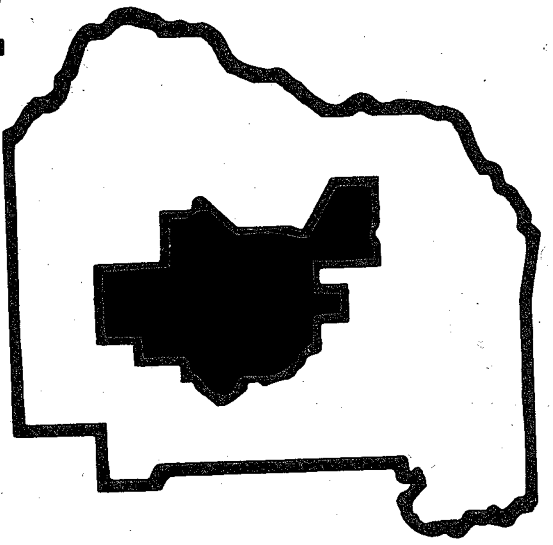
SITE CERTIFICATION APPLICATION

DEERHAVEN STATION

UNIT 2

VOL. I



SUBMITTED BY

GAINESVILLE/ALACHUA COUNTY
REGIONAL ELECTRIC, WATER &
SEWER UTILITIES BOARD

AMENDED APPLICATION FOR CERTIFICATION

for the Deerhaven Unit 2 Steam Electric Generating Facility

CITY OF GAINESVILLE &
GAINESVILLE/ALACHUA COUNTY
REGIONAL ELECTRIC, WATER &
SEWER UTILITIES BOARD

ACKNOWLEDGEMENTS

RUB acknowledges the complete cooperation by various consultants in the preparation of extensive technical studies and engineering analyses as follows:

The Project impact on the terrestrial and aquatic environment by Breedlove & Associates, Inc., Gainesville, Florida under the direction of Mr. Ben Breedlove.

The surface and sub-surface hydrological work conducted by Jones, Edmunds & Associates, Gainesville, Florida, and Geraghty & Miller, Inc., Tampa, Florida under the direction of Mr. Bob Edmunds and Mr. Paul Hackenberry, respectively.

The investigation of the need for the facility and the socio-economic impacts of the Project by R. W. Beck & Associates, Orlando, Florida and Denver, Colorado offices under the direction of Mr. Bruce Holmes and Mr. Joe Brack.

The Project impact on noise and air quality by Scholtes & Koogler, Inc., Gainesville, Florida under the direction of Dr. John Koogler.

The evaluation of potential Project impacts to historical and archaeological sites by Cultural Resources, Inc., Tallahassee, Florida under the direction of Mr. James Miller.

The descriptions of the plant and associated facilities by Burns & McDonnell, Architect-Engineers, Kansas City, Missouri under the direction of Mr. Karl Wolfs.

The Deerhaven Unit 2 Project Team acknowledges the complete cooperation of the entire RUB staff without which this report could not have been accomplished.

PREFACE

PREFACE

The City of Gainesville, pursuant to Chapter 12760, Laws of Florida, Special Acts of 1927, as amended and supplemented, owns and operates an integrated electric, water and sewer utilities system to provide the city and certain unincorporated areas of Alachua County with electric, water and sewer service. The electric system was established in 1912 to provide street lighting and electric service to the downtown Gainesville area. Continuous expansion of the electric system and its generating capacity has resulted in an electric system which currently serves about 38,000 customers.

In 1972 the City of Gainesville and Alachua County entered into an interlocal agreement pursuant to Florida Interlocal Cooperation Act of 1969, Section 163, Part 1, Florida Statutes (1975), which authorizes cities and counties to enter into local contracts with each other to provide services and facilities in accordance with geographic, economic, population and other factors influencing the needs and development of the local community. Under this agreement, on December 19, 1972, the Gainesville Utilities Department and the county owned electric, water and sewer systems combined to form the Gainesville-Alachua County Regional Electric, Water & Sewer Utilities Board (RUB) whose duty it is to provide electric utility, water and sanitary sewer services to the city and the unincorporated areas of the county. Under the terms of the agreement, the city acquired the county's electric, water and sewer system to operate with its own as a single, combined utility. Pursuant to the agreement, the RUB makes all policies for the administration,

operation, maintenance, extension enlargement, development, replacement and repair of the system. The RUB consists of five elected City Commissioners and five elected County Commissioners each having one vote. The System's official headquarters are located at 700 Southeast Third Street, P. O. Box 490, Gainesville, Florida, 32602.

Mr. B. Harold Farmer, City Manager of Gainesville is the chief operating officer of the city's Utilities Department. Mr. Farmer is also the Chief Executive Officer and General Manager of the Gainesville-Alachua County Regional Utilities Board. To assist the General Manager in carrying out the policies of the city and RUB, Mr. Farmer has appointed Mr. Stanley L. Livengood as Deputy City Manager for Utilities, whose responsibility it is to administer all aspects of finance, operations, engineering and planning for the system. Mr. Livengood has assigned Mr. Larry R. Gawlik, as RUB's Project Manager, the responsibility of obtaining certification for the Deerhaven Unit 2.

The Deerhaven site is located approximately six miles northwest of Gainesville on U.S. Highway 441 in the county of Alachua. The site is located at latitude 29 degrees, 45 minutes, 30.75 seconds and longitude 82 degrees, 23 minutes, 18.40 seconds. Its corresponding UTM is East 364875 and North 329625. RUB's existing facilities at this site consist of an 81,000 kW steam electric generating unit and two 20,000 kW combustion turbines. The Deerhaven 2 expansion consists of the addition of a coal-fired 235,000 kW steam electric generating unit and related facilities

at the existing 1,116 acre site. This unit will include a modern steam generator, a reheat turbine generator, groundwater pumping facilities, cooling towers, ash handling, fuel storage and handling facilities, deep injection wells for effluent disposal, complete auxiliary equipment, instrumentation, control, step-up transformers and associated equipment.

The following environmental analysis of the Deerhaven Unit 2 Project was written to assist the Department of Environmental Regulation and other agencies in their review of the Project. The purpose of the analysis is to give the public as well as all interested state agencies an opportunity to review and comment on the environmental impacts of the Project. This analysis, along with other supporting documentation, can be found at the:

Board of County Commissioners
Alachua County Courthouse
Fourth Floor
Gainesville, Florida

Clerk of the City Commission
City Hall
200 East University Avenue
Gainesville, Florida

Gainesville-Alachua County Regional Utilities Board
Engineering and Planning Building
700 Southeast Third Street
Gainesville, Florida

North Central Florida Regional Planning Council
2002 Northwest 13th Street
Suite 202
Gainesville, Florida

Santa Fe Regional Library
222 East University Avenue
Gainesville, Florida

(NOTE: This application is being submitted jointly by the City and RUB, but for convenience of reference throughout this document, RUB will be used to denote both applicants.)

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CHAPTER 1

PURPOSE OF THE PROPOSED FACILITY

To assess the need for Deerhaven Unit 2, the following sections describe the existing RUB electric generating system, as well as the characteristics of the customers it serves and is projected to serve. Furthermore, changes that could occur in end use, conservation, and other areas that affect generation planning are described.

The overall power supply situation in Florida is reviewed and presented with respect to existing and planned types of generating capacity. The ability of such to serve existing and forecasted energy demands is also considered. Finally, the relationship between RUB and other Florida utilities as they relate to power supply operations and transactions, reliability considerations, and generation planning are delineated generally and specifically, because they affect RUB and its proposed Deerhaven Unit 2 coal-fired generating unit.

1.1 Description of Existing System

RUB operates a fully integrated generation, transmission and distribution system (Table 1.1-1). The service area of the RUB system includes the City of Gainesville and the unincorporated area of Alachua County, an area of over 900 square miles (Figure 1.1-1). The existing electric system facilities currently serve an area of approximately 150 square miles including all of Gainesville. Electric service is also provided in the unincorporated area of Alachua County and in other municipalities by Florida Power and Light Company, Florida Power Corporation, Clay Electric Cooperative and Central Florida Electric Cooperative.

