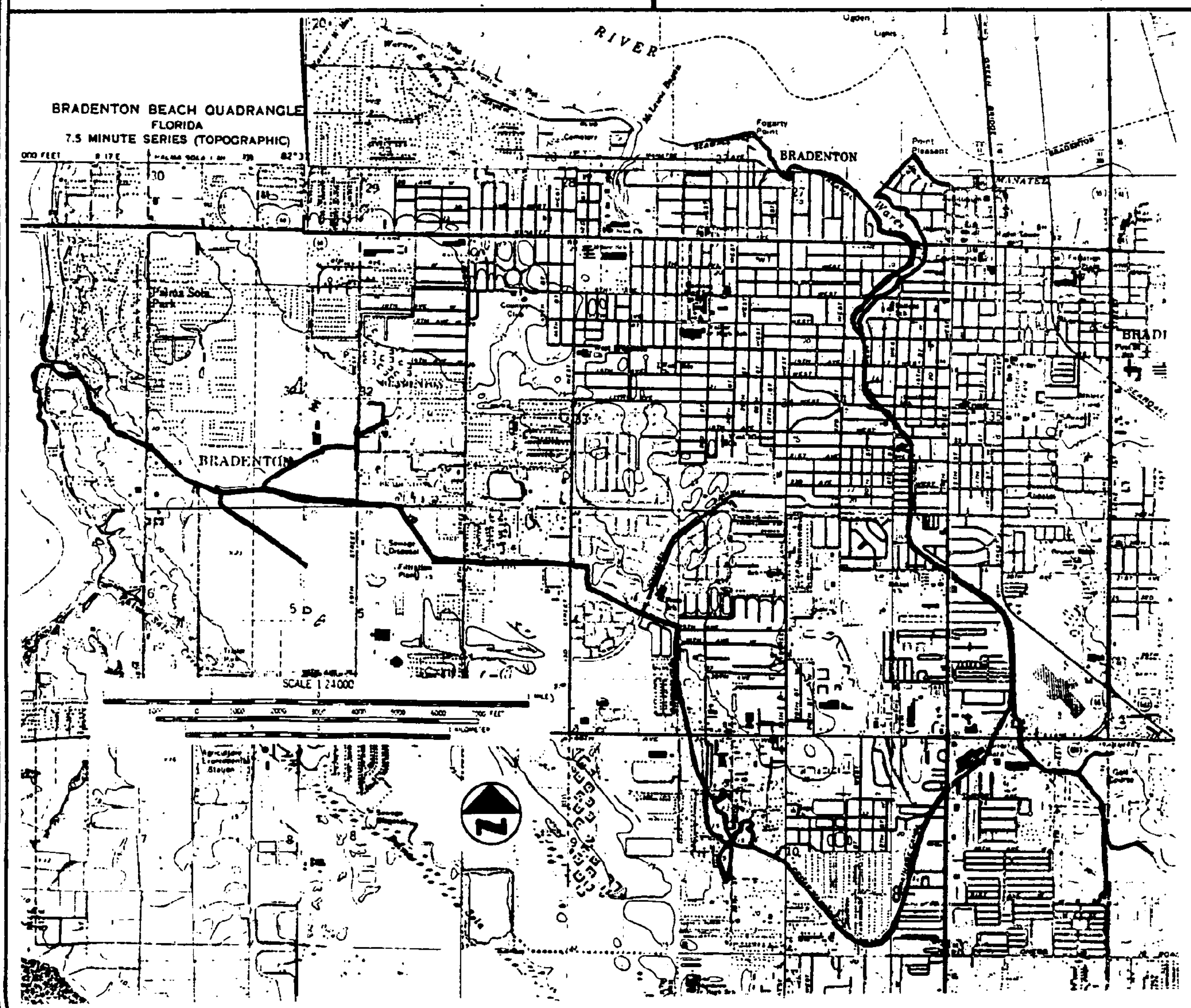
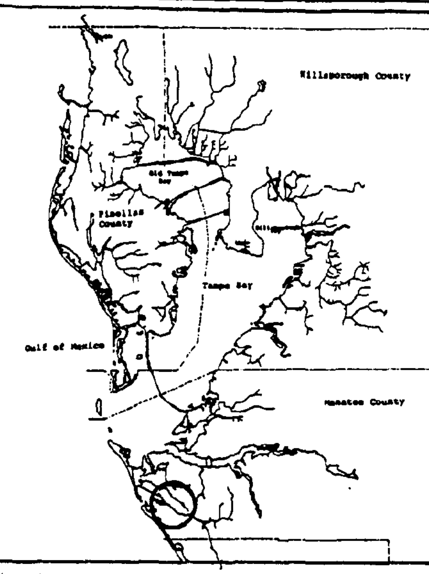
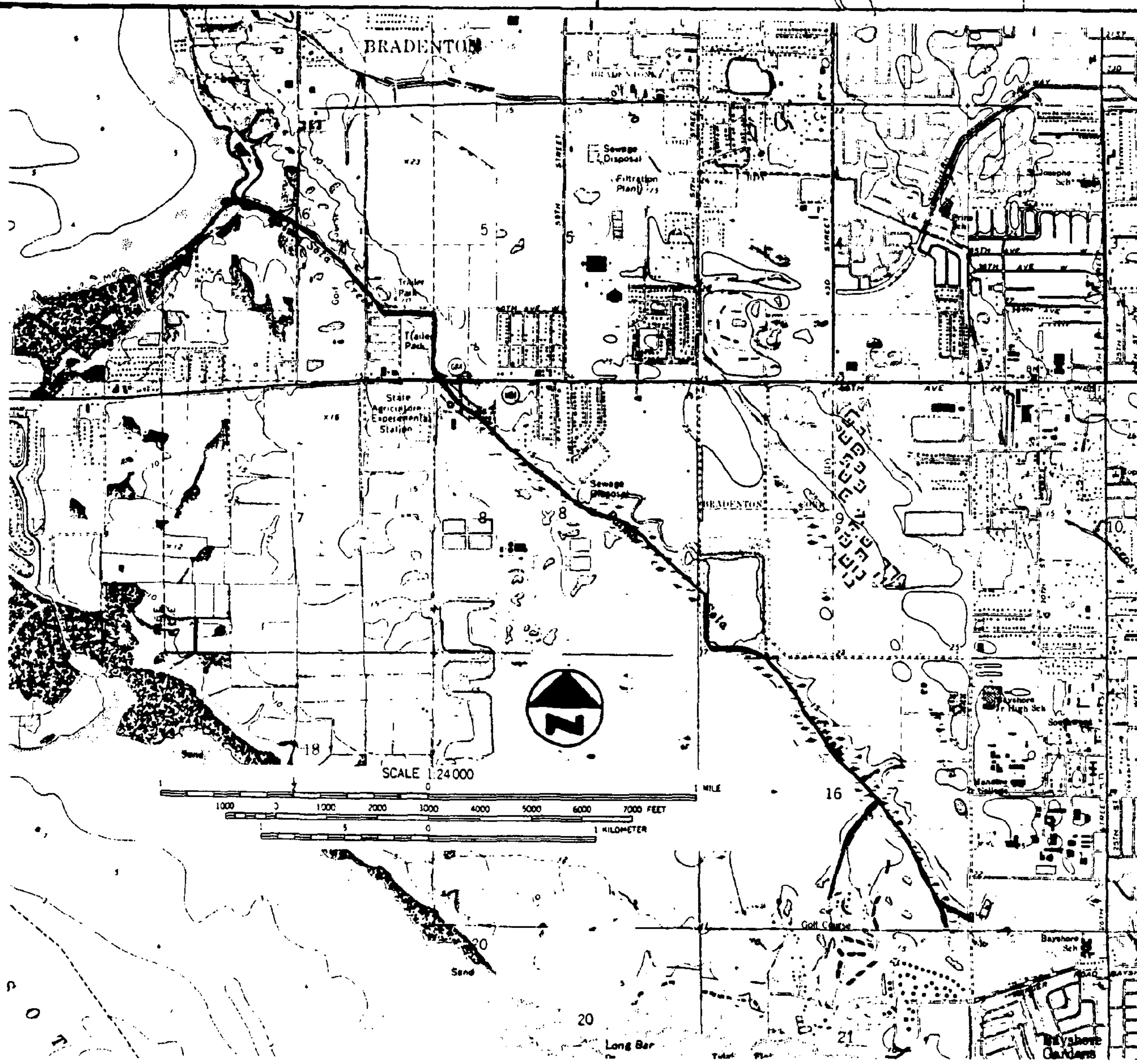


Figure 50.

Palma Sola Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior





within the marsh system and the headwaters drain a golf course, residential development and agricultural parcels.

The Creek has retained the majority of the extensive marsh system in the drainage basin. The tidal portion suffers only low development pressure. Therefore, Palma Sola Creek is categorized as a natural tidal tributary.

1.38 Bowles Creek

Bowles Creek flows into Sarasota Bay just north of the southern county line in Manatee County (Figure 51). The creek flows in a southwestern direction approximately 4.1 miles in length to Sarasota Bay.

The lower segment and mouth of Bowles Creek is hardened and channelized for residential development. The upper two-thirds receives mixed usage of urban development including residential, industrial and agricultural areas.

Considering its urbanized nature, Bowles Creek is classified as a stressed tidal tributary.

1.39 Classification Summary:

Historically, the tidal tributaries to Tampa Bay were immensely productive systems, importing freshwater and food sources to estuaries and providing critical habitat, protective cover, feeding and breeding grounds for the early developmental stages of marine and estuarine life forms. Man's presence in the Tampa Bay Region has encroached upon many of the creek systems, while retaining the natural character of others.

Table 1 identifies the length, land use and condition of each tidal tributary reviewed in this report. Table 2 represents the breakdown of classified creek conditions for each of the three counties surrounding Tampa Bay.

County Classification Summary
Table 2

County	Stressed	Restorable	Natural	Other	Total
Pinellas	13	2	3	0	18
Hillsborough	5	8	3	3	19
Manatee	2	1	3	1	7
Total	20	11	9	4	44

Over one half of the stressed tidal tributaries identified occurs within Pinellas County. This observation is partially due to the intensive development that has previously occurred and partially due to the County being surrounded on three sides by marine and estuarine waters, allowing creek flow in three directions. There are two and three restorable and natural tidal tributaries in Pinellas County, respectively.

Figure 52 identifies the Developments of Regional Impact (DRI's) that are currently in various stages of review by the Tampa Bay Regional Planning Council (TBRPC) in Pinellas County. The localized development is centered around:

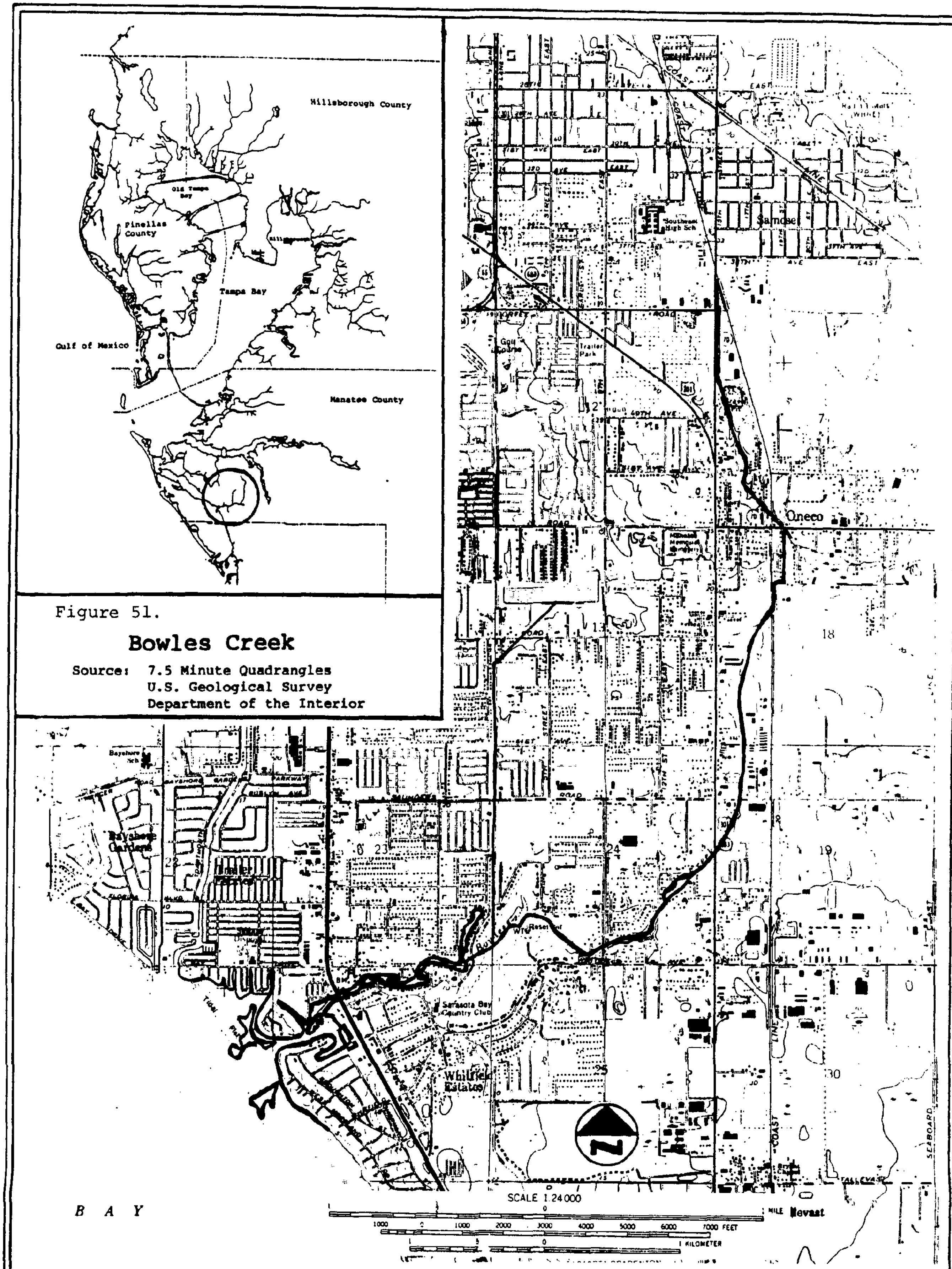


Figure 51.

Bowles Creek

Source: 7.5 Minute Quadrangles
U.S. Geological Survey
Department of the Interior

TIDAL CREEK SUMMARY

Table 1.

Creek/County	Approx. Length (Miles)	Land Use	Condition
Pinellas County			
1. Curlew Creek	4	Res.	Stressed
2. Jerry Branch	2.4	Res.	Stressed
3. Stevenson Creek	4	Res./Ind.	Stressed
4. McKay Creek	4.7	Res.	Stressed
5. Church Creek	1.6	Low Res.	Stressed
6. Joe's Creek	2.0	Res./Ind.	Stressed
7. St. Joe's Creek	6.6	Res./Ind.	Stressed
8. Bear Creek	2.7	Res.	Stressed
9. Salt Creek	1.5	Res.	Stressed
10. Booker Creek	1.9	Comm./Ind./Res.	Stressed
11. Tinney Creek	2.7	Res./Comm.	Stressed
12. Grassy Creek	0.8	Open Space/Comm.	Natural
13. Long Branch Creek	3.4	Res./Comm.	Restorable
14. Allen Creek	6.0	Res./Comm.	Stressed
15. Alligator Creek	4.4	Res./Agr.	Stressed
16. Mullet Creek	2.3	Res./Comm.	Restorable
17. Bishop Creek	1.8	Res.	Natural
18. Moccasin Creek	1.5	Res./Agr.	Natural
Hillsborough County			
19. Double Branch Creek	6.8	Agr.	Natural
20. Channel A	4.1	Res./Agr.	Man-made
21. Rocky Creek	10.9	Res./Agr.	Stressed
22. Brushy Creek	6.4	Res./Agr.	Non-tidal
23. Dick Creek	1.6	Res./Open	Restorable
24. Woods Creek	1.6	Res./Ind.	Stressed
25. Peppermound Creek	1.6	Res.	Restorable
26. Sweetwater Creek	10.4	Res./Agr.	Stressed
27. Fish Creek	2.3	Comm.	Restorable
28. Coon Hammock Creek	0.5	Open Space	Restorable
29. Broad Creek	2.5	Comm.	Restorable
30. Delany Creek	10.8	Ind./Agr.	Stressed
31. Archie Creek	4.9	Ind./Res.	Restorable
32. Bullfrog Creek	17.5	Agr.	Restorable
33. Little Bullfrog Creek	6.0	Agr.	Non-Tidal
34. Newman Branch	2.5	Ind./Res.	Stressed
35. Wolf Branch	6.5	Agr.	Restorable
36. Cockroach Creek	2.5	Agr./Res.	Natural
37. Piney Point Creek	2.7	Agr./Ind.	Natural
Manatee County			
38. Little Redfish Creek	0.5	Open/Ind.	Restorable
39. Frog Creek	11.5	Open/Agr.	Natural
40. Cabbage Slough	3.9	Agr.	Non-tidal
41. McMullen Creek	3.8	Res./Agr.	Natural
42. Wares Creek	9.4	Res./Comm./Ind.	Stressed
43. Palma Sola Creek	4.1	Res./Agr.	Natural
44. Bowles Creek	4.1	Res./Ind./Agr.	Stressed

NOTE: Res.=Residential, Comm.=Commercial, Ind.=Industrial, Agr.=Agricultural

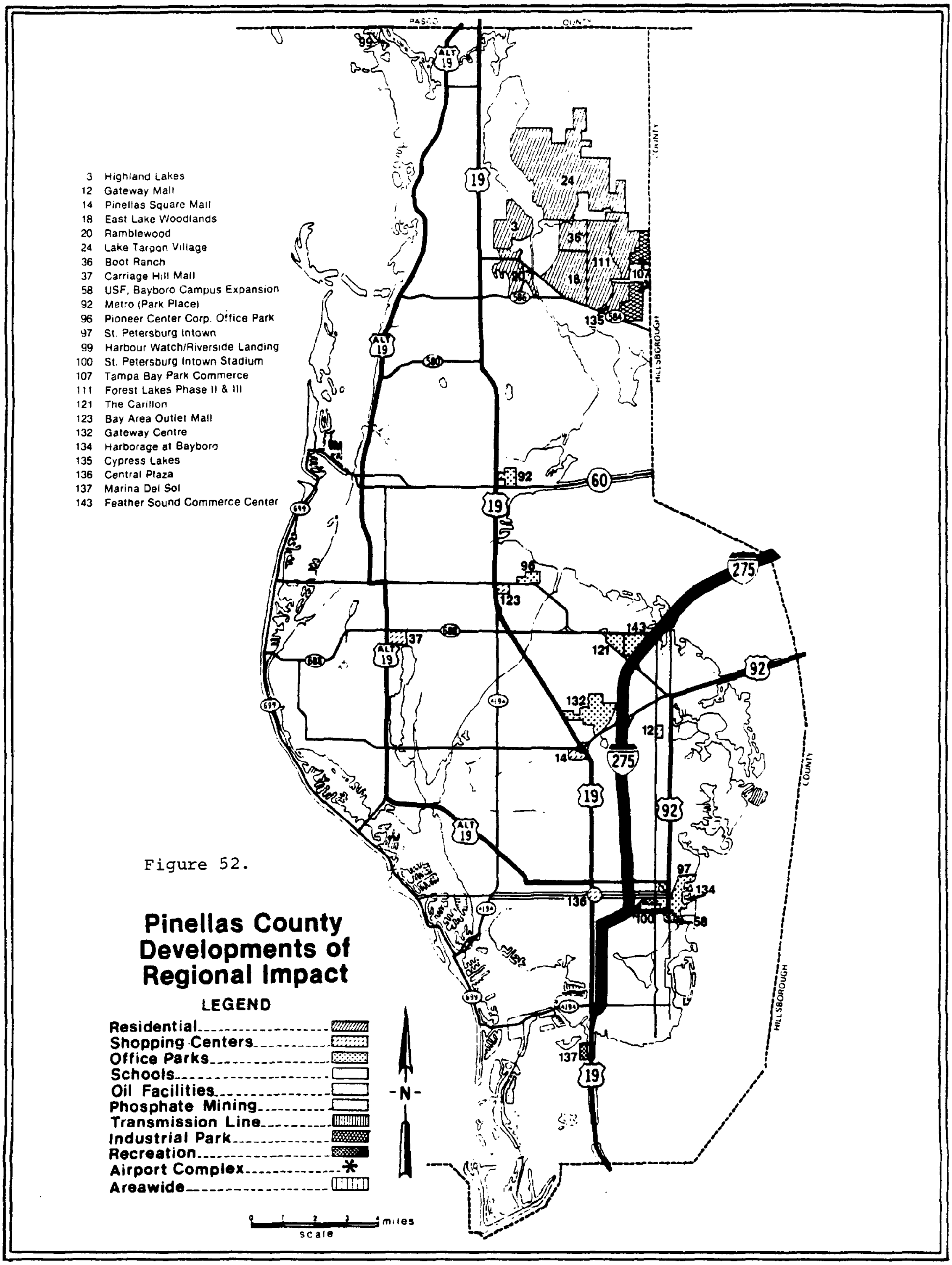


Figure 52.

Pinellas County Developments of Regional Impact

- downtown St. Petersburg redevelopment

- remaining undeveloped parcels in the central county area

- large open agricultural tracts in northern Pinellas County.

Due to past development activities, few open expanses of land are available in Pinellas County for continued long-term development.

Hillsborough County contains a total of nineteen minor tidal tributaries identified in this report. The majority of the tributaries remain in restorable (eight) or natural (three) condition. Extensive agricultural areas remain in the county and urban expansion is expected to continue.

Figure 53 portrays the DRI's currently under review by TBRPC in Hillsborough County. Centers for development are located in the following areas:

- downtown Tampa and adjacent fringe areas

- Interstate 75 corridor

- phosphate mining.

In general the trend within Hillsborough County is the conversion of agricultural lands to other forms of development.

One-half of the surveyed tidal creeks in Manatee County are classified as natural in condition. Two creek systems are considered stressed with one in restorable condition. Within the county the urban areas are located in the western half with agricultural and mining areas in the eastern portion.

Figure 54 illustrates the DRI's currently being reviewed by TBRPC in Manatee County. The current trends in development in Manatee County include:

- scattered coastal developments

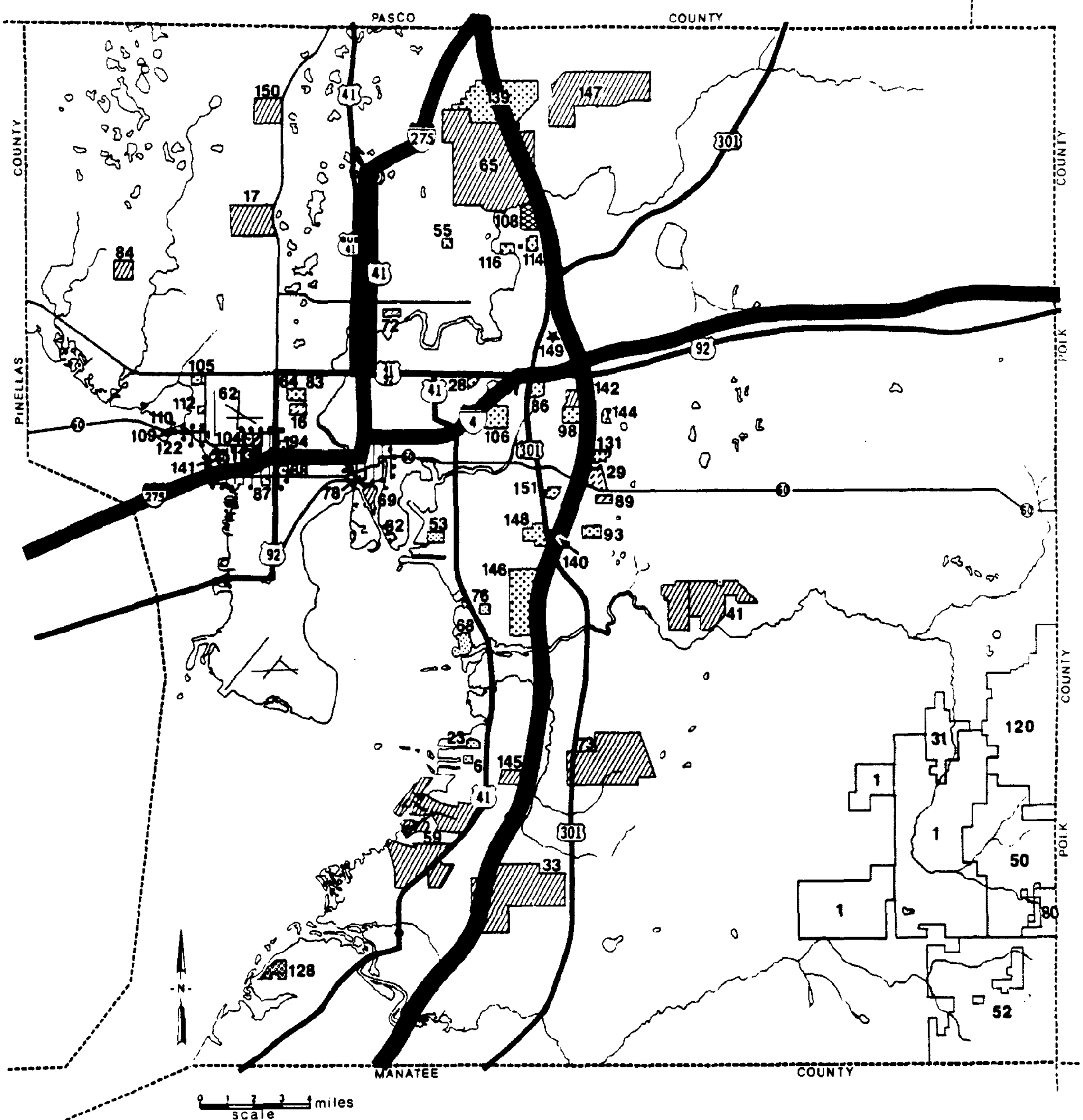
- Interstate 75 corridor

- phosphate mining development.

Urban areas are centrally located around Palmetto, Bradenton, Sarasota and the Gulf Beaches. Continued development is expected to occur in the undeveloped portions of the county.

In general, the majority of the tidal tributaries surveyed remain in natural or restorable condition. The tidal tributaries to the Tampa Bay estuary add to the quality of life the residents of the Tampa Bay Region have grown to appreciate. With the population growth expected to occur within the area, it is essential that management considerations protect the value of tidal creek systems to promote the quality of life in our region.

Figure 53.



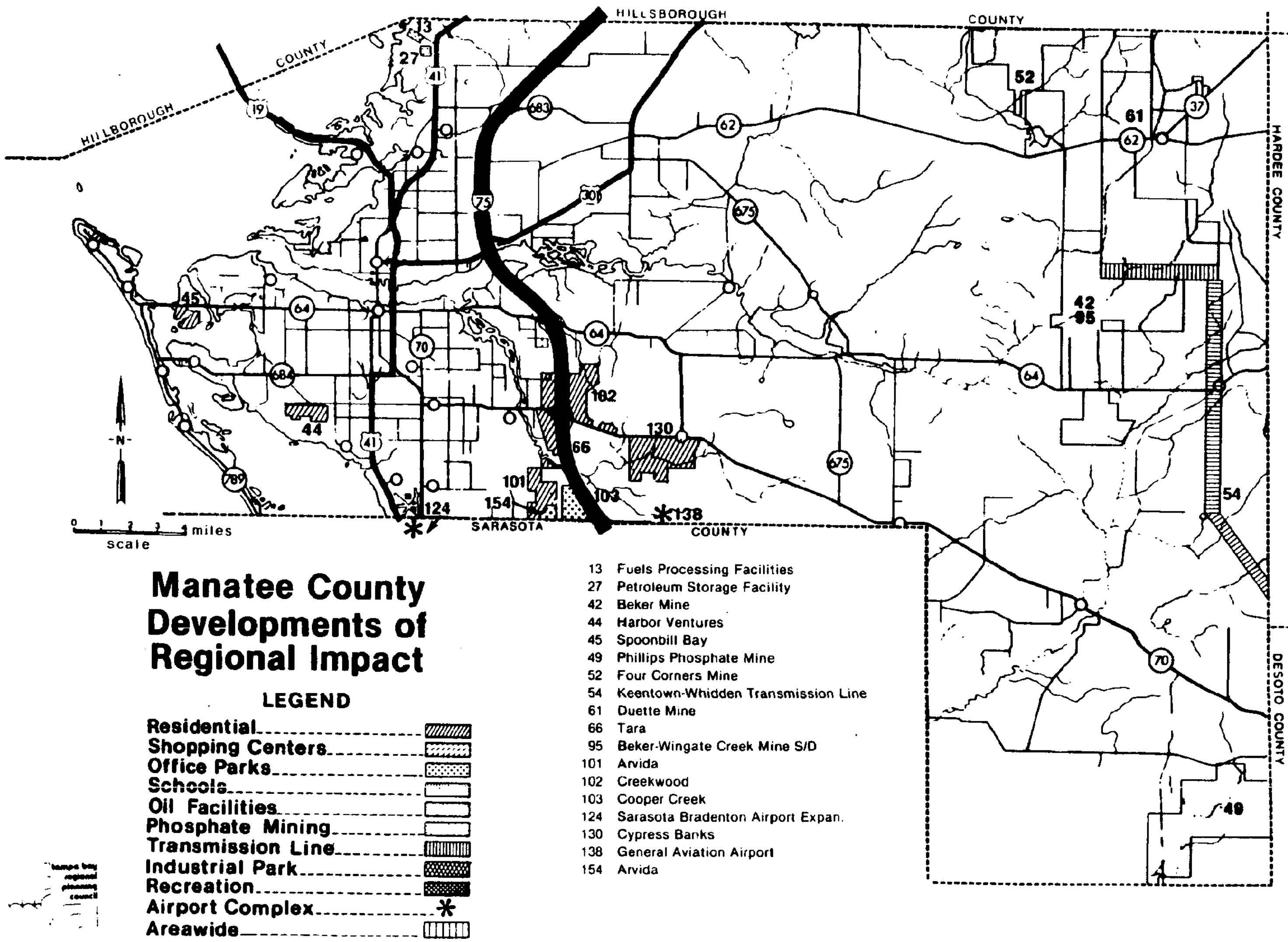
Hillsborough County Developments of Regional Impact

LEGEND

- Residential
- Shopping Centers
- Office Parks
- Schools
- Oil Facilities
- Phosphate Mining
- Transmission Line
- Industrial Park
- Recreation
- Airport Complex *
- Areawide

1 Brewster
6 Big Bend Station Oil Storage Tank
16 Bay Mall
17 Carrollwood Village
23 Agrico Wet Rock Phosphate Terminal
28 East Lake Square Mall
29 Brandon Mall
31 Kingsford Mine
33 Dominion
41 Bloomingdale
50 Bordon Big Four Mine
52 Four Corners Mine
53 East Seaboard Petroleum Storage Facility
55 USF Mass Seating Facility
59 Apollo Beach
62 TIA Runway Extension
63 Quad Block
64 Tampa Bay Park
65 Tampa Palms
68 Gardinier Chemical Plant Expansion
69 Harbour (Seddon) Island
70 Tampa Financial Center
72 Busch Gardens Expansion
73 Big Bend
76 Gardinier
78 Central Business Dist. Master Plan
80 AMAX Phosphate Mine
82 Tampa Terminals
83 Tampa Bay Park II & III
84 Thomas Ranch
86 Interstate Business Park
87 The Urban Centre
88 Freedom Financial Center
89 Brandon Town Center
93 Florida Corporate Center
94 TampaSphere
95 Beker-Wingate Creek Mine S/D
98 Sabal
104 International Plaza
105 Sunforest
106 Corporex
108 Hidden River
109 Island Center
110 Babcock
112 Colonial Penn
113 Lake Tower Place
114 GTE 64
115 Woodland Corporate Center
116 GTE 326
118 Port of Tampa Cruise Ship
120 IMC Kingsford Mine
122 Lifsey Rocky Point
128 Mangrove Bay Marina
131 Regency Park North
133 Harbour Island Phase II
139 Tampa Technology Park
140 Tampa Triangle
141 Westshore Areawide
142 Highland Park
144 Sunway
145 South Bend
146 Parkway
147 Hunter's Green
148 301 Lumsden
149 Vandenberg General Aviation
150 Calusa Trace
151 Hyper Shoppes

Figure 54.


HILLSBOROUGH COUNTY
HARDEE COUNTY
DESOTO COUNTY
SARASOTA COUNTY
0 1 2 3 4 miles
scale
N
Manatee County Developments of Regional Impact
LEGEND
Residential
Shopping Centers
Office Parks
Schools
Oil Facilities
Phosphate Mining
Transmission Line
Industrial Park
Recreation
Airport Complex
Areawide
13 Fuels Processing Facilities
27 Petroleum Storage Facility
42 Beker Mine
44 Harbor Ventures
45 Spoonbill Bay
49 Phillips Phosphate Mine
52 Four Corners Mine
54 Keentown-Whidden Transmission Line
61 Duette Mine
66 Tara
95 Beker-Wingate Creek Mine S/D
101 Arvida
102 Creekwood
103 Cooper Creek
124 Sarasota Bradenton Airport Expan.
130 Cypress Banks
138 General Aviation Airport
154 Arvida

2.0 ECOLOGICAL ASSESSMENT OF SELECTED MINOR TRIBUTARIES

Allen Creek in Pinellas County, Delaney Creek in Hillsborough County, and Frog Creek in Manatee County were studied with respect to hydrographic features, biology and chemistry, and physical and chemical alterations. Allen Creek represented a minor tributary through a largely urbanized area with the major land use being residential and commercial. Delaney Creek represented a system through an industrialized, urban, and agricultural area with rapid urbanization taking place. Frog Creek represented a system through an agricultural-rural watershed with little alteration in the estuarine portion of the creek.

This section presents the data collected through limited studies of each of the three creeks and acquired from contract services with Environmental Science and Engineering, Inc. Due to the limited scope of the project, descriptions of the three creeks from the hydrographic, biologic and chemical perspectives cannot be considered comprehensive but rather as a "snap shot" identification of existing conditions. Understanding the existing conditions in the tidal segments will facilitate the development of management and/or restoration programs for each tributary.

2.1 Allen Creek

2.1.1 Hydrographic Features

The Allen Creek watershed and general land use are depicted in Figure 55. The watershed basin comprises an area of approximately 5,281 acres in the City of Clearwater, Florida. The watershed can be divided into ten sub-basins by topography, creek branches and drainage canals. The sub-basins range in size from 162.1 acres to 1,563.8 acres (Table 3). The dominant land use in the immediate area of Allen Creek is residential with nearly the entire basin having been urbanized and built up. A few small areas are still used for agriculture (citrus groves), and can be expected to become urbanized in the future.

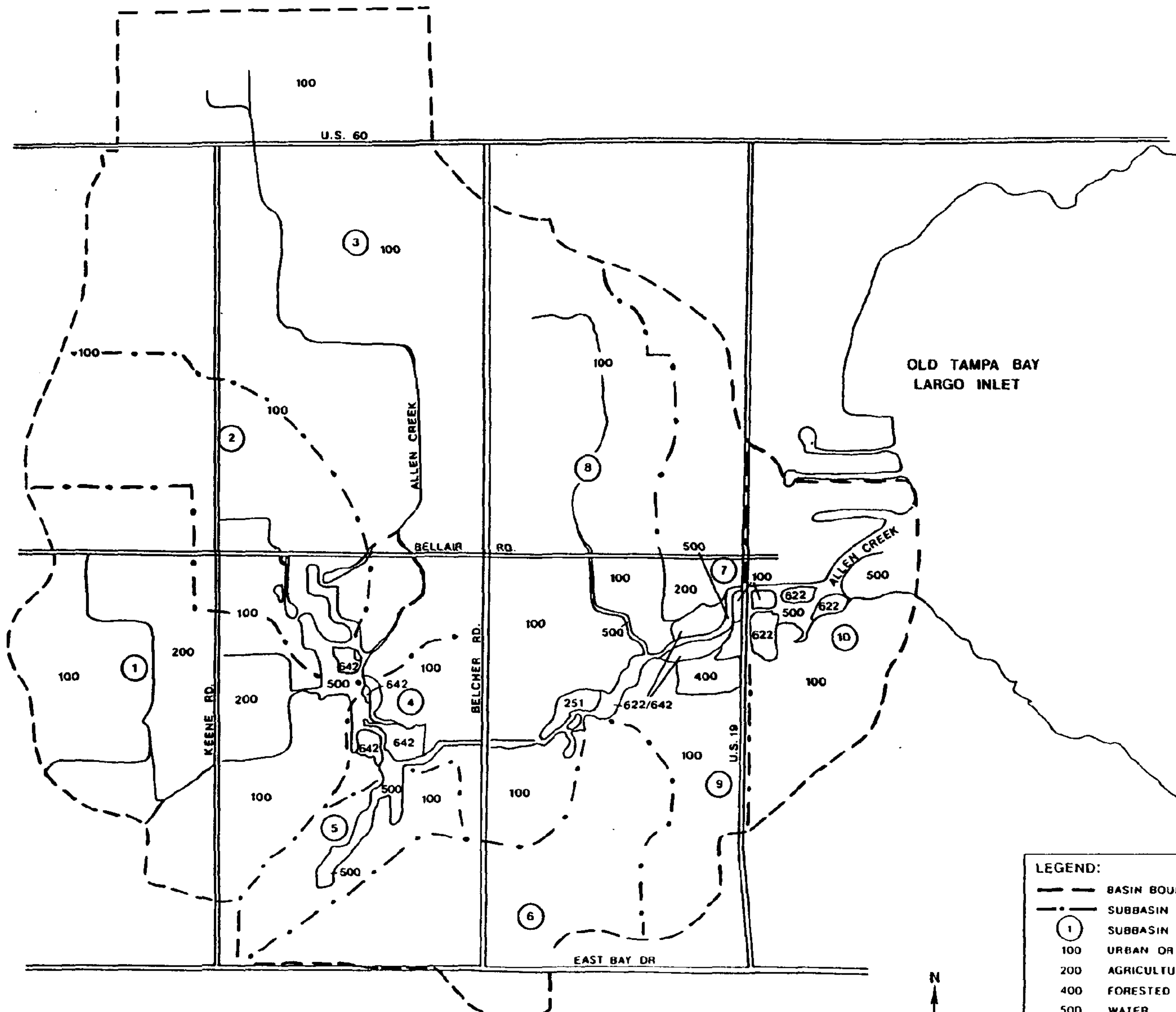
Allen Creek is a first order stream as defined by the Florida Land Use Cover Classification System (FLUCCS, 1977). It flows into Largo Inlet (3rd order bay) which is on the western side of lower Old Tampa Bay (2nd order bay).

At the time of the field sampling program on April 15, 1986, the measurement of freshwater discharge and flow rates was not practical. It was not possible to penetrate to an upstream freshwater segment with any appreciable flow. A drainage canal entered north of Bellair Road (Station 1F), but salinity remained brackish (see following discussion) with no appreciable outflow existing.

The average monthly discharges of surface water based on 1981-1982 rainfall data are listed in Table 4. The Allen Creek drainage basin was determined to be roughly half the size of the Frog Creek and Delaney Creek basins, but had calculated discharges two to three times higher than either Frog or Delaney Creek. Calculated monthly discharges ranged from 92.8 acre-feet to 909.8 acre-feet.

The saltwater influence extended the entire study length of Allen Creek (Table 5, Figure 56). On the day of tidal prism measurements the tide was diurnal, with low tide occurring at approximately 0220 hrs. and high tide at approximately 1820 hrs. (N.O.A.A., 1985), which resulted in a flood tide during the study period. Salinity concentrations of Allen Creek during the study period ranged from 24.48 ppt at the bottom of the water column at station 1, (located at the creek mouth) to 15.12 ppt at station 1F (located in a drainage canal north of Bellair Road). The salinity level remained relatively high throughout Allen Creek and was still at a value of 19.30 ppt at station SB2 west of Belcher Road. Existing vegetation communities also indicated little freshwater influence in Allen Creek as mangroves extended up to Belcher Road and *Juncus* marsh predominated west of Belcher Road. The City of Clearwater maintains a sampling station on Allen Creek at Nursery Road. Conductivity measurements taken at the station indicate freshwater conditions year-round. Apparently the saltwater/freshwater interface in Allen Creek is located north of Bellair Road where Allen Creek essentially serves as an urban drainage ditch.

Channel profiles and sediment types are depicted in Figure 57. Channel profiling was conducted on a flood tide. At the time of profiling transect No. 1, the tide appeared to have approximately an additional ten inches to rise as estimated from the waterline on the bulkhead. Transects No. 2-5



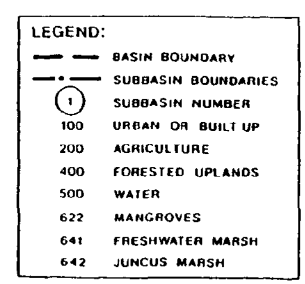


Figure 55.
ALLEN CREEK WATERSHED BASIN BOUNDARIES AND GENERAL LAND USE
SOURCE: ESE, 1986.

Table 3. Allen Creek Drainage Basin and Subbasin Area

Subbasin No.	Acres
1	775.0
2	522.0
3	1,563.8
4	391.2
5	164.8
6	460.5
7	270.0
8	573.5
9	162.1
10	398.1
	5,281.0

Source: ESE, 1986

Table 4. Average Monthly Surface Water Discharge (Acre-Feet) of Creek Basins Into Creeks

MONTH	MONTHLY DISCHARGE (ACRE-FEET)OF CREEK BASINS INTO CREEKS ALLEN CREEK	FROG CREEK	DELANEY CREEK
Dec. 1981	133.3	52.4	26.9
Jan. 1982	170.4	40.4	17.6
Feb.	226.9	149.1	93.9
March	352.2	170.2	98.3
April	92.8	16.2	5.3
May	102.7	15.3	4.8
June	715.2	451.5	288.0
July	909.8	836.6	588.7
Aug.	589.7	345.4	219.6
Sept.	721.7	364.5	137.8
Oct.	185.2	66.8	111.1
Nov.	251.5	178.5	115.2

Source: ESE, 1986

Table 5.

TAMPA BAY REGIONAL PLANNING COUNCIL

IN SITU WATER QUALITY PARAMETERS

CREEK	DATE	TIME	STATION	DEPTH FT.	DO PPM	COND MMMHOS	SAL PPT	TEMP C	pH	TURB NTU	SECCHI FT
ALLEN	15-Apr-86	10:45	1	0	7.60	34.86	22.88	24.90	8.11	4.9	4.25
ALLEN	15-Apr-86	10:45	1	4.5	7.20	36.28	24.41	23.84	7.82	5.5	
ALLEN	15-Apr-86	10:45	1	9	6.55	36.51	24.48	23.58	7.96	6.9	
ALLEN	15-Apr-86	12:55	2	0	10.40	28.06	17.52	26.32	8.14	5.2	2.00
ALLEN	15-Apr-86	12:55	2	2.5	10.00	32.02	20.38	26.10	7.83	10.0	
ALLEN	15-Apr-86	12:55	2	5	7.20	33.72	21.48	26.38	7.62	14.0	
ALLEN	15-Apr-86	11:30	1A	0		35.08	22.44	26.00			
ALLEN	15-Apr-86	11:30	1A	4		35.76	23.28	24.78			
ALLEN	15-Apr-86	11:30	1A	8		36.02	23.70	24.86			
ALLEN	15-Apr-86	11:45	1B	0		35.80	22.44	26.00			
ALLEN	15-Apr-86	11:45	1B	3		35.69	22.88	25.24			
ALLEN	15-Apr-86	11:45	1B	6		35.60	22.74	25.70			
ALLEN	15-Apr-86	12:00	1C	0		36.06	23.04	25.51			
ALLEN	15-Apr-86	12:00	1C	1		35.99	22.88	25.24			
ALLEN	15-Apr-86	12:00	1C	2.5		35.90	22.80	25.66			
ALLEN	15-Apr-86	12:15	1D	0		32.68	20.04	27.14			
ALLEN	15-Apr-86	12:15	1D	3		34.30	21.90	25.52			
ALLEN	15-Apr-86	12:30	1E	0		29.82	18.60	26.72			
ALLEN	15-Apr-86	12:30	1E	3		30.30	18.74	26.78			
ALLEN	15-Apr-86	12:35	1F	1.5	9.80	24.96	15.12	26.32	7.78	3.5	1.50
ALLEN	15-Apr-86	14:00	SB1	0		36.60	22.61	27.00			
ALLEN	15-Apr-86	14:00	SB1	15		36.54	22.52	27.41			
ALLEN	15-Apr-86	14:40	SB2	0		27.12	16.32	27.84			
ALLEN	15-Apr-86	14:40	SB2	13		30.40	19.30	25.79			
FROG	23-Apr-86	08:20	5	2.2	4.50	20.60	14.31	19.62	6.95	9.5	2.20
FROG	23-Apr-86	09:25	5A	1.75		9.18	5.90	20.84			
FROG	23-Apr-86	15:15	5A	3		16.30	9.84	25.92			
FROG	23-Apr-86	10:05	5B	1		17.18	11.11	19.58			
FROG	23-Apr-86	10:40	5C	1		4.80	3.04	22.21			
FROG	23-Apr-86	14:50	5C	1		11.14	6.58	26.52			
FROG	23-Apr-86	10:50	5D	3.1		3.70	2.32	22.44			
FROG	23-Apr-86	14:15	5D	1.25		5.28	3.24	25.50			
FROG	23-Apr-86	11:25	5E	2.4	6.80	1.62	0.98	22.56			
FROG	23-Apr-86	11:50	6	4	8.60	1.20	0.82	22.54	7.92		4.00
DELANEY	17-Apr-86	07:20	3	2	6.30	38.64	26.24	22.95	7.92	3.8	2.00
DELANEY	17-Apr-86	08:10	3A	2		19.72	13.36	20.30			
DELANEY	17-Apr-86	08:26	3B	1.5		27.02	18.02	22.81			
DELANEY	17-Apr-86	14:20	3B	4.8		39.86	25.64	25.68			
DELANEY	17-Apr-86	08:50	3C	2		17.40	11.60	21.26			
DELANEY	17-Apr-86	09:14	3D	1.49		8.00	5.21	20.72			
DELANEY	17-Apr-86	09:30	4	2.5	5.00	5.24	3.16	19.87	6.24	9.4	2.50
DELANEY	17-Apr-86	13:15	4	2.8		9.32	5.91	24.02			
DELANEY	17-Apr-86	10:00	4A	1.6		2.48	1.56	21.84			
DELANEY	17-Apr-86	12:00	4A				1.74				
DELANEY	17-Apr-86	10:30	4B	0.5	7.30	0.89	0.78	21.84			

Source: ESE, 1986

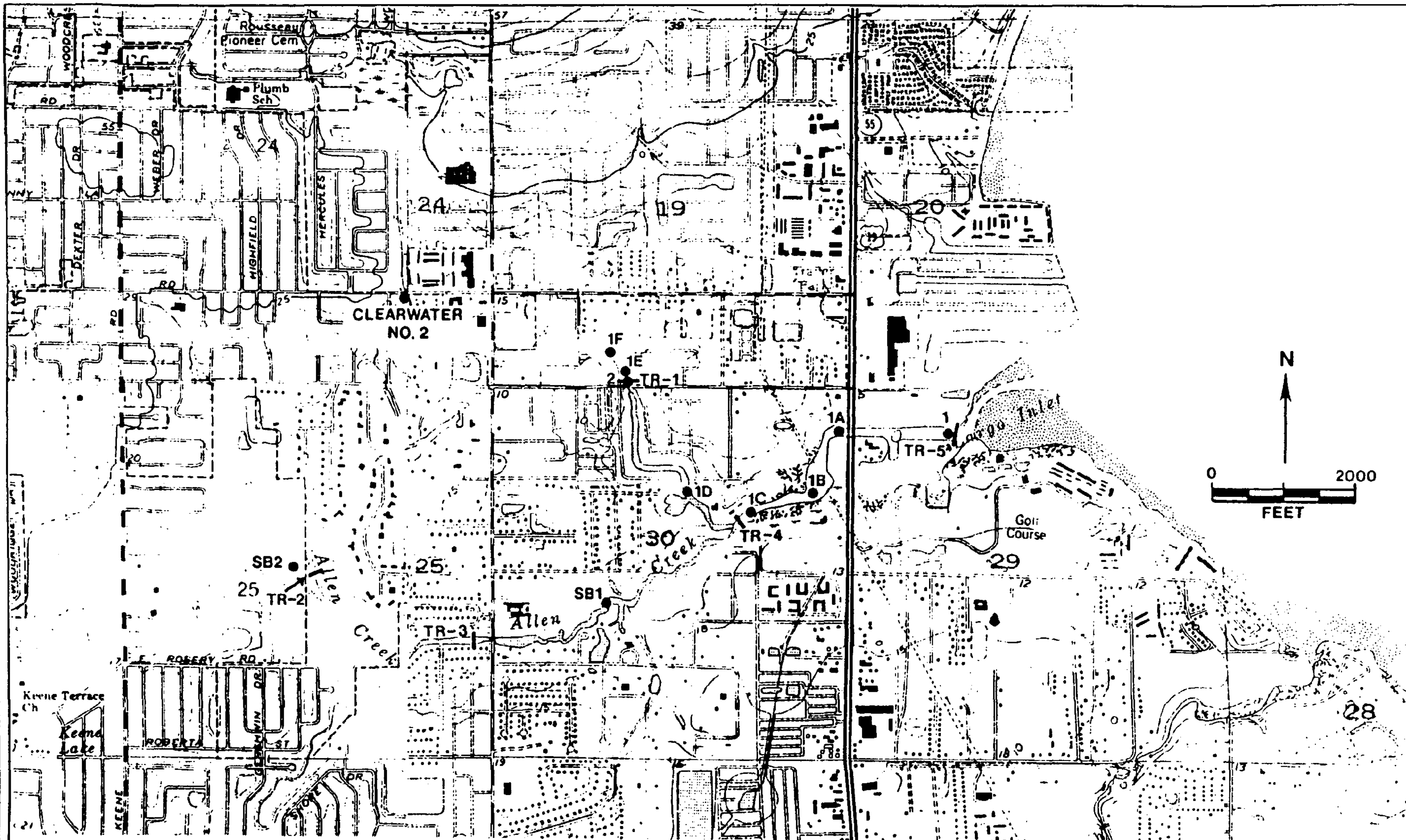
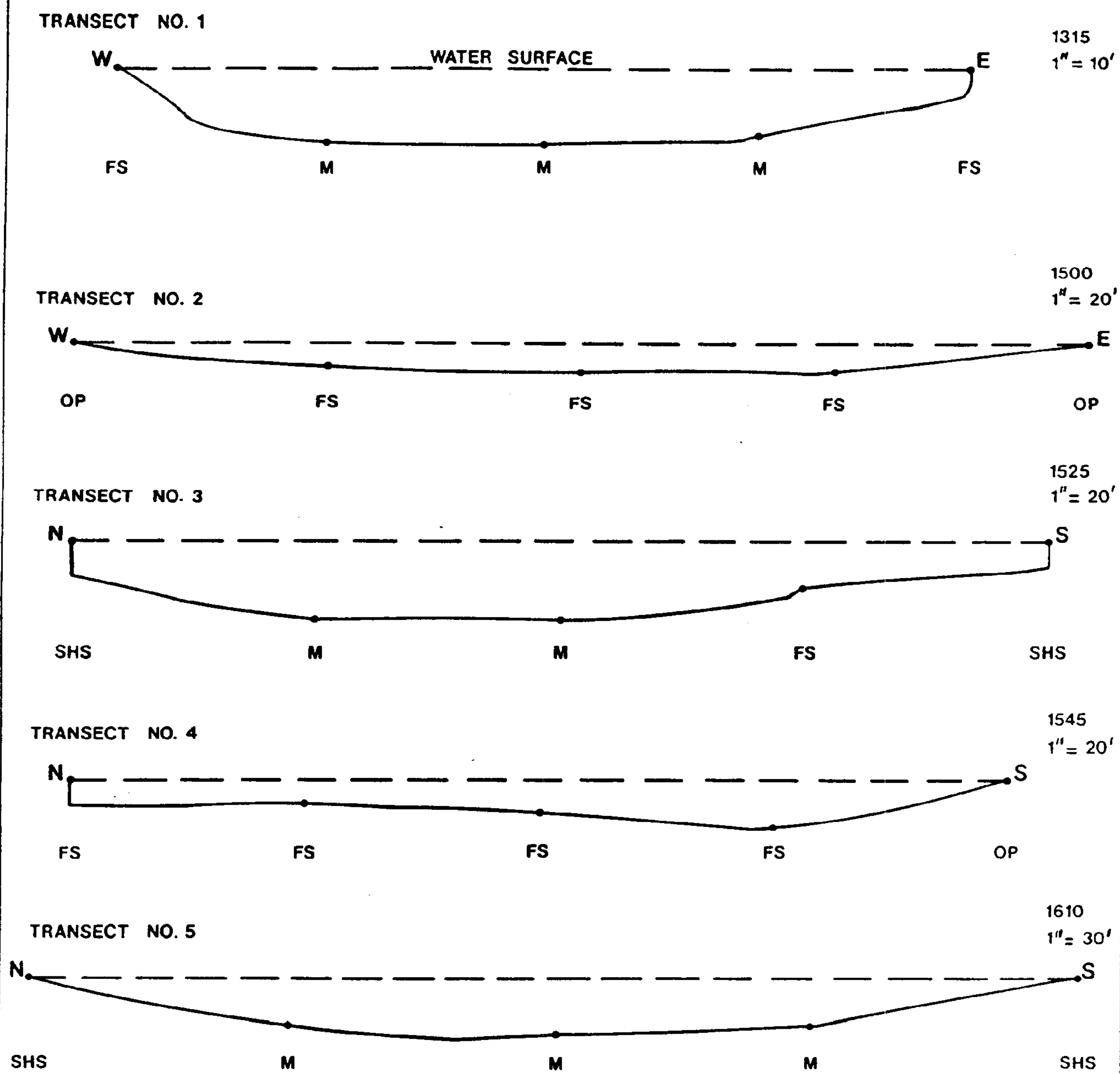


Figure 56.
ALLEN CREEK, PINELLAS COUNTY, FLORIDA
SAMPLING STATIONS AND CHANNEL PROFILE LOCATIONS; APRIL 15, 1986

SOURCE: ESE, 1986.

TAMPA BAY REGIONAL PLANNING COUNCIL



QUALITATIVE SEDIMENT DESCRIPTION

C	Clay
FS	Medium to fine sand with little silt
FS/OY	Fine sand with oysters
M	Muck; no sand, black ooze
M/FS	Mucky fine sand
OP	Organic-peatlike
RR	Rip-rap
SHS	Shelly sand
SSC	Silty sand with some clay

Figure 57.
CHANNEL PROFILES, ALLEN CREEK, APRIL 15, 1986

TAMPA BAY REGIONAL PLANNING COUNCIL

Table 6.

TAMPA BAY REGIONAL PLANNING COUNCIL
QUALITATIVE SEDIMENT DESCRIPTIONS

ALLEN CREEK. 4/15/86

TRANSECT NO. 1
JUST NORTH OF BELLAIR ROAD
W--)E, 1315, WIDTH = 55'
0(0')-------SILTY, MEDIUM - FINE SAND
1/4(4.5')---H2S, MUCK OVER SAND
1/2(4.75')--H2S, MUCK
3/4(4.5')---H2S, OVER SAND
4/4(1')---- SILTY, MEDIUM FINE SAND

TRANSECT NO. 2
SOUTH BRANCH, JUNCUS MARSH
W--)E, 1500, WIDTH = 130'
0(0')------ORGANIC PEATLIKE
1/4(2.5')--MEDIUM-FINE SAND, RELATIVELY CLEAN
1/2(3.5')--SILTY, ORGANIC, MEDIUM-FINE SAND
3/4(3.3')--MEDIUM-FINE SAND, RELATIVELY CLEAN
4/4(0')----ORGANIC PEATLIKE, ROOTS

TRANSECT NO. 3
SOUTH BRANCH, JUST WEST OF BELCHER
S-) N, 1525, WIDTH = 125'
0(3')----SHELLY SAND
1/4(6')--SILTY, MEDIUM-FINE SAND
1/2(10')-H2S, MUCK OVER SILTY, MEDIUM-FINE SAND
3/4(10')-H2S, MUCK
4/4(4')--SHELLY, SILTY, MEDIUM-FINE SAND

TRANSECT NO. 4
MAIN STEM, FROM JUNCUS MARSH TO BULKHEAD
S-) N, 1545, WIDTH = 120'
0(0')----ORGANIC, PEATLIKE, ROOTS, SILTY SAND
1/4(6')--MEDIUM-FINE SAND, RELATIVELY CLEAN
1/2(4')--MEDIUM-FINE SAND, RELATIVELY CLEAN
3/4(3')--MEDIUM-FINE SAND, RELATIVELY CLEAN
4/4(3')--MEDIUM-FINE SAND, RELATIVELY CLEAN

TRANSECT NO. 5
MOUTH OF CREEK
S--)N, 1610, WIDTH = 200'
0(0')----HARD BOTTOM, SHELLY SAND ?
1/4(9')--H2S, MUCK, CLAY
1/2(10.5')--H2S, MUCK
3/4(9')--H2S, MUCK
4/4(0')--SHELLY-COARSE SAND

Source: ESE, 1986

were conducted near the high tide level. Bottom depths were measured from the waters edge at the time of profiling.

The channel profiles indicate that the channel across transects No. 2 and 4 is relatively uniform and contains sediments composed of medium-fine sand, whereas channel segments which had been dredged (transects no. 1, 3 and 5) are relatively deep in mid-channel and contain sediments composed of anoxic, black muck. This implies that channel segments that had been altered through dredging became sinks for fine grained sediments.

Qualitative sediment descriptions along the five transects are described in Table 6. Sediments across transect 1 contain silty medium-fine sand at either shoreline with anoxic muck across the majority of the channel. The western side of the channel is bulkheaded.

Transect 2 is located across the channel running through the Juncus marsh west of Belcher Road. This channel segment did not appear, from aerial photographs, to have been dredged, although dredging on either end is apparent. The sediment at both channel margins is highly organic and peatlike, reflecting the marsh habitat. The sediments across the channel are predominantly sands with the channel center having some silt and organics. The sediments at the one-quarter and three-quarter points are relatively clean (Table 6, Figure 57).

Transect 3 is located just west of Belcher Road in a residentially developed area, with bulkheaded shorelines and a channelized creek. The sediments at the base of the bulkheads consist of shelly sands while the deeper channel segments (10 feet deep at time of measurements) contain sediments consisting of anoxic muck.

Transect 4 is located in the mainstream of Allen Creek west of U.S. 19 A Juncus marsh exists along the south shore of the creek, while the north shore is bulkheaded. No apparent dredging had been accomplished in this stream segment. Sediments at the marsh shoreline were observed to be organic and peatlike while the remainder of the channel bottom consisted of relatively clean, medium-fine sand.

Transect 5 is located across the creek between red mangroves on the south and a hard, shelly, coarse sand beach on the north. The bottom just off the mangroves was hard and impenetrable by the sediment core. Presumably it consisted of a shelly sand bottom, or possibly an oyster bottom. The remaining quarter points had bottom sediments composed of anoxic, black muck.

2.1.2 Biological and Chemical Characterization

Dissolved oxygen concentrations ranged from 6.55 ppm to 10.40 ppm (Table 5). The dissolved oxygen concentrations at station 1 decreased slightly with a depth from a high of 7.80 ppm at the surface to a low of 6.55 ppm at a depth of 9 feet. Dissolved oxygen concentrations were highest at station 2 just north of Bellair Road, where surface concentrations equalled 10.4 ppm and bottom concentrations (at 5 feet) equalled 7.20 ppm. An additional dissolved oxygen reading at Station 1F equalled 9.80 ppm. The dissolved oxygen readings at Stations 2 and 1F were taken at midday. At the time of sampling, extensive algal blooms were evident in this portion of Allen Creek, suggesting potentially high nutrient loadings. The chlorophyll-a concentrations at Station 2 averaged 24.5 ug/l and at Station 1 averaged 10 ug/l (Table 7). The high dissolved oxygen readings are likely the result of algal photosynthesis. Night time dissolved oxygen concentrations would likely be depressed as algal respiration and decay utilize the dissolved oxygen available in the water mass.

Water temperature over the course of the sampling period (1045 - 1440 hours), ranged from 23.58 degrees to 27.84 degrees C. The measured pH values in Allen Creek ranged from 7.62 to 8.14. Turbidity ranged from 3.5 nephlometric turbidity units (NTU) at Station 1F to 14.0 NTU at the bottom of Station 2. At Stations 1 and 2 there was an increase of turbidity with depth. This increase was slight at Station 1 but nearly 2 to 3 times at Station 2. The higher turbidities measured at the mid and bottom depths at Station 2 most likely resulted from the previously mentioned algal blooms. Secchi disk visibility depth was approximately 4 feet at Station 1 while only 2 feet at Station 2. The reduced visibility at Station 2 was again most likely due to the algal blooms. The total suspended solid concentration averaged 7 mg/l at Station 2 and was below detection limits at Station 1. Additional City of Clearwater water quality data for Allen Creek is included in Appendix A.

Mangroves and Juncus marsh were the predominant vegetation types in areas which remained undeveloped along Allen Creek (Figure 55). In the lower creek, from U.S. 19 to the creek mouth, the southern shore of Allen Creek consisted predominantly of red mangrove (Rhizophora mangle) and black mangrove (Avicennia germinans). The mangrove area extended from the creek mouth to the channel east of the Sea Ray Marina and back in and around the marina to U.S. 19. Dredge and fill operations have created channels and uplands within this area. Approximately 400 feet of the north shore from U.S. 19 to the east is colonized by a narrow band of red mangroves in the intertidal zone. At higher elevations the land is disturbed and site preparation work for a new commercial development was underway. From 400 feet east of U.S. 19 to the creek mouth, the intertidal zone is mostly unvegetated and consists of a coarse, shelly sand beach. This most likely resulted from past dredging operations along this creek segment, which removed vegetation and created the steep creek bank.

From U.S. 19 to the west, the shoreline along Allen Creek remains relatively undeveloped for approximately one-half mile. Bordering the south shore and U.S. 19 is a small commercial strip center. The shoreline behind the center was built into a steep slope with red and black mangroves in the intertidal zone and Brazilian pepper (Schinus terebinthifolius) on the slope face. For approximately one-half mile from the commercial strip center to the creek fork, the southern shore of the creek is colonized predominantly by red mangroves and black rush (Juncus roemerianus). A limited growth of Spartina alterniflora also occurs in this stream segment.

The northern shore from U.S. 19 to the west is also predominantly mangrove and Juncus. The last 700 feet of the northern shoreline before the creek fork consists of bulkheaded residential area. A large percentage of the mangroves in this segment of Allen Creek were apparently cold-killed. New growth was evident, however.

Table 7. Chlorophyll a and Total Suspended Solids Concentrations

ENVIRONMENTAL SCIENCE & ENGINEERING 05/14/86 STATUS: PAGE# 1

PROJECT NUMBER 86414V0500 PROJECT NAME TAMPA BAY REGIONAL PLANNING COUNCIL
FIELD GROUP TBRPC PROJECT MANAGER LISA BARE
LAB COORDINATOR LISA BARE

PARAMETERS UNITS	STORET # METHOD	STA1-1 TBRPC 1	STA1-2 TBRPC 2	STA2-1 TBRPC 3	STA2-2 TBRPC 4	STA3-1 TBRPC 5	STA3-2 TBRPC 6	SAMPLE ID/# STA4-1 TBRPC 7	STA4-2 TBRPC 8	STA5-1 TBRPC 9	STA5-2 TBRPC 10	STA6-1 TBRPC 11	STA6-2 TBRPC 12
DATE TIME		04/15/86 00:00	04/15/86 00:00	04/15/86 00:00	04/15/86 00:00	04/17/86	04/17/86	04/17/86	04/17/86	04/23/86 08:20	04/23/86 08:20	04/23/86 11:50	04/23/86 11:50
RESIDUE, SUSP. MG/L	530 0	<5	<5	9	5	<5	7	5	<5	16	16	12	10
CHLOROPHYLL, A, CORR., SPECT UG/L	32211 0	12	7.9	22	27	4.7	5.5	28	20	6.9	8.8	5.5	7.2
PHEOPHYTIN-A UG/L	32218 0	4.36	2.70	0.96	0.08	4.55	3.98	2.45	3.21	5.23	4.54	1.40	1.32

Source: ESE, 1986

North of the fork, Allen Creek is developed for residential use and shoreline vegetation has been largely eliminated and replaced with bulkheads. At the fork confluence and to the south, the creek opens into a shallow meandering channel with black rush and red mangroves along the intertidal areas. Again, a large percentage of the mangrove population was reduced by cold shock. On either side of the creek the land has been drained and filled for residential use with a limited amount of agricultural activity (grove and horse pasture). From the marsh-mangrove area at the beginning of the south fork to Belcher Road, wetland vegetation becomes very limited with only a few small red mangroves and occasional sea purslane (Sesuvium portulacastrum) observed along the shoreline. Although not bulkheaded, the shoreline of the stream segment is built up for residential use on the south shore with primarily horse pasture on the north shore. Some dredging is also evident from earlier aerial photography.

From Belcher Road to the west nearly the entire shoreline of Allen Creek has been bulkheaded and filled for residential development. Approximately 1300 feet west of Belcher Road there is a Juncus marsh equally approximately 26 acres. The marsh is surrounded by residential development and portions of the marsh have obviously been dredged and filled for development of the residential area.

A gill net set at the mouth of Allen Creek for approximately seven hours (1000-1700 hrs.) on flood tide yielded nine species of marine fish (Table 8). Perhaps most significant among these are the Spanish mackerel (Scomberomorus maculatus) and bluefish (Pomatomus saltatrix). Fourteen Spanish mackerel all slightly longer than 200 mm in standard length were caught, indicating the utilization of at least lower Allen Creek by this important sport and commercial species. Five bluefish ranging in standard length from 133 mm to 153 mm were caught, again indicating the utilization of Allen Creek by marine fish species as a nursery area. Spot (Seiosotmus xanthurus) and gulf menhaden (Brevoortia patronus) collected within this area are also important species with sport and commercial value. Redfish, an important sport fishing species, may also utilize Allen Creek. A conversation with a fisherman, fishing the channel in the Juncus marsh west of Belcher Road, indicated that large redfish inhabit Allen Creek.

Although no fisheries collections were made in freshwater areas connected with Allen Creek, a largemouth bass was observed north of Bellair Road. At the time of the field study, salinities in this creek section were in the mesohaline salinity regime. Vegetation at this location (Station 1E) however, indicated that on the average, salinities were generally lower since a stand of cattails (Typha sp.) and bullrush (Scirpus sp.) were observed.

2.1.3 Physical and Chemical Alterations

Allen Creek has few point source discharges. The only discharge listed was for the Belcher Road Elementary School (TBRPC, 1977). However, the creek has numerous storm drains and drainage ditches emptying into it from the surrounding residential and commercial development. The branches of Allen Creek north of Bellair Road have essentially been turned into storm drainage ditches extending up to S.R. 60. At U.S. 19 stormwater runoff from the

TABLE 8

TAMPA BAY REGIONAL PLANNING COUNCIL
FISH COLLECTED IN ALLEN CREEK APRIL 15, 1986
GILL NET SET AT MOUTH OF CREEK, 1000 - 1700 HOURS ON FLOOD TIDE

SPECIES	STANDARD LENGTH (MM)
Bagre marinus (gafftopsail catfish)	335
Scomberomorus maculatus (Spanish mackerel)	222
	205
	215
	205
	214
	218
	230
	227
	227
	230
	220
	210
	212
	201
Elops saurus (ladyfish)	295
	300
	335
Leiostomus xanthurus (spot)	132
	136
	132
	133
	147
	149
	73
Brevoortia patronus (gulf menhaden)	207
	210
	227
	190
	205
	208
	195
	200
	208
Opisthonema oglinum (Atlantic thread herring)	130
	134
	120
	124
	88
	85
	85
	80
Alosa chrysochloris (skipjack herring)	145
Pomatomus saltatrix (bluefish)	140
	153
	142
	148
	133
Anchoa hepsetus (striped anchovy)	106
	100
	94
	91
	98
	110
	77
	55

Source: ESE, 1986

roadway is directed into Allen Creek from the area surrounding the bridge crossing. At the time of the field survey (April 13, 1986), a new commercial development was underway to the north of Allen Creek and east of U.S. 19. This development is surrounded by a storm drainage system which will eventually discharge into Allen Creek approximately 550 feet east of U.S. 19. Wetlands which extend along U.S. 19 for approximately 1100 feet south of the Sea Ray Marina most likely receive runoff from the roadway, some of which may travel to Allen Creek and eventually Tampa Bay. The small strip center on the western side of U.S. 19 and bordering Allen Creek has a 12-inch parking lot drain discharging directly into Allen Creek. Between U.S. 19 and Belcher Road there are few storm drains entering the creek, but several large drainage ditches entered the creek from the south. At Belcher Road two storm drains receiving roadway runoff entered the creek. West of Belcher Road residential storm drains and drainage swales additionally empty into the creek.

No salinity barriers were observed along the course of Allen Creek from the mouth of the creek to Bellair Road. The major physical alteration to Allen Creek was the extensive bulkheading of the creek shoreline for residential development. Of the approximately three nautical miles of stream course surveyed, there are approximately 2.9 nautical miles of bulkheading inclusive of both stream banks. The creek banks are not extensively bulkheaded in the creek segment east of Belcher Road, however filling has created steep banks with little littoral zone available for the establishment of wetland vegetation.

Allen Creek has been dredged and channelized in various creek segments and remains relatively undisturbed in other segments. The large majority of the creek, however, has been subjected to dredge and fill activities related to residential development. The lower creek segment is dredged from U.S. 19 to the creek mouth. Aerial photographs indicate a channel for Allen Creek has been dredged to allow boat access to Largo Inlet, the Sea Ray Marina and a small boat facility south of the creek.

West of U.S. 19 to the creek fork (approximately 0.5 miles upstream), no apparent channelization has occurred. This channel segment contains a slight meander and is relatively shallow. The north branch of the first channel fork has been channelized and bulkheaded, extending north of Bellair Road. Along this branch, Allen Creek eventually becomes a drainage canal from a point just upstream of Belleair Road.

The southern branch, and main creek channel, has no apparent dredging or channelization through the first 1800 feet. From the end of this mangrove-marsh area to Belcher Road the creek channel meanders slightly. However, it appears from aerial photography that some dredging has taken place for filling of adjacent lands. From Belcher Road west, Allen Creek has had extensive dredging, filling and stream channelization. Apparently the only undredged area remaining is the channel running north-south through the Juncus marsh.

2.1.4 Habitat Assessment

Allen Creek has been measurably altered, primarily through the activities of streambed alteration associated with the urbanization of the watershed. The creek has been extensively dredged and bulkheaded along the creek banks. The primary land use surrounding Allen Creek is residential with numerous storm drains entering directly into the creek from residential areas. The creek branches which extended north of Bellair Road have essentially been turned into urban drainage ditches extending up to U.S. 60.

The deeper dredged portions of Allen Creek contain predominantly anoxic muds, and have apparently become sediment sinks. Although no chemical analyses were performed on bottom sediments, these fine sediments may end up as sinks for pollutants discharged into the creek. Eutrophic conditions are evident within the water column as illustrated by high daily oxygen concentrations with low light penetration.

Within the Allen Creek system, isolated wetland areas remain which have not been filled or bulkheaded. These areas are located at the mouth of the creek, between U.S. 19 and the creek fork, at the creek fork in the southern branch, and a *Juncus* marsh west of Belcher Road. This *Juncus* marsh was the largest remaining wetland area, but has obviously been encroached upon from all sides. The wetland areas, primarily mangroves at the creek mouth and the *Juncus* marsh upstream, can provide nursery and feeding habitat for commercially and recreationally important species of fish and shellfish. Although fisheries collections were limited in Allen Creek, the fish collected near the mouth of the creek indicated that Allen Creek provides potential nursery habitat for important marine species such as Spanish mackerel. The preservation of the remaining wetland along Allen Creek is essential in maintaining whatever limited populations of fish species the creek now supports.

2.2 Delaney Creek

2.2.1 Hydrographic Features

The Delaney Creek drainage basin encompasses approximately 11,069 acres (Table 9). The basin can be divided into 27 sub-basins created by drainage ditches and roadways resulting from urbanization in the area (Figure 58). The sub-basins range in size from 69.8 acres to 2,442.6 acres. Land use within the basin, as estimated from 1979 (1"=2000') aerial photography consists of a mixture of industrial, residential, commercial, and agricultural. The area between Tampa and Brandon is one of the fastest growing areas in the Tampa Bay Region and estimates based on 1979 photograph may overestimate the percentage of land in agriculture, and underestimate the urban and built up areas.

Delaney Creek is a first order stream as defined by the Florida Land Use and Cover Classification System (1977). The creek flows westward from the Brandon area and empties into the Hillsborough Bay subsection of Tampa Bay.

Calculations of discharge of surface waters through Delaney Creek to Tampa Bay are based on rainfall data from the year 1981-1982. The average monthly discharge of Delaney Creek ranged from 4.8 acre-feet to 5,888.7 acre-feet (Table 4) with highest discharges occurring in the summer and fall months corresponding to natural rainfall cycles. With the urbanization of the Delaney Creek watershed, the discharge volumes are expected to increase. Compared with the Allen Creek watershed, which is the smallest of the three selected watersheds, the Frog and Delaney Creek discharges were calculated to be much lower. The high discharge of Allen Creek was due to the impervious surfaces dominating the watershed. As the Delaney Creek watershed becomes urbanized a similar situation can be expected to occur.

Channel profiles and sediment types for Delaney Creek are depicted in Figure 59 and depths are given in Table 10. On the day of the survey (April 17, 1986) Hillsborough Bay had a diurnal tide with the low at 0325 hrs. and the high at 1916 hrs. The low was predicted to be at 0.0 feet and the high at 1.9 feet (NOAA, 1985). The profiles in Figure 59 are uncorrected for tidal changes since no vertical control was surveyed into the analysis. All depths therefore are those recorded at that particular time of day and tidal stage. Estimates of tidal range are made from water marks on existing structures and creek banks, and from a staff gauge located on the Seaboard Coast Line (SCL) railroad trestle. Sampling stations and transect locations are found on Figure 60 for Delaney Creek.

Depths recorded for transect No. 1 are recorded very near low tide. When the station was first sampled (1030 hrs.) the water was flowing out and stopped shortly thereafter. The water level at a staff gauge on the SCL railroad trestle reflected 1.6 feet at 1000 hrs. A second reading at 1200 hrs. equalled 1.74 feet, and a third reading at 1250 equalled 1.92 feet, indicating a change from ebb to flood during this time span. At the time of depth profiling, no flow could be observed. An estimate of high tide levels was acquired from the water mark on the staff gauge and estimated at 2.75 feet. This indicated a tidal range of at least 1.2 feet within this creek segment. Water marks on the creek bank indicated the tidal range could be as great as 1.5-2 feet.

Table 9. Delaney Creek Drainage Basin and Subbasin Area

Subbasin No.	Acres
1	2,442.6
2	753.0
3	417.8
4	619.8
5	461.0
6	275.5
7	377.6
8	286.5
9	69.8
10	94.6
11	28.5
12	176.3
13	670.3
14	345.3
15	166.2
16	113.9
17	216.7
18	329.7
19	251.6
20	232.3
21	93.7
22	459.1
23	315.0
24	679.5
25	69.8
26	408.6
27	714.4
	11,069.1

Source: ESE, 1986

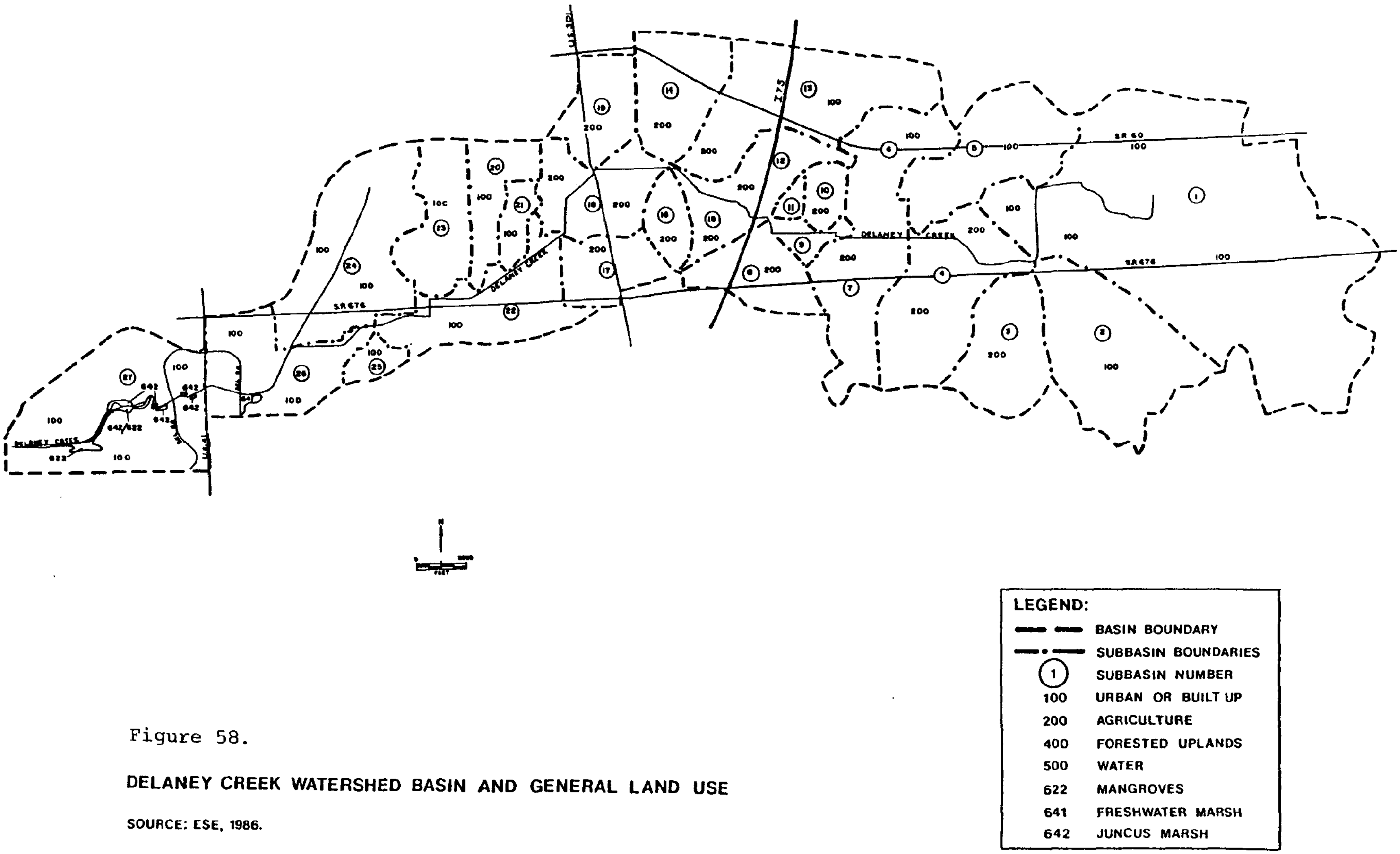
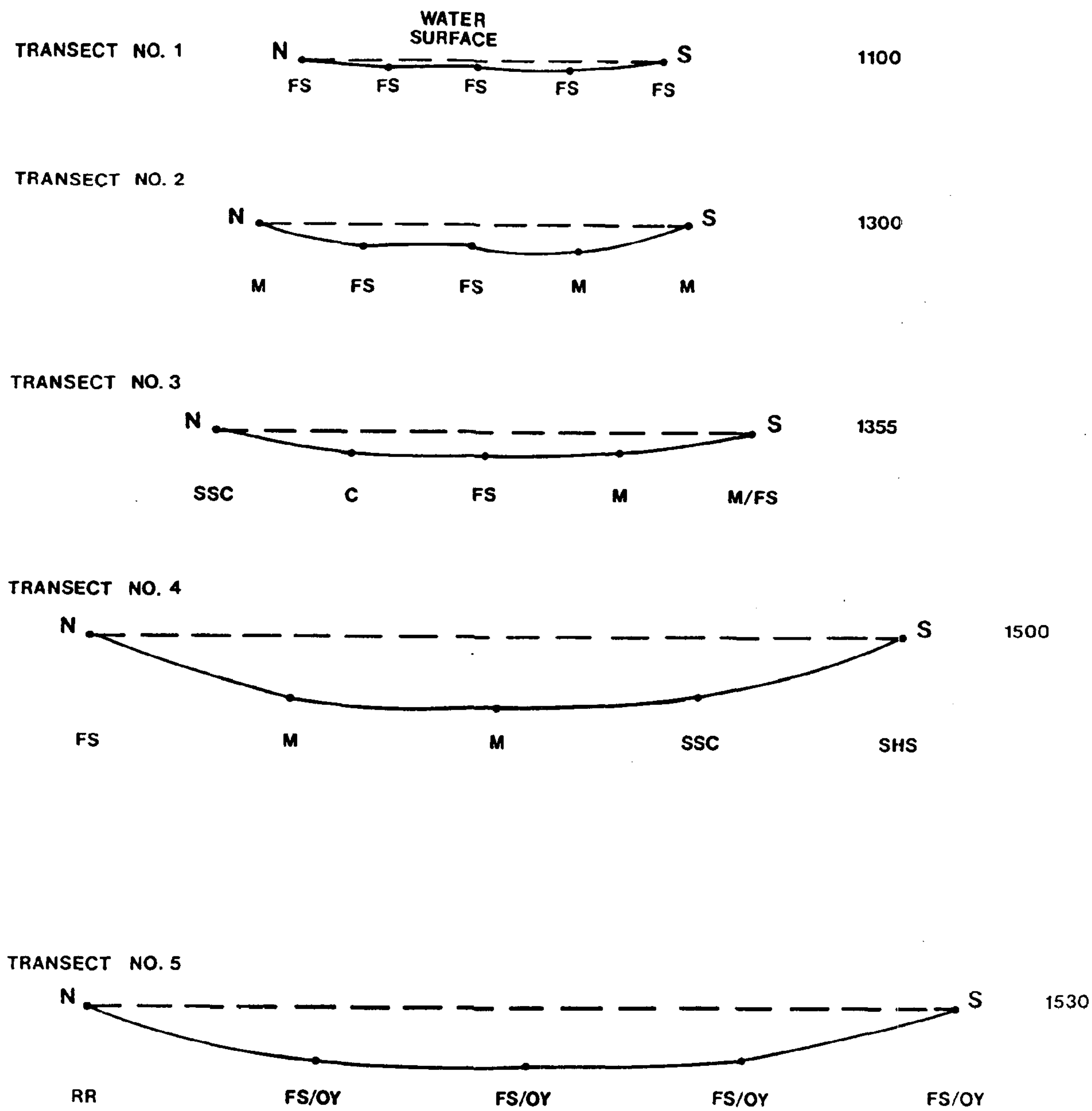


Figure 58.

DELANEY CREEK WATERSHED BASIN AND GENERAL LAND USE

SOURCE: ESE, 1986.



QUALITATIVE SEDIMENT DESCRIPTION

C	Clay
FS	Medium to fine sand with little silt
FS/OY	Fine sand with oysters
M	Muck; no sand, black ooze
M/FS	Mucky fine sand
OP	Organic-peatlike
RR	Rip-rap
SHS	Shelly sand
SSC	Silty sand with some clay

NOTES:

- DEPTHS ARE THOSE DEPTHS RECORDED AT TIME OF SURVEY AND ARE NOT CORRECTED FOR TIDE
- CHANNEL WIDTHS ARE APPROXIMATE: ESTIMATED FROM 1″ = 200′ AERIAL PHOTOS
- DEPTHS MEASURED FROM EDGE OF WATER

SCALE: 1″ = 15′

Figure 59.
CHANNEL PROFILES, DELANEY CREEK, APRIL 17, 1986

TAMPA BAY REGIONAL PLANNING COUNCIL

Table 10. Sediments - Delaney Creek

TAMPA BAY REGIONAL PLANNING COUNCIL
QUALITATIVE SEDIMENT DESCIPTIONS

DELANEY CREEK, 4/17/86

TRANSECT NO. 1
TIDAL FRESHWATER, 300' UPSTREAM OF RAILROAD TRESTLE
N--)S, 1100,'WIDTH=33'
0(0')------SILTY-FINE SAND
1/4(0.5')--SILTY-FINE SAND
1/2(0.5')--SILTY-FINE SAND
3/4(1.0')--SILTY-FINE SAND
4/4(0.)----SILTY-FINE SAND

TRANSECT NO. 2
APPROX. 400' UPSTREAM OF U.S. HWY. 41
N--)S, 1300, WIDTH = 40'
0(0')------ORGANIC MUCK ON SAND, STICKS
1/4(2.1')--MEDIUM-FINE SAND, RELATIVELY CLEAN
1/2(2.0')--MEDIUM-FINE SAND, RELATIVELY CLEAN
3/4(2.3')--MUCKY SAND, OILY SHEEN
4/4(0')----MUCKY SAND, WOOD DEBRIS, LITTLE CLAY

TRANSECT NO. 3
JUST UPSTREAM OF HORSESHOE BEND
S-) N, 1355, WIDTH = 50'
0(0')------MUCKY-FINE SAND, ROOT MATERIAL,
1/4(2.1')--6" MUCK OVER MEDIUM-FINE SAND
1/2(2.25')-MEDIUM-FINE SAND, RELATIVELY CLEAN, THIN DETRITAL LAYER
3/4(2.25')-H2S, CLAY
4/4(0')----VERY SILTY, MEDIUM-FINE SAND, CLAY

TRANSECT NO. 4
CHANNELIZED STREAM, LOWER CREEK
S-) N, 1500, WIDTH = 75'
0(0')-----SHELLY SAND
1/4(5.5')-SILTY/CLAY SAND
1/2(6.25')H2S, MUCK, LEAVES
3/4(6')---MUCK
4/4(0')---SILTY SAND, ROOT MATERIAL

TRANSECT NO. 5
LOWER CREEK
N--)S, 1530, WIDRH = 80'
0(0')------MEDIUM-FINE SAND, OYSTERS
1/4(5')----MEDIUM-FINE SAND, OYSTERS
1/2(5.25')-MEDIUM-FINE SAND, OYSTERS
3/4(5')----MEDIUM-FINE SAND, OYSTERS
4/4(0')----MEDIUM-FINE SAND, OYSTERS

Source: ESE, 1986

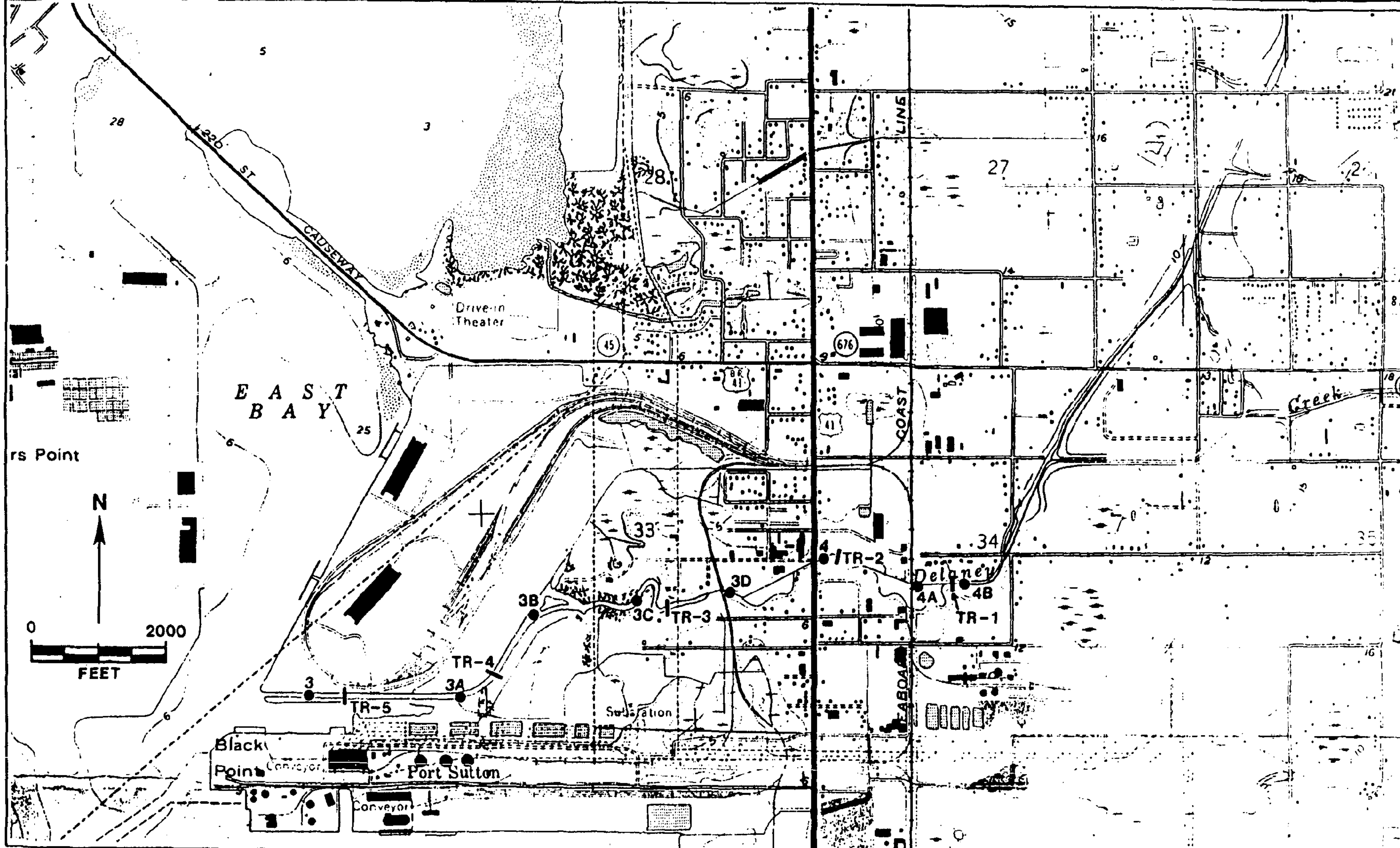


Figure 60.

DELANEY CREEK, HILLSBOROUGH COUNTY, FLORIDA
SAMPLING STATIONS AND CHANNEL PROFILE LOCATIONS; APRIL 17, 1986

SOURCE: ESE, 1986.

TAMPA BAY REGIONAL PLANNING COUNCIL

Station 3 located at the mouth of Delaney Creek was first occupied at 0720 hrs. During this time the tide was estimated to be down approximately two feet as evidenced by the water line on the rip-rap along the north shore. Transect No. 5 was conducted just upstream of Station 3, and at the time of bottom profiling, the tide was estimated to be down approximately one foot. The East Coast tide tables (NOAA, 1985) gave the mean diurnal range for Hillsborough Bay as 2.8 feet, which reflects the tidal range at the mouth of Delaney Creek. Difference in water depth at individual stations sampled by FDER (data appendix in CCI, 1985) indicate a tidal range of 1.5-2 feet in the middle reaches of the tidally influenced portion of Delaney Creek.

Therefore, the depth profiles for Delaney Creek were conducted from low water at the upper study limit to approximately two-thirds of the high tide cycle in the lower creek segment. The channel depths as a result would be approximately one to two feet deeper during high tide than are depicted.

Sediment transect No. 1 is located approximately 300 feet upstream from the SCL railroad trestle. During the time of the channel cross section analysis, the maximum depth equalled 1.0 feet. The sediment across the channel was uniform in nature and consisted of a silty fine sand.

Sediment transect No. 2 is located approximately 400 feet upstream of U.S. 41 adjacent to an auto junk yard. Maximum water depth at the time of sampling measured 2.3 feet. Sediments across the transect ranged from relatively clean, medium-fine sand at the quarter and half points (from north to south) to mucky sand along the north shore, at the three-quarter point, and at the south shore.

The sediments at transect No. 3, located just upstream of the meander, ranged from sand to clay. Along the southern shoreline the sediments contained a soft mucky, fine sand with root material from the bordering black rush marsh. At the one-quarter point the sediments consisted of a 6-inch layer of black muck over medium fine sand. In the channel center, the bottom consisted of relatively clean medium-fine sand covered with a thin detrital layer. The sediments at the three-quarter point were predominantly clay with a hydrogen sulfide odor. Sediments along the north bank were very silty medium-fine sand with some clay.

In the channelized lower creek segment along transect No. 4, the sediments at the south and north shorelines consisted of shelly sand and silty sand respectively. The deeper portions of the channel contained additional fine material with the first quarter point sample containing predominantly silt and clay with some sand, while the sediments at the mid-channel and three-quarter points consisted of black muck with a hydrogen sulfide odor.

Sediments across transect No. 5 near the mouth of the creek were uniform in nature. The bottom consisted of a medium fine sand intermixed with scattered clumps of oysters.

2.2.2 Biological and Chemical Characterization

In-situ water quality parameters were measured between 0720 and 1420 hrs. on April 17, 1986 (Table 5). All data was collected during a flood tide. Dissolved oxygen was measured at three locations, Stations 3, 4 and 4B (Figure 60) and ranged from 5.00 ppm to 7.30 ppm. Maximum water depth at the time of dissolved oxygen measurements was 2.5 feet.

Salinity measurements in Delaney Creek ranged from 0.78 ppt (Station 4B) to 26.24 ppt (Station 3), indicating the freshwater-saltwater interface occurred just upstream from the Seaboard Coast Line railroad trestle. Salinity measurements taken at Station 4A showed an increase from 1.56 ppt at 1000 hrs. to 1.74 ppt at 1200 hrs. Salinity recorded at Station 3B identified an increase from 18.02 ppt at 0826 hrs. to 25.64 ppt at 1420 hrs. Station 4 salinity increased from 3.16 ppt at 0930 hrs. to 5.91 ppt at 1315 hrs.

In-situ water quality sampling measurements collected in February, 1985 by Conservation Consultants Inc. (CCI) defined the freshwater-saltwater interface of Delaney Creek essentially within the same creek segment as the present study. At U.S. 41, CCI found the conductivity to range from 4.91 mmohs/cm at low tide to 26.40 mmohs/cm at high tide. At the railroad trestle, CCI reported conductivity to equal 3.41 mmohs/cm at low tide. At CCI Station 4 (approximately 2000 feet upstream of Station 4B of the present study), a conductivity of 0.51 mmohs/cm was recorded at low tide. This data indicates that Delaney Creek from U.S. 41 to approximately one-half mile upstream may range from freshwater to mesohaline salinities depending upon tidal stage and freshwater discharge.

The Hillsborough County Environmental Protection Commission (HCEPC) routinely collects water quality data at U.S. 41. Although they list this station as a freshwater station, their data (Table 11) indicates this segment of Delaney Creek to be oligohaline. The HCEPC Station 138 (54th St. and 36th Ave.) predominantly reflects freshwater characteristics (Table 12).

Florida Department of Environmental Regulation data on Delaney Creek (Appendix B in CCI, 1985) indicate tidal influence and some brackish water characteristics as far upstream as the 54th Street bridge over Delaney Creek, depending upon tidal stage. The creek, however, is predominantly freshwater at this point.

Dissolved oxygen concentrations measured in Delaney Creek equalled 6.30 ppm, 5.00 ppm and 7.30 ppm at Stations 3, 4 and 4B respectively (Table 5). In the tidal portion of Delaney Creek, CCI (1985) identified dissolved oxygen concentrations ranging from 5.5 to 6.4 ppm and a range of 5.1 ppm to 8.5 ppm between the railroad trestle and U.S. 301. In their sampling CCI reported only one measurement below the Class III standard of 5.0 ppm, this recorded just north of SR 676.

Studies conducted on Delaney Creek by the FDER (Appendix B in CCI, 1985) recorded numerous dissolved oxygen concentrations below the 5.0 ppm Class III standard. Low dissolved oxygen concentrations were recorded from Maydell Street and SR 676 down to the mouth of Delaney Creek, and occurred throughout the day. Dissolved oxygen concentrations at HCEPC station 133

Table 11. **Water Quality Parameters Station 133. Hillsborough County Environmental Protection Commission**

Year	mmhos/cm Conductivity	$S^o/_{oo}$	(µg/l) Chl a	(inches) Effective Light Penetration	mid D.O.	pH (min)	pH (max)	NTU	SS (mg/l)
1978	6.8	3.8	23.43	18.8	4.5			3.92	13.7
1979	6.9		29.1	17.3	4.1			5.3	15.8
1980	4.64	2.6	24.0	17.8	3.9			3.2	8.8
1981	6.6	3.8	19.0	19.1	4.4	6.8	7.6	3.3	12.0
1982	2.5	1.3	22.8	16.4	3.5	6.5	7.6	5.5	8.0
1983	0.97	2.3	9.1	14.5	3.4	7.2	7.6	33.8	19.5

Source: HCEPC, 1979, 1985

Table 12. Water Quality Parameters Station 138. Hillsborough County Environmental Protection Commission

Year	mmhos/cm Conductivity	$S^o/_{oo}$	(µg/l) Chl a	(inches) Effective Light Penetration	mid D.O.	pH (min)	pH (max)	NTU	SS (mg/l)
1981	2.58	1.5	15.4	13.4	3.0	7.3	9.1	3.3	5.9
1982	0.69	0.4	4.8	16.3	4.3	7.1	8.1	5.5	4.2
1983	0.62	0.3	5.7	14.5	4.1	7.5	7.9	32.5	15.2

Source: HCEPC, 1982, 1985

(U.S. 41) averaged less than 5.0 ppm from 1978-1983 (Table 11). HCEPC Station 138 (54th Street and 36th Avenue) averaged less than 5.0 ppm for the years 1981, 1982, and 1983 (Table 12).

Turbidity, secchi disk depth and pH for Delaney Creek are listed in Table 5. At the time of sampling, the secchi depth reached down to the creek bottom. During the time of sampling the tide was low and flooding. At Station 4 (U.S. 41) the disk remained visible at 2.5 feet. HCEPC has measured an effective light penetration at this station of less than two feet from 1978 through 1983. Turbidity at the mouth of Delaney Creek measured 3.8 NTU and increased upstream at Station 4 to 9.4 NTU. HCEPC recorded turbidities ranging from 3.2 NTU to 33.8 NTU at U.S. 41 from the years 1978-1983.

Total suspended solids sampled at the mouth of Delaney Creek (Station 3) and at U.S. 41 (Station 4) were relatively low. The amount of suspended solids ranged from less than 5 mg/l to 7 mg/l (Table 7). Chlorophyll-a concentrations measured at the same two stations showed an increase from the mouth of the creek to the upstream segment. Concentrations measured at the creek mouth were 4.7 ug/l and 5.5 ug/l while upstream at U.S. 41 the chlorophyll-a concentrations were 28 ug/l and 20 ug/l. Over the years 1978-1983, HCEPC measured chlorophyll-a concentrations at U.S. 41 (Station 133) ranging from 9.1 ug/l to 29.1 ug/l. In June, 1981 FDER (Data in Appendix B in CCI, 1985) recorded very high chlorophyll-a concentrations in Delaney Creek. Concentrations ranged from 67.7 ug/l to 168.1 ug/l within the creek segment from the mouth of Delaney Creek to just above the Seaboard Coast Line railroad trestle. During the time of the FDER sampling, phytoplankton blooms were evident in Delaney Creek. FDER water quality investigations conducted in August 1984 measured chlorophyll-a concentrations of 2.7 ug/l at the Seaboard Coastline railroad trestle, 5.3 ug/l to 14.4 ug/l at U.S. 41, and 17.9 ug/l to 194.2 ug/l at the mouth of Delaney Creek.

Along Delaney Creek, limited salt tolerant aquatic vegetation was observed. The upstream limit of salt tolerant plants extended to just downstream of U.S. 41. The largest area of aquatic vegetation occurred along the shores of the unchannelized meander in the lower creek segment. The dominant plant species observed is black rush (Juncus roemerianus). Additional plants included black mangrove (Avicennia germinans) (many of which had been cold shocked), and saltwort (Batis maritima). Slightly higher elevations supported sea myrtle (Baccharis halimifolia) and marsh elder (Iva frutescens). Upstream of the meander and below U.S. 41, the small black rush marshes generally occurred at lower elevations behind the creek banks that had been elevated due to streambed channelization. The tops of the banks generally contained Brazilian pepper, saw palmetto (Serenoa repens) and cabbage palms (Sabal palmetto).

From the mouth of Delaney Creek up to the meander, little aquatic vegetation occurred along the creek shores. The lower creek has been channelized creating very high, steep banks. The intertidal zone at the base of the banks contained scattered small red and black mangroves. At the creek mouth many of the mangroves have been cold shocked. Along higher elevation of the banks some sea myrtle and marsh elder occur, but the area is dominated by Brazilian pepper and cabbage palms. The ditched areas along the south side of Delaney Creek, north of the TECO-Gannon plant, are colonized by predominantly black mangroves, a large portion of which are apparently cold shocked.

Above U.S. 41, little aquatic vegetation occur due to the steep banks created by channelization. The most significant area of aquatic vegetation was a herbaceous freshwater marsh along the Nitram Chemical Co. discharge. This marsh area is approximately 1.8 acres in size.

The majority of fish collected in Delaney Creek were caught by beach seine at the freshwater-saltwater interface (Station 4B). Nine fish species were collected by beach seine within this area. Collected specimens include sailfin molly (Poecilia latipinna), bluegill (Lepomis macrochirus), sheepshead minnow (Cyprinodon variegatus), mosquito fish (Gambusia affinis), Fundulus spp., redfish (Sciaenops ocellatus) and rainwater killifish (Lucania parva) (Table 13). A gill net set just downstream of the Seaboard Coast Line railroad trestle (Station 4A) netted a Tilapia spp. Additionally, Tilapia spp. were observed in the small stream (Nitram discharge) entering Delaney Creek just upstream of the railroad trestle. Blue crabs were also collected by beach seine and gill net in this stream segment.

The majority of these identified species of fish range from brackish to freshwater and are common at the saltwater-freshwater interface. Most significant among the fish collections was the capture of juvenile redfish. Six individuals ranging from 4 to 6 inches were collected at Station 4B. Redfish are an important recreational species in the Tampa Bay area. The collection of these juvenile fish in Delaney Creek indicates that the creek is serving as a nursery area for this species. The lower Alafia River, just south of Delaney Creek, has been reported to be the major spawning/nursery area for redfish in Tampa Bay (FDNR, personal communications).

A gill net set in the lower creek for approximately 6 hours acquired very few fish. The only fish caught were two sea catfish (Arius felis). Blue crabs and crown conch (Melongena corona) were also collected in the gill net. During the time of sampling, lower Delaney Creek was being commercially fished for blue crabs.

2.2.3 Physical and Chemical Alterations

The two major point source discharges into lower Delaney Creek originate from Chloride Metals, Inc. and Nitram Chemicals, Inc. Nitram is a fertilizer manufacturing plant and Chloride Metals, Inc. is involved in the manufacturing of lead acid batteries.

Chloride Metals, Inc. has been issued a discharge permit which expires October 1, 1986, (FDER permit files). The wastewater streams consist of drainage from the raw plate storage area, overflow from the material crushing/separation process, plant washdown water, scrubber overflow, and stormwater runoff from the production area. Treated water is normally recycled. The bleed down of treated process water and treated stormwater in excess of a 10-year, 24-hour event is discharged to Delaney Creek (letter of permit issuance, March 1975). The discharge permit places maximum daily limitations on total suspended solids (3.06 lbs./day), antimony (0.214 lbs./day), arsenic (0.089 lbs./day), lead (0.066 lbs./day), zinc (0.066

Table 13.

TAMPA BAY REGIONAL PLANNING COUNCIL
FISH COLLECTED IN DELANEY CREEK, APRIL 17, 1986
BEACH SEINE, TIDAL FRESH WATER
GILL NET, TIDAL FRESH WATER
GILL NET, TIDAL SALT WATER

SPECIES	STANDARD LENGTH
Poecilia latipinna (sailfin molly)	
Lepomis macrochirus (bluegill)	
Cyprinodon variegatus (sheepshead minnow)	
Sciencops ocellata (redfish)	6 @ 100-155
Menidia beryllina (tidewater silverside)	
Gambusia affinis (mosquito fish)	
Fundulus sp. (heteroclitus ?)	
Lucania parva (rainwater killifish)	
Tilapia sp.	
Arius felis (sea catfish)	

Source: ESE, 1986

lbs./day), copper (0.015 mg/l), nickel (0.10 mg/l), turbidity (29.0 NTU above background), and pH (6.0-8.5). No discharge occurred from the percolation ponds during January, March, April, May or June of 1985.

FDER water quality investigations on Delaney Creek have measured very high concentrations of nitrogen compounds below the Nitram discharge (FDER data, 1984 in Appendix B, CCI 1985). In the FDER samples collected in August, 1984, NH_3-N values increased from a range of 0.2 - 0.3 mg/l at 54th Street and 36th Avenue to almost 6 mg/l at U.S. 41. TKN increased from less than 2 mg/l at 54th Street and 36th Avenue to almost 7 mg/l at U.S. 41, and nitrate plus nitrite increased from approximately 0.3 mg/l to 3-7 mg/l at U.S. 41. Significant increases in these nitrogen species occurred down to the mouth of the creek. HCEPC monitoring data also reported a large increase in nitrogen species concentrations between Stations 138 and 133 (HCEPC, 1985).

Additional point source discharges to Delaney Creek listed by the Tampa Bay Regional Planning Council (1977) include Redwing Carriers, Inc. (trucking), and Contract Manufacturing Inc. (electric storage batteries). The HCEPC (1979) listed 175 wastewater treatment facilities in the Delaney Creek drainage basin as of July 1979, fifteen of which discharged to surface waters.

CCI (1985) found mercury, lead and copper concentrations in surface waters of Delaney Creek to be in compliance with Class III water quality standards. These three heavy metals were below detection limits in Delaney Creek sediments. FDER (cited in CCI, 1985) found arsenic, cadmium, chromium, lead, copper and zinc to be in compliance with Class III standards. Heavy metal levels in creek sediments near the Nitram discharge were relatively high (FDER cited in CCI, 1985).

Just upstream of U.S. 41 and extending for approximately 1000 feet along the south bank is an auto junk yard. This area is approximately 4.5 acres in size. Assorted debris and car trash has collected in the adjacent *Juncus* marsh. No direct discharge from this area was observed, however the area could be a potential source of oils and greases to Delaney Creek as they are washed from the wreckage during rainstorms.

No salinity barriers were located in the surveyed segment of Delaney Creek. The Seaboard Coast Line railroad trestle, although not an actual salinity barrier, is stabilized with rocks underneath it. These rock piles may cause a slight restriction of water movement at low tides and at times of low flow.

Little of the shoreline of Delaney Creek is hardened. A small bulkhead was located just below U.S. 41, and constructed of old battery casings. At the mouth of the creek the northern shoreline has been rip-rapped for approximately 1800 feet.

The major physical alteration to Delaney Creek is the channelization of the creek system. The entire creek system has been channelized except for a short meandering segment in the lower creek approximately 4000 feet upstream from the creek mouth. This meandering segment extended for a distance of approximately 1700 feet. Between Causeway Blvd. and U.S. 41, spoil from past channelization operations has been placed along the channel, creating steep side slopes of 1.5:1 (Ghioto, Singhofen & Assoc., 1985). CCI (1985) characterized most of Delaney Creek as a small channelized stream consisting of straight segments with the stream being a small ditch from the east to U.S. 301.

The channelization in the lower creek below the meander has resulted in steep banks created from dredged spoil, with a very narrow intertidal zone. The northern shore of the lower creek has been industrialized for port and rail facilities. The southern shore of the creek has also been industrialized. On the southern side downstream from the meander the land behind the spoil bank has been ditched and receives drainage from the industrialized surroundings of Port Sutton. Industries occurring around the mouth of Delaney Creek include Ideal Cement, TECO-Gannon, and W.R. Grace & Company (HCEPC, 1978).

2.2.4 Habitat Assessment

Delaney Creek is designated as Class III waters as defined by the Florida Administrative Code, Chapter 17-3. The creek however, does not meet these standards. The waters of Delaney Creek often exhibit low dissolved oxygen values, and extremely high nutrient concentrations particularly in the estuarine segment of the creek below the Nitram discharge, and has exhibited phytoplankton blooms in the past. FDER is presently working on a wasteload allocation study for Delaney Creek which will set limits for the discharge of pollutants into the creek system. Delaney Creek is stressed from a water quality perspective.

From the perspective of aquatic habitat, Delaney Creek is also stressed. The freshwater segments of Delaney Creek have been channelized for the majority of its length and does not contain any significant floodplain vegetation (CCI, 1985). In the estuarine portion of Delaney Creek below U.S. 41, aquatic habitat is limited due to the channelization of the creek creating steep, bermed shorelines with little intertidal zone available. The only appreciable aquatic vegetation and habitat in Delaney Creek is found in the unchannelized segment of the creek. Additional small areas of black rush marsh occur below U.S. 41 where ground elevation behind the creek banks is low enough to allow the maintenance of these small marshes.

Curiously enough, the second area of any significant aquatic habitat was found along the stream course of the Nitram discharge. This area contained freshwater herbaceous marsh which appeared to be quite productive for small forage fish. Relatively large schools of minnows were visible in the waters of this area.

The occurrence of juvenile blue crabs and juvenile redfish in Delaney Creek above U.S. 41 indicate the potential of Delaney Creek as a nursery area. Further evidence of the value as a productive blue crab area was the fact that the lower creek was being commercially fished for blue crabs. Redfish are an important species to Tampa Bay and the Gulf of Mexico. The protection and restoration of the nursery habitat is essential to the continued existence of a viable redfish fishery.

2.3 Frog Creek

2.3.1 Hydrographic Features

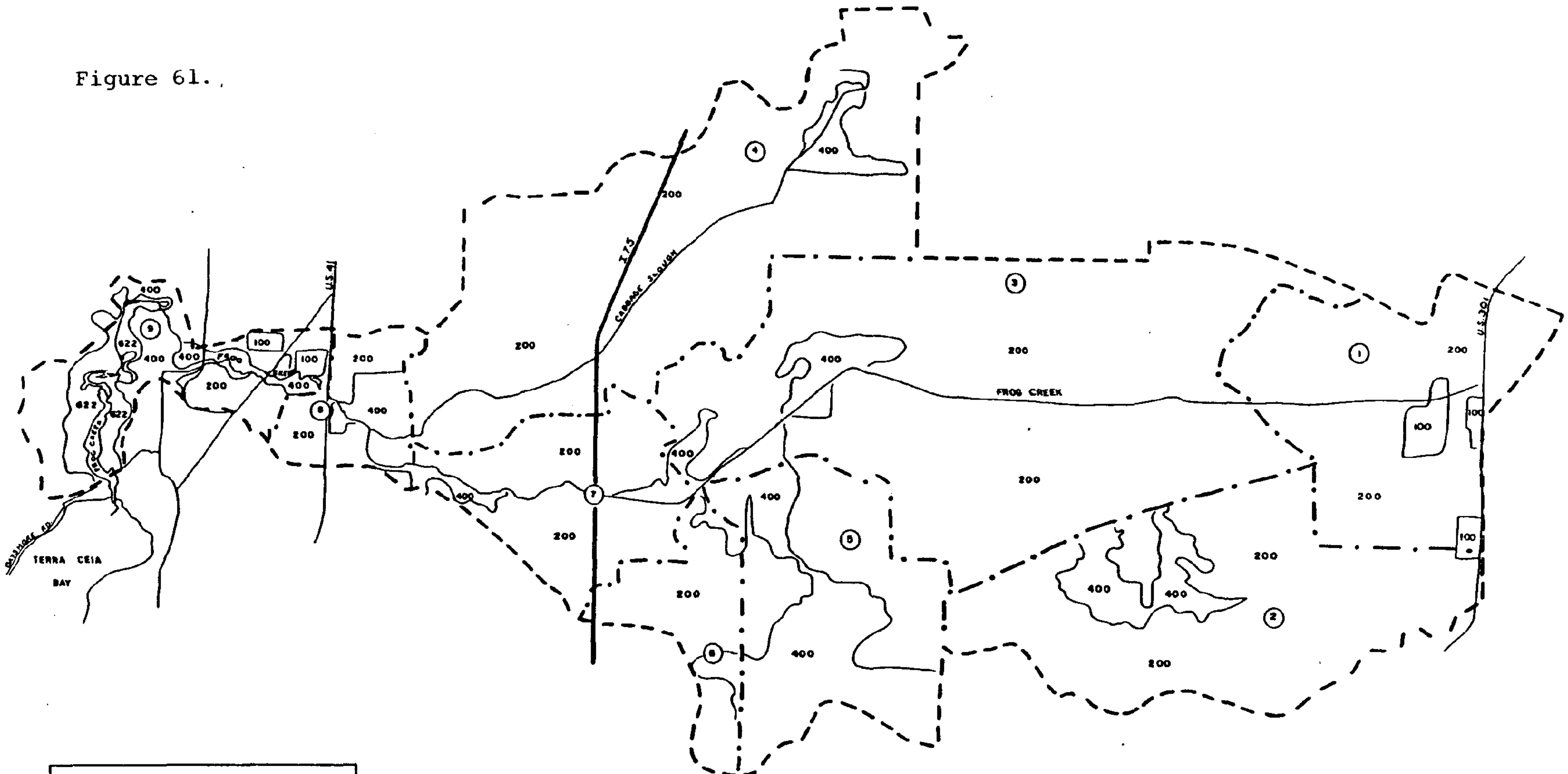
Frog Creek has the largest drainage basin of the three creeks studied, equalling approximately 12,898.5 acres. The drainage basin is subdivided into nine sub-basins (Figure 61) ranging in size from 359 acres to 3,423.3 acres (Table 14). The lower creek west of U.S. 41 remain relatively unaltered, maintaining a meandering course to Terra Ceia Bay. East of U.S. 41, however, Frog Creek splits into what has become essentially two large agricultural drainages. Cabbage Slough runs to the northeast and Frog Creek runs east to Parrish, Florida. For the majority of its length from just east of U.S. 41 to Parrish, Frog Creek has been straightened and connected with an extensive agricultural drainage system. The same situation exists for Cabbage Slough. Limited amounts of residential development occur in the Frog Creek drainage basin.

The calculated average monthly surface water discharge through Frog Creek, based on 1981-1982 rainfall data, ranged from 15.3 acre-feet to 836.6 acre-feet (Table 4). Although the surface area of the drainage basin is over twice the size of the Allen Creek basin, the discharge was less, due to the difference in land uses. The discharge of Frog Creek is generally higher than the discharge of Delaney Creek although the basins were nearly the same size. This situation will most likely become reversed as the Delaney Creek watershed berms urbanized to a greater extent. This may have already occurred since the land use and impervious surfaces for Delaney Creek were base on 1979 aerial photography and 1981 quad sheets, while much development has occurred in this area since then.

Salinity was measured along Frog Creek from near the mouth at Station 5 to the saltwater/freshwater interface at Station 6 (Figure 62). The salinity decreased upstream from a measurement of 14.31 ppt in the lower creek (taken just after the onset of flood tide) to 0.82 ppt at Station 6 (Table 5). From Station 5 to Station 5A, a distance of approximately 2000 feet, salinity decreased to 590 ppt. A second salinity reading at Station 5A taken approximately six hours later showed an increase of 3.94 ppt to 9.84 ppt. The second reading was acquired approximately one to one and one-half hours after high tide. Salinity did not decrease between Stations 5A and 5B and actually a slight increase was measured. At Station 5C salinity dropped to 3.04 ppt. At 5D salinity equalled 2.32 ppt with a lesser increase of only 0.92 ppt. approximately five and one half hours later. The interface between salt and fresh water appeared to occur at about the level of Station 5E, approximately one nautical mile upstream, where salinity equalled 0.98 ppt. Aquatic vegetation also identified this area to be the vicinity of the saltwater/freshwater interface as a shift in vegetation was obvious, with the disappearance of mangroves and the appearance of cattails, waternet, torpedo grass, and American water lily. Salinity at Station 6 was measured at 0.82 ppt.

The reference station for tides for Frog Creek is Bradenton. Inspection of tide tables and field observations indicated that tides in Frog Creek were approximately 1.5-2 hours later than at the reference station. Low tide on April 23, 1986, occurred at approximately 0730. Measurement of the barnacle

Figure 61.



LEGEND:	
— —	BASIN BOUNDARY
—·—	SUBBASIN BOUNDARIES
(1)	SUBBASIN NUMBER
100	URBAN OR BUILT UP
200	AGRICULTURE
400	FORESTED UPLANDS
500	WATER
622	MANGROVES
641	FRESHWATER MARSH
642	JUNCUS MARSH

FROG CREEK WATERSHED BASIN AND GENERAL LAND USE

SOURCE: ESE, 1986.

Table 14. Frog Creek Drainage Basin and Subbasin Area

Subbasin No.	Acres
1	1,397.6
2	1,874.7
3	3,423.3
4	2,643.7
5	1,193.8
6	463.7
7	835.2
8	359.0
9	707.5
	12,898.5

Source: ESE, 1986

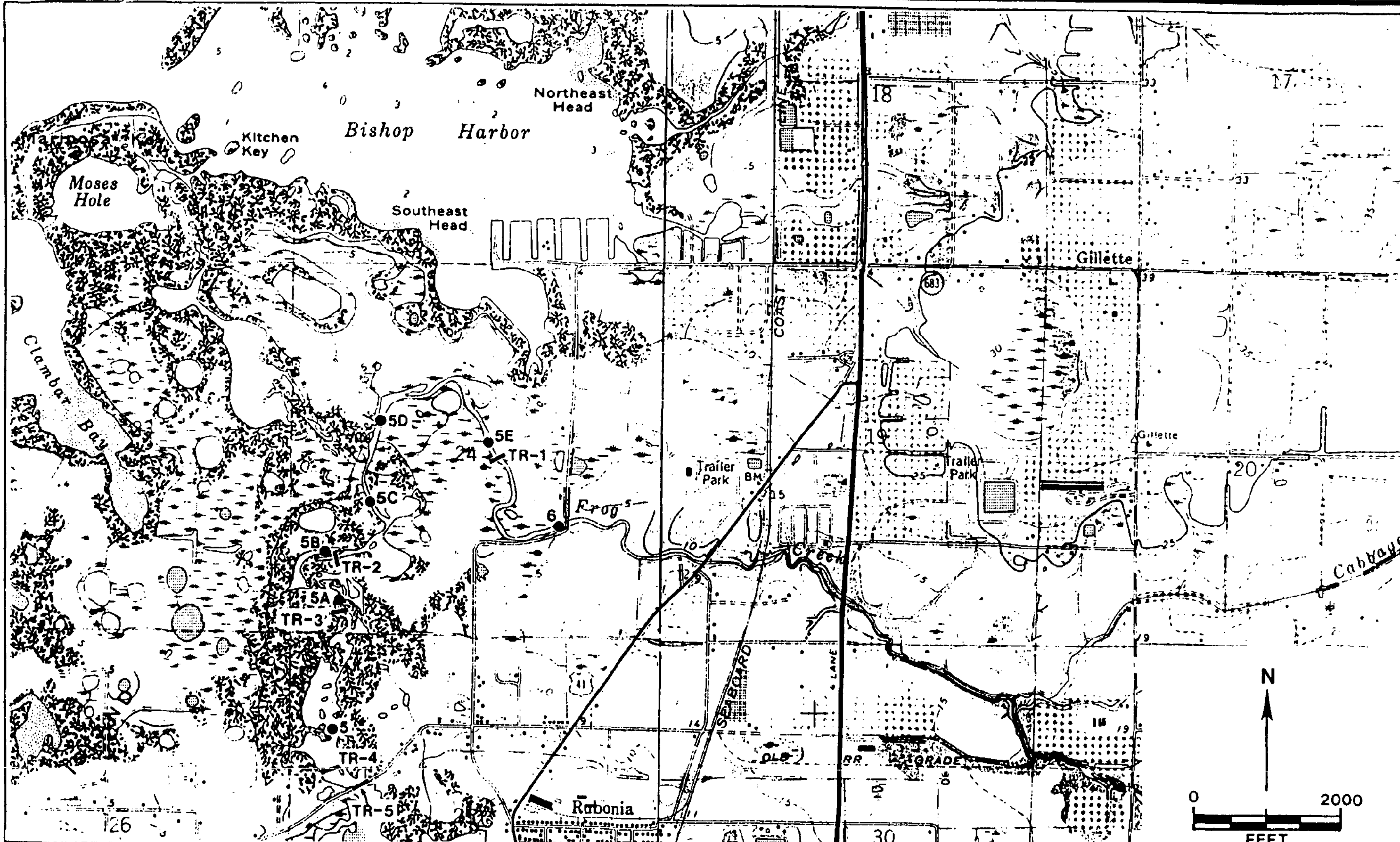


Figure 62.

FROG CREEK, MANATEE COUNTY, FLORIDA
SAMPLING STATIONS AND CHANNEL PROFILE LOCATIONS; APRIL 23, 1986

SOURCE: ESE, 1986.

TAMPA BAY REGIONAL PLANNING COUNCIL

line and water mark on bridge pilings indicated a tidal range of approximately sixteen to eighteen inches at the mouth of the creek.

Depth measurements at transect No. 1 were taken at approximately high tide (Figure 63). Depths along the following transects were taken during a falling tide. By the time profiles for transects No. 4 and 5 were recorded the tide near the mouth of the creek was down about 1.5 feet. Depth measurements were recorded from the edge of the water, independent of tidal height data.

Additional depth soundings were collected along the creek channel from the level of Station 5D to near the mouth. Depths ranged from 0.5 feet to 3 feet with the majority of depths in the 1 to 2 foot range. The lower creek, where it widens within the mangrove wetlands, is uniformly shallow with depths of 1 to 2 feet, and sediments composed of very silty, fine sand.

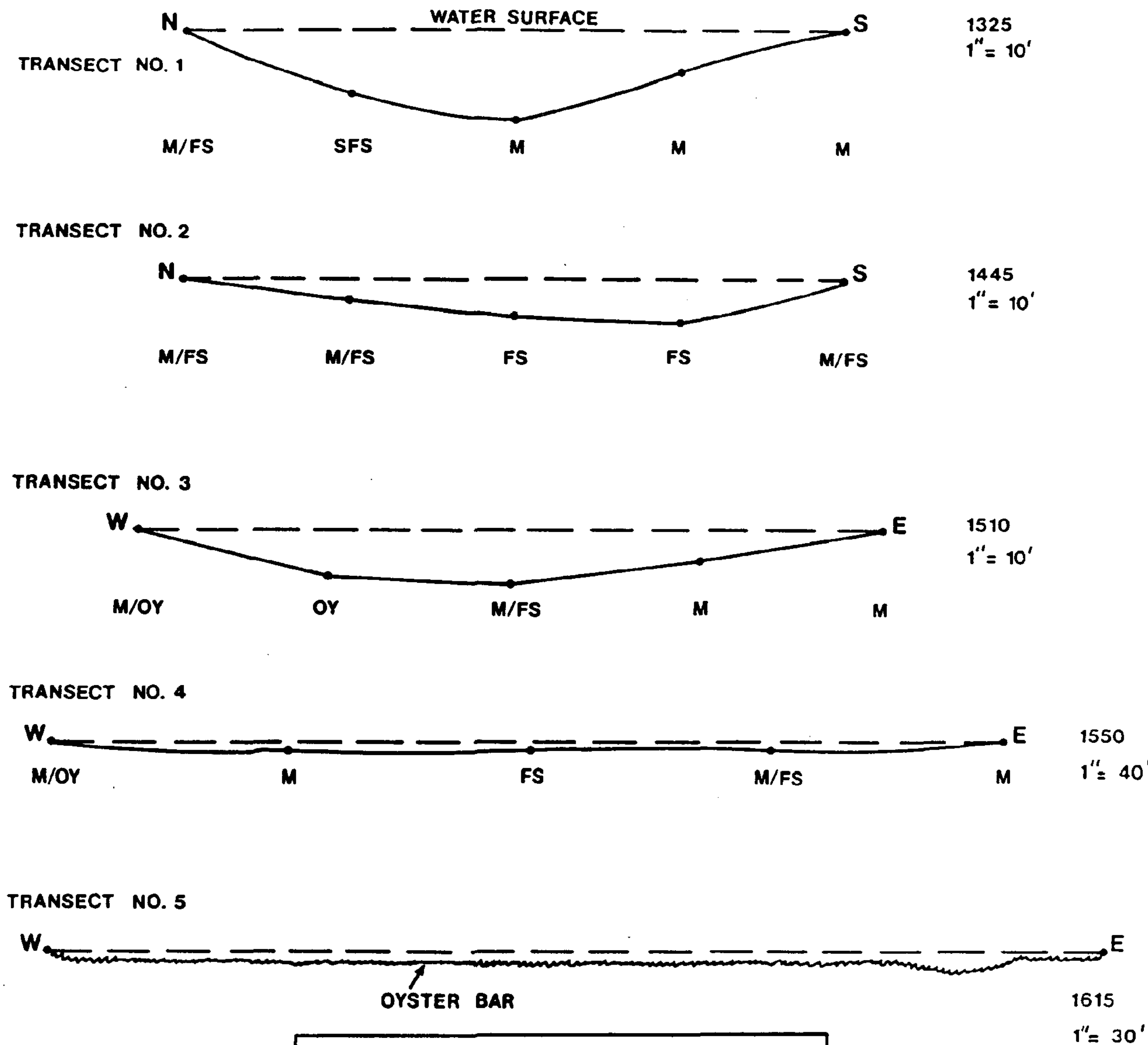
The upper creek above the saltwater/freshwater interface is more deeply incised with well defined steep banks. Frog Creek retains a meandering channel as opposed to Delaney and Allen Creeks which have channel segments straightened. The meandering of Frog Creek is particularly evident in the estuarine zone. At the level of Station 5D the creek dead ends somewhat with only a small cut passing through the mangroves allowing limited access. The lower reaches of the creek opens into broad shallow areas containing mangrove islands and oyster bars with no well defined channel. Broad shallow embayments, evident from aerial photographs, also occur in the mangrove wetlands along Frog Creek.

The majority of bottom sediments inspected in Frog Creek are fine soft sediments. Sediment sampling across the channel on transect No. 1 were predominantly muck (Table 15, Figure 63). At the north shoreline some sand-sized material was evident. From the middle of the channel to the south shore 1.5 to 2 feet of muck overlies medium-fine sand. The sediment had a hydrogen sulfide odor indicating anoxic conditions with the samples.

Along transect No. 2 the sediments contained more sand than at transect No. 1. The sandier sediment occurred in the deeper portions of the channel with the muddier sediment closer to the banks and the mangroves.

Sediments sampled along transect No. 3 were predominantly a fine black muck. Towards the western shore, oysters had colonized the bottom creating a hard substrate interspersed with muck. Along transect No. 4, which ran from a small mangrove island in the center of the creek to the western shore, the sediments contained soft black muck near shore and became somewhat sandier near the center of the transect. The majority of sediment samples contained a hydrogen sulfide odor.

The fifth transect (transect No. 5) was collected under the Bayshore Road bridge. The bottom across nearly the entire bridge span consisted of oyster bars exposed during low tide. At high tide the water level was estimated at approximately 1.5 feet as indicated by the water and barnacle line on the bridge pilings. A narrow channel coursed through the oysters at the eastern end of the bridge span. Although no depths were recorded downstream of the Bayshore Road bridge, the entrance to Frog Creek from Terra Ceia Bay is very shallow, one foot or less at low tide with extensive oyster coverage.



QUALITATIVE SEDIMENT DESCRIPTION

C	Clay
FS	Medium to fine sand with little silt
FS/OY	Fine sand with oysters
M	Muck; no sand, black ooze
M/FS	Mucky fine sand
OP	Organic-peatlike
RR	Rip-rap
SHS	Shelly sand
SSC	Silty sand with some clay

NOTES: SEE FIGURE 5

Figure 63.
CHANNEL PROFILES, FROG CREEK, APRIL 23, 1986

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Table 15. Sediments - Frog Creek

TAMPA BAY REGIONAL PLANNING COUNCIL
QUALITATIVE SEDIMENT DESCRIPTIONS

FROG CREEK, 4/23/86

TRANSECT NO. 1
SALT/FRESH WATER INTERFACE
N-->S, 1325, WIDTH = 40'
0(0')-----MEDIUM-FINE SAND, MUCK
1/4(4')---MUDDY MEDIUM-FINE SAND
1/2(5.5')-MUCK OVER MEDIUM-FINE SAND. SLIGHT H2S
3/4(2.5')-MUCK (2') OVER MEDIUM-FINE SAND
4/4(0')---MUCK (1.5') OVER MEDIUM-FINE SAND, H2S

TRANSECT NO. 2
N-->S, 1445, WIDRH = 40'
0(0')-----MUDDY MEDIUM-FINE SAND, H2S
1/4(1')---MUDDY MEDIUM-FINE SAND, H2S
1/2(2')---SILT, MEDIUM-FINE SAND(90%), SHELL FRAGMENTS
3/4(2.5')-SILT, MEDIUM-FINE SAND(90%), SHELL FRAGMENTS
4/4(0')---MUDDY MEDIUM-FINE SAND, H2S

TRANSECT NO. 3
E-->W, 1510, WIDTH = 45'
0(0')------MUCK
1/4(1.75')-MUCK
1/2(3')----MUDDY MEDIUM-FINE SAND
3/4(2.75')-HARD BOTTOM W/ OYSTERS
4/4(0')----MUCK W/ OYSTERS

TRANSECT NO. 4
E-->W, 1550, WIDTH = 230'
FROM OYSTER/MANGROVE ISLAND IN CHANNEL TO SHORE
UPSTREAM OF BAYSHORE DR. BRIDGE
0(0')-----SLIGHTLY SANDY MUCK W/ SHELL, H2S
1/4(1.5')-MUDDY MEDIUM-FINE SAND (70%0), SHELL FRAGMENTS, SLIGHT H2S
1/2(1.5')-RELATIVELY CLEAN MEDIUM-FINE SAND, SHELL FRAGMENTS
3/4(2')---SLIGHTLY SANDY MUCK, H2S, SHELL
4/4(0')---MUCK, SCATTERED OYSTERS, H2S

TRANSECT NO. 5
1415, WIDTH = 190'
UNDER BAYSHORE DR. BRIDGE
OYSTER BARS ACROSS ENTIRE CHANNEL EXCEPT
FOR NARROW CHANNEL AT EAST END
OYSTERS EXPOSED AT LOW TIDE
TIDE RANGE ABOUT 1.5' AS MEASURED FROM BARNACLE
LINE ON BRIDGE SUPPORTS

Source: ESE, 1986

2.3.2 Biological and Chemical Characterization

In situ water quality parameters for Frog Creek are listed in Table 5, and sampling locations are depicted on Figure 62. Station 5 is located in the lower estuarine portion of the creek and Station 6 is located in the area of the saltwater/freshwater interface.

Sampling at Station 5 was conducted just after the onset of flood tide. The measured dissolved oxygen concentration equalled 4.50 ppm. This is slightly below the 5.0 ppm standard. The salinity equalled 14.3 ppt, the pH equalled 65.95, and the secchi disk was observed to the bottom at 2.2 feet. Turbidity equalled 9.5 NTU and total suspended solids equalled 15 mg/1. The chlorophyll-a concentration averaged 7.85 ug/1 (Table 7).

At Station 6 the dissolved oxygen concentration was measured at 8.60 ppm. The salinity measured 0.82 ppt and pH measured 7.92. The secchi disk was observed to the creek bottom at 4 feet. Chlorophyll-a averaged 6.4 ug/1 and total suspended solids averaged 11 mg/1 (Table 7).

Very limited background data regarding water quality could be found for Frog Creek. The Florida Department of Natural Resources - Shellfish Section maintains water quality sampling stations in Bishops Harbor and surrounding areas but has no stations located on Frog Creek. Robert Sadler (FDNR personal communication) related that Terra Ceia Bay and Frog Creek have been closed to shellfishing due to excessive bacterial concentrations. A problem within the Frog Creek area with respect to water quality has been the use of septic tanks primarily in the Rubonia area, however plans to put Rubonia on a central sewer system have been proposed (Robert Sadler, personal communications).

The estuarine portion of Frog Creek is dominated by extensive stands of mangroves. Black (Avicennia germinans), red (Rhizophora mangle), and white mangroves (Laguncularia racemosa) are all prevalent. The red mangrove is dominant in the lower portion of the creek and has colonized oyster bars within the creek forming small mangrove islands. For approximately one mile upstream from the mouth of Frog Creek the mangrove wetlands extend approximately 2000 feet from their western border to their eastern border, with Frog Creek traveling roughly through the middle of the wetlands. Upstream, the mangrove wetlands gradually narrow to their disappearance just downstream of Station 5E. It can be observed from aerial photographs (1"=2000') that the wetlands surrounding Frog Creek are continuous with wetlands along Tampa Bay and Bishops Harbor. The wetlands within the 2000-foot band surrounding Frog Creek are estimated to equal approximately 215 acres. Blackrush (Juncus roemerianus), saltwort (Batis maritima), sea purslane (Sesuvium portulacastrum), and cordgrass (Spartina alterniflora) also occurred in the upper reaches of the estuarine portion of Frog Creek.

At about the level of Station 5E, the aquatic vegetation changed from an estuarine/marine flora to a brackish/freshwater flora. The aquatic vegetation along this creek segment is restricted primarily to the creek margins as the channel becomes well defined and deeply incised. At the level of Station 5E the freshwater algal, Waternet (Hydrodictyon sp.) became prevalent within the water column. This plant is indicative of hard water, high pH systems and agricultural runoff. Cattails (Typha sp.) and American water lily (Crinum americanum) are also common where the slope of creek banks allowed establishment. The vegetation along Frog Creek from Station 5E and upstream is predominantly upland vegetation with aquatics limited to the creek margins.

Fish were collected in Frog Creek using both beach seine and gill net (Table 16). Two gill nets were set, one in the lower estuarine zone and one at the saltwater/freshwater interface at Station 5E. Beach seining was conducted near Station 5B in a mangrove area. Small estuarine forage fish collected at this location included tidewater silverside (Menidia beryllina), pinfish (Lagondon rhomboides), sheepshead minnow (Cyprinodon variegatus) and rainwater killifish (Lucania parva).

The gill net set in the lower creek netted mainly juvenile spot (Leiostomus xanthurus) ranging in size from 45 to 93 mm standard length. An unidentifiable catfish was also netted. The gill net set at Station 5E caught a wider variety of fish of both salt and freshwater origins. Fish caught at Station 5E included striped mullet (Mugil cephalus), a small tarpon (Megalops atlantica; 335 mm standard length), ladyfish (Elops saurus), spot (L. xanthurus), gulf menhaden (Brevoortia patronus), white catfish (Ictalurus catus), and spotted gar (Lepisosteus oculatus). The collection of the tarpon and spot indicate the nursery use of the saltwater/freshwater interface of tidal creeks by these recreationally important species. FDNR has reviewed Frog Creek as a potential area for the enhancement of the snook fishery. No snook were found, and Frog Creek has since been abandoned with respect to this program (Paul Carlson, personal communication).

Just upstream of Station 5E, recreational fishermen questioned indicated they generally caught catfish, mullet and occasionally largemouth bass (Micropterus salmoides), further indicating this area as the breakpoint between salt and freshwater. Observation of fish above this point revealed bluegill (Lepomis macrochirus) and largemouth bass.

Frog Creek is a highly productive area for blue crabs (Callinectes sapidus) which were observed throughout the creek during the field survey. Blue crabs are recreationally fished at least as far upstream as just west of U.S. 41. Frog Creek has been used for commercial mullet and crab fishing (Robert Sadler, FDNR personal communications).

The lower estuarine portion of Frog Creek is highly productive with respect to oysters. Many large oyster bars occurred in the lower creek where the water is shallow. The extensive oyster areas extended up Frog Creek to about the level of Station 5A. These oyster areas however have not been opened to harvesting due to excessive bacterial concentrations monitored in the area.

2.3.3 Physical and Chemical Alterations

Few physical alterations were apparent in the segment of Frog Creek surveyed. The only apparent alterations in the estuarine zone are the bridge crossing of Bayshore Drive across the creek mouth and the bridge crossing of the Interstate 75 spur just upstream. Several more bridge

Table 16.

TAMPA BAY REGIONAL PLANNING COUNCIL
FISH COLLECTED IN FROG CREEK, APRIL 23, 1986
BEACH SEINE, TIDAL BRACKISH WATER
GILL NET, TIDAL FRESH WATER
GILL NET, TIDAL SALT WATER

SPECIES	STANDARD LENGTH
Mugil cephalus (striped mullet)	338
Megaiops atlantica (tarpon)	335
Elops saurus (ladyfish)	230
Leiostomus xanthurus (spot)	97
	94
	93
	64
	64
	64
	45
	53
	34
Brevoortia patronus (gulf menhaden)	156
	169
Ictalurus catus (white catfish)	235
	244
	265
	275
Lepisosteus oculatus (spotted gar)	238
	256
Menidia beryllina (tidewater silverside)	
Lagodon rhomboides (pinfish)	
Cyprinodon variegatus (sheepshesd minnow)	
Lucania parva (rainwater killiffish)	

Source: ESE, 1986

crossings occur across Frog Creek in the freshwater portion of the stream. No bulkheads, discharge pipes, or channelization appears to exist in Frog Creek downstream of U.S. 41. Approximately 3000 feet upstream of U.S. 41, Frog Creek has been channelized and runs through predominantly agricultural lands to the east. From aerial photography (1"=2000') Frog Creek appeared to function as a large drainage ditch as far east as Parrish, Florida, with numerous agricultural drainages entering along the way.

No additional baseline water quality data was obtained for Frog Creek. Considering the predominantly agricultural watershed the creek drains, non-point discharges potentially could discharge high loads of nutrients, pesticides, herbicides, and sediments into the creek drainage system. Septic tank discharges may also contribute to bacterial and nutrient contamination of Frog Creek.

One point source discharge into Frog Creek is listed by TBRPC (1977). This is the Coach House Mobile Home Park, with a discharge of 8.5 mg/l BOD and 12.4 mg/l suspended solids. The effluent is listed as having pretreatment by contact stabilization and discharges to a canal and into Frog Creek.

2.3.4 Habitat Assessment

With respect to physical alterations, lower Frog Creek west of U.S. 41 has remained in relatively pristine condition. The lower estuarine section of Frog Creek has maintained extensive mangrove wetlands and is highly productive for oysters and blue crabs. Fishery collections near the saltwater/freshwater interface indicate that Frog Creek is utilized as a nursery area by important fish species such as tarpon and spot. Frog Creek has also been utilized by commercial mullet and crab fishermen. The mangrove wetlands of Frog Creek maintain a connection with wetlands bordering Bishops Harbor and Tampa Bay, indicating that Frog Creek is not an isolated system but an integral part of the larger Tampa Bay estuarine system.

In addition to fisheries habitat, the mangrove wetlands of Frog Creek provide important bird habitat. Numerous coastal wading birds were observed along Frog Creek. Most significant was the location of nesting colonies for the yellow-crowned night heron (Nyctanassa violacea). This bird was found to be nesting along Frog Creek particularly on a small mangrove island in mid-creek where nests are quite numerous. Lower Frog Creek is also utilized by the roseate spoonbill (Ajaia ajaja), a rare species and listed as a Species of Special Concern by the Florida Game and Freshwater Fish Commission (1985).

3.0 MANAGEMENT/RESTORATION PLAN FOR TAMPA BAY TIDAL CREEKS

Tidal Creeks to Tampa Bay vary greatly in condition. In addition, a wide variety of jurisdictional agencies are involved in the management of the creek systems. Appendix B illustrates the multifaceted authorities involved with management responsibilities in the Region.

Previous chapters have identified the importance of tidal creek systems to the estuary of Tampa Bay. Developmental pressures within the watershed can potentially affect downstream conditions. Therefore, management considerations for Tampa Bay are dependent upon the status of tidal rivers and tributaries to the estuarine system.

Due to the variety of governing organizations responsible for tidal creek and watershed management, it is necessary to acquire input from as many viewpoints as possible. A public workshop to develop management/restoration plans for each selected tidal tributary was held to facilitate local involvement. Local governments, environmental organizations and concerned citizens were invited to attend the public workshops. A summary of the ecological assessment was included with the public notice and additional background information was available through TBRPC's Regional Information Center for review.

3.1 Result of the Workshops

A variety of input was received during the public workshop sessions. Results were tabulated and organized into general policies to support the management objectives. The framework was then reviewed by the Natural Resource Committee of the Council's Agency on Bay Management.

The framework is used as a general plan for all tidal tributaries and is illustrated on Table 64. The application for the recommended plan is expected to vary significantly depending upon the tidal creek condition and existing authority involvement. The management/restoration plan will be applied to the three selected tidal tributaries as a test for consistency. In addition, recommendations for stressed, restorable and natural tributaries will be offered.

Figure 64. Framework for management/restoration plan

Objective: Maintenance/Restoration of Natural Function

CONSIDERATION: Water Quality and Quantity

Policy: Water Quality Improvement through control of non-point source pollutant loadings.

a. Identify problem areas.
b. Prioritize improvements.
c. Coordination of agencies for improvements.

Policy: Minimize point-source pollutants.

a. Develop ecological criteria for all discharges.
b. Promote water recycling.
c. Promote effluent disposal alternatives for problematic septic tank and package plant systems.

Policy: Protect natural freshwater inputs

a. Groundwater
b. Surface water

Policy: Develop consistent tidal creek monitoring and enforcement program.

a. Water quality
b. Habitat and species utilization

CONSIDERATION: Habitat Utilization

Policy: Protect or improve natural channel alignment and elevation requirements for maintenance of productivity.

Policy: Preserve natural vegetation and fish and wildlife resources.

a. Removal of exotic species.
b. Encourage wetland creation.
c. Restore impacted areas.

Policy: Protection of archaeological sites.

a. Identification of sites in all areas before development.

b. Preservation or excavation prior to destruction.

Objective: Develop consistent and compatible land use standards.

Policy: Promote public land acquisition and conservation easements for environmentally sensitive lands.

Figure 64. Framework for management/restoration plan continued

Policy: Encourage compatible low density development on adjacent upland areas.

a. Minimize development within the 25 year floodplain

Policy: Encourage clustering of water oriented land uses.

Objective: Management of tidal creeks as an important public asset.

Policy: Promote public education.

a. Value of tidal tributaries.
b. Prevent public degradation.
c. Minimize user conflicts.

Policy: Promote compatible public access.

3.2 Allen Creek Plan

Allen Creek represents a stressed tidal tributary to Tampa Bay. The system is impacted by residential development as identified by small pockets of natural wetland habitat, increased runoff rates, and extensive bulkheading of the shoreline.

3.2.1 Objective: Maintenance/Restoration of Natural Function

Policy: Water Quality Improvement Through Control of Non-point Source Pollutant Loadings

Pinellas County and the City of Clearwater are currently undertaking a joint study with the Florida Department of Environmental Regulation (FDER) to assess existing conditions in Allen Creek. A two-year monitoring program will be established to: a) identify problem areas; and b) prioritize improvements. Results of the extensive joint study will be used to develop a specific management plan for the watershed and potentially will improve problem areas where necessary and practical.

Additional ideas to promote non-point source management, generated by the Allen Creek workshop, include the following:

- Development of man-made borrow pits may eliminate their value as historic stormwater treatment areas. Currently isolated borrow pits remain unregulated and retention capacity is required in other locations or downstream water quality may be affected

- Engineering design of stormwater management systems are not always carried out in an environmentally acceptable manner. Increased awareness during project design is required to resolve both concerns. As an example, grassed swales are more efficient then cement swales while serving similar purposes

- The planting of trees designed to shade portions of the creek may reduce the potential of algal blooms within the water mass.

Policy: Minimize Point - Source Pollutants

Point-source discharges to Allen Creek will be examined during the joint water quality study. Identification of creek water quality problem areas will determine the feasibility of various improvements to the system. Additional consideration should be given to:

- ecological criteria for all effluent disposal

- promotion of water recycling

- promotion of effluent disposal alternatives for septic systems and package plants.

These considerations may not be an identifiable source of water quality degradation but add to the general decline in condition.

Policy: Protection of Natural Freshwater Input

The ecological assessment identified that calculated surface water discharges for Allen Creek are two to three times higher than Frog or Delaney Creeks despite the smaller area of the drainage basin. This high level of freshwater input is created by the large percentage of impervious surfaces within the watershed. The intensive urbanization of the watershed prevents major improvement of discharge quantities. Present and future development is regulated by local and regional agencies controlling surface runoff.

When compared with other creeks, freshwater withdrawal from Allen Creek apparently is not a problem. Currently the creek does not serve as a potable water supply and future consumptive use would require regulatory review.

The groundwater aquifers underlying Allen Creek are affected by saltwater intrusion. The intrusion is due to the close proximity of Tampa Bay and historic groundwater withdrawals. Intrusion prevents underlying groundwater use as a potable water supply. However, private individuals may continue to use groundwater for lawn irrigation.

Policy: Develop Consistent Monitoring and Enforcement Program

The joint study planned by Pinellas County, City of Clearwater and FDER will address monitoring of Allen Creek. The program is anticipated to identify water quality conditions, habitat and wildlife usage of the area. It is recommended that a continuous program be implemented for Allen Creek in order to monitor improvements to the ecosystem and the benefits to the estuarine system of Tampa Bay.

Applicable comments received during the workshop include:

- Historic fishkills are oftentimes reported too late for any valuable information to be obtained. Citizens should be encouraged to immediately report incidents and collect samples if possible

- Monitoring of benthic invertebrates and fisheries can provide tools to determine the condition of the tidal tributary. Species diversity and abundance potentially can be compared with a natural system (e.g., Frog Creek).

In order to prevent unnecessary impacts to Allen Creek and the Tampa Bay Estuary, a local enforcement program is recommended to be implemented in conjunction with the monitoring program. The local enforcement program can include: impact identification; enforcement of fisheries, boating, and water quality regulations; and, monitoring of creek conditions.

Policy: Protect or Improve Channel Alignment and Elevation Requirements for Maintenance of Productivity

Historically, tributary configuration has been impacted by channel dredging, residential bulkheading and flood control ditching activities. Future maintenance dredging to remove sedimentation shoals may be necessary to retain existing access to residential developments.

However, areas within Allen Creek that retain a natural alignment, as described in the environmental assessment, are recommended to be protected in their existing condition. Future bulkhead construction or channel maintenance must consider habitat utilization and rise in sea level during design and permitting.

Policy: Preservation of Natural Vegetation and Fish and Wildlife Resources

Tidal marsh systems within Allen Creek have decreased in area and continue to be encroached upon by development. The remaining systems of marsh and mangrove require preservation to support the fish and wildlife that utilize the area, while providing additional water quality benefits.

It is recommended that a local program to remove exotic and nuisance species of plants be created for all lands within public ownership. In addition, increased public awareness is necessary for private landowners to understand the problem of continuous spreading of exotic plants in Florida and the effects on native vegetation.

The ecological assessment of Allen Creek identified potential nursery habitat for important marine fish species such as Spanish Mackerel. Additional seasonal fisheries sampling would yield important information on marine fish species utilizing Allen Creek. It is essential to retain existing natural wetland systems, channel alignment and water quality to protect the natural productivity of the area.

Incentive programs are necessary to improve wildlife habitat in the area. Due to the stressed condition of the creek, many potential restoration sites are slated for development. Additional streambed alteration and extensive bulkheads prevent major restoration efforts. However, new construction activity can include habitat establishment as part of project design, if local incentives are applied.

Wetland destruction is often the result of illegal dredge or fill activities. Cleanup efforts are often required by state enforcement programs. Additional restoration or creation may be possible through the Pinellas County Fisheries Habitat Restoration Plan (FDNR), the Pollution Recovery Trust Fund (FDER), or other local programs and organizations.

Policy: Protection of Archaeological Sites

Within the drainage basin of Allen Creek, the majority of the land area has been developed. All new development is required to perform an archaeological survey. Identified sites are recommended to be evaluated in terms of State of Florida or Federal criteria for significance to determine eligibility for listing in the National Register of Historic Places. Eligible sites must either be preserved or excavated prior to destruction.

3.2.2. Objective: Develop Consistent and Compatible Land Use Standards

Policy: Promote Public Land Acquisition and Conservation Easements for Environmentally Sensitive Lands

The majority of suitable land surrounding Allen Creek is developed. The remaining marsh systems within the creek alignment are isolated or abutting residential areas. Public acquisition of the remaining lands may not be necessary due to existing regulatory protection measures. However, acquisition of environmentally sensitive lands for additional habitat creation and increased public usage and awareness should be promoted at the local and state level.

Input during the workshop process indicated a lack of public access for fishermen, which has resulted in property damage by attempts to gain creek access. Public ownership is recommended to alleviate user conflicts and degradation by the creation of a local park.

Policy: Encourage Compatible Low Density Development on Adjacent Upland Areas

This management tool may not apply for Allen Creek. The stressed tidal tributary is approaching build-out along the adjacent upland areas.

Policy: Encourage Clustering of Water-Oriented Land Uses

Due to the intensive development along Allen Creek, the encouragement of clustering water-oriented uses would be after the fact. A marina does exist near the creek mouth and is limited by U.S. 19 and sensitive natural areas for any additional major expansion. Existing development and channel depth will restrict any new marina siting.

3.2.3. Objective: Management of Tidal Creeks as an Important Public Asset

Policy: Promote Public Education

With intensive residential development occurring on Allen Creek it is important to educate the general public to the significance of tidal tributaries with respect to water quality and habitat. In addition, a major value of tributaries supporting the Tampa Bay Estuary is in providing freshwater input, food source, protection from predators and nursery habitat. Programs or brochures which relate the importance of even small creeks and marshes can be made available through the school systems or local media.

Development within the watershed creates user conflicts and misuse by the public. Education is additionally necessary to prevent casual impacts that can accumulate into a serious problem. Examples include:

- bagging of lawn clippings

- washing cars on the lawn instead of street

- maintenance of mangroves or salt marsh along the shoreline

- removal of exotic plant species.

Flyers for property owners can be distributed through local publications or the U.S. mail service.

Policy: Promote Compatible Public Access

Presently public access is limited to Allen Creek due to adjacent residential development, lack of local parks, and depth of channel for boating uses. Additional boating access will require the channel alterations and shoal removal, and displacement of habitat and benthic invertebrates. This is considered to be incompatible with management of the remaining resources.

However, the provision of water frontage for park development can alleviate existing user conflicts along the creek, promote public awareness and maintain natural ecosystems.

3.3 Delaney Creek Plan

Delaney Creek is classified as a stressed tidal tributary to Tampa Bay. The lower segment of the drainage basin contains industrial land use with predominately agriculture in the upper basin area. The Delaney Creek area is experiencing rapid development created by the opening of Interstate 75. Major impacts to the creek are associated with channelization, dredge and fill activities, industrial discharges and non-point source pollutants.

3.3.1. Objective: Maintenance/Restoration of Natural Function

Policy: Water quality Improvements through Control of Non-Point Source Pollutant Loadings

The environmental assessment identified that the Delaney Creek drainage area is over twice the size of Allen Creek with almost half the discharge rate. In addition, workshop participants indicated that underlying clay layers create flooding conditions within the basin.

Due to historic flooding problems, Hillsborough County classifies the area as volume sensitive and requires additional retention of stormwater. To address watershed flooding conditions, the Southwest Florida Water Management District (SWFWMD) has completed the Delaney Creek Stormwater Management Master Plan (Ghioto, Singhofen & Assoc., Inc., 1986). Figures 65 and 66 show the preferred plan capital improvements recommend for the creek.

The Stormwater Management Plan is directed toward control of flood conditions within the watershed. Additional workshop recommendations addressing the master plan include:

- Review of the Stormwater Management Master Plan by TBRPC's Agency on Bay Management

- Treatment of stormwater runoff before it enters the creek

- Sound environmental practices to control flooding should be implemented

- Due to the volume sensitivity of the area, additional retrofitting of specific flood prone areas may be necessary.

SWFWMD has addressed flood maintenance measures without concern for runoff water quality. Therefore, it is recommended that Hillsborough County include the Delaney Creek watershed in the Alafia River Study. In addition, the Tampa Port Authority (TPA) can assist the Hillsborough County Environmental Protection Commission (HCEPC) in an extensive water quality study of Delaney Creek to:

- identify problem areas

- prioritize improvements

Figure 65. Preferred capital improvements plan west of 78th street (Ghioto, Singhofen & Assoc., Inc., 1986)

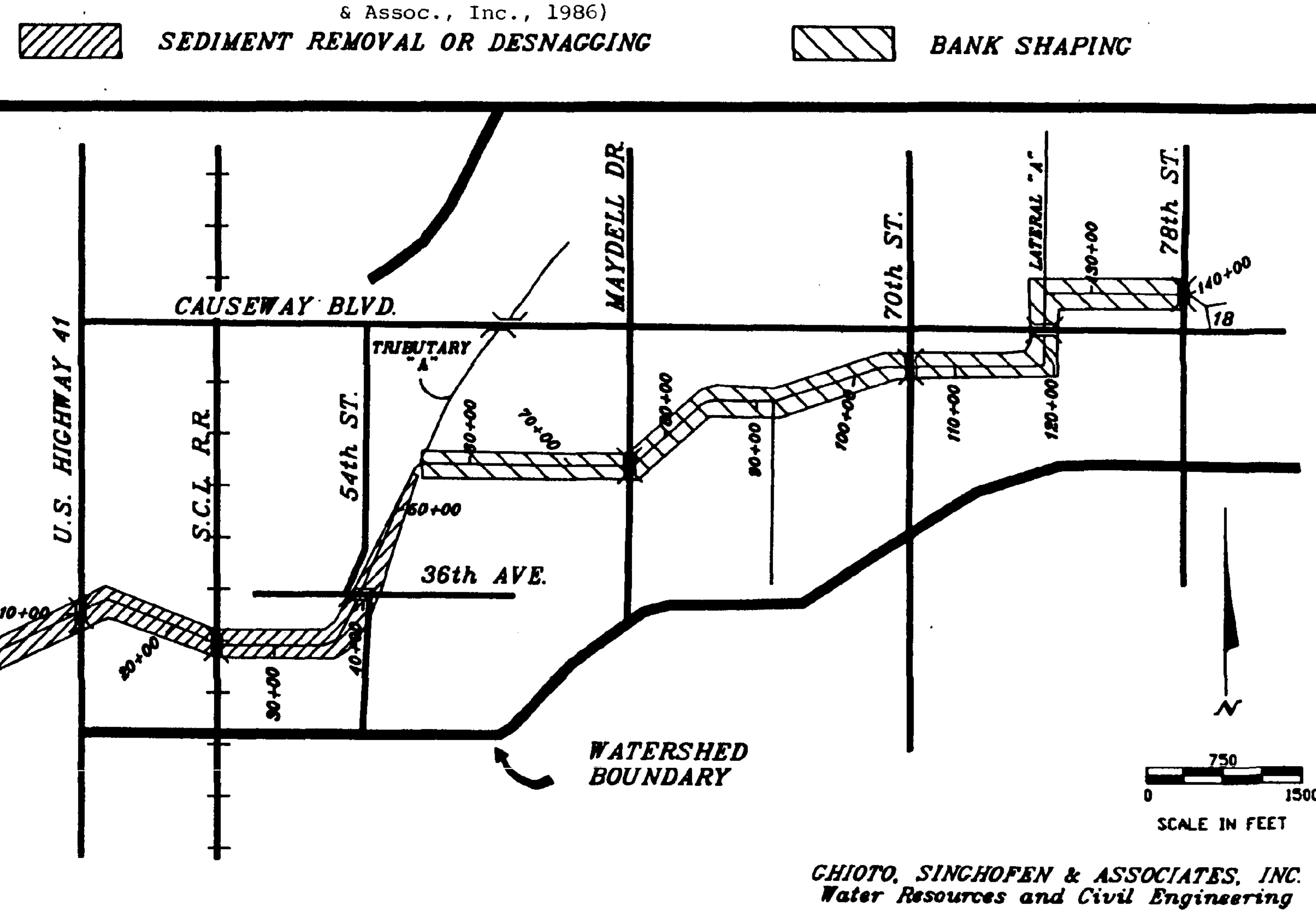
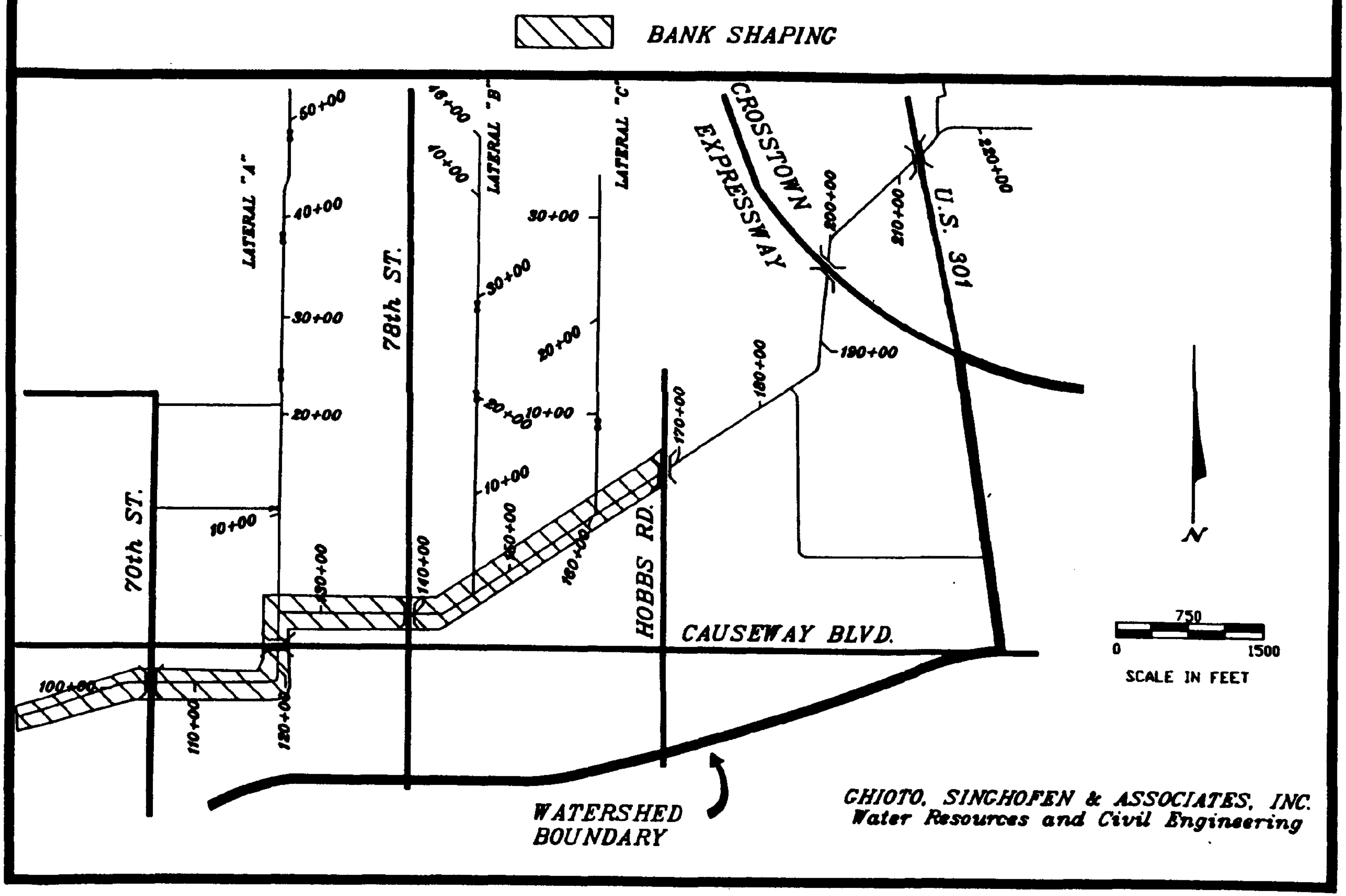


Figure 66. Preferred capital improvements plan east of 78th street (Ghioto, Singhofen & Assoc., Inc., 1986)



- coordinate the responsible agencies to implement improvements.

Currently FDER is working on the Wasteload Allocation Study for Delaney Creek. Therefore, the TPA/HCEPC water quality study should focus on non-point source water quality problems and improvements.

Policy: Minimize Point-Source Pollutants

Delaney Creek is classified as a Class III body of water by FDER. Previous water quality monitoring programs have shown dissolved oxygen determinations to be below the 5.0 mg/l Class III standard. Nitram, Inc. is currently being reviewed by the Enforcement Branch of FDER for problems with effluent disposal to Delaney Creek. Past and present industrial discharges have impacted water quality in the creek and potentially within Tampa Bay.

The FDER is working on a point source Wasteload Allocation Study for Delaney Creek to determine effluent limits to be received by the tidal tributary. Additional considerations to be incorporated in the study include:

- Consideration of the background non-point source water quality with respect to the Class III water quality standards

- Effluent limits that are consistent with ecological systems.

It is anticipated that improvements in industrial effluent loadings to Delaney Creek will help alleviate degradation of water quality conditions.

Policy: Protect Natural Freshwater Inputs

Due to the nature of the confining clay layer underlying the Delaney Creek area, base flow is considered to be predominantly derived from the shallow aquifer. Large quantities of freshwater are additionally provided by stormwater runoff. Delaney Creek does not currently serve as a source of potable water.

Small quantities of freshwater may be used for agricultural irrigation or fish farm production. Major freshwater withdrawals would alter the ecological systems within the creek and would require careful evaluation by responsible regulatory agencies.

Policy: Develop Consistent Tidal Creek Monitoring and Enforcement Program

It is essential within a stressed tidal tributary, such as Delaney Creek, that a thorough monitoring program be established to maintain productive ecosystems and water quality. The programs recommended for the FDER and HCEPC/TPA will evaluate and potentially improve existing conditions.
Follow-up monitoring will be necessary to evaluate improvements and prevent future degradations.

Development within the Delaney Creek watershed is expected to accelerate in the very near future. Figure 53 identifies four Developments of Regional

Impact currently in various stages of review by TBRPC. In addition, the ongoing water quality degradation and dredge and fill activities require a local enforcement program to reduce the impacts to the creek system.

Hillsborough County Environmental Protection Commission has been recommended as the agency to undertake the long term monitoring and enforcement of creek conditions. The HCEPC can additionally monitor watershed development, instream water quality impacts, and illegal activities. A single local authority is ideal in order to maintain consistent review of conditions and enforcement.

Policy: Protect or Improve Natural Channel Alignment and Elevation Requirements for Maintenance of Productivity

The remaining natural estuarine areas identified in the environmental assessment should be preserved in its existing condition. The meandering alignment in areas that are not channelized allow natural sedimentation and pollutant removal by the wetland vegetation.

Workshop participants recommended that TBRPC's Agency on Bay Management review the Delaney Creek Stormwater Management Master Plan (Ghioto, Singhofen & Assoc., Inc., 1986). Potential Master Plan improvement may include:

- widening of the creek banks as opposed to deepening of the channel

- bank shaping of the creek can require slopes that will allow beneficial establishment of aquatic vegetation

- wetland habitat creation

- additional ecological criteria for the design of channel alignment.

Through the Development of Regional Impact Review, TBRPC should require:

- bank shaping for wetland vegetation establishment

- any new channel alignment to require meandering orientation

- mitigation can include wetland creation adjacent to Delaney Creek.

Similar considerations can be applied by local governments, TBRPC and FDER through Dredge/Fill Permit Application reviews. Additional improvement locations that are identified in the environmental assessment include:

- Between Causeway Boulevard and U.S. 41, spoil piles along the creek have created steep side slopes. Bank reshaping or berm removal can provide for additional vegetational establishment

- Removal of the rubble below the Seaboard Coast Line railroad trestle.

Policy: Preserve Natural Vegetation and Fish and Wildlife Resources

Preservation of natural ecosystems remaining in Delaney Creek will maintain habitat and nursery areas for many commercially and recreationally important species of fish and shellfish. Due to the stressed nature of Delaney Creek, natural vegetation and habitat productivity can be improved by:

- Removal of exotic species of plants on all public lands. Local incentive programs and education for exotic plant removal on private lands

- Removal of battery casing bulkhead below U.S. 41 as identified in the environmental assessment

- Removal of junk cars and trash from auto junk yard located within the *Juncus* marsh system upstream of U.S. 41.

Wetland creation will provide additional fish and wildlife habitat to the creek system. It is recommended that Hillsborough County establish a similar program as Pasco, Pinellas, and Manatee Counties by creating a gill net license fee for fish habitat research and restoration. Funds from the recommended program can be used to restore impacted areas or create new habitat along tidal tributaries, such as Delaney Creek. Additionally the Tampa Port Authority and/or Hillsborough County could establish a fund for habitat restoration/creation projects.

Fisheries sampling at the saltwater-freshwater interface in Delaney Creek yielded six juvenile redfish, as detailed in the environmental assessment. The collection of these recreationally important species in the creek indicates that the creek is serving as a nursery area. It is essential to retain the remaining natural wetland areas and channel configuration to maintain the supporting habitat for fish and wildlife.

Additional supporting habitat can be created by local and state organizations. Incentive programs are necessary for developments to set aside not only environmentally sensitive wetlands but adjacent uplands as a buffer from development. Mitigation for environmental impacts should consider potential fish and wildlife usage in project design.

Policy: Protection of Archaeological Sites

Future growth is anticipated to be predominantly located in the agricultural areas of the watershed. All new development should be required to:

- Identify archaeological sites in all areas before development

- Preserve or excavate significant sites prior to destruction.

3.3.2 Objective: Develop Consistent and Compatible Land Use Standards

Policy: Promote Public Land Acquisition and Conservation Easements for Environmentally Sensitive Lands.

The majority of land within the Delaney Creek drainage basin has been historically altered for agricultural, industrial or residential uses. Future alteration of land use (e.g., agriculture to residential) will require regulatory reviews.

Future channel improvements by SWFWMD will require easements along the creek alignment for access. It is recommended that the Stormwater Management Master Plan (Ghioto, Singhofen & Assoc., Inc., 1986) be expanded to include setting aside the easement to provide a buffer area along the creek corridor.

In addition, funds may be acquired from the Save Our River program or State Conservation and Recreational Lands program (CARL) for the purchase of environmentally sensitive lands on Delaney Creek.

Policy: Encourage Compatible Low Density Development on Adjacent Upland Areas

Future development practices within the Delaney Creek area are addressed in the Hillsborough County Interstate 75 Corridor Plan. New development will require additional management practices due to the volume sensitive nature of the area. Other considerations recommended during the public workshop include:

- Density Credits to be applied for wetland protection or creation

- Prevent development within the 25-year floodplain.

Policy: Encourage Clustering of Water Oriented Land Uses

The lower tidal segment of Delaney Creek is the only section navigable for small boat traffic. The remaining creek segments may be passible with a canoe or small jon boat. The middle and upper segments have been channelized for drainage enhancement but remain relatively narrow.

Potentially, conditions can be improved to enhance areas along Delaney Creek and provide recreational benefits, with proper management. Future developments should consider the value that tidal tributaries intrinsically provide. Design considerations to facilitate policy implementation would include:

- development of buffer areas

- setback requirements for tall structures and buildings to maintain visual aesthetics within the creek alignment

- clustering of water-oriented facilities and structures which cross the creek (roadways, watermains, wires, etc.).

3.3.3 Objective: Management of Tidal Creeks as an Important Public Asset

Policy: Promote Public Education

Delaney Creek is currently stressed from industrial and agricultural development. Future growth in the area will alter historic agricultural lands for more intensive developments.

It is critical that future development occur in an environmentally sensitive manner. Education and regulation of Delaney Creek is recommended to emphasize the value of tidal tributaries as vital systems supporting the Tampa Bay estuary.

Existing and planned residential areas can be enlightened by providing educational material through local schools, clubs and the media. The education program should focus upon:

- value of tidal tributaries

- prevention of unnecessary public degradation by implementing simplistic measures of protection (same as Allen Creek)

- minimization of user conflicts.

Policy: Promote Compatible Public Access

Currently the lower tidal segment of the creek is navigable and used for commercial blue crab harvesting. Upstream segments are not passable due to shoaling or other features. Increased boating activity is not considered a compatible use for the stressed tidal tributary.

However, the construction of a local park on Delaney Creek for passive recreation is desirable. With the increase in development and associated influx of residents will come the need for additional green space.

3.4 Frog Creek Plan

Located within Manatee County, Frog Creek represents a natural tidal tributary to Tampa Bay. The lower tidal section of the creek is relatively pristine with only minor impacts derived from several roadway crossings. The upper watershed is dominated by agricultural activities, with limited residential development. Within the agricultural areas the creek segment has been channelized to facilitate drainage. Water quality within Frog Creek is affected by non-point source pollutant loadings and is currently closed to public shellfish harvesting.

During the public workshop, participants indicated that the lower segment of Frog Creek retains a tidal connection through the extensive mangrove forest to Bishop Harbor. Since the area functions as one natural system, the tidal expanse to Bishop Harbor is included within the management recommendations.

3.4.1 Objective: Maintenance/Restoration of Natural Function

Policy: Water Quality Improvement through Control of Non-Point Source Pollutant Loadings

The estuarine portion of Frog Creek is classified as a natural tidal tributary to Tampa Bay. However, bacterial contamination has closed Terra Ceia Bay and Frog Creek to shellfish harvesting. In addition the environmental assessment identified quantities of the freshwater alga Waternet (Hydrodictyon sp.), which is indicative of agricultural runoff. Considering the agricultural nature of the watershed, rainwater runoff could potentially discharge high loads of nutrients, pesticides, herbicides, and sediments into the creek system. Septic tank discharge may also contribute to bacterial and nutrient contamination of Frog Creek.

The participants of the creek workshop recommended that, through the U. S. Department of Agriculture Department, the Soil Conservation Service should develop a program to work with the agriculture industry in developing conservation plans minimizing non-point source pollutants.

To prevent further water quality degradation and restore safe shellfish harvesting in the area, a water quality monitoring program is required. The program can be designed to determine the impacts of non-point source pollutants to the creek system derived from:

- agricultural areas

- sod farms

- fish farms

- septic tanks.

The monitoring program would best be implemented by Manatee County and can address the following:

- identification of problem areas
- prioritization of improvements
- coordination of responsible agencies for implementation of improvements.

Policy: Minimize Point Source Pollutants

Only one point source discharge is identified in the environmental assessment. The recommended monitoring program can determine its affect on the Frog Creek system.

Due to the undeveloped and agricultural nature of the watershed several protective recommendations are identified:

- No new surface water discharge should be allowed
- No new septic systems should be allowed within 2,000 feet of Frog Creek or its tributaries
- Effluent disposal alternatives for existing facilities shall be evaluated. The Manatee County Public Works Department is eligible to utilize Section 201 of the Federal Water Pollution Control Act funds to provide sewer line service in the watershed.

Policy: Protect Natural Freshwater Inputs

Currently, Frog Creek is not used as a source of potable water. Workshop participants identified a plan by the City of Palmetto to dam off Frog Creek. In order to retain the estuarine character of Frog Creek and Tampa Bay this action is not recommended.

Freshwater flows derived from the drainage basin provide highly productive environments when diluted with marine sea waters. The tidally influenced portion of Frog Creek contains extensive stands of mangroves and oyster bars, which in turn are utilized by a variety of birds, fish, crustaceans and others. Protection of freshwater input is imperative to retain the natural ecosystems of Frog Creek. Protective measures to maintain freshwater flows to Frog Creek include:

- prohibit new surface water withdrawals
- promotion of water recycling for all existing facilities to minimize freshwater withdrawals.

Policy: Develop Consistent Tidal Creek Monitoring and Enforcement Program

To prevent degradation within natural tidal creek systems a creek monitoring program is recommended. The program can be designed to include:

- water quality and quantity

- habitat and species utilization

- long-term benthic infaunal analysis which can serve as a comparison for stressed and restorable tributaries within the Tampa Bay estuary.

In addition, an enforcement program is recommended to be implemented by the same organization to maintain consistent management of the creek system. The enforcement program can address:

- dredge and fill activities

- shellfish harvesting and fishing regulations

- water quality violations

- protection of archaeological sites.

The monitoring and enforcement program would best be implemented through Manatee County. The county can carry out the enforcement role by identifying problem areas to responsible regulatory agencies.

Policy: Protect or Improve Natural Channel Alignment and Elevation Requirements for Maintenance of Productivity

Due to natural conditions within the tidally influenced portion of Frog Creek, management of productivity is centered around preservation of existing conditions. Channel alignment and elevation requirements can be protected by the following recommended guidelines:

- No new channelization or dredging activities allowed below U.S. 41 bridge

- Preservation of all natural bank slopes and the addition of upland buffers to prevent developmental encroachment and protect ecological systems during sea level rise.

Policy: Preserve Natural Vegetation and Fish and Wildlife Resources

The natural areas within the tidally influenced portion of Frog Creek are recommended to be preserved as a whole. Currently the area contains an extensive system of mangroves, salt marsh and oyster bar communities supporting an abundance of fish and wildlife. Additional enhancement of the area should be encouraged and can include the following:

- Removal of exotic species and prevention of additional encroachment

- Removal of illegal dump sites (trash, brush, etc.)

- Restoration of impacted areas. Workshop participants identified historic dikes located between Bishops Harbor and Frog Creek. Enhancement of tidal circulation and freshwater sheet flows can be accomplished by removing portions of the dike.

The diversity of fish and wildlife within Frog Creek is identified within the environmental assessment. Numerous roseate spoonbill were observed in the lower tidal segment. Several nesting colonies of yellow-crowned night herons existed on mangrove islands within the creek. In addition, the collection of tarpon, ladyfish, mullet, gulf menhaden and spotted gar at the freshwater-saltwater interface identifies the utilization of Frog Creek by estuarine and freshwater fish species. Preservation of the natural habitat is imperative to maintain suitable conditions for fish and wildlife populations.

<u>Policy</u>: Protection of Archaeological Sites

Several shell mounds were observed directly adjacent to Frog Creek during the site visit. In addition, participants of the creek workshop identified areas of historic and prehistoric value. Many of the prehistoric sites are reported to date around 1500 BC and occur below the water level. Protective recommendations for identified and potential sites include:

- Information on site locations should not be published to prevent vandalism and loss of the irreplaceable resource

- Before development takes place within the watershed an archaeological survey should be accomplished on all lands (including wetlands) to identify sites

- Preservation or excavation prior to destruction of significant sites.

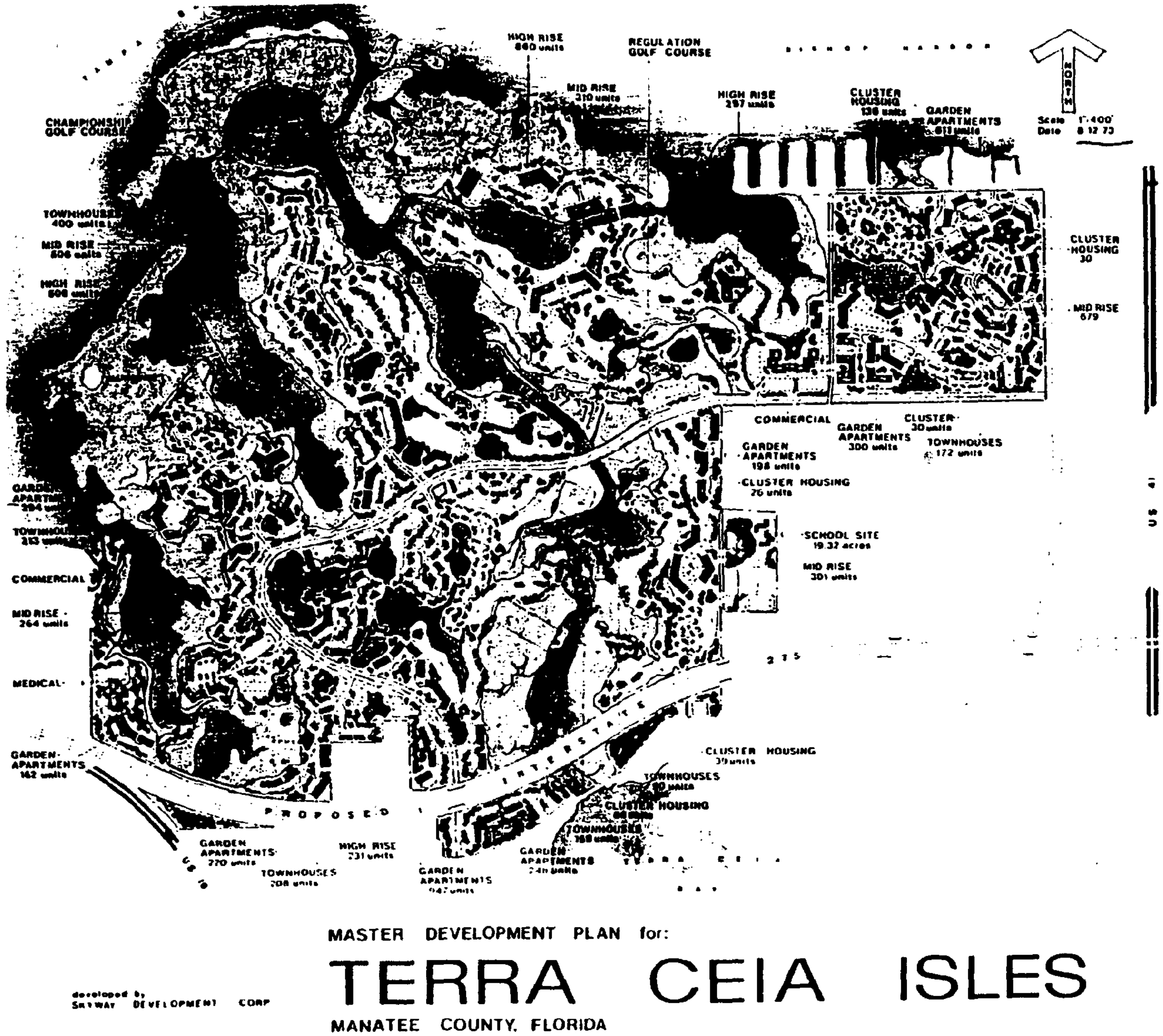
<u>Objective</u>: Develop Consistent and Compatible Land Use Standards

<u>Policy</u>: Promote Public Land Acquisition and Conservation Easements for Environmentally Sensitive Lands

Strong recommendations were received during the workshop to explore the purchase of the Terra Ceia Isles development for public conservation (Figure 67). Currently the land contains extensive natural areas with very little infrastructure for intensive development. Public acquisition can be partially accomplished with funds from the CARL program. The development has received a Binding Letter of Interpretation and is slated for development. Public acquisition of the property will protect the environmentally sensitive lands while providing additional passive recreation to the area.

Additional workshop recommendations suggested that conservation easements should be implemented along Frog Creek to provide a buffer area from future development and provide public access. Buffer conservation should not be used as mitigation for environmental impacts.

Figure 67. Master development plan for Terra Ceia Isles



Source: Binding Letter of Interpretation (BLI) Application 1985

Policy: Encourage Compatible Low Density Development on Adjacent Upland Areas

The majority of the Frog Creek drainage basin contains agricultural or undeveloped lands. The nature of the watershed allows protective measures to be implemented before development occurs. Several recommendations have been developed to maintain the natural environmental systems of Frog Creek and include:

- Prevention of all development within the 25-year flood zone

- The limits of the Aquatic Preserve and Outstanding Florida Waters (OFW) boundary must be extended above the Mean High Water (MHW) line to the landward extent of State Waters (defined by jurisdictional vegetation and soils). Currently the designations only protect a portion of the jurisdictional wetlands and not the whole systems (example: the high salt marsh systems remain unprotected). This recommendation should further be explored through the Department of Natural Resources, Department of Environmental Regulation and the Agency on Bay Management

- Land Use zoning within the Frog Creek watershed should retain the existing agricultural designation

- Tax incentives should be established for preservation of environmentally sensitive lands. However wetlands are not recommended to be traded for additional density zoning credits.

Policy: Encourage Clustering of Water-Oriented Land Uses

The only physical alterations of the estuarine portion, identified in the environmental assessment, are the bridge crossings of Bayshore Drive and the Interstate 75 spur across the creek mouth. The crossings are adjacent to each other and future infrastructure needs are recommended to utilize this location to cluster overhead crossings.

The natural, undeveloped nature of the tidally influenced portion of the creek should be retained as a public amenity. Boating is limited by the shallow depth of the creek. Intensive development along stretches of Frog Creek should be prohibited.

3.4.3 Objective: Management of Tidal Creeks as an Important Public Asset

Policy: Promote Public Education

Frog Creek currently remains relatively undeveloped. The creek system offers the opportunity for the public to identify with the value of natural tidal tributaries to Tampa Bay. Passive development of a local park can facilitate public interaction with the natural communities of Frog Creek with:

- boardwalks through conservation areas
- limited canoe access
- education center for local schools and clubs.

Education of the public and local residents should include:

- the value of natural tidal tributaries
- the affects of stressed tributaries
- preventative maintenance for Frog Creek (public degradation and user conflicts).

Policy: Promote Compatible Public Access

Due to the limited depths within Frog Creek, public access can best be provided through the development of a public park. Boat ramps or dredging should be discouraged.

The extensive oyster bars existing within the lower estuarine segment of Frog Creek currently cannot be utilized due to bacterial contamination. This represents loss of a natural resource available to the public. Improvements in water quality can potentially result in a reopening of the area to public shellfish harvesting.

3.5 Additional Applications of the Management/Restoration Plan

3.5.1 Objective: Maintenance/Restoration of Natural Function

Policy: Water Quality Improvements through Control of Non-Point Source Pollutants

Urban and agricultural stormwater runoff have been identified as the major sources of water pollution in Tampa Bay, with the former apparently predominating (TBRPC, 1978 and 1985). All tidal tributaries draining to Tampa Bay are affected by non-point source pollutants.

Reductions in the stormwater pollutant loadings to Tampa Bay can occur through stormwater legislation, such as House Bill 242 (1985). Specific recommendations for future legislation must include:

- the establishment of priorities and time frames for all developed areas

- the inclusion of agricultural areas in legislation and the permitting process.

Non-point source pollutant loadings have impacted the Tampa Bay estuary by historic development practices, wetland draining, tributary channelization, impervious surfaces, etc.). Many sources will require retrofitting to improve water quality conditions. Stormwater pollution abatement will benefit all tidal tributaries in the Tampa Bay Region.

Policy: Minimize Point-source Pollutants

Stressed tidal tributaries to Tampa Bay are often affected by industrial and municipal discharges to the creek systems, examples include Joe's, Allen, Rocky, Delaney, and Wares Creeks. Management considerations for stressed tributaries shall be orientated toward minimizing water quality impacts to the downstream systems. Recommendations include:

- develop ecological criteria for all discharges

- promote effluent disposal alternatives

- promote water recycling.

Restorable tidal tributaries offer the potential for improvement. All measures should be taken to improve or eliminate point discharge quantities. Further protective measures can include prevention of any new surface water discharge within restorable creek watersheds.

Natural tributaries within the Tampa Bay Region receive point source discharges while retaining the ecological character of a natural system (examples include Piney Point and Frog Creeks). Further degradation of natural conditions must be prevented. Effluent discharge alternatives for point source discharges to natural systems are recommended to be implemented. All new surface water discharge to natural tidal tributaries should be prohibited.

Policy: Protect Natural Freshwater Inputs

Many tributaries to Tampa Bay are in a stressed condition due to disruption of natural freshwater flows. Alligator Creek has lost the natural connection to Old Tampa Bay by the installation of an elevated weir. McKay Creek is dammed to form Taylor Lake. In addition, Tinny Creek has been bypassed with a large open drainage ditch to Tampa Bay. Alteration of freshwater flow down the tidal tributary can eliminate the creek's estuarine system (Alligator Creek) or disrupt the natural movement of the saltwater-freshwater interface and associated environmental systems.

Maintenance or restoration of natural freshwater inputs are vital to the estuarine system. Stressed systems should be evaluated with respect to the importance of limiting freshwater (water supply, residential lake, etc.) or the value of downstream ecosystems. Restoration of flows is recommended where practical and beneficial results can be identified.

Restorable creek systems can be improved through regulation of freshwater flows. Areas containing large quantities of impervious surfaces will benefit by stormwater retention. Dammed or rerouted systems can be designed to follow natural drainage features and acquire typical runoff volumes. Channel "A", for example, has circumvented freshwater flows down Rocky Creek and isolated adjacent wetland systems. Natural freshwater sheetflow through tidal marsh systems can be restored by lowering portions or all of the berm along Channel "A" to allow freshwater/tidal inundation.

Natural Tampa Bay tributaries should retain freshwater inputs through preservation. Disruption of freshwater flows can potentially degrade the natural ecosystems and protective measures should be taken to:

- Prevent large surface water withdrawals

- Maintain natural base flow quantities

- Prevent salinity barriers, dams or other flow impediments.

Policy: Develop Consistent Tidal Creek Monitoring Program

The value of tidal tributaries to estuarine systems is readily apparent but often overlooked. Historic research activities have focused upon larger rivers and tributaries. Little consistent information has been accumulated for the conditions within smaller tributaries feeding the Tampa Bay estuary. Tidal creek monitoring programs should include water quality and biological analysis.

Tidal creek monitoring programs are required for stressed tributaries to prevent further degradation to the creek and bay systems. Programs developed for restorable tributaries can monitor and identify improvements to the system that can then be applied to other tributaries. Monitoring and enforcement programs for natural systems can prevent alterations and provide baseline information for creek management objectives.

Policy: Protect or Improve Natural Channel Alignment and Elevation Requirements for Maintenance of Productivity

The environmental assessment identified that stressed tidal tributaries to Tampa Bay continue to provide habitat for fish and wildlife usage. Maintenance of existing natural systems and improvement where possible will continue to maintain and/or increase the potential for wildlife to utilize stressed tributaries.

Restorable tributaries provide the greatest potential for improvement through channel configuration and elevation alterations. Fish Creek has been channelized in an extensive drainage system around Tampa International Airport. The lower segment of Broad Creek retains a natural tidal marsh system while the middle and upper segments have been channelized for drainage from MacDill Air Force Base. Both tidal creek systems can be improved by realignment or lowering of the berms for additional creation of wetland acreage while maintaining drainage for the airports.

Bullfrog Creek currently has moderate habitat loss through piecemeal development. The Future of Tampa Bay (TBRPC, 1985) recommended that Hillsborough County should amend its comprehensive plan to tighten control of shoreline uses and establish incentives for private landowners to restore the shoreline.

Little Redfish Creek has been impacted by illegal filling activities by the Hendry Corporation during the development of Port Manatee. Currently FDER is applying monies from the Pollution Recovery Trust Fund for restoration in the area. One area of restoration under consideration is removing silt from the creek bottom and reestablishing a tidal connection with adjacent isolated ponds. The program has the potential to restore habitat available for fish and wildlife uses.

Natural tributaries retain the requirements for habitat environments. Often small areas for restoration exist within the creek system. The focus of attention within natural systems is oriented toward preservation.

Policy: Preserve Natural Vegetation and Fish and Wildlife Resources

Stressed creek systems normally retain pockets of natural vegetation utilized by local fish and wildlife populations. If productivity is to be maintained in stressed tributaries it is imperative to protect the natural areas from continued developmental encroachment.

Restorable tributaries can be improved to provide conditions that are advantageous to fish and wildlife usage. The addition of natural vegetation and habitat will help to buffer cultural shocks to the estuary system. Local and regional programs are necessary to restore the impacted areas and create additional habitat.

The natural ecosystems within tidal tributaries should be protected to provide natural habitat for fish and wildlife. In addition, wildlife corridors are recommended to combine natural habitats together for a more effective and diverse system. The proximity of Cockroach and Piney Point Creeks, two tributaries classified as natural, to each other allow wildlife populations to intermix and form a more productive ecosystem. Protection of marsh and open green space is necessary to maintain a wildlife corridor between the tidal tributaries.

Policy: Protection of Archaeological Sites

The provision for protection of archaeological sites is applicable to all tributaries and is independent of current creek condition. Archaeological surveys are currently required and accomplished before development. Identified sites are evaluated by the State of Florida or federal criteria for significance to determine eligibility for listing in the National Register of Historic Places. Sites meeting the criteria must either be preserved or excavated prior to destruction. Additional recommendations include survey of wetlands prior to development.

3.5.2 Objective:Develop Consistent and Compatible Land Use Standards

Policy: Promote Public Land Acquisition and Conservation Easements for Environmentally Sensitive Lands

Tributaries in stressed conditions around Tampa Bay are often encroached upon by adjacent development (e.g., Allen Creek). Public land acquisition of available sensitive lands can be accomplished to:

- preserve the remaining natural system

- promote habitat creation

- increase public utilization for recreation.

Creek systems currently classified as restorable may require transfer of ownership to the public to allow restoration. Areas along Archie Creek are currently within private ownership (Gardinier, Inc.). Restoration of channel alignment and bank configuration can improve conditions within the creek system. Acquisition of adjacent areas into public ownership can facilitate restoration efforts and prevent further encroachment.

Public land acquisition and implementation of conservation easements will protect environmentally sensitive systems within natural tidal tributaries. Undeveloped areas can be set aside for future generations of inhabitants (people and wildlife) to utilize. Buffer easements established before development can provide public access, prevent developmental encroachments, and buffer the impacts of a rise in sea-level.

As previously mentioned, the purchase of Terra Ceia Isles by the CARL Program can prevent unsuitable development in an environmentally sensitive area along Frog Creek. In addition, the acquisition of upland areas between Cockroach and Piney Point Creeks can:

- maintain a wildlife corridor

- preserve the uplands between two natural tributaries

- provide passive recreation

- allow restoration of historic agricultural dikes

- maintain natural zonation of wetlands during sea level rise.

Policy: Encourage Compatible Low Density Development on Adjacent Upland Areas

Stressed creeks to Tampa Bay have historical development that may limit future management of adjacent upland areas. Creeks impacted by water quality degradation should consider setbacks or buffer zones to allow wetland creation that will help buffer impacts to the estuarine system. New development on stressed tributaries should be very limited or prohibited within the 25-year flood plain.

Restorable tributaries should prohibit development within the 25-year flood plain to accomplish necessary improvements to the creek. In addition, low density development adjacent to the creek will prevent encroachment to the tributary after potential restoration processes have been completed.

Natural systems are necessary to be preserved or protected from intensive development. Nine natural tributaries are identified in the three county region. Protection of the remaining unique systems through low intensity zoning or preservation is required.

Policy: Encourage Clustering of Water-Oriented Land Uses

Clustering of water dependent land uses within stressed creek systems is often after-the-fact management. For restorable and stressed tributaries to Tampa Bay new development should utilize existing alterations during design. Examples include:

- marina siting is encouraged along existing channels with good circulation and sufficient natural depth. Environmental impacts must be minimized

- Overhead crossings (roads, infrastructure, etc.) should be clustered or follow existing routes

- Industrial development utilizing surface waters must prevent environmental degradations and long term impacts.

Natural systems allow development of more stringent preventive management measurements and can include:

- no new development in environmentally sensitive areas

- overhead crossings can be clustered

- infrastructure can travel under the creek to promote long-term aesthetic qualities.

3.5.3 Objective: Management of Tidal Creeks as an Important Public Asset

Policy: Promote Public Education

The focus of education for the general public should include:

- the intrinsic value of tidal tributaries
- prevention of public degradations
- minimization of user conflicts.

Due to developmental pressures occurring upon stressed creek systems, all three recommendations apply. Generally, education will help prevent unnecessary impacts to downstream systems.

Restorable tributaries differ by providing increased awareness on ways man can improve conditions within tributaries and affects on the Tampa Bay estuary. Restoration can improve the quality of life by:

- improving water quality for water contact sports, fish and shellfish harvesting and scenic aesthetic
- additional wetland creation potentially can provide:
  - o utilization by fish and wildlife
  - o buffering of water quality impacts
  - o prevention of erosion
  - o scenic amenity.

Natural tidal tributaries can be utilized for identification of unaltered conditions. Baseline information and education must have a control for comparison. Creek systems in natural condition will provide the model for restoration of impacted systems.

Policy: Promote Compatible Public Access

Public access is necessary for all conditions of tidal creeks but is limited by proximity to urban areas and available resources. Stressed tributaries often have the greatest access available, due to the close proximity to urban areas. However, the stressed creeks are affected by the increase in usage and continued public degradation.

Restorable and natural tidal tributaries can control type and volume of public usage within the watershed. Low intensity access should be provided to restorable tributaries for education of the public toward restoration and the benefits derived from improved conditions.

Passive recreation is also recommended for natural systems for people to identify with the high productivity pristine environments provide. The natural system provides the highest quality of aesthetic resources available.

SUMMARY

The importance of rivers and creeks to estuaries has been documented in studies throughout the world. Rivers and lesser streams import freshwater and foodstuffs to estuaries and provide critical habitat, refuge, feeding and breeding grounds for the early life history stages of marine and estuarine life forms.

Rivers and tidal creeks are vulnerable to numerous impacts which also become evident downstream in terms of decreased estuarine productivity. Examples include: hydroperiod alterations through excess drainage or impoundments; loss of corridor by damming; changes to stream loads by increasing runoff or discharging pollutants, and diverting or preventing flows; increased relief and habitat losses through dredging and filling; and contamination through disposal of toxic materials. As rivers and creeks deteriorate, their ability to buffer cultural shocks to the estuary are lost.

Rivers and creeks flowing to Tampa Bay vary greatly in condition. Historical and anecdotal evidence exists to show that these streams were immensely productive estuarine zones and modern data on relatively pristine rivers and creeks support this view. Much basic information on tidal rivers and creeks is lacking but enough exists to allow important ones to be classified by their overall condition from a management point of view. All classifications identified in this report are based on conditions in the tidal segment of each stream.

Developing general management/restoration recommendations for tidal creek ecosystems is difficult, due to great diversity of the individual tributary systems involved; their particular condition and management needs; and regulatory, economic and other facets of each problem. Emphasis should be placed on the restorable tributaries since restoration can potentially prevent them from becoming a stressed system. Second, priority is then given to protection of the natural tributary, followed by preventing additional impacts to the estuary from stressed tidal tributaries.

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Appendix A.

WATER QUALITY DATA
ALLEN CREEK
CITY OF CLEARWATER, FLORIDA
1982 - 1985

Station Allen's Creek No. 1

Location North side of Druid Rd. at Arcturas Ave.

Date	Time	Temperature (°C)	pH	Conductivity (μmhos.)	Dissolved Oxygen (mg./l)	Biochemical Oxygen Demand (mg./l)	Fecal Coliform (No./100ml)	Fecal Strep (No./100ml)	Oil and Grease (mg./l)	NH_3N (mg./l)	Organic N (mg./l)	NO_2N (mg./l)	NO_3N (mg./l)	Ortho Phosphate (mg./l)
3-31-82 (820)	1120	24.0	-	-	8.50	1	550	3000	2.5	< 0.02	1.50	< 0.02	0.25	< 0.04
4-21-82 (841)	0800	24.0	8.0	345	5.25	1	276	1000	13.4	< 0.02	0.04	< 0.02	0.12	< 0.04
5-19-82 (869)	-	-	7.0	390	-	5	640	720	< 0.1	< 0.02	< 0.04	< 0.02	0.08	< 0.04
7-7-82 (918)	0835	26.0	7.2	350	5.25	2	< 300	4687	< 0.1	0.11	1.12	< 0.02	0.23	< 0.04
9-1-82 (974)	0805	26.0	6.6	360	5.00	3	8600	1400	8.4	< 0.02	0.60	< 0.02	0.34	0.69
9-15-82 (988)	0745	25.0	6.7	380	5.50	2	6200	1080	< 0.1	< 0.02	0.50	< 0.02	0.28	0.04
11-4-82 (1038)	0935	23.0	6.3	130	7.00	12	3000	2000	< 0.1	< 0.02	1.00	< 0.02	0.31	0.19
12-2-82 (1066)	0915	24.0	6.4	362	4.00	3	many clear colonies	2500	0.2	< 0.02	0.80	< 0.02	0.06	< 0.04
1-6-83 (1101)	0900	15.3	6.2	360	4.10	4	5000	1280	0.7	< 0.02	1.00	< 0.02	0.13	< 0.04
2-3-83 (1129)	0914	17.7	6.4	240	6.60	1	3900	10500	< 0.1	< 0.02	0.78	< 0.02	0.12	0.02
2-17-83 (1143)	0914	16.7	6.4	210	8.10	2	3700	25000	0.2	< 0.02	0.40	< 0.02	0.20	0.04
3-3-83 (1157)	0922	18.6	6.3	330	6.50	1	260	1500	0.2	< 0.02	0.30	< 0.02	0.28	0.04
3-17-83 (1171)	0913	18.8	6.6	210	7.00	2	5000	10400	0.1	< 0.02	0.10	< 0.02	0.03	0.06
4-7-83 (1192)	0922	22.0	6.5	360	8.70	2	120	1800	0.2	< 0.02	0.40	< 0.02	0.29	< 0.04

Station Allen's Creek (No. 1)

Location North side of Druid Rd. at Arcturas Ave.

Date	Time	Temperature (°C)	pH	Conductivity (μmhos.)	Dissolved Oxygen (mg./l)	Biochemical Oxygen Demand (mg./l)	Fecal Coliform (No./100ml)	Fecal Strep (No./100ml)	Oil and Grease (mg./l)	NH_3N (mg./l)	Organic N (mg./l)	NO_2N (mg./l)	NO_3N (mg./l)	Ortho Phosphate (mg./l)
4-11-84 (1562)	0932	22.2	7.3	238	6.90	2	44	420	<0.1	<0.02	0.60	0.02	0.20	0.09
7-17-84 (1659)	1019	27.3	6.3	350	6.90	2	2240	520	0.3	0.12	0.86	<0.02	0.30	0.14
9-27-84 (1731)	0923	24.2	7.1	369	4.10	1	440	150	0.17	<0.02	0.39	<0.02	<0.02	0.16
12-17-84 (1812)	1025	21.0	6.4	345	7.75	2	1050	680	<0.1	0.33	0.07	<0.02	0.09	0.05
1-9-85 (1835)	1050	16.0	6.5	364	3.20	9	780	453	0.009	0.15	0.32	<0.02	0.07	0.07
1-21-85 (1847)	0935	10.5	6.6	265	5.40	3	confluent growth	950	0.027	0.17	0.38	<0.02	0.18	0.05
2-4-85 (1861)	1000	19.0	6.6	335	3.50	2	500	1300	<0.1	0.16	0.46	<0.02	0.03	[illegible]
2-19-85 (1876)	0850	17.0	6.8	350	5.40	1	165	930	0.112	0.09	0.45	<0.02	0.15	0.06
3-4-85 (1889)	0940	20.5	6.6	361	8.20	1	305	365	0.021	0.27	0.58	<0.02	0.03	0.08
3-19-85 (1904)	1040	17.0	6.3	450	5.00	5	3000	740		0.56	0.81	<0.02	<0.02	0.07
4-1-85 (1917)	0930	23.0	6.8	370	4.10	2	370	830	0.56	0.26	0.29	<0.02	<0.02	0.05
4-15-85 (1931)	1100	23.0	6.4	348	5.80	5	400	770	0.02	<0.02	1.23	<0.02	0.08	0.05
5-6-85 (1952)	0910	23.0	6.5	350	3.00	3	165	395	0.37	0.02	0.51	<0.02	<0.02	0.05

Station Allen's Creek (No. 1)

Location North side of Druid Rd. at Arcturas Ave.

Date	Time	Temperature (°C)	pH	Conductivity (μmhos.)	Dissolved Oxygen (mg./l)	Biochemical Oxygen Demand (mg./l)	Fecal Coliform (No./100ml)	Fecal Strep (No./100ml)	Oil and Grease (mg./l)	NH_3N (mg./l)	Organic N (mg./l)	NO_2N (mg./l)	NO_3N (mg./l)	Ortho Phosphate (mg./l)
5-20-85 (1967)	1040	28.0	6.2	480	2.55	<1	1	10	0.23	0.14	0.22	<0.02	<0.02	
6-6-85 (1983)	0925	28.0	7.1	452	2.40	3	40	435	0.10	0.14	0.35	<0.02	<0.02	0.10
6-24-85 (2001)	0915	25.5	6.8	300	1.80	5	-9800	433	0.99	0.20	0.42	0.03	0.25	0.10
7-24-85 (2031)	0925	26.5	6.5	363	3.00	1	4800	63	0.52	0.34	0.59	<0.02	0.11	0.14
8-4-85 (2045)	1050	28.5	6.7	340	4.70	1	+550	290	0.13	0.19	0.29	<0.02	0.14	0.03
8-27-85 (2065)	1030	26.5	6.5	360	5.20	4	660	233	0.49	0.31	0.49	0.02	0.21	0.06
9-25-85 (2094)	1000	27.0	6.6	370	5.40	2	2200	510	0.22	0.17	0.41	0.03	0.28	0.25
10-17-85 (2116)	1000	26.0	6.4	360	4.85	2	3600	750	0.32	0.12	0.36	0.02	0.29	0.23
11-18-85 (2148)	0845	23.5	6.5	350	4.00	5	+610	2500	0.22	0.54	0.04	<0.02	0.26	0.06
12-16-85 (2176)	1025	16.0	6.4		5.50	TMD	>6000	4400	0.30	0.28	0.90	<0.02	0.12	0.10
2-3-86 (2225)	1020	19.5	6.4		5.45		350	353	0.01	0.22	0.24	<0.02	0.17	0.02

Station Allen Creek No. 2

Location South side of Nursery Rd. at Beverly Dr.

Date	Time	Temperature (°C)	pH	Conductivity (μmhos.)	Dissolved Oxygen (mg./l)	Biochemical Oxygen Demand (mg./l)	Fecal Coliform (No./100ml)	Fecal Strep (No./100ml)	Oil and Grease (mg./l)	NH_3N (mg./l)	Organic N (mg./l)	NO_2N (mg./l)	NO_3N (mg./l)	Ortho Phosphate (mg./l)
3-31-82 (820)	1120	24.0	-	-	7.00	2	210	510	3.8	< 0.02	1.80	0.03	0.37	0.12
4-21-82 (841)	0800	25.0	8.0	380	5.25	1	290	580	19.9	< 0.02	<0.04	0.04	0.20	0.16
5-19-82 (869)	-	-	7.3	415	-	2	5800	370	<0.1	0.70	0.80	<0.02	0.17	0.14
7-7-82 (918)	0845	25.0	7.1	360	6.00	2	2015	1695	9.6	0.17	1.29	0.02	0.28	0.14
9-1-82 (974)	0820	26.0	6.6	390	6.00	3	4850	360	46.0	< 0.02	0.70	<0.02	0.25	0.12
9-15-82 (988)	0800	27.0	6.8	395	5.50	2	6000	1200	56.2	< 0.02	0.60	0.02	0.25	0.13
11-4-82 (1038)	0950	23.5	6.4	350	4.25	8	2000	3000	0.1	< 0.02	0.80	<0.02	0.41	0.19
12-2-82 (1066)	0930	23.0	6.4	415	2.25	2	many clear colonies	4450	0.4	< 0.02	0.70	<0.02	0.14	0.43
1-6-83 (1101)	0917	15.2	6.4	355	6.60	1	180	1160	0.7	< 0.02	1.00	< 0.02	0.24	0.18
2-3-83 (1129)	0925	17.3	6.4	310	6.40	2	3500	9200	0.2	< 0.02	0.90	< 0.02	0.20	0.09
2-17-83 (1143)	0924	16.1	6.5	187	8.90	2	4900	32000	0.1	< 0.02	0.30	< 0.02	0.28	0.07
3-3-83 (1157)	0935	18.7	6.5	335	6.80	2	320	6000	< 0.1	< 0.02	0.80	<0.02	0.39	0.10
3-17-83 (1171)	0926	19.2	6.6	265	6.60	3	2600	5000	0.1	< 0.02	0.30	0.02	0.41	0.09
4-7-83 (1192)	0933	22.0	6.6	370	5.40	2	1600	1600	0.1	< 0.02	0.60	0.02	0.32	0.17

Station Allen Creek (No. 2)

Location South side of Nursery Rd. at Beverly Dr.

Date	Time	Temperature (°C)	pH	Conductivity (μmhos.)	Dissolved Oxygen (mg./l)	Biochemical Oxygen Demand (mg./l)	Fecal Coliform (No./100ml)	Fecal Strep (No./100ml)	Oil and Grease (mg./l)	NH_3N (mg./l)	Organic N (mg./l)	NO_2N (mg./l)	NO_3N (mg./l)	Ortho Phosphate (mg./l)
4-11-84 (1562)	0946	23.8	7.1	309	6.00	2	320	1320	< 0.1	< 0.02	< 0.04	< 0.02	0.26	< 0.04
7-17-84 (1659)	1029	27.6	6.2	340	5.50	1	260	150	0.2	0.21	1.04	< 0.02	0.29	0.20
9-27-84 (1731)	0936	25.0	7.2	381	5.00	1	150	120	0.26	< 0.02	0.22	< 0.02	< 0.02	0.18
12-17-84 (1812)	1040	21.0	6.7	382	6.50	1	273	10100	0.1	0.13	0.52	< 0.02	0.16	0.14
1-9-85 (1835)	1040	15.0	6.6	285	6.60	2	130	340	0.009	0.19	0.44	0.02	0.16	0.18
1-21-85 (1847)	0950	11.5	6.7	240	8.20	3	100	370	0.033	0.32	0.26	< 0.02	0.18	0.16
2-4-85 (1861)	0945	19.5	6.8	360	6.10	2	2200	1800	0.2	0.36	0.49	0.02	0.14	0.15
2-19-85 (1876)	0900	17.0	6.9	385	7.35	2	270	383	0.147	0.21	0.34	0.02	0.16	0.16
3-4-85 (1889)	0930	22.0	6.8	382	5.35	1	155	555	0.038	0.35	0.62	0.02	0.11	0.18
3-19-85 (1904)	1050	18.0	6.7	373	7.85	< 1	320	247		0.57	0.53	< 0.02	0.06	0.18
4-1-85 (1917)	0945	24.5	7.1	388	4.65	1	140	730	0.552	0.31	0.40	0.02	0.06	0.18
4-15-85 (1931)	1050	23.5	6.1	248	6.20	4	30	298	0.05	0.02	0.59	< 0.02	0.15	0.19
5-6-85 (1952)	0920	25.0	6.0	360	5.35	7	270	120	0.32	0.02	0.62	< 0.02	0.03	0.12

Station Allen's Creek (No. 2)

Location South side of Nursery Rd. at Beverly Dr.

Date	Time	Temperature (°C)	pH	Conductivity (μmhos.)	Dissolved Oxygen (mg./l)	Biochemical Oxygen Demand (mg./l)	Fecal Coliform (No./100ml)	Fecal Strep (No./100ml)	Oil and Grease (mg./l)	NH_3N (mg./l)	Organic N (mg./l)	NO_2N (mg./l)	NO_3N (mg./l)	Ortho Phosphate (mg./l)
5-20-85 (1967)	1055	28.5	6.6	432	4.65	2	2600	680	0.07	0.14	0.56		0.05	
6-6-85 (1983)	1000	30.0	7.3	390	3.60	4	230	145	0.02	0.24	0.54	<0.02	0.02	0.21
6-24-85 (2001)	0925	27.5	7.0	290	4.40	2	500	225	0.97	0.64	0.42	0.06	0.03	0.25
7-24-85 (2031)	0935	27.0	6.7	332	4.90	2	800	1400	0.52	0.45	0.64	0.03	0.05	0.18
8-4-85 (2045)	1040	30.0	6.8	255	5.70	4	180	312	0.14	0.27	0.35	0.02	0.10	0.15
8-27-85 (2065)	1045	27.5	6.7	378	5.70	2	2600	385	0.60	0.34	0.55	0.03	0.20	<0.02
9-25-85 (2094)	1010	27.0	6.4	401	5.60	6	510	283	0.09	0.23	0.61	0.05	0.33	0.15
10-17-85 (2116)	1020	26.0	6.7	400	5.80	2	303	333	0.34	0.18	0.46	0.02	0.29	0.05
11-18-85 (2148)	0900	23.5	6.9	203	5.95	1	203	378	0.21	0.54	0.11	0.02	0.26	0.14
12-16-85 (2176)	1045	14.5	6.6		8.35	2	470	288	0.57	0.35	0.53	<0.02	0.22	0.19
2-3-86 (2225)	1035	18.0	6.4		6.05	TMD	125	3200		0.39	0.38	<0.02	0.20	0.07

APPENDIX-B

Agenda Item #7
7/9/84

TAMPA BAY MANAGEMENT STUDY COMMISSION
EXISTING AUTHORITIES MATRIX

Over the past six months the Long-Term/Existing Authorities Subcommittee of the Tampa Bay Management Steering Committee has been developing an inventory of all federal, state, regional and local governmental agencies having jurisdiction over activities associated with Tampa Bay. This inventory has been prepared in matrix form and is intended to be used to pinpoint agency and authority jurisdiction and responsibilities with regard to the priority bay management issues. During the upcoming months the Tampa Bay Management Study Commission will be using the matrix to develop solutions and specific implementation strategies for each identified issue. From this process it is anticipated that a more refined understanding of each agency's function, as well as jurisdictional gaps and overlaps, will be derived. At this point in time, four categories of agency involvement have been identified. These categories are defined as follows:

- Regulation/Enforcement Category

  By statute or ordinance an agency has the authority to issue a permit and/or veto a project or activity. This category of involvement is denoted in the matrix by a * symbol.

- Review/Advisory Category

  By statute, ordinance or local policy, an agency is required to become aware of a project or activity and make recommendations or comments. This category of involvement is denoted in the matrix by a o symbol.

- Planning/Policy Development

  Through statute, ordinance or local policy, this agency will establish goals and set guidelines, and develop implementation strategies for activities or projects. This category of involvement is denoted in the matrix by a + symbol.

- Research/Education

  Agencies which contribute research and/or education information to other agencies and to the general public. This category of involvement is denoted in the matrix by a - symbol.

FEDERAL GOVERNMENT / ACTIVITY	USACE	EPA	USF&WS	NOAA/OCZM	NOAA/NMFS	COAST GUARD	HUD	DOT	USDA	USGS	SEAGRANT	USAF/MACDILL
RESOURCE UTILIZATION												
- Boating and Navigation	* +			o +		* + -					o -	
- Commercial and Recreational Fishing			o + -	o +	* + -	o					o -	
- Public Access to Shoreline			* +	o +		*	* +				o -	
RESOURCE MANAGEMENT												
- Habitat Management	o	o	* + -	o +	o						o -	* -
- Fish and Wildlife Management	o	o	* + -	o +	* + -						o -	
- Shoreline Parks and Marine Preserves			* + -	o +	o							
- Protection of Water Quality	* + -	* + -	o	o	o	*			o +	o -	o -	
- Protection of Water Quantity	* + -		o							o -		
- Soil Conservation and Erosion Control	* + -	o		o +					* + -	o -	o -	
- Pest and Aquatic Weed Control		* + -	o						* + -			
- Hazardous Waste Disposal		* + -										
- Protection of Air Quality		* + -										
RESOURCE DEVELOPMENT												
- Dredge and Fill Activities	* + -	o	o		o	o	o +					
- Docks, Moorings, Bulkheads, Breakwaters	* + -	o	o		o	o +	o +					
- Bridges, Causeways, Roads, etc.	o	o	o		o	o +	o +	* + -				
- Canals, Levees, Salinity Structures, etc.	* + -	o	o		o		o +					
- Marina Siting	o		o	o +	o	o						
- Port Development and Operations	* +		o	o +	o	* +						
- Power Plant Siting	o	* +	o		o							
- Industrial Discharges and Operations		* +				*						
- Mining Discharges and Reclamation		* +										
- Urban Development and Public Works	o	o		o +	o		* +					

Agency

USACE = U.S. Army Corps of Engineers
EPA = Environmental Protection Agency
USF&WS = U.S. Fish and Wildlife Service
NOAA/OCZM = Office of Coastal Zone Management
NOAA/NMFS = National Marine Fisheries Service
HUD = Housing and Urban Development
DOT = Department of Transportation
USDA = U.S. Department of Agriculture
USGS = U.S. Geological Survey
USAF/MacDill = U.S. Air Force/MacDill AFB

Authority

* Regulation/Enforcement
o Review/Advisory
+ Planning/Policy Development
- Research/Education

STATE GOVERNMENT

ACTIVITY	DER	DNR	G&FWFC	DCA	DOT	DACS	MFC	ERC	GOPB	USF
RESOURCE UTILIZATION										
- Boating and Navigation		* + -							o	-
- Commercial and Recreational Fishing		* + -	* + -				o + -		o	-
- Public Access to Shoreline	o +	* + -	o	* + -				o +	o	-
RESOURCE MANAGEMENT										
- Habitat Management		* + -	* + -	o +			o + -	o +	o	-
- Fish and Wildlife Management		* + -	* + -	o +			o + -		o	-
- Shoreline Parks and Marine Preserves		* +	o	o +					o	-
- Protection of Water Quality	* + -	*	o	o +				o +	o	-
- Protection of Water Quantity	o		o	o +				o +	o	-
- Soil Conservation and Erosion Control	o +	* + -				* + -		o +	o	-
- Pest and Aquatic Weed Control	o	* + -				o +		o +	o	-
- Hazardous Waste Disposal	* + -			o +				o +	o	-
- Protection of Air Quality	* + -							o +	o	-
RESOURCE DEVELOPMENT										
- Dredge and Fill Activities	* + -	o	o	o					o	-
- Docks, Moorings, Bulkheads, Breakwaters	* + -	o	o						o	-
- Bridges, Causeways, Roads, etc.	o		o	o	* + -				o	-
- Canals, Levees, Salinity Structures, etc.	o		o	o					o	-
- Marina Siting	o	* + -	o	o +					o	-
- Port Development and Operations	o	o	o	o +					o	-
- Power Plant Siting	* + -	o	o	o +					o	-
- Industrial Discharges and Operations	* + -								o	-
- Mining Discharges and Reclamation	* + -	* + -	o						o	-
- Urban Development and Public Works	* + -			* + -					o	-

Agency

DER = Department of Environmental Regulation
DNR = Department of Natural Resources
G&FWFC = Game and Freshwater Fish Commission
DCA = Department of Community Affairs
DOT = Department of Transportation
DACS = Department of Agriculture and Consumer Services
MFC = Marine Fisheries Commission
ERC = Environmental Regulatory Commission
GOPB = Governors Office of Planning and Budget
USF = University of South Florida

Authority

* Regulation/Enforcement
o Review/Advisory
+ Planning/Policy Development
- Research/Education

REGIONAL AGENCIES / ACTIVITY	SWFWMD	TBRPC	TPA	WCRWSA	MPO
RESOURCE UTILIZATION					
- Boating and Navigation		o +	• + -		
- Commercial and Recreational Fishing		o +	o		
- Public Access to Shoreline		o +	o		
RESOURCE MANAGEMENT					
- Habitat Management	• + -	o + -	• + -		
- Fish and Wildlife Management	o	o +	o +		
- Shoreline Parks and Marine Preserves		o +	o		
- Protection of Water Quality	• + -	o + -	o + -		
- Protection of Water Quantity	• + -	o +		o + -	
- Soil Conservation and Erosion Control	o	o +	o		
- Pest and Aquatic Weed Control	• +	o +			
- Hazardous Waste Disposal	o +	o + -	o +		
- Protection of Air Quality		o +	o		
RESOURCE DEVELOPMENT					
- Dredge and Fill Activities	• +	o +	• +		
- Docks, Moorings, Bulkheads, Breakwaters		o +	• +		
- Bridges, Causeways, Roads, etc.	o	o +	• +		o + -
- Canals, Levees, Salinity Structures, etc.	• + -	o +	• +		
- Marina Siting		o + -	o		
- Port Development and Operations		o +	• + -		
- Power Plant Siting		o +	o		
- Industrial Discharges and Operations	• +	o +	o		
- Mining Discharges and Reclamation	o +	o +	o		
- Urban Development and Public Works	• +	• +	o		

Agency

SWFWMD = Southwest Florida Water Management District
TBRPC = Tampa Bay Regional Planning Council
TPA = Tampa Port Authority
WCRWSA = West Coast Regional Water Supply Authority
MPO = Metropolitan Planning Organizations

Authority

• Regulation/Enforcement
o Review/Advisory
+ Planning/Policy Development
- Research/Education

HILLSBOROUGH COUNTY

ACTIVITY	BOCC	EPC	DDC	CCPC	PARKS & REC.	M&AWC	HEALTH	W&W UTIL.	S&WCD	SHERIFF	BCC
RESOURCE UTILIZATION											
- Boating and Navigation	* +			o +						*	-
- Commercial and Recreational Fishing	* +	o		o	* +					*	-
- Public Access to Shoreline	* +	o +		o +	* +					*	-
RESOURCE MANAGEMENT											
- Habitat Management	* +	* +		o +	* +						-
- Fish and Wildlife Management	* +	* +		o +	* +						-
- Shoreline Parks and Marine Preserves	* +	o		o +							-
- Protection of Water Quality	* +	* +		o +			* +	* + -			-
- Protection of Water Quantity	* +	* +		o +				* + -			-
- Soil Conservation and Erosion Control	* +	* +		o +					* + -		-
- Pest and Aquatic Weed Control	* +	o		o		* +					-
- Hazardous Waste Disposal	* +	* +		o +							-
- Protection of Air Quality	* +	* +		o +			* +				-
RESOURCE DEVELOPMENT											
- Dredge and Fill Activities	* +	* +	o +	o							-
- Docks, Moorings, Bulkheads, Breakwaters	* +	*	o	o							-
- Bridges, Causeways, Roads, etc.	* +	*	o +	o +							-
- Canals, Levees, Salinity Structures, etc.	* +	* +	o +	o							-
- Marina Siting	* +	o	o +	o +							-
- Port Development and Operations	* +	o	o +	o +							-
- Power Plant Siting	* +	o	o +	o +							-
- Industrial Discharges and Operations	* +	* +	o	o							-
- Mining Discharges and Reclamation	* +	* +	* +	o							-
- Urban Development and Public Works	* +	* +	o +	o +				o +			-

Agency

BOCC = Board of County Commissioners
EPC = Environmental Protection Commission
DDC = Department of Development Coordination
CCPC = City-County Planning Commission
M&AWC = Mosquito and Aquatic Weed Control
W&W UTIL = Water and Wastewater Utilities
S&WCD = Soil and Water Conservation District
HCC = Hillsborough Community College

Authority

* Regulation/Enforcement
o Review/Advisory
\+ Planning/Policy Development
\- Research/Education

MANATEE COUNTY / ACTIVITY	BOCC	DPC	DL&NR	PLANNING & DEV.	MPA	NAVIGATION DIST.	MCD	PARKS & REC.	HEALTH	PUBLIC UTIL.	S&WCD	SHERIFF
RESOURCE UTILIZATION												
- Boating and Navigation	• +		o	o	• +	• +						•
- Commercial and Recreational Fishing	• +		o + -	o								o
- Public Access to Shoreline	• +	o +	o	o +		o +		• +				•
RESOURCE MANAGEMENT												
- Habitat Management	• +	• +	o -	o +		o		• +				
- Fish and Wildlife Management	• +	• +	o -	o +		o		• +				
- Shoreline Parks and Marine Preserves	• +	o	o -	o +		o		• +				
- Protection of Water Quality	• +	• +	• +	o +		o				• +		
- Protection of Water Quantity	• +	o	• +	o +		o +			• +	• +		
- Soil Conservation and Erosion Control	• +	• +	• + -	o +		o					• + -	
- Pest and Aquatic Weed Control	• +	o	o -	o			• +					
- Hazardous Waste Disposal	• +	• +	o	o +								
- Protection of Air Quality	• +	• +	o	o +								
RESOURCE DEVELOPMENT												
- Dredge and Fill Activities	• +	• +	o	o +	o	o +						
- Docks, Moorings, Bulkheads, Breakwaters	• +	•	o	o +	o	o +						
- Bridges, Causeways, Roads, etc.	• +	•	o	o +	o	o +						
- Canals, Levees, Salinity Structures, etc.	• +	•	o	o +		o +						
- Marina Siting	• +	o	o	o +	o	o +						
- Port Development and Operations	• +	o		o +	• +	o +						
- Power Plant Siting	• +	• +		o +	o	o						
- Industrial Discharges and Operations	• +	• +		o		o						
- Mining Discharges and Reclamation	• +	• + -	• + -	o								
- Urban Development and Public Works	• +	• +		o +						• +		

Agency

BOCC = Board of County Commissioners
DPC = Department of Pollution Control
DL&NR = Department of Land and Natural Resources
MPA = Manatee Port Authority
MCD = Mosquito Control District
S&WCD = Soil and Water Conservation District

Authority

• Regulation/Enforcement
o Review/Advisory
+ Planning/Policy Development
- Research/Education

PINELLAS COUNTY / ACTIVITY	BOCC	DEM	W&NCA	PLANNING	MC&AR	PARKS	HEALTH	SEWER	ENG. & PUBLIC WORKS	S&WCD	SHERIFF	SPJC
RESOURCE UTILIZATION												
- Boating and Navigation	• +		• +	o							•	-
- Commercial and Recreational Fishing	• +					• +					•	-
- Public Access to Shoreline	• +	o +	• +	o +	o	• +					•	-
RESOURCE MANAGEMENT												
- Habitat Management	• +	• +		o +	• +	• +						-
- Fish and Wildlife Management	• +	• +		o +		• +						-
- Shoreline Parks and Marine Preserves	• +	o		o +		• +						-
- Protection of Water Quality	• +	• +		o +			o +	• + -	•			-
- Protection of Water Quantity	• +	• +	• +	o +					•			-
- Soil Conservation and Erosion Control	• +	• +		o +						• + -		-
- Pest and Aquatic Weed Control	• +	o			• +							-
- Hazardous Waste Disposal	• +	• +		o +								-
- Protection of Air Quality	• +	• +		o +			o +					-
RESOURCE DEVELOPMENT												
- Dredge and Fill Activities	• +	• +	• +	o					•			-
- Docks, Moorings, Bulkheads, Breakwaters	• +	•	• +	o					•			-
- Bridges, Causeways, Roads, etc.	• +	•	•	o +					•			-
- Canals, Levees, Salinity Structures, etc.	• +	•	• +	o +					•			-
- Marina Siting	• +	o	• +	o +								-
- Port Development and Operations	• +	o	• +	o +								-
- Power Plant Siting	• +	o	o	o +								-
- Industrial Discharges and Operations	• +	• +		o								-
- Mining Discharges and Reclamation	• +	o		o								-
- Urban Development and Public Works	• +	• +	o	o +				o +	• +			-

Agency

BOCC = Board of County Commissioners
DEM = Department of Environmental Management
W&NCA = Water and Navigation Control Authority
MC&AR = Mosquito Control and Artificial Reef
S&WCD = Soil and Water Conservation District
SPJC = St. Petersburg Junior College

Authority

• Regulation/Enforcement
o Review/Advisory
+ Planning/Policy Development
- Research/Education

ACTIVITY \ CITY OF TAMPA	URBAN ENVIRON. COORD.	PARKS	PUBLIC WORKS	SANITARY SEWER	POLICE	UNIV. OF TAMPA
RESOURCE UTILIZATION						
- Boating and Navigation					*	-
- Commercial and Recreational Fishing		*			*	-
- Public Access to Shoreline	o +	* +			*	-
RESOURCE MANAGEMENT						
- Habitat Management		* + -				-
- Fish and Wildlife Management		* + -				-
- Shoreline Parks and Marine Preserves	o +	* + -				-
- Protection of Water Quality	o +			* + -		-
- Protection of Water Quantity	o +		* + -			-
- Soil Conservation and Erosion Control	o +					-
- Pest and Aquatic Weed Control	o +	o				-
- Hazardous Waste Disposal	o +					-
- Protection of Air Quality	o +					-
RESOURCE DEVELOPMENT						
- Dredge and Fill Activities	o +					-
- Docks, Moorings, Bulkheads, Breakwaters	o +					-
- Bridges, Causeways, Roads, etc.	o +					-
- Canals, Levees, Salinity Structures, etc.	o +					-
- Marina Siting	o +					-
- Port Development and Operations	o +					-
- Power Plant Siting	o +					-
- Industrial Discharges and Operations	o +			* + -		-
- Mining Discharges and Reclamation	o +					-
- Urban Development and Public Works	o +		* +			-

Authority

* Regulation/Enforcement
o Review/Advisory
+ Planning/Policy Development
- Research/Education

CITY OF ST. PETERSBURG / ACTIVITY	POLLUTION CONT.	PLANNING	URBAN REDEVELOPMENT	PORT AUTHORITY	LEISURE SERVICES	PU&WT	ENGINEERING	POLICE	ECKERD COLLEGE
RESOURCE UTILIZATION									
- Boating and Navigation		o +						*	-
- Commercial and Recreational Fishing					*			*	-
- Public Access to Shoreline		o +			* +			*	-
RESOURCE MANAGEMENT									
- Habitat Management	o	o +			* + -				-
- Fish and Wildlife Management		o +			* + -				-
- Shoreline Parks and Marine Preserves		o +			* + -				-
- Protection of Water Quality	* + -	o +				* + -			-
- Protection of Water Quantity		o +				* + -			-
- Soil Conservation and Erosion Control	o +	o +							-
- Pest and Aquatic Weed Control	o +	o +							-
- Hazardous Waste Disposal	* +	o +							-
- Protection of Air Quality	* + -	o +							-
RESOURCE DEVELOPMENT									
- Dredge and Fill Activities	o +	o +					o		-
- Docks, Moorings, Bulkheads, Breakwaters		o +					o		-
- Bridges, Causeways, Roads, etc.		o +					o		-
- Canals, Levees, Salinity Structures, etc.		o +				o			-
- Marina Siting		o +							-
- Port Development and Operations		o +		o +					-
- Power Plant Siting		o +							-
- Industrial Discharges and Operations		o +				* + -			-
- Mining Discharges and Reclamation		o +							-
- Urban Development and Public Works		o +	o +			* +	o		-

Agency

PU&WT = Public Utilities and Wastewater Treatment

Authority

* Regulation/Enforcement
o Review/Advisory
\+ Planning/Policy Development
\- Research/Education

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Respectfully submitted,

Peter A. Clark, Project Manager
Agency on Bay Management
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