Lemon Bay Wtr Qlty Study

EXECUTIVE SUMMARY

208 PROGRAM WATER QUALITY

STUDY OF THE

LEMON BAY COMPLEX STUDY AREA

FOR DISCUSSION PURPOSES ONLY

Prepared for:

The Southwest Florida Regional Planning Council

by:

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INTRODUCTION

In recent years the people of the Lemon Bay area have experienced an apparent decline in water quality and fishing in the Bay. Traditional clam and oyster beds have been closed. The scallops have all but disappeared. From the 1960's to the present local fish kills and Winter-Spring blooms of blue green algae have caused public concern as have wet season periodic reports of coliform/fecal coliform contamination of surface water in road-side ditches in residential-commercial areas. Beginning in the early 1960's the area has also experienced a steady increase in resident and tourist populations. These and other environmental concerns for human health, safety and welfare led to the inclusion of the Lemon Bay Area in the SWFRPC 208 Water Quality Study Program.

The overall concerns, goals and priorities for the Lemon Bay Complex of the regional 208 Program were summarized in the Basin I Priorities Workshop, Coastal Sarasota Basin 208 Advisory Committee, April 22, 1976 after a series of public meetings and two technical summaries of existing information and water quality problems by SWFRPC consultants.

The potential environmental hazards of malfunctioning onsite wastewater systems caused by improper installation and maintenance, soil drainage, and flooding conditions, initially directed the focus of the Lemon Bay Complex Study toward septic tanks and their non-point source contributions to nutrient and pollutant loading and lowered water quality in the receiving waters of the Lemon Bay area. In addition, upland runoff and surface-subsurface drainage patterns were to be examined for their contribution to the wasteload entering the receiving waters. Finally, the wasteload budget and transport for the entire area were to be determined. The work scope of the study is outlined in Appendix A of the Technical Report.

In the Technical Report we collated and summarized a variety of information on the existing and historical environmental conditions in the Lemon Bay Area. The various environmental parameters associated with non-point sources of nutrients and pollutants are discussed. Finally, recommendations and topics for further consideration and study are suggested for onsite wastewater systems, land uses, and regional planning.

While most of the information presented in the Technical Report was gleaned from reports by local, regional, and state agencies and their consultants, we did not review these reports in detail. Rather we utilized these and other data to develop a baseline analysis of existing non-point pollution sources, land uses, and water quality. Our analysis included the following: geographical setting, climate, physical features, demographic and land use overviews, a synopsis of existing water quality and hydrographic information, the 208 Water Quality Study, and recommendations.

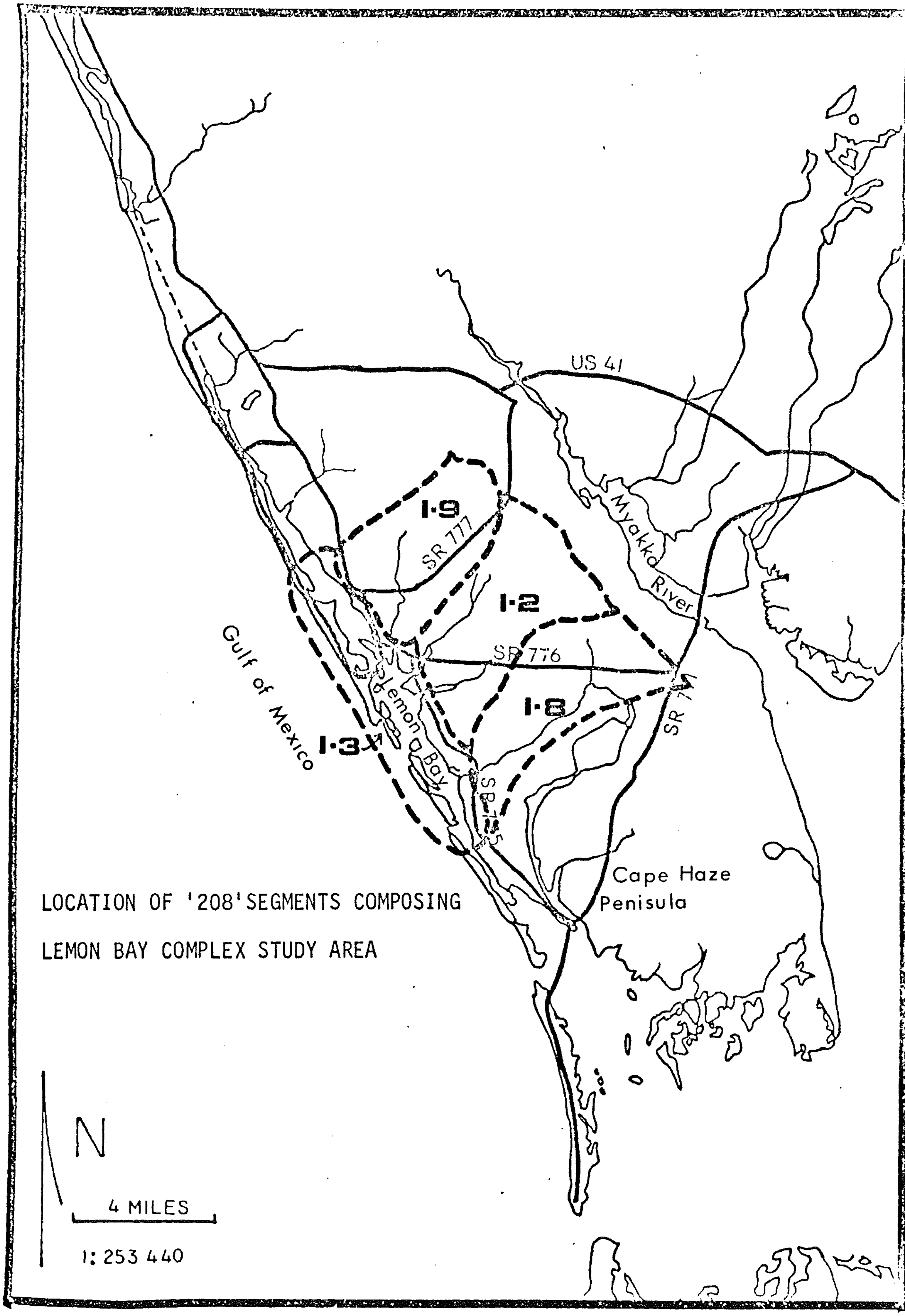
GEOGRAPHICAL SETTING

The general location of the Lemon Bay 208 Complex is shown in Figure 1. The Complex includes the following coastal Sarasota segments: Segment I-3, Lemon Bay; Segment I-9, Gottfried Creek drainage basin; Segment I-2, Ainger and Oyster Creek drainage basins; and Segment I-8, Buck Creek drainage basin. The Forked Creek basin at the northern end of Lemon Bay was not included because a tidal current study in 1974 reported that tidal nodes occurred south of Forked Creek and at Palm Island Cut (The narrows) at the southern end of the Bay.

Lemon Bay is a 15 mile long narrow embayment separated from the Gulf of Mexico by two barrier islands, Manasota Key and Knight Island. It is directly connected to the Gulf of Mexico by Stump Pass between these islands. Secondary connections with the Gulf are via Placida Harbor and Gasparilla Pass to the south and the Venice By-Pass Canal of the Intracoastal Waterway to the north. Historically there were three additional passes in the Lemon Bay area - Blind Pass on Manasota Key, Bocillia Pass between Knight and Don Pedro Island, and Little Gasparilla Pass between Don Pedro and Little Gasparilla Island.

Over the last 100 years the uplands bordering the Bay evolved into several unincorporated communities - Englewood, Grove City, and Englewood Beach. In addition scattered resorts and homes occur on the margins of the Bay and its tributaries. Although still unincorporated with the north half in Sarasota County and the southern half in Charlotte County, the Englewood-Lemon Bay area has a degree of geographic cohesiveness because of the quasi-governmental unit, the Englewood Water District (EWD). The area serviced by the EWD (Figure 2) with few exceptions encompasses the developed areas within the Lemon Bay 208 Complex. In addition to the EWD, the Englewood Chamber of Commerce and various civic groups have played key roles in maintaining the area as a single community.

Figure 1. Location of "208" study segments (I-2, I-3, I-8, I-9) composing Lemon Bay Complex study area.



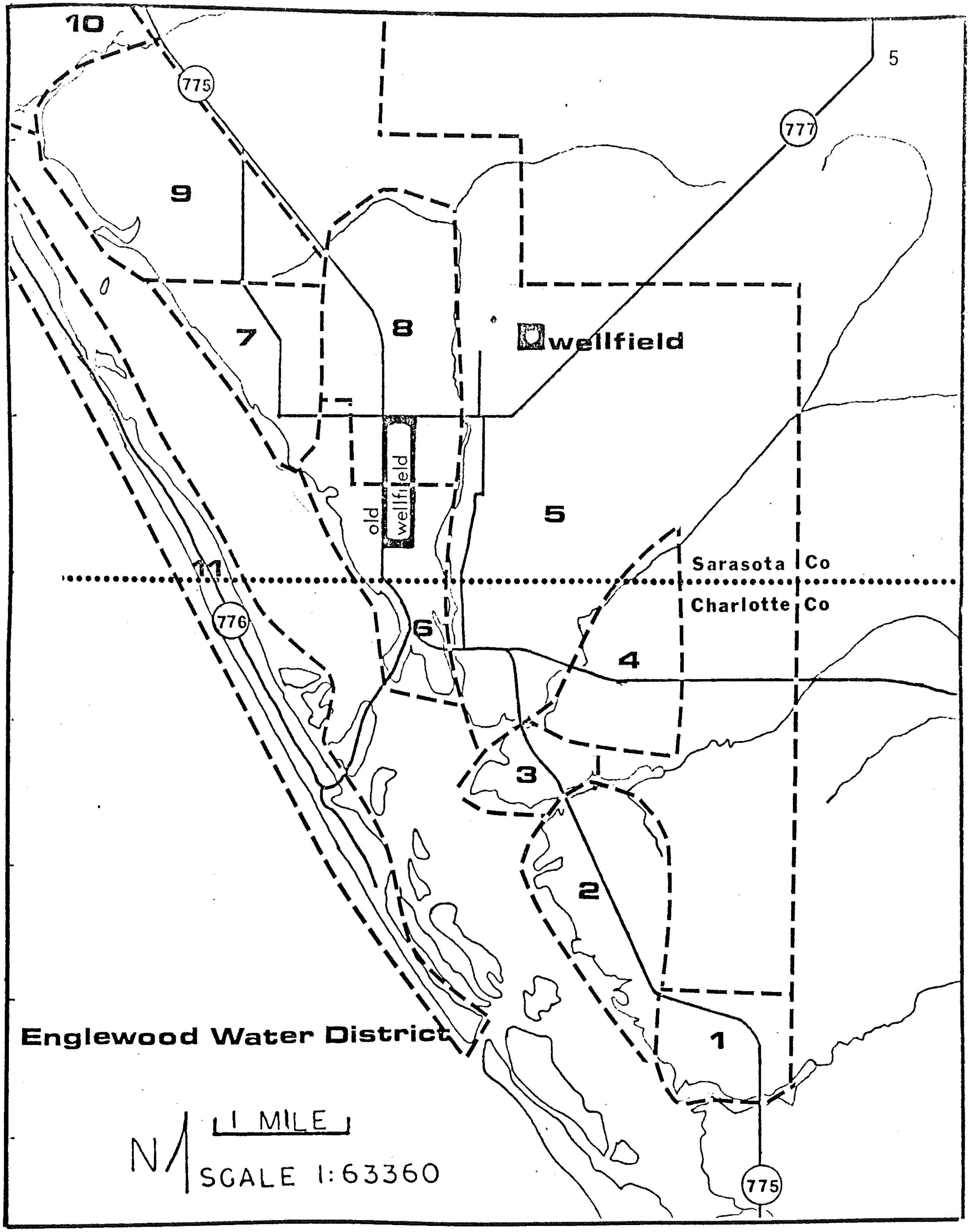


Figure 2. Geographical limits of Englewood Water District, subdistricts, and locations of well fields. Note: subdistricts 10 and 11 extend northward to the Manasota Key Bridge.

HISTORY OF LAND USE AND POPULATION DISTRIBUTION

The apparent decline in water quality of Lemon Bay and its tributaries in recent years is the result of nearly a hundred years of changing land use practices on the several watersheds and the evolution of a rural, seasonal, fishing, resort community into an expanding suburban retirement, resort community. Some of the highlights of this evolution are summarized in Table 1.

The early settlers built on the highest land and land most suitable for on site wastewater treatment systems. Lands less suited for homesites because of seasonal flooding were cleared for small farms and later clear cut for timber. Following clear cutting in the early 1900's most of the creek watersheds became unimproved pastureland for range cattle. Following World War II the population increased steadily with homesites extending upstream along the shores of the tidal creeks and dead end canals off the creeks. During this period homesites increased rapidly on Manasota Key and on the mainland side of Lemon Bay. Beginning in the late 1960's large land developments have altered the upstream drainage basins and watersheds of Buck, Oyster and Ainger Creeks. In the 1970's small tract developments began to extend inland from the Bay and its tributaries on to lands less suited for on site wastewater facilities. All of these land use and development activities as well as the dredging of the Intracoastal Waterway in the mid-1960's have contributed to increases in nutrients, pollutants and silt to the Bay and its tributaries.

As of 1976 more than 80 percent of the developed lands in the Lemon Bay watershed had two or less housing units per acre. Those areas with three or more housing units per acre were limited to trailer and mobile home parks and condominiums, nearly all of which had small wastewater treatment plants (total of 22).

Nearly all of the housing units (3295) fronting on the creeks and Bay are single family units whose on site septic tank systems have been suspected as being major contributors to the wasteload of the adjoining surface waters. Of these waterfront housing units some 1434 were built prior to 1972 when the current septic tank system regulations were initiated. These septic tank systems in particular may be contributing to the wasteload of the surface waters because of improper siting, installation and maintenance. Furthermore, septic tank systems sited along the shores of the Bay on filled land on top of mangrove peaty soil may not function properly.

In addition to the potential waste loads from septic tank systems, other sources may contribute to the overall waste loads of the creeks and Bay. These sources include twelve waterfront marinas and their service facilities; run off from unimproved and improved pastureland in the watersheds of Gottfried, Ainger and Oyster Creeks; and large land clearing and land development activities in the watersheds of Oyster and Buck Creeks. Except along the major highways wasteloads from roadside surface run off is reduced since most roadside drainage ditches are shallow and vegetated. However, these and other man-made drainage networks have altered the historical flow patterns of surface water run off.

Our shoreline survey of the Bay and creeks showed that more than 70 percent of the natural shores have been either disturbed or altered by the construction of seawalls. Nevertheless, a significant percentage of the shorelines on the individual creeks and the Bay in the suburban area are still in a natural state (i.e., Lemon Bay, 22%; Gottfried Creek, 22%; Ainger Creek, 11%; Oyster Creek, 41%; and Buck Creek, 82%). These shores and the adjoining flood prone upland areas constitute the region's major environmental conservation elements and are critical in the overall biological tertiary treatment and assimilation of wasteloads from various upland sources including ground water seepage.

Table 1. Historical sketch of certain events leading to present day land use and water quality conditions in the Lemon Bay area.

Date	Event	Estimated Resident Population
1850-1870	First settlers bring "woods cows" and razor back hogs	
1850-1900	Woods cows in herds roam Englewood area.	
1866	Grove City first laid out in woodlands.	
1870	Goff family raised rice in slough at head waters of Oyster Creek.	
1883	Hamilton Disston purchased 600 acres of Grove City area for 25¢/acre. Subsequently land went through eight different owners.	
1886	January freeze one of the worst known.	
1894-95	Freezes on December 29-30, 1894 and February 9, 1895 after 2-3 weeks of rain.	
1896	Lemon Bay Company filed a plat for town of Englewood. 2000 acres, 24 city blocks and 96 ten acre "grove" lots. Residential lots were 1 acre (two city lots). Before this, area called Vineland.	
1903	Summer rainy season, ground between Englewood and Venice covered with water, especially in the area called Woodmere.	
1911	June, 14 days of rain, Myakka River was 10 feet higher than ever recorded, high water line on trees 10-20 feet above ground.	
1890-1919	Englewood had a small sawmill and turpentine stills.	
1917-18	Englewood road (S.R. 775) to Sarasota built with local rock from Deer (Gottfried) Creek,	
1918	Manasota Lumber Company established a mill town near junction of S.R. 775 and U.S. 41 and clear cut the pine flat woods of Cape Haze peninsula.	
1921	In the hurricane of that year the water in Lemon Bay reached the second story of the present-day Tate Buchanan House and flooded for blocks inland	
1926	Hurricane-storm resulted in extensive flooding.	
1926	Englewood incorporated as a 13 square mile tract, 12 miles of water frontage of which 4 miles were on Gulf; 2 years later was again unincorporated.	300
1928	The Tamiami Trail (Highway 31l, now SR775) passed through Englewood.	

Sources: Josephine O. Cortes. 1976. The History of Early Englewood. Mr. Beryl Chadwick, Englewood, Dr. Stewart Springer, Placida. Newspaper articles on file in public libraries of Grove City and Englewood.

Date	Event	Estimated Resident Population
1930's-1940's	The deforested Cape Haze Peninsula became open range cattle land. Tamiami Trail (U.S. 41) re-routed to by-pass Englewood.	
1939	Local red tide with thousands of fish washed ashore in Englewood.	
1940	Grove City, over 1000 acres acquired by Grove City Land Realty Corp, Samuel Spinosa, President. Between then and early 1950's, small lots (many with 30 foot frontage) were consolidated and the whole area was replatted into 100 x 100 foot lots.	
1948	Florida Fence Law abolished open range land.	
1948	West Branch of Gottfried Creek with drainage ditch as far as S.R. 775. Subsequently the sloughs of north and east branch linked to creek by drainage ditches.	
1948-1952	Sloughs at head waters of Ainger Creek connected by drainage ditch. Subsequently a drainage ditch linked sloughs of Buck Creek basin to Ainger Creek.	
1951	E. Vanderbilt purchased 54 square mile tract (35,000 acres) on Cape Haze peninsula.	
1952	E. Vanderbilt opened Two V Ranch with 1,000 certified cattle. At one time an estimated 5,000 head of cattle roamed this ranch land. Vanderbilt also purchased land along Lemon Bay (Cape Haze) and on Manasota Key. He and his family were instrumental in promoting the area for seasonal residents.	
1954	Residential restrictions placed on development in Grove City by Grove City Land Realty Corporation.	
1955	Following this year canals and electric lights added to Grove City area.	
1956	Population reported to double in winter tourist season.	1,400
1960		5,000
1961	Lemon Bay hardshell clam industry had been declining for 15 years because of gradual silting.	
1963-68	Englewood Water District and central well water plant established.	
1963-65	Intracoastal waterway dredge and dredge spoil placed on mangrove islands, submerged grass flats, fringe mangrove shores and uplands the length of Bay. Residents determined not to have spoil islands in the Bay but willingly accepted spoil on submerged lands adjacent to shores.	

Date	Event	Estimated Resident Population
1964	Paulson Point (Furbeck's Point), Englewood, site of Indian Mounds. Diked and filled with dredged spoil.	7,500
	Blind Pass Island, Manasota Key. 30 acres of uplands created by placing spoil on grass flats and 17 acres of mangroves.	
	In the Manasota Key section south of Manasota Key Bridge a dike of spoil parallel to Waterway outlined the proposed future shoreline of the Key and an area of grass flat to be filled with spoil thereby doubling the width of the Key.	
1965(?)	Venice Cut opened, linking the waters of Lemon Bay with Roberts Bay and Venice Pass. The result was a marked change in tidal circulation and seasonal salinity gradients in upper Lemon Bay.	
1965-67	Rotunda West began to be developed intercepting Buck Creek and Coral Creek drainage basin systems.	
1968	Buck Creek and west branch of Coral Creek intercepted by a segment of proposed circular canal with overflow wiers placed on each creek.	10,000
1969		12,000
1970		13,000
1971	Rotunda West Circular Canal or River partially completed.	14,000
1972		15,864
1972-73	Oyster Creek channelized between S.R. 45A (776) and Sarasota-Charlotte County line with drainage basin north of county line intercepted by an east-west canal and spoil dike.	
1973		17,906
1974	Gasparilla Pines Golf Course intercepted Lemon Creek drainage basin east of S.R. 775. Control wier and dike across the creek just east of S.R. 775.	
1975	Spring, large outbreak of blue-green algae. GDC received D.E.R. permit to place a wier on the upper reaches of Ainger Creek.	18,803
1976		18,880
1977	Cape Cave Corporation received D.E.R. permit to dike Buck Creek and construct two retention ponds and "grassy" filters in pine flatwoods along Buck Creek, west of Rotunda West.	

WATER QUALITY STUDIES

In keeping with other segments of the 208 Water Quality Program of the Southwest Florida Regional Planning Council, the goals of the water quality study of the Lemon Bay Complex were two-fold - to develop a pollutant loading or mass balance equation for nutrients and other pollutants in Lemon Bay and to determine the contribution of septic tank systems to the wasteload. An intensive 2-day, dry season, network sampling program was designed to determine the potential contribution of septic tank systems without interference or masking by surface water run off and other ground water non-point sources. Records of the Englewood Water District and population data showed that more water is used during the dry season (Feb. to May) than any other season and that the tourist and resident population is highest at this time of the year. The sampling period of March 26-27, 1977 coincided then with the peak residential-tourist population, a three-week period of only 0.8 inches total rainfall and a weekend of intensive boating activity and sport fishing. The tides were of the mixed diurnal variety with a short flood tide followed by a long ebb tide and then a long flood tide. Thus the water sampling study should represent the "worst case" conditions of dry season water quality and the maximum dry season season levels of pollutant-nutrient loads of the tidal creeks and Lemon Bay. An abbreviated wet season water quality study was also performed in August, 1977.

In the March (dry season) study water samples from 18 sampling stations were collected during each phase of two tide cycles and analyzed for 18 water quality parameters. The locations of the sampling stations shown in Figure 3 were chosen so that at least one station was upstream of developed areas on

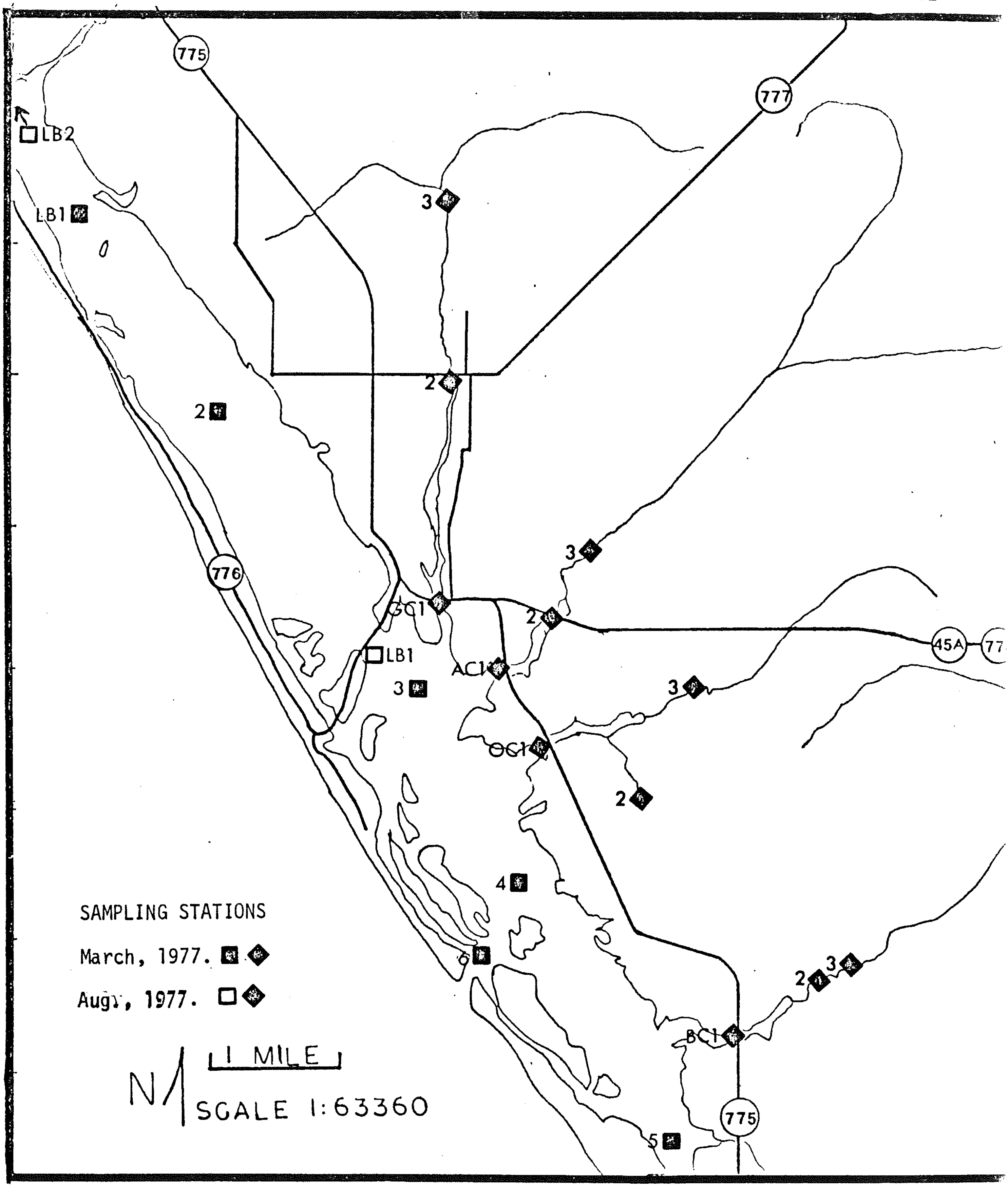


Figure 3. Locations of water sampling stations for Lemon Bay '208' Study, 1977. LB, Lemon Bay; GC, Gottfried Creek; AC, Ainger Creek; OC, Oyster Creek; BC, Buck Creek.

each creek and one station near the mouth of each creek. Of the six stations in Lemon Bay one was at Stump Pass, one was near the northern tidal node and one was near the southern tidal node in the Bay. In addition, the Florida State Department of Regulation performed limiting nutrient algal assays of water samples from Lemon Bay.

The most pertinent water quality data from the eight sample runs are summarized in Tables 2, 3, 4, and 5 for sample runs A, C, E and G. Runs A and E, near the end of an ebbing tide, represent the worst water quality situation. Runs C and G, near the end of a flooding tide, represent the best water quality situation.

In general the water quality was higher in Lemon Bay than in the four tidal creeks and the water quality at station 1 near the mouth of each creek was higher than at station 3 upstream of the developed area of each creek. In Lemon Bay the lowest quality water occurred at LB station 1 south of Forked Creek. The limiting nutrient algal assays on Lemon Bay water samples showed that phosphorus was in limited concentrations in the area of Lemon Bay directly influenced by tidal exchange with the Gulf of Mexico via Stump Pass and that nitrogen was a limiting factor in Lemon Bay south of Forked Creek. The algal assays further showed that at the time of sampling the waters at stations LB 3, 4, 5, and 6 were capable of supporting only reduced algal growths and waters at stations LB 1 and 2 could support moderate algal growth. The algal assays and the tidal current patterns in Lemon Bay suggest that the more nutrient rich waters of northern Lemon Bay influence the middle reaches of Lemon Bay during ebb tides.

A current meter and current drogue study at the northern end of Lemon Bay and in the Venice By-Pass Canal off of Alligator Creek showed that the waters

Table 2. Results of Water Quality Study, Lemon Bay Complex, March 26, 1977.
Run A; Time, 0900-100; Low slack water after 0.1 foot ebb tide.

Samples Stations

Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC	BC	BC
Salinity	PPTH	35.3	36.1	36.9	37.7	37.7	37.7	35.1	30.3	1.2	34.4	35.3	29.5	35.3	34.4	34.4	35.7	1.1	0.9
Turbidity	FTU	4.3	6.5	4.4	4.2	5.1	1.9	1.7	2.6	0.8	2.9	2.0	1.9	2.4	3.8	4.0	1.8	1.7	3.0
pH	Units	8.3	8.2	8.1	8.1	8.2	8.1	7.8	7.7	8.0	8.0	7.8	7.7	8.0	7.7	7.7	7.9	7.6	7.9
D.O.	mg/l	8.3	8.0	7.7	7.8	7.5	8.1	4.1	4.5	5.3	4.6	4.0	5.6	5.5	4.0	2.5	4.8	5.1	5.3
B.O.D.	mg/l	3.7	3.4	1.6	1.3	2.5	1.6	2.2	3.2	0.7	1.8	1.5	3.2	1.8	4.0	2.5	1.4	0.9	1.9
O-PO_4-P	mg/l	.009	.005	.005	.005	.005	.005	.013	.050	.102	.008	.010	.006	.005	.012	.011	.005	.006	.005
Tot. PO_4-P	mg/l	.016	.010	.005	.005	.008	.010	.025	.106	.125	.022	.020	.012	.027	.056	.032	.007	.112	1.41
NO_3-N	mg/l	.013	.011	.005	.005	.011	.006	.013	.006	.005	.011	.013	.013	.006	.013	.013	.014	.009	.015
TKN	mg/l	1.04	1.05	.61	.80	.56	.76	1.11	1.91	1.38	.90	1.25	1.65	.72	1.47	1.68	1.42	1.77	1.45
NH_3-N	mg/l	.001	.001	.001	.001	.001	.001	.048	.109	.018	.049	.068	.024	.036	.042	.046	.038	.088	.019
TOC	mg/l	13	23	9.5	7	12	9	14	17	27.5	15.5	14.5	17.5	12.5	16	14	13	18.5	31
Total Coli	#/100ml	0	20	0	0	0	0	0	80	440	0	100	40	40	180	100	40	1160	1700
Fecal Coli	#/100ml	10	0	0	0	0	0	0	0	160	30	0	0	0	140	0	10	20	30
Fecal Strep	#/100ml	10	0	0	0	0	0	10	30	540	0	40	0	10	140	70	120	30	30

Table 3 Results of Water Quality Study, Lemon Bay Complex, March 26, 1977. Run E; Time, 2330-2430; Tide, end of ebb tide, 1.9 foot fall over 7 hours

Samples Stations

Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Salinity	PPTH	34.4	36.1	36.1	35.7	36.1	36.1	34.4	38.7	1.2	34.3	32.8	28.4	35.3	33.6	32.8	36.5	0.9	0.7
Turbidity	FTU	2.9	4.6	6.4	4.4	3.2	6.4	1.7	2.6	1.2	2.4	2.7	2.7	2.4	3.3	3.7	1.8	1.7	2.5
pH	Units	7.9	8.1	8.1	8.1	8.0	8.1	7.7	7.7	8.0	7.7	7.7	7.7	7.8	7.7	7.6	7.8	7.8	7.9
D.O.	Mg/1	7.8	7.8	7.8	8.5	6.9	7.7	5.3	5.9	1.7	5.6	5.5	5.6	4.4	5.2	5.0	5.0	6.6	6.0
B.O.D	Mg/1	3.7	3.4	2.4	1.6	1.8	1.9	1.5	1.9	1.1	1.4	1.4	1.6	1.4	3.1	3.7	2.0	0.9	2.2
$O-PO_4-P$	Mg/1	.013	.008	.005	.005	.005	.005	.019	.049	.082	.010	.008	.005	.008	.013	.013	.005	.005	.005
Tot. PO_4-P	Mg/1	.031	.017	.005	.005	.005	.005	.019	.056	.084	.011	.012	.008	.011	.021	.021	.005	.005	.005
NO_3-N	Mg/1	.005	.007	.013	.005	.005	.005	.005	.007	.013	.006	.015	.006	.011	.011	.005	.013	.020	.006
TKN	Mg/1	.85	.57	1.05	1.00	.75	.80	.71	1.17	1.28	.80	.92	.77	1.02	1.05	.89	1.01	1.36	1.24
NH_3-N	Mg/1	.001	.001	.001	.001	.001	.001	.071	.015	.023	.028	.030	.001	.048	.001	.001	.062	.099	.001
TOC	Mg/1	13	12.5	-	12.5	9	11	13	15	33	13.5	13	14.5	11	15	15	15.5	-	27.5
Total Coli	#/100ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coli	#/100ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Strep	#/100ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 Results of Water Quality Study, Lemon Bay Complex, March 26, 1977. Run C; Time 1600-1700; High tide, slack water, after 1 foot rise over 7 hours.

Samples Stations

Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Salinity	PPTH	35.3	35.3	36.1	36.1	36.1	35.3	35.3	31.0	1.2	36.8	33.6	30.3	36.2	34.4	34.4	36.5	1.0	0.7
Turbidity	FTU	3.9	5.0	3.1	4.0	2.7	1.9	2.3	3.0	2.7	2.4	2.2	2.6	3.2	2.1	3.5	2.1	2.2	2.1
pH	Units	8.1	8.1	8.1	7.9	8.1	7.9	8.1	7.7	8.7	8.2	7.9	7.8	8.0	7.7	7.8	8.0	8.1	8.1
D.O.	Mg/l	9.8	9.7	8.6	8.4	7.5	8.6	9.4	6.1	14.8	10.0	7.2	8.3	7.8	6.3	5.2	9.6	7.6	7.5
B.O.D.	Mg/l	4.3	4.0	1.3	1.7	2.0	1.8	2.6	3.5	2.2	2.0	1.2	4.0	1.2	3.1	3.8	1.9	1.4	-
O-PO_4-P	Mg/l	.012	.005	.005	.005	.005	.005	.006	.036	.076	.005	.008	.006	.035	.014	.012	.028	.007	.005
Tot. PO_4-P	Mg/l	.030	.005	.005	.005	.005	.005	.012	.170	.082	.012	.016	.012	.037	.018	.029	.034	.007	.013
NO_3-N	Mg/l	.005	.005	.011	.005	.005	.005	.034	.013	.030	.005	.012	.005	.005	.007	.005	.007	.022	.005
TKN	Mg/l	1.00	.77	.97	.56	.77	1.02	.81	1.04	1.42	.56	1.23	1.34	.79	.96	.95	.69	1.38	1.30
NH_3-N	Mg/l	.001	.001	.001	.020	.001	.045	.015	.035	.018	.015	.056	.015	.078	.046	.078	.036	.098	.079
TOC	Mg/l	12.5	7.5	7.	10.5	9.5	10.5	13	15	-	10.5	14	19.5	12.5	17	16	11.5	28.5	35.5
Total Coli	#/100ml	0	0	0	0	0	0	20	60	1280	0	420	60	20	160	180	40	360	760
Fecal Coli	#/100ml	0	0	0	0	0	0	10	20	0	0	110	0	60	0	100	0	10	-
Fecal Strep	#/100ml	10	0	0	0	0	10	10	70	260	160	60	70	50	3030	260	20	200	150

Table 5 Results of Water Quality Study, Lemon Bay Complex, March 27, 1977. Run G; Time, 1600-1700; near end of flood tide (1.8 foot rise over 17 hours).

Samples Stations

Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Salinity	PPTH	35.4	36.1	36.5	36.6	36.8	36.8	36.5	32.8	1.4	36.9	35.3	32.8	36.5	33.6	34.4	38.5	1.3	0.9
Turbidity	FTU	5.7	6.1	7.2	5.0	9.0	9.5	2.2	4.7	1.9	3.6	2.4	2.7	3.4	2.7	2.8	2.8	1.7	2.4
pH	Units	8.1	8.2	8.1	8.0	8.1	8.1	8.1	7.8	8.6	8.3	8.1	7.9	8.3	8.0	7.9	8.2	8.0	8.0
D.O.	mg/l	7.9	8.7	8.0	7.9	7.7	7.5	8.1	8.1	15.2	12.8	8.1	8.2	9.5	8.5	7.1	11.2	8.8	7.7
B.O.D.	mg/l	3.1	2.4	1.1	1.1	1.7	1.0	2.1	3.6	1.6	3.8	1.2	3.2	1.5	3.3	2.7	2.7	1.1	1.8
O-PO_4-P	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tot. PO_4-P	mg/l	.031	.036	.005	.006	.005	.002	.013	.046	.104	.010	.006	.022	.008	.022	.016	.005	.006	.005
NO_3-N	mg/l	.032	.029	.032	.029	.040	.031	.040	.041	.034	.040	.042	.033	.039	.048	.040	.047	.046	.040
TKN	mg/l	.89	.85	.046	.49	.51	.36	.94	1.36	1.34	.80	.66	.76	.55	1.14	1.13	.79	.63	.64
NH_3-N	mg/l	.001	.001	.001	.001	.001	.001	.055	.001	.015	.020	.026	.015	.026	.001	.010	.015	.057	.010
TOC	mg/l	12.5	12.5	9.5	12	10	12	14.5	17.5	-	16	15.5	19	11	16	15.5	16.5	30	30.5
Total Coli	#/100ml	0	0	0	0	0	20	-	60	1920	260	280	40	160	60	120	120	1160	TNTC
Fecal Coli	#/100ml	10	0	0	0	0	0	0	30	90	50	100	10	40	10	30	10	40	30
Fecal Strep	#/100ml	0	0	0	0	0	0	0	10	140	20	100	20	50	80	160	0	40	10

entering the By-Pass Canal from Alligator Creek and Red Lake flow northward toward Venice and that the water near the mouth of Forked Creek also tends to flow northward. The results of our studies and other studies on the waters of Lemon Bay indicate that even before the Intracoastal Waterway, the area of Lemon Bay north of Forked Creek exhibited nutrient rich, low quality water due to poor tidal flushing and mixing.

Our current drogue studies of the ebb tide flow of water in Gottfried, Ainger and Oyster Creek indicate that the downstream, suburban segments of these creeks exhibit good tidal flushing during most tidal cycles. Once these downstream waters enter the Bay, they tend to flow over the shallow grass flats along the eastern shore of the Bay before passing into the Gulf through Stump Pass. The shallows of the creeks and the grass flats function as physical and biological filters. Upstream of a certain point on each creek is a seasonably variable stream segment where the water quality is low due to poor tidal flushing and exchange and freshwater flow and discharges from stream segments that drain undeveloped and agricultural lands.

<u>Nutrient Loading</u>.

During our dry season water quality study the predominant sources of nutrient loading of the waters of Lemon Bay were from Gottfried, Ainger and Oyster Creek and ground water influx. Stream flow in these creeks was primarily from ground water. The total flow from the three creeks was determined to be approximately 160 MGD. The total possible contribution by human water usage (through-house and irrigation) to the ground water flow was less than 2 MGD based on well water pumpage records of the Englewood Water District. Thus the potential contribution of waters from human sources to the total stream flow in these creeks was only a small fraction of the total ground water entering the streams.

Table 6 shows that the nutrient loads from these three creeks is minimal relative to the assimilative capacity and tidal flushing of the Bay. Storm run off and ground water flow during the summer wet season can be expected to increase stream flow, and nutrient and B.O.D. loads on the Lemon Bay system. At the same time both the seasonal and residental population as well as human use of through-house water is lowest in the summer months.

Bacteria

The number of total coliform and fecal coliform bacteria in samples of surface water is used routinely to indicate human sources of wastewater pollution. Previous studies in Lemon Bay and its tributaries have clearly shown that in water from the creeks, dead end canals and along certain shores of Lemon Bay both total and fecal coliform counts exceeded Florida State standards for class II waters. In both our dry and wet season bacteriological studies we also found high levels of total coliform and fecal coliform bacteria at many stations. However, with one or two exceptions high fecal coliform counts were accompanied by even higher fecal streptococcus counts, particularly at the tidal creek stations upstream of the suburban areas. The low ratios of fecal coliform to fecal streptococcus indicate that the major sources of these organisms are non-human and probably from pasture lands upstream of the suburban area.

TABLE 6 Estimated Pollutant Loads to Lemon Bay from Gottfried, Ainger, and Oyster Creeks

	Flow Rate[1]	Flow Volume[2]		Total PO_4P		Kjeldahl N		NO_3-N		B.O.D.$_5$		Organic C	
Creek	Ft/Sec	MGD	MLD	LB/Day	KG/Day	LB/Day	KG/Day	LB/Day	KG/Day	LB/Day	KG/Day	LB/Day	KG/Day
Gottfried	.093	27	102	4.2	1.9	210	96	0.9	0.4	450	204	3150	1430
Ainger	.364	53	200	6.6	3.0	340	153	3.4	1.6	880	400	6070	2760
Oyster	.364	82	312	11.7	5.3	540	246	4.6	2.1	1030	468	8510	3870
Total		162	614	22.5	10.2	1090	495	8.9	4.1	2360	1072	17,730	8060

Estimates made on dry season pollutant and flow data using the following formula:

LOAD = (FLOW VOLUME) X (POLLUTANT CONCENTRATION AVERAGE)

[1] Net Downstream Rate Calculated from Current Meter Data at the furthest downstream stations over one tidal cycle, March 26 and 27, 1977.

[2] Flow Volume = (Flow Rate) X (Cross Sectional Area) X (Conversion Factors for Time and Volume) Results in Million Gallons Per Day and Million Liters Per Day.

HOT SPOTS

The review and analysis of the water quality of Lemon Bay, and the potential impact of septic tank systems on the water quality of the bay and its tributaries would not be complete without red flagging potential "hot spot", non-point source pollutant areas. From our field studies and laboratory analyses and other water quality studies, we mapped(Figure 4) 12 areas in the Lemon Bay complex whose upland activities are contributing, or may contribute, to the apparent decline in the water quality in Lemon Bay. Table 7 summarizes the potential causitive element(s) for each area. However, each area deserves a brief explanation because not everyone may agree on certain areas.

Area 1. Lemon Bay from Forked Creek north to Alligator Creek. The water quality in this area has and will probably continue to be low due to the variety of non-point sources and wasteloads entering the Bay. These wasteloads remain in this narrow segment of the bay for a relatively long time because of the poor tidal flushing. Furthermore, the ability of the bay to assimilate the wasteloads is low, because of a relative lack of marine grass beds north of Manasota Key Bridge.

Area 2. Artist's Avenue Subdivision Area of Englewood. The soils, the topography and the drainage along the historical west branch of Gottfried Creek make this area below the 11 to 12 foot contour line a high risk area for siting septic tank systems even if the system is elevated above the natural ground level. Future developments in this area between Edwards Street and Wentworth Street should be compatible with the existing drainage and wet season flooding constraints. Construction of a series of real estate lakes and improvement of the stream flow in the west branch of

Figure 4. Locations of existing and potential water quality problem areas in the Lemon Bay 208 Complex. Note, problem area number 1, Lemon Bay north of Forked Creek, is not shown on this map.

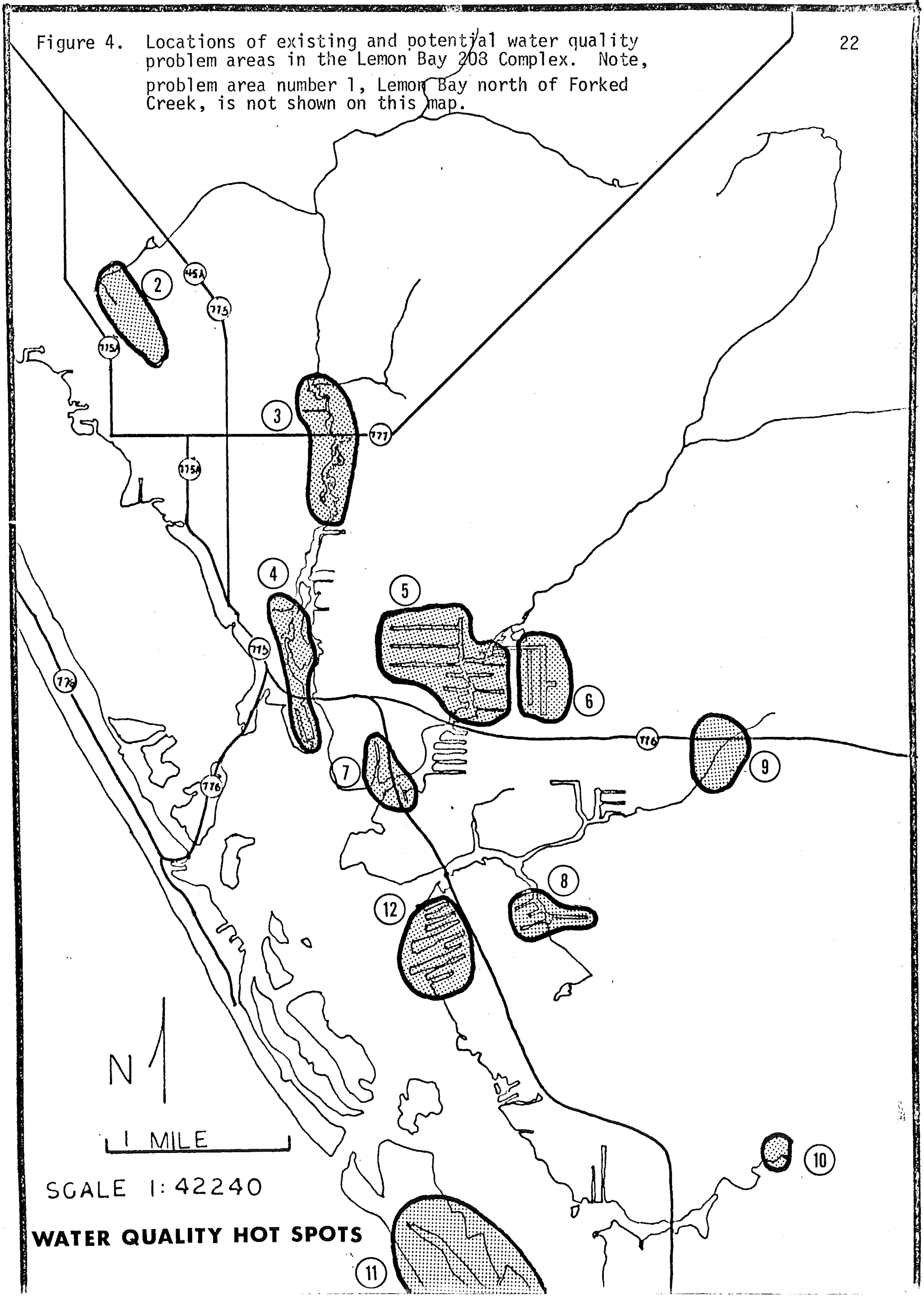


TABLE 7

KEY FOR WATER QUALITY HOT SPOTS MAP

NO.	LOCATION	PROBABLE OR POTENTIAL CAUSES OF LOWERED WATER QUALITY
1.	Lemon Bay, north of Forked Creek	poor tidal circulation
2.	Artists Avenue area	area unsuitable for septic tanks because of poorly drained soils
3.	Gottfried Creek, northern section	poor flushing
4.	Gottfried Creek, southern section	undetermined
5.	Ainger Creek, mid-section	poor flushing
6.	Ainger Creek, eastern canals	poor flushing
7.	Ainger Creek, mouth	poor flushing of canals; marinas
8.	Oyster Creek, south fork	poor flushing
9.	Oyster Creek by S.R. 776	land development
10.	Buck Creek near Rotunda	land development
11.	Don Pedro Island	area unsuitable for septic tanks because of poorly drained soils
12.	Dead end canals on Lemon Bay, Grove City	poor flushing

Gottfried Creek could improve the existing situation. However, such a program would require proper forethought, design, and individual landowner cooperation.

Area 3. North Section of Gottfried Creek. North of the Deer Creek Trailer Partk, Gottfried Creek is poorly flushed. Major roadside storm water outfalls occur at SR 777 and north of SR 777. At the same time, nutrient-bacterial enriched fresh water flows into this area from the upstream pastured and partially channelized segments of the creek. To a certain degree the low water quality in this area is a natural historical phenomenon. Therefore, before further channelization and a flood control program like that developed by Smalley, Wellfora and Nalven for the Board of County Commissioners, Sarasota County, 1975, occurs, serious consideration should be given to the roles the upper watersheds of Gottfried Creek play in the nutrient regime of the downstream surface waters and the groundwater-aquifer recharge system.

Area 4. Southern Section of Gottfried Creek. The data from our study as well as other water quality studies indicate that somewhere in the vicinity of the mouth of the Creek there exist one or more significant wasteload sources. Because of the tidal circulation patterns at the mouth of the Creek, it appears that on-site waste water systems and irrigation run-off, plus ground water seepage from one or more waterfront units on the Point of Pines are contributing measurably to the wasteload in this area.

Area 5. Midsection of Ainger Creek. The water quality in the long, deadend canals perpendicular to the streamflow and tidal currents in section 2 of Ainger Creek will continue to deteriorate as the lots along the canals are filled with housing units. Even where there is a central sewage system, the water quality will deteriorate unless the canals are redesigned or receive the proper maintenance. The same is true for other dead end canals in the Lemon Bay 208 Study Complex.

Area 6. Eastern Canals of Ainger Creek. The long and deep dead end canals in section 3 of Ainger Creek will experience water quality problems resulting from surface water runoff from waterfront lots and the roadside drainage networks.

Area 7. Mouth of Ainger Creek. All of the evidence to date indicates that water from the three dead end canals in the vicinity of the bridge at S.R. 775 is the primary contributor to the unacceptable levels of nutrients and pollutants in section 1 of the Creek. Both the canals and some of the waterfront housing units date from the late 1940's. The water quality in this area could be improved if improperly located septic tank systems were resited and if the canals were scoured to remove some 30 years' worth of sediments rich in organic matter.

Area 8. South Branch of Oyster Creek. From the results of previous water quality studies and the local geography, one could conclude that the low water quality in this section of Oyster Creek is due to the waterfront housing along the Creek and in particular along the Brookwood Road Canal. However, the results of our bacteriological studies demonstrate that drainage from the wetland areas upstream of the suburban development on this section of the Creek is the major source of the wasteload.

Area 9, Oyster Creek, Northeast of San Casa Road. At the present time the surface water entering the Creek in this area has a relatively high nutrient-sediment-pollutant wasteload derived from nearby land development activities and an improved pasture. The character of this wasteload will undoubtedly change in the future.

Area 10. Buck Creek, Downstream of Rotunda River. At the present time the waters of Buck Creek are receiving high amounts of nutrients, sediment and fine silt via surface runoff from nearby land development activities. In the future, surface runoff from the developed land will continue to be the major non-point source of pollution for Buck Creek.

Area 11. Don Pedro and Knight Island. Until now, the contribution to the wasteload of the southern segment of Lemon by land development and the seawalling of historical dead end tidal channels on the bayside of these islands has been minimal. However, platted land sales and homesite construction are increasing. Septic tank system permits are being issued. If, and when, the islands are connected to the mainland by a bridge, land development and waterfront homesite activities will become major elements in the wasteload budget in this area. However, a major portion of this wasteload will probably flow south out of Lemon Bay and into Placida Harbor.

Area 12. Grove City Dead End Canals on Lemon Bay. The 1975-1977 water quality data of the Charlotte County Health Department indicate that the waters in these canals are receiving significant wasteloads from waterfront housing units. Although the origins of the wasteloads have not been identified, ground water drainage through the dredged spoil soil of some of the lots on the canals is probably a major contributing factor. Spoil soil is one of the few soils in the area for which there is little or no information on the soil's characteristics. Since building sites on the filled sections of these and other dead end canals are underlain by this type of soil, this soil merits immediate study.

Other areas with dead end canal systems with spoil soil from submerged lands include New Point Comfort, the mouths of Buck and Lemon Creeks, and the bay side of Don Pedro Island.

CONCLUSIONS AND RECOMMENDATIONS

The water quality of Lemon Bay and its tributaries is affected by various non-point sources of nutrients and pollutants other than onsite wastewater systems. Approved land use activities continue to contribute to the wasteload of the Lemon Bay system. At the same time the historic tidal circulation of Lemon Bay and stream discharge patterns have been altered. Runoff and drainage from stream segments upstream of the developed areas of the creeks contribute significantly to the stream wasteloads as do waterfront homesite activities.

The "natural" lands in the suburban sections of Lemon Bay and the creeks plus the flood plains that remain in the creeks upstream of the suburban areas are all that remain of the original hydro-biological-nutrient system that once made Lemon Bay a famous fishing and shellfishing resort. The conservation of these shorelines and wetlands are critical to the maintenance and restoration of the chemical, physical and biological integrity of the local waters.

Tidal current studies to date show that the water in the Red Lake - Alligator Creek area does not flow into Lemon Bay and that the area of the Bay between Furbeck Point in Englewood and Forked Creek exhibits poor tidal flushing. The segment of Lemon Bay north of Forked Creek has always exhibited poor tidal flushing.

Tidal flushing and freshwater discharges of the creeks have been adversely affected by alterations in natural drainage patterns. If the present trends of flood control, land development and urbanization continue the lower reaches of the creeks will assume many of the adverse characteristics of dead end canals.

All of the dead end canals surveyed in this study had surface sediments rich in organic matter. In order to maintain and restore the water quality in these canals, maintenance programs should be developed which include the following elements:

1. maintenance scouring of the canals to remove organic rich sediments,
2. stabilization of shorelines to minimize erosion and surface water runoff,
3. pruning of shoreline trees and shrubs where their branches have grown out over the waterways, and
4. removal of debris that accumulates at the upper ends of the canals and around boat docks.

As the population of the Englewood Water District increases and more housing units spread onto marginal soils inland of the water courses, alternatives to conventional onsite wastewater and central sewage treatment systems will need to be considered. At the same time modern detailed soil maps and one foot interval contour maps are needed to optimize the compatability between future land developments and the natural land drainage patterns.

The remaining flood plains and flood prone zones of the tidal creeks and the shores of Lemon Bay should be protected from future conventional land development activities. These areas, particularly along the creeks, are critical to maintaining the water quality in the creeks. At the same time they are important wildlife habitats and are ideal "open space" areas. On each creek there are areas whose uplands should be preserved for parks and "green belts".

Circumstantial evidence strongly indicates that the confined aquifer which is the local source of high quality well water is recharged by local surface and ground water. Thus it is imperative that the water crop and ground water recharge water use budgets be studied in detail to determine the relative contributions to the water budget by natural surface water percolation in each creek basin and by the through-house and irrigation water pumped from the several well fields.

The twelve "hot spot" areas of non-point source pollution identified in this study illustrate that pollution of surface waters by onsite wastewater systems is only one element in the overall non-point source pollution problem. Perhaps the dominant pollutant in the area has been, and is, silt. Nevertheless, onsite wastewater systems constitute a recognizeable source of pollution in the area. Accordingly, the following recommendations are in order:

1. On site inspection of all septic tank systems constructed before 1972 to determine which systems may not be functioning properly due to improper siting, installation or maintenance.
2. Dye tracer studies of septic tanks on properties adjoining open waters on a neighborhood basis.
3. Inspection and dye tracer studies of all septic tank systems in filled land near open waters.
4. An inventory of onsite wastewater systems of multiple housing units (i.e., condominiums, motels, mobile home parks and trailer parks) to determine where peak, seasonal population uses may exceed the design capacity of individual septic tank and package plant systems.

5. Future water quality monitoring programs in the area should include the following elements: fecal coliform/fecal streptococcus ratios, phytoplankton composition and diversity, organic carbon and chemical oxygen demands. In addition, appropriately sited stream flow gauges, a network of ground water monitoring wells, and a modern meteorological station are needed for the area.

If the population in the Englewood Water District surrounding Lemon Bay continues to increase, the present day land zoning, land platting, and land use practices will continue to increase the wasteloads entering the Bay unless the constraints of the natural systems in the regions are thoroughly understood by landowners, developers and the public's permitting agencies. Alternatives to conventional land use, water use and wastewater disposal practices deserve serious consideration in order to improve the quality of the waters of Lemon Bay and its tributaries and the quality of life in the communities of the Englewood Water District.