Table 1.1-1 RUB Existing Generating Facilities (DSP Form 1A)

Plant Name	Unit No.	Location	Type	Fuel Primary	Fuel Alternative	Commercial In-Service Mo/Yr	Expected Retirement Mo/Yr	Gen.Max. Nameplate KW	Net Capability Summer MW	Net Capability Winter MW
J.R. Kelly		Section 4 Township 10S Range 20E						138,412	124	128
	8		Fossil	Heavy Oil	Natural Gas	4/29/65	Unknown	50,000	44	45
	7		Fossil	Heavy Oil	Natural Gas	8/29/61	Unknown	25,000	23	23
	6		Fossil	Heavy Oil	Natural Gas	3/24/58	Unknown	18,750	14	14
	3		Combustion Turbine	Light Oil	Natural Gas	2/7/69	Unknown	14,500	14	15
	2		Combustion Turbine	Light Oil	Natural Gas	9/3/68	Unknown	14,500	14	15
	1		Combustion Turbine	Light Oil	Natural Gas	5/1/68	Unknown	14,500	14	15
			Diesel	Light Oil		9/9/49	Unknown	1,162	1	1
Deerhaven		Section 26 27 35 Township 8S Range 19E								
	1		Fossil	Heavy Oil	Natural Gas	8/25/72	Unknown	75,000	81	83
	1		Combustion Turbine	Light Oil	Natural Gas	8/12/76	Unknown	26,640	20	26
	2		Combustion Turbine	Light Oil	Natural Gas	8/12/76	Unknown	26,640	20	26
Crystal River	3	Section 33 Township 17S Range 16E	Nuclear	Nuclear		3/14/77	Unknown	12,113	12	12
							TOTAL:		257	275

Source: 1977 Ten Year Site Plan.

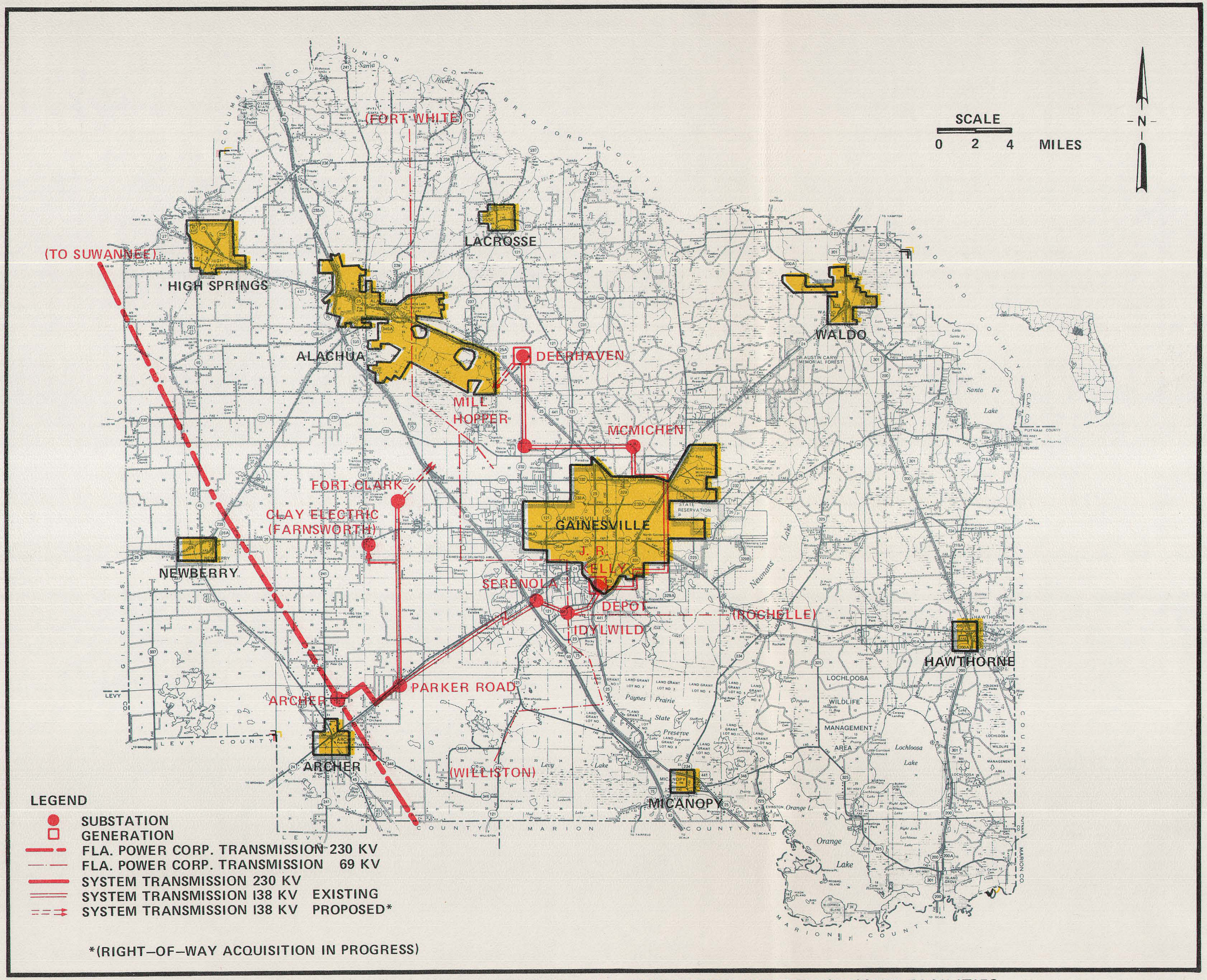


FIGURE 1.1-1 RUB ELECTRICAL SYSTEM SERVICE AREA, GENERATION AND TRANSMISSION FACILITIES.

RUB owns and operates two oil/gas fueled generating stations having a combined total net summer capability of 245,000 kW. RUB also owns a 11,620 kW share of the Crystal River 3 nuclear powered electric generating unit. All of the System's power requirements are provided from these generating stations via a 138 kilovolt (kV) transmission network and three interconnections with Florida Power Corporation.

The John R. Kelly Station (JRK Station) is located in southeast Gainesville and consists of three steam generators, three combustion turbines and one black-start diesel unit. All of the units at this station are equipped for oil/gas firing. The JRK Station has a maximum summer capability of 124,000 kW.

The Deerhaven Station is on a 1,116 acre site approximately 6 miles northwest of Gainesville and consists of one steam turbine and two combustion turbine units. Deerhaven Unit 1 was completed in 1972 and placed into commercial operation in August, 1972. Unit 1 is equipped for oil/gas firing and has a net maximum summer capability of 81,000 kW. With the addition of two combustion turbines of 20,000 kW each in 1976, the Deerhaven Station has a net maximum summer capability of 121,000 kW.

Crystal River 3 is an 825,000 kW nuclear powered electric generating unit. RUB owns a 1.4079% (11,620 kW) share of the plant capacity. The power from this unit is transmitted over Florida Power Corporation's transmission system to its points of interconnection with RUB pursuant to a tariff filed with the Federal Energy Regulatory Commission (FERC).

1.1.1 Existing Generating Capability

The RUB system is operated based on dispatching procedures which take into account fuel costs, expected load conditions, coordinated reserve requirements and scheduled maintenance. By consideration of these factors generation from the system capability is added to meet system energy requirements reliably and economically.

The four fossil steam turbines located at the JRK and Deerhaven Stations are capable of burning No. 6 oil or natural gas. Deerhaven Unit 1 is primarily used for base load, JRK Units 7 and 8 for intermediate load, and JRK Unit 6 for peaking purposes. Although the fossil steam units represent only 63% of the system's net summer capabilty, they produced 98.8% of the energy supplied to the system in 1976.

The five combustion turbines on the system are fueled by No. 2 oil or natural gas and are used for peaking purposes and emergencies. These units, which can be started and placed on line in less than 30 minutes, represent 32% of the system's net summer capability, but since they are less efficient than steam units and are designed for peaking operation, they produced less than 2% of the energy supplied to the system in 1976. A 1,162 kW diesel unit at the JRK Station is used only for black-start purposes.

The 11,620 kW ownership interest in Crystal River 3 represents approximately 4.7% of the system's net summer capability and is expected to produce 9% of the energy requirements by 1978.

1.1.2 Interconnected Operations

RUB as well as most municipal, investor owned and rural electric cooperative utilities in Florida are members of the Florida Electric Power Coordinating Group, Inc. (FCG). The members of FCG have developed and published an active operating handbook which makes recommendations for standard practices associated with various facets of interconnected operations. The handbook covers the allocation of daily operating reserves for each system, emergency procedures, scheduled and inadvertent interchange procedures, time error correction procedures, control of regulating errors and various communication channels between the system control centers.

Present bilateral interconnection agreements among FCG members provide various classes of scheduled interchange services. These classes include Emergency Service, Scheduled Electric Service for use during maintenance of facilities, Economy Service on a split-the-savings basis and Firm Electric Service used primarily to stagger generating unit additions between systems to take advantage of the economies of scale. Use of these services varies according to each system's needs and its ability to meet the needs of other systems. These services provide system operators flexibility in meeting their system requirements in a manner consistent with established operating guidelines, the need for reliability and economy, and the responsibility of each system first to provide reliable service to its own customers.

Florida Power Corporation/RUB Interconnection Agreement

RUB entered into an Interconnection Agreement with Florida Power Corporation effective July 2, 1973, for an initial period of seven years, automatically renewable for periods of three years each. The contract calls for six electric service schedules consisting of Emergency, Scheduled, Energy Interchange, Firm, Secondary, and Power Transmission electric service. RUB's Parker Road Substation with 200,000 kVA of transformation from 230 kV to 138 kV interconnects with Florida Power Corporation's Archer Substation via a 230 kV transmission line. Two additional interconnections are provided between RUB's 138 kV network and Florida Power Corporation's 69 kV subtransmission system via an 88,000 kVA 138/69 kV transformer at the Florida Power Corporation Idylwild Substation.

Coordination With Other Systems

As a member of FCG, RUB shares installed and spinning reserves with other members thus achieving a substantial reduction in the amount of reserves required for proper operation and reliability.

RUB is also a member of the Southeastern Electric Reliability Council (SERC), along with other major utilities in the southeastern United States. The purpose of SERC is to augment further the reliability and adequacy of bulk power supply in the areas served by its member systems.

1.2 Historical Power Supply Requirements

Projecting future power supply demands requires an understanding of electrical energy consumption patterns on the RUB system, of the factors which influence seasonal and annual changes in these patterns and of potential influences on future energy use.

The following sections examine: (1) monthly electric demand and energy use for 1972-1977 to determine seasonal demand and energy use patterns; (2) average monthly growth rates for the same period to determine changes and possible patterns; (3) annual energy use by customer class for 1967-1976 to detect changes in customer class relationships; and (4) average annual demand and energy growth rates for RUB and other utilities.

Three definitions are important to an understanding of the data in this and the following sections:

1. Demand represents usage of electricity at a point in time (usually an hour) and is expressed in kilowatts (kW) or megawatts (mW). A megawatt (mW) equals 1,000 kW.

2. Energy represents demand summed over time and is expressed as kilowatt hours (kWh), megawatt hours (mWh) or gigawatt hours (gWh). One megawatt hour (mWh) equals 1,000 kWh. One gigawatt hour (gWh) equals 1,000,000 kWh.

3. Load Factor represents the average load $\left(\frac{\text{kilowatt hours}}{\text{hours}}\right)$ for a period divided by the peak load (kW) for the same period.

1.2.1 Monthly System Demands

An examination of growth rates in peak monthly demand for 1972-1976 reveals average annual growth rates ranging from 4% to 17% (Table 1.2-1). The largest growth rates were for the winter months of January (17%), February (10%), March (11%), and for the summer months of July (10%), and August (8%). The annual peak demand occurred consistently during the summer months of July, August and September. Demand data can be misleading when used to analyze short term trends since abnormally severe or abnormally moderate weather conditions in the summer or winter can cause abnormally high or low demands on a system. Such factors, however, must be taken into account in planning requirements to provide adequate service for extreme weather conditions.

The effect of increased oil prices can be seen in data for 1973 and 1974 (Table 1.2-1). Demand increased from 134 mW in 1973 to 142 mW in 1974 (6%), but energy use for the same period increased only 2%, from 593 mWh to 604 mWh. This disparity can be attributed mainly to the fact that price and conservation awareness inhibit use until a certain level of discomfort causes heating or air conditioning loads to be added.

Table 1.2-1 RUB 1972-1976 Monthly Historical Demand and Energy Analysis

	1972		1973		1974		1975		1976		1972-76 Average Annual Growth Rate	
Month	Demand (MW)	Energy (GWH)	Demand (MW)	Energy (GWH)	Demand (MW)	Energy (GWH)	Demand (MW)	Energy (GWH)	Demand (MW)	Energy (GWH)	Demand (%)	Energy (%)
Jan.	70	34	95	43	84	39	113	48	133	58	17	14
Feb.	75	33	97	39	103	40	94	41	108	47	10	9
Mar.	66	33	94	40	90	41	104	46	101	47	11	9
Apr.	85	35	87	43	107	42	119	46	107	47	6	8
May	92	41	123	47	137	57	141	60	117	53	6	7
June	105	47	127	57	137	58	148	63	138	59	7	6
July	109	53	128	64(1)	136	61	137	63	160(2)	71(1)	10	8
Aug.	108	54(1)	134(2)	62	140	63(1)	148(2)	68(1)	147	69	8	6
Sept.	117(2)	52	129	61	142(2)	63	140	61	148	62	6	5
Oct.	103	43	131	53	111	47	128	55	121	51	4	4
Nov.	100	39	97	41	99	45	110	49	131	52	7	7
Dec.	92	39	96	43	111	48	114	51	121	55	7	9
Max. Annual Demand - (MW)	117(2)		134(2)		142(2)		148(2)		160(2)		8%	
Total Annual Energy - (GWH)		503		593		604		651		671		7%

(1) Largest monthly kWh sales for the year.
(2) Peak demand for the year.

1.2.2 Monthly System Energy Use

The largest average annual growth rates for energy by months for 1972-1976 occurred in the winter months of January (14%), February (9%), March (9%), and December (9%) (Table 1.2-1). The largest monthly energy usage, however, occurred consistently in the summer months of July and August. Three reasons for the higher demand and energy use in the summer season are: (1) electric air conditioning demands are greater than those experienced with electric heating; (2) the hours of daily operation for electric air conditioning exceed those experienced with electric heating; and (3) the saturation level for electric air conditioning is higher than that experienced with electric heating.

The increasing energy use in winter months from 1974-1976 apparently results from a gain in the use of electric heating over oil and natural gas. This gain must be considered in forecasting future use of the system.

1.2.3 Energy Use by Customer Class

RUB segregates rate schedules and customer classes into Residential, General Service, Large Power, Lighting, Sale for Resale, and Utility Uses and Losses. Table 1.2-2 presents total sales (gWh), net peak demands (mW) and load factors for 1967-1976. Average annual growth rates for the customer classes are at the bottom of each column. The sales to each class as a percentage of the total sales for each year are presented on an annual basis.

Table 1.2-2 RUB Historical Sales by Customer Class (GWH), Instantaneous Net Peak and Load Factor

Fiscal Year	Residential (GWH)	Residential (%)	General Service (GWH)	General Service (%)	Large Power (GWH)	Large Power (%)	Lighting (GWH)	Lighting (%)	Utility Use and Losses (GWH)	Utility Use and Losses (%)	Total Sales (GWH)	Total Sales (%)	Net Peak (MW)	Load Factor (%)
1967(2)	111	44	117	47	NA(1)	-	5	2	18	7	251	100	57(4)	50.3
1968	137	45	152	39	NA(1)	-	5	2	13	4	307	100	71(4)	49.4
1969	158	45	159	46	NA(1)	-	6	2	26	7	349	100	80(4)	49.8
1970	183	51	156	39	25	6	7	2	26	7	397	100	91(4)	49.8
1971	204	47	175	40	26	6	9	2	24	5	438	100	99(4)	50.5
1972	222	45	197	41	29	6	10	2	28	6	487	100	117(4)	47.7
1973	268	46	229	40	36	6	11	2	34	6	578	100	134	49.4
1974	280	47	230	38	40	6	12	2	39	7	601	100	142	48.2
1975	302	48	231	36	48	8	14	2	32	5	636(3)	100(3)	148	49.0
1976	304	45	244	35	52	9	13	2	40	6	670(3)	100(3)	160	47.9
Avg. Annual Growth Rate: 1967-76	11.8		8.5		13.0		11.2		9.0		11.5		12.4	49.2 Avg.

(1) Data not available.
(2) 1967-1976 Data: 1977 Ten Year Site Plan.
(3) Total Sales includes 9 GWH (1%) and 17 GWH (3%) of Sales for Resale in 1975 and 1976 respectively.
(4) Represents gross values adjusted by approximation of system auxiliaries.

The two major classes are Residential and General Service, which together comprise about 80% of sales. The Residential class has represented from 44% to 51% of total sales since 1967 and has grown at an average annual rate of 11.8%. This class presently has the largest percentage of total system sales.

General Service was the largest class until Large Power was made a separate class in 1970. It now includes commercial, general power, and a former separate rate schedule known as the hospital class. Although it has represented from 35% to 41% of total system sales since 1970, with an average annual growth rate of 8.5%, its percentage of total sales decreased from 41% in 1972 to 35% in 1976.

Although the Large Power class retained a constant percentage of total sales until 1974, the latest trend shows this class increasing. This trend could continue with additional industry being attracted to the RUB system service area.

One future industrial addition to the RUB system is the firm of Bear Archery, a large sporting goods manufacturer, which is anticipated to begin operation in late 1978. Another existing large power consumer within the RUB service area is the University of Florida. Although not presently serviced by RUB, future service negotiations will be carried out.

The Lighting class has been a constant percentage of total sales, though it has grown at an average annual rate of 11.2%. The Utility Uses and Losses percentage has ranged from 4% to 7%. Since 1971 it has remained relatively constant at 5% to 7%.

A new class called Sales for Resale was created in 1975 when RUB began selling wholesale power to Clay Electric Cooperative. Although not shown in Table 1.2-2 as a separate class, 9 gWh and 17 gWh were sold in 1975 and 1976, respectively, representing 1% and 3% of total sales.

The last three columns in Table 1.2-2 show historical total sales, peak demand, and the resulting load factor. Since load factor relates average energy use to peak demand in the system, it represents the utilization efficiency of installed capacity, therefore providing a comparative relationship between expected peak demand and forecast energy use. In spite of certain changes in customer usage patterns, the overall system load factor has remained relatively constant over the 10-year period 1967-1976.

Figure 1.2-1 graphically portrays historical system energy use from 1968 through fiscal year 1977. Although the average annual growth rate over the 1967-1976 period was 11.8%, the quadrupling of oil prices in late 1973 and the following period of inflation and recession have resulted in a lowering of system energy use and an average annual growth of only 5.6% from 1974-1976.

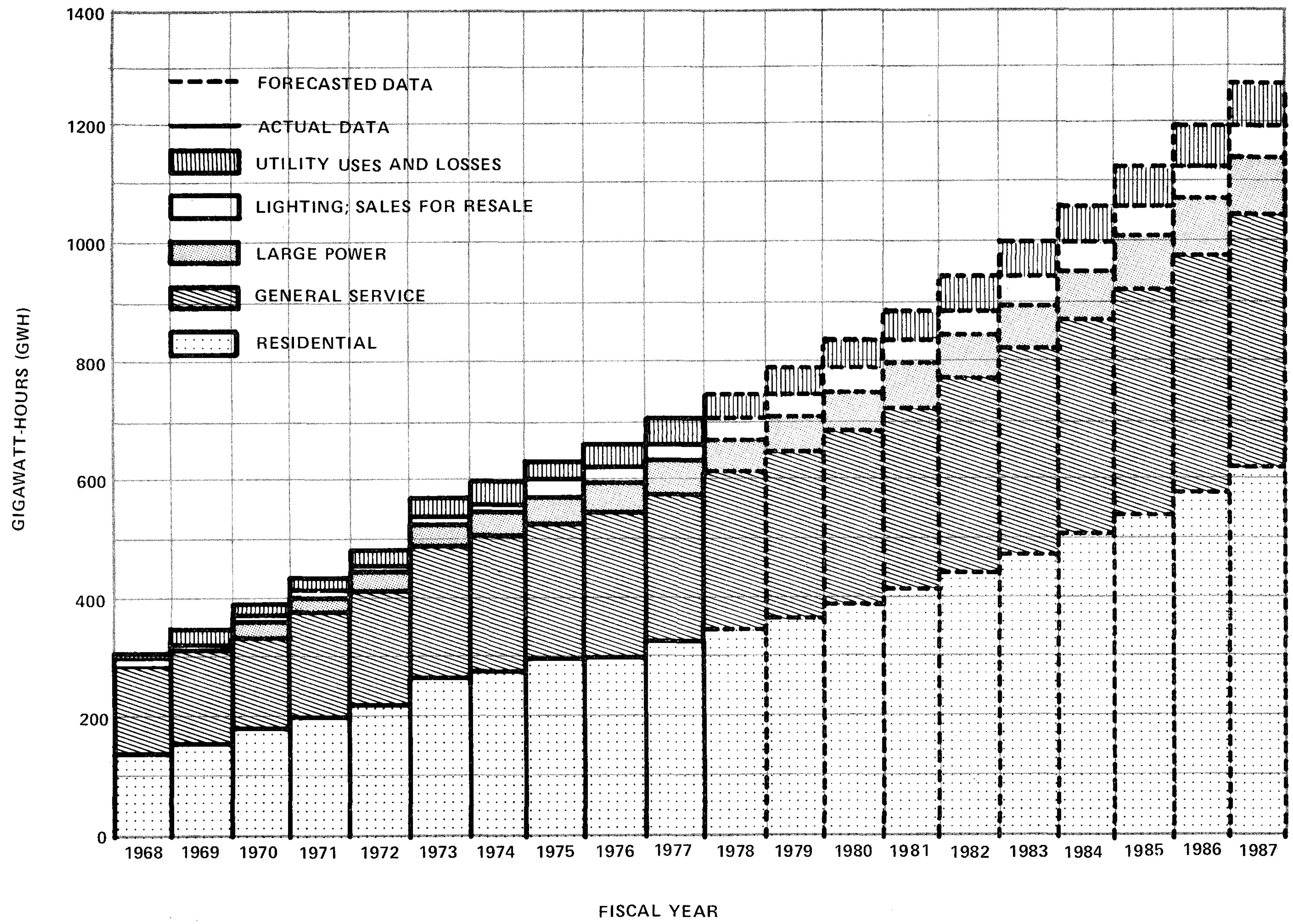


FIGURE 1.2-1 HISTORY AND FORECAST OF ENERGY CONSUMPTION.

1.2.4 Demand and Energy Use - Peninsular Florida

For major peninsular Florida utilities, the recession beginning in 1974 resulted in approximately 50% lower growth rates in net energy for load (Table 1.2-3) and summer peak demand (Table 1.2-4) than for the overall 1966-1976 period. However, in every year since 1967, except 1972, RUB's growth in demand and energy use has been higher than the aggregate of these utilities (Figures 1.2-2 and 1.2-3).

1.3 Demand and Energy Forecast

The most recent forecast of future demand and energy requirements was developed in October of 1977. An econometric model incorporating growth rates of inflation, population, per capita income, and consumption correlated with expected average system power costs, was jointly developed by RUB and the University of Florida Bureau of Economic and Business Research for application to the forecast. Econometric modeling, as applied to electric energy forecasting, is a state of the art technique and is used to be descriptive of the economic situation, economic motives, and resulting economic behavior, and thus the nature of the consumers' demand for electricity. A probabilistic forecast using historical peak load data and regression techniques was presented in the 1977 Load and Energy Forecast and is used for comparative purposes.

1.3.1 The Econometric Model

The following assumptions were the basis for the projection of future economic conditions used in the Econometric forecast:

Table 1.2-3 History of Net Energy for Load - GWH (Millions of KWH) (1)

Year	FPL(2)	FPC(2)	FTP(2)	GVL(2)	GPC(2)	JEA(2)	LWU(2)	LAK(2)	OUC(2)	TAL(2)	TEC(2)	VER(2)	Total
1966	15,056	5,921	126	245	2,435	2,771	101	433	925	358	4,952	104	33,437
1967	16,640	6,573	135	251	2,588	2,928	112	457	985	405	5,383	116	36,573
1968	19,347	7,627	148	307	3,059	3,351	134	502	1,111	492	5,629	132	41,839
1969	22,218	8,713	172	349	3,346	3,709	150	567	1,250	559	5,885	149	47,067
1970	25,113	9,855	195	397	3,764	4,098	172	635	1,375	656	6,542	164	52,966
1971	25,884	10,961	210	438	4,072	4,454	186	687	1,480	708	6,846	182	58,108
1972	31,498	12,678	245	487	4,604	4,831	205	793	1,677	802	7,429	211	65,460
1973	35,185	14,817	271	578	4,978	5,281	231	901	1,893	915	8,291	244	73,585
1974	35,465	14,402	269	601	4,983	4,968	226	890	1,787	886	8,485	243	73,205
1975	37,151	15,237	283	636	5,148	5,318	236	935	1,866	947	9,015	258	77,030
1976	38,025	16,032	296	670	5,474	5,575	235	965	1,917	971	9,294	267	79,721
Avg. Annual Growth Rate: 1966-76	9.7%	10.5%	8.9%	10.6%	8.4%	7.2%	8.8%	8.3%	7.6%	10.2%	6.5%	9.9%	9.1%
1974-76	3.6%	5.5%	4.9%	5.6%	4.8%	5.9%	2.0%	4.1%	3.6%	4.7%	4.7%	4.8%	4.4%

(1) 1976 and 1977 Ten Year Site Plan for State of Florida - Table A3.
(2) FPL - Florida Power & Light Company
FPC - Florida Power Corporation
FTP - Fort Pierce Utilities Authority
GVL - Gainesville/Alachua County Regional Utilities Board
GPC - Gulf Power Company
JEA - Jacksonville Electric Authority
LWU - Lake Worth Utilities Authority
LAK - City of Lakeland
OUC - Orlando Utilities Commission
TAL - City of Tallahassee
TEC - Tampa Electric Company
VER - Vero Beach Municipal Utilities

Table 1.2-4 History of Summer Peak Load by Utilities - Net MW (1)

Year	FPL(2)	FPC(2)	FTP(2)	GVL(2)	GPC(2)	JEA(2)	LWU(2)	LAK(2)	OUC(2)	TAL(2)	TEC(2)	VER(2)	Total
1966	2,827	1,104	26	53(3)	497	568	22	84	194	86	802	24	6,287(3)
1967	3,160	1,254	27	57(3)	523	598	23	90	213	93	865	26	6,929(3)
1968	3,789	1,487	32	71(3)	620	688	28	101	238	109	951	33	8,147(3)
1969	4,329	1,710	36	80(3)	711	763	32	112	271	127	1,005	39	9,215(3)
1970	5,031	1,988	40	91(3)	774	834	36	130	288	149	1,098	40	10,499(3)
1971	5,496	2,143	43	99(3)	842	898	41	142	310	160	1,194	39	11,407(3)
1972	6,243	2,564	52	117	956	1,013	44	169	352	195	1,302	46	13,053
1973	6,894	2,862	59	134	1,014	1,090	51	186	400	202	1,441	55	14,388
1974	7,235	2,835	60	142	1,081	1,067	52	197	379	203	1,527	58	14,836
1975	7,076	2,975	60	148	1,078	1,116	51	198	385	216	1,565	61	14,929
1976	7,598	3,223	62	160	1,140	1,181	54	202	406	227	1,568	60	15,881
Avg. Annual Growth Rate: 1966-76	10.4%	11.3%	9.1%	11.7%	8.7%	7.6%	9.4%	9.2%	7.7%	10.2%	6.9%	9.6%	9.7%
1974-76	2.5%	6.6%	1.7%	6.2%	2.7%	5.2%	1.9%	1.3%	3.5%	5.8%	1.3%	1.7%	3.5%
Winter Growth Rates (1967-68/1976-77)	11.2%	12.2%	10.2%	12.8%	11.5%	10.7%	8.9%	10.8%	10.4%	14.5%	7.0%	13.4%	10.9%

(1) From 1976 and 1977 Ten Year Site Plan for State of Florida - Table A1.

(2) FPL - Florida Power & Light Company
FPC - Florida Power Corporation
FTP - Fort Pierce Utilities Authority
GVL - Gainesville/Alachua County Regional Utilities Board
GPC - Gulf Power Company
JEA - Jacksonville Electric Authority
LWU - Lake Worth Utilities Authority
LAK - City of Lakeland
OUC - Orlando Utilities Commission
TAL - City of Tallahassee
TEC - Tampa Electric Company
VER - Vero Beach Municipal Utilities

(3) October 1977 Revision.

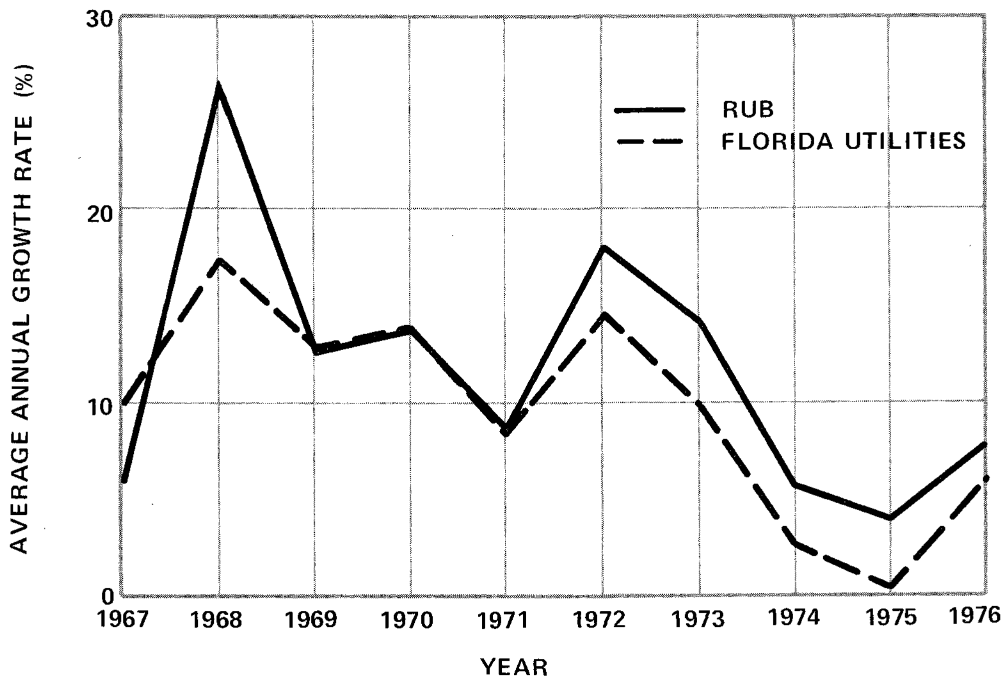


FIGURE 1.2-2 ANNUAL SUMMER PEAK DEMAND GROWTH RATE.

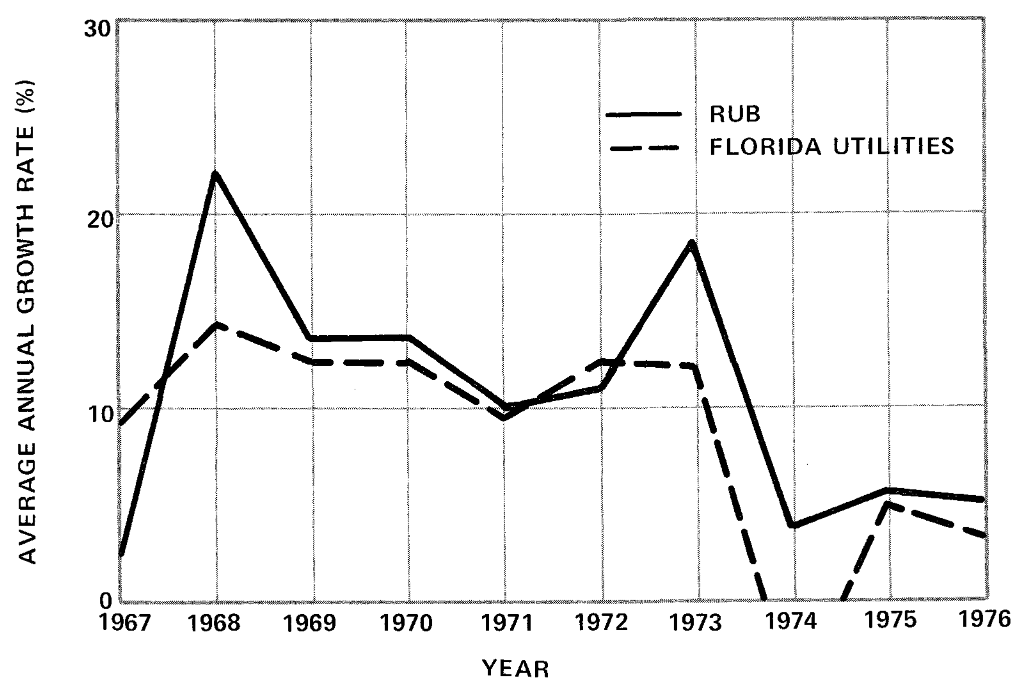


FIGURE 1.2-3 ANNUAL ENERGY GROWTH RATE

Econometric Model Growth Rate Assumptions

	*AAGR 1977-1987 (percent)
Fuel Cost	
Oil	6.0
Coal	5.0
Nuclear	8.0
Population	2.1
Income	9.7
Inflation	6.0

*Average Annual Growth Rate

The econometric model used by RUB considers cost of electricity and income, adjusted for inflation. The forecast was developed from the preceding economic conditions by customer class (Section 1.2). From log-linear regression analysis, a price elasticity coefficient of -0.459 was determined and used, together with electricity price and per capita income assumptions, to predict expected electric consumption.

The econometric model was used to project annual customer consumption in kWh, which was then multiplied by the projected number of customers to give the Residential sales forecast in mWh.

The General Service consumption forecast used the econometric technique considering the price of electricity and the number of Gainesville Urban Area households. Historical consumption requirements for Large Power customers were reviewed. Based on that review, Large Power Consumption was projected as a uniform percentage of the forecasted General Service consumption.

Forecasts (mWh) made for the Lighting Class (Rental and Public Lighting) were developed from historical trends. The Sales for Resale service growth rate was projected at 6.7% and System Losses at 5.9% of total sales to ultimate customers per year.

All of the energy forecasts for each class were totaled to yield a forecast reflecting the assumed economic conditions with an average annual growth rate of 5.9% for 1977-1986. The history and forecast of energy use is presented in Table 1.3-1 and is shown graphically in Figure 1.2-1. A constant load factor of 49%, determined from historical data, was used to calculate net summer peak demand. For this figure to change significantly there would have to be a large increase in the industrial load, and no such additions are foreseen. Summer and winter net peak loads for this forecast are shown in Figures 1.3-1 and 1.3-2.

Econometric Forecast Assumptions

Power Costs - Projected average annual power costs and operation and maintenance expenses for 1977-1990 were developed based on the addition of Deerhaven Unit 2 as a low-sulfur, coal-fired unit with commercial operation beginning in 1981. Total costs were developed from a determination of the minimum net revenue and debt coverage requirements necessary to meet financing requirements for sale of electric revenue bonds to fund construction of Deerhaven Unit 2. This analysis assumed the cost escalation rate for coal to be 5%, oil 6%, and nuclear fuel 8%. The average annual power cost was determined from the projected system sales.

Table 1.3-1 RUB History and Forecast of Energy Use (DSP Form 2)

Fiscal Year Ending	Rural and Residential GWH	Rural and Residential No. of Customers	Rural and Residential Average KWH Consumption Per Customer	General Service GWH	General Service Average No. of Customers	Large Power GWH	Large Power Average No. of Customers	Street & Highway Lighting GWH	Other Sales to Ultimate Consumers GWH	Total Sales to Ultimate Consumers GWH	Sales For Resale* GWH	Utility Use & Losses GWH	Net Energy For Load GWH
1967	111	15,999	6,937	117	1,923	1/	1/	5	0	233	0	18	251
1968	137	17,084	8,037	152	2,002	1/	1/	5	0	294	0	13	307
1969	158	19,118	8,272	159	2,129	1/	1/	6	0	323	0	26	349
1970	183	20,915	9,564	156	2,460	25	4	7	0	371	0	26	397
1971	204	22,189	9,212	175	2,790	26	4	9	0	414	0	24	438
1972	222	23,122	9,608	197	3,068	29	5	10	0	459	0	28	487
1973	268	25,485	10,500	229	3,244	36	6	11	0	544	0	34	578
1974	280	27,900	10,030	230	3,343	40	7	12	0	562	0	39	601
1975	302	30,300	9,970	231	3,418	48	8	14	0	594	9	32	636
1976	304	31,424	9,690	244	3,349	52	8	13	0	613	17	40	670
1977	329	32,470	10,132	256	3,395	55	8	13	0	653	20	45	718
1978	351	33,136	10,586	269	N/A	58	N/A	15	0	692	20	43	755
1979	372	33,836	11,004	283		61		15	0	732	21	46	798
1980	395	34,551	11,437	298		64		16	0	772	23	47	843
1981	422	35,518	11,888	313		68		16	0	819	24	51	894
1982	451	36,512	12,357	329		71		17	0	868	26	54	948
1983	482	37,534	12,844	346		75		18	0	921	28	57	1,006
1984	515	38,585	13,350	364		79		18	0	977	30	61	1,067
1985	550	39,665	13,877	383		83		19	0	1,035	32	64	1,131
1986	588	40,789	14,424	403		87		20	0	1,098	34	68	1,200

1/ Data not available prior to 1970. Large power is included in General Service prior to this time.
2/ Includes rental lighting sales.
* To Class III and Class V systems.

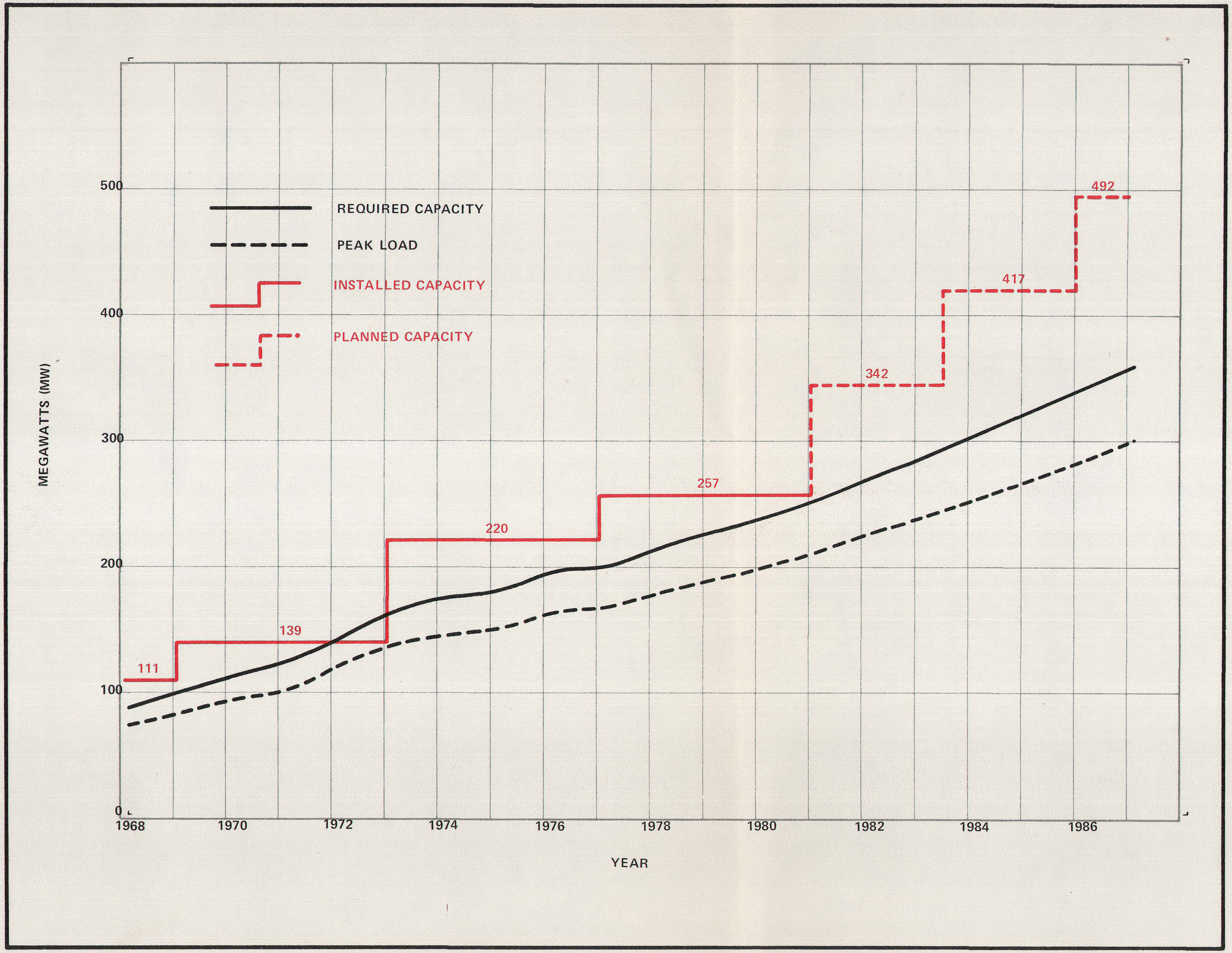


FIGURE 1.3-1 SUMMER NET PEAK LOAD AND GENERATION CAPACITY.

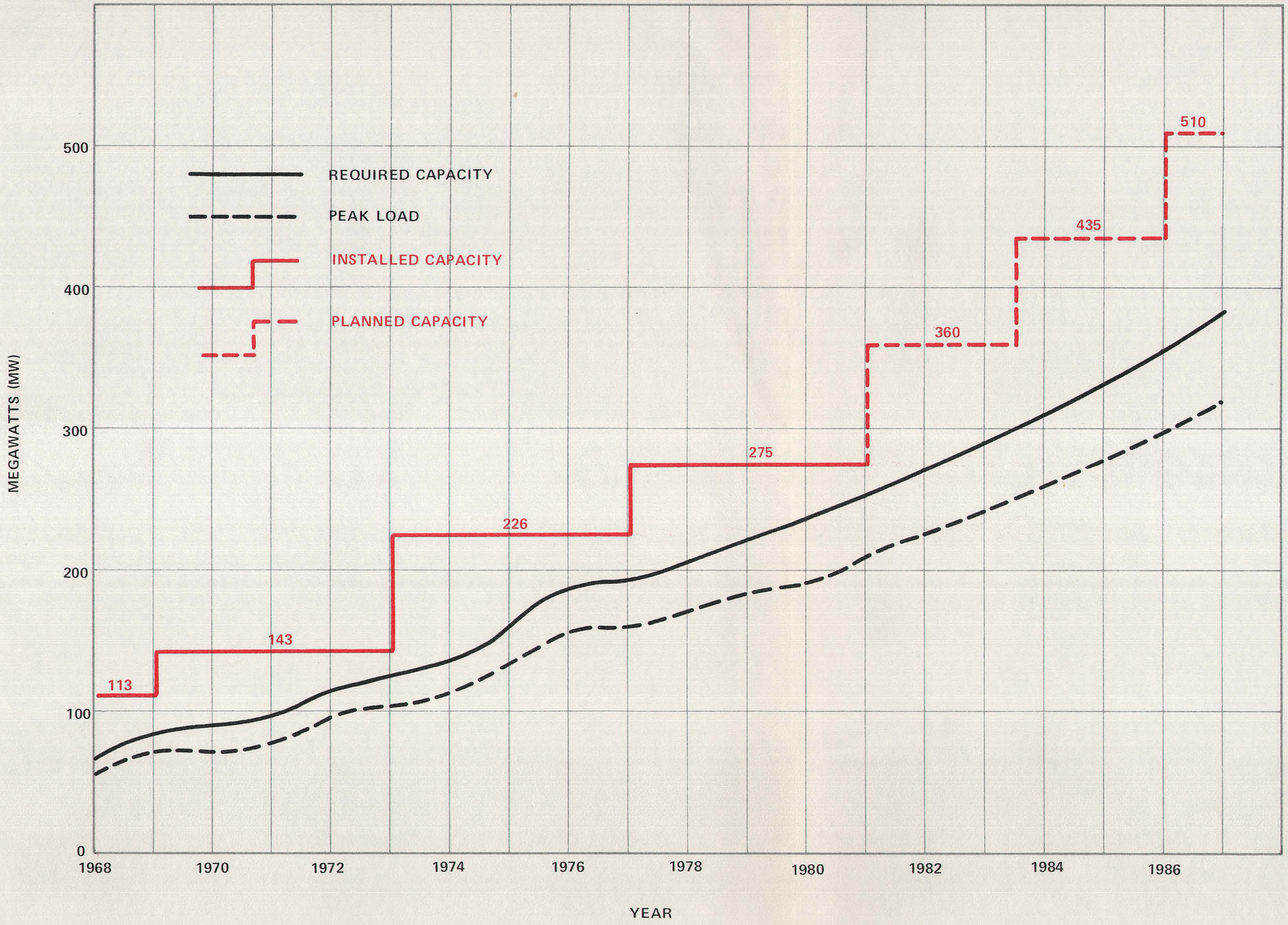


FIGURE 1.3-2 WINTER NET PEAK LOAD AND GENERATION CAPACITY.

Population Forecast - The population projection was developed by the Bureau of Economics and Business Research, College of Business Administration, University of Florida in July, 1977. Historical population trends (Table 1.3-2) show that Florida, the Gainesville Urban Area, and Alachua County have experienced higher average annual growth rates than the nation. Their average annual growth rates for 1950-1970, respectively were 4.6%, 4.2%, and 3.1%, compared to the U.S. growth rate of 1.5%.

The population growth rate utilized in the forecast was 2.1%. This is lower than the historical rate for Alachua County and the Gainesville Urban Area and should therefore prove to be conservative when applied to the RUB system.

Per Capita Income - Per capita income information for the State of Florida and Gainesville (Table 1.3-3) was taken from the Florida Statistical Abstract - 1976, prepared by the Bureau of Economics and Business Research, College of Business Administration, University of Florida. Gainesville's per capita income has historically been lower than that of the State, but the average annual growth rate has been higher (Table 1.3-3). The historical average annual growth rate for Gainesville for 1950-1974 was 7.2%, 10.9% from 1965-1974 and more recently, 12.0% from 1970-1974. The forecast projection of a growth rate of 9.7% is conservative and consistent with historical experience.

Table 1.3-2 Population Changes* (000)

	1950	1960	1970	Average Annual Growth Rates 1950-1960	1960-1970	1950-1970
United States	151,683	179,992	203,213	1.7%	1.2%	1.5%
Florida	2,771	4,952	6,789	6.0%	3.2%	4.6%
Gainesville Urban Area**	36.36	53.111	82.411	3.9%	4.5%	4.2%
Alachua County**	56.5	72.6	103.268	2.5%	3.6%	3.1%

* U.S. Department of Commerce, Bureau of Census 1950, 1960, 1970, Census of Population taken from Alachua County Comprehensive Plan 1975-1995 dated December, 1975, Revised August, 1976.

** Alachua County Comprehensive Plan 1975-1995, Revised August, 1976.

Table 1.3-3 Per Capita Income 1950-1974 For Gainesville and the State of Florida

Year	State of Florida	Gainesville
1950	$1,280	$ 861
1965	$2,404	$1,809
1968	$3,119	$2,467
1969	$3,444	$2,647
1970	$3,738	$2,917
1971	$4,034	$3,302
1972	$4,510	$3,654
1973	$5,041	$4,195
1974	$5,412	$4,588
	Average Annual Growth Rates	
1950-1965	4.3%	5.1%
1950-1974	6.2%	7.2%
1965-1974	9.4%	10.9%
1970-1974	9.7%	12.0%

Source: Florida Statistical Abstract - 1976: Bureau of Economic and Business Research, College of Business Administration, University of Florida.

Inflation - The forecast assumed a 6.0% inflation rate based on the Consumer Price Index for 1971-1976 (Table 1.3-4). This is within the range of 3.3% to 11.0% for the years 1972-1976 and does not assume a repeat of the recessionary period experienced in 1973.

Appliance Saturation - In January 1977, RUB conducted a telephone survey of 282 residential customers to determine appliance saturation. There were 120 acceptable responses obtained from the sample selected. The resulting information was used to determine the average annual energy consumption per customer and was compared to the results of the econometric model.

1.3.2 Probabilistic Forecast

A probabilistic forecast was developed in the 1977 Load and Energy Forecast. Probabilistic load forecasting uses historical data to find a statistical description of the system peak load at some future point in time. A probability density function must be calculated to quantify the uncertainty associated with the forecast load and establish a range within which the load will likely fall.

The probabilistic forecasting method assumed that the load was divided into a weather-sensitive component, a seasonal component, and a non-weather-sensitive component. The non-weather-sensitive component was extrapolated by using a second order discounted multiple regression technique. The seasonal and winter weather-sensitive components were

Table 1.3-4 U.S. Consumer Price Index

Year	Consumer Price Index 1967 Dollars (1)	Growth Rates (%)
1970	116.3	
1971	121.3	4.3 (2)
1972	125.3	3.3
1973	133.1	6.2
1974	147.7	11.0
1975	161.2	9.1
1976	169.2 (3)	5.0

(1) U.S. Bureau of Census. Statistical Abstract of the United States, 1976, Washington, D.C., July 1976, p. 43.

(2) Consumer Price Index (CPI) 1971/CPI 1970

(3) As of May 1976.

considered relatively stable and were modeled using a linear least squares technique. The summer weather-sensitive component, attributed mainly to air conditioning, grew rapidly to 1973 and due to saturation effects in customer usage, was modeled by an inverted decaying exponential. The uncertainties of the components were expressed in the form of probability density functions which were combined through convolution to produce one probability density. From this, a mean forecast with associated confidence intervals was determined. The net peak load from this forecast with a 90% confidence interval along with the net peak load from the econometric forecast is shown in Figure 1.3-3.

1.4 Load Effecting Programs

The Customer Service Division, through the use of public information programs, promotes energy conservation with presentations to schools and civic and business groups concerning the efficient use of electric energy. Bill stuffers are also mailed periodically to remind customers to conserve during peak seasons. RUB has no advertising programs promoting the sale of electrical energy. Promoting conservation and efficient use of electrical energy can affect patterns of energy use and possibly reduce peak or largest demands. Other methods of controlling peak demand period are through load management programs.

1.4.1 Load Management

The purpose of load management is to control the use of energy during peak period hours and thus reduce peak demand. Studies of systems

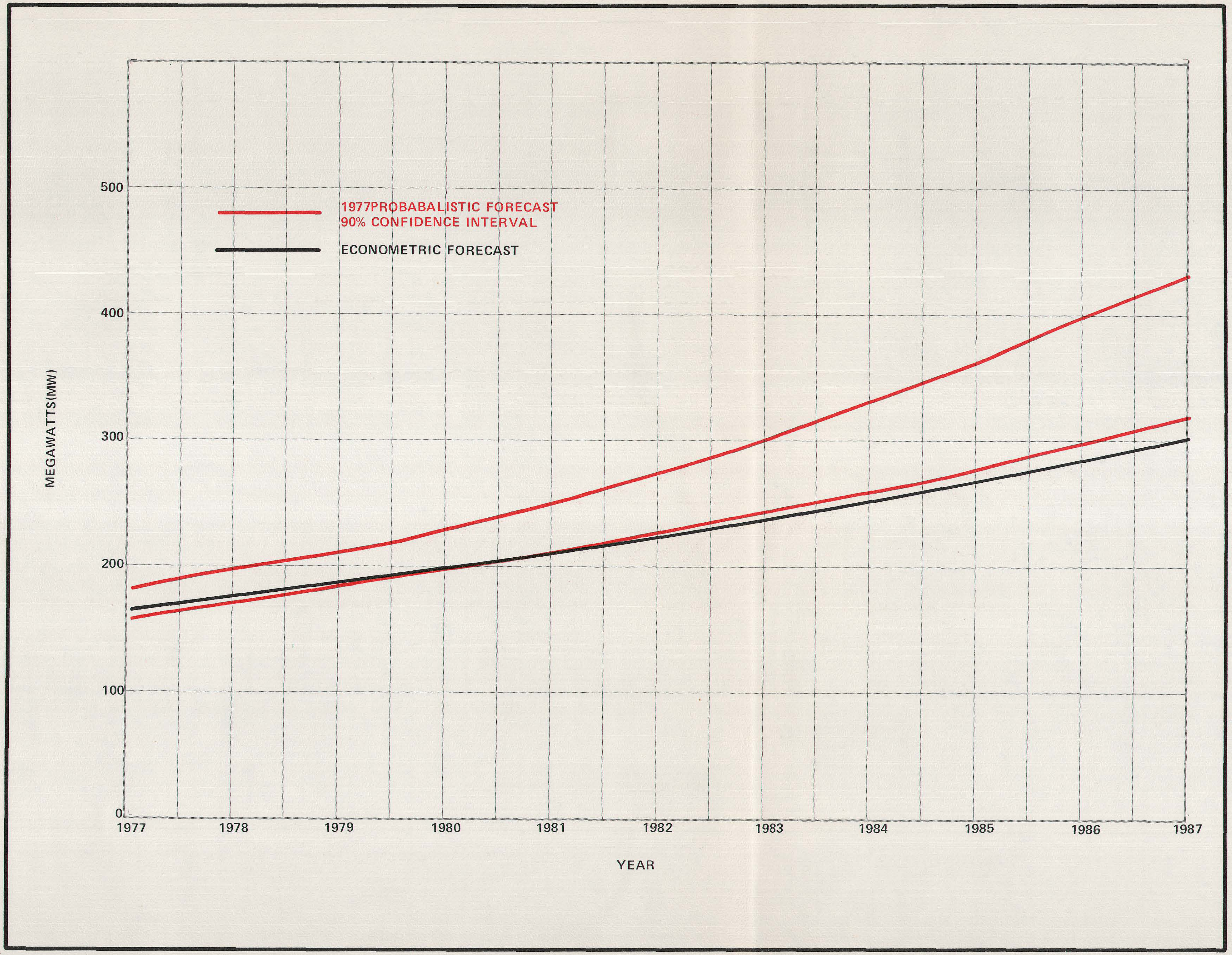


FIGURE 1.3-3 COMPARISON OF PEAK LOAD FORECAST.

indicate that although peak loads can be modified, the total energy requirements for a system will be approximately the same with or without a load management program.

Several methods of load management are available that could possibly reduce the annual peak demand on most any utility system. The cost and benefits of installing such a program depend upon the power supply characteristics unique to each system. A load management program for the RUB system would result in an immediate increase in fixed costs on the system. However, it could reduce fixed costs in the future and immediately reduce amounts of higher cost fuels for combustion turbines used during peak demand periods. In future years, such a program could modify the amount of additional generating capacity required to meet peak loads and provide adequate reserves. A cost-effective program would require that savings from reduced fuel consumption and capacity exceed the cost of installing and maintaining the program.

In order to evaluate the potential effect of a load management program on RUB's future power supply requirements, a cursory estimate of the reduction in peak load that might be achieved through control of central air conditioners was prepared. Assuming such a program were started in 1978, the earliest probable date full implementation could be achieved would be 1981, as the program would require installation of some 16,000 control devices on central air conditioning units in individual homes and apartments, as well as the monitoring and control system. Table 1.4-1

presents the estimated controllable demand and reduction in forecast peak demand for 1981. In order to maintain this level of reduction, all central air conditioning units installed in the future would have to be controlled. If total energy consumption remained the same, such a program could result in an annual system load factor improvement. Although such a program could initially result in an immediate peak demand decrease, future increases in demand and energy use would make the impact of the improvements less significant.

The available methods of active load management are categorized as either indirect or direct utility control. Indirect control includes voltage reduction where no direct control exists on any particular appliances. Two of the available direct methods presently utilized are radio control and ripple control. These methods allow particular electric appliances to be directly controlled by the utility. A brief discussion of these three methods is presented below.

Voltage Reduction

Within limits, the load on an electrical distribution system is approximately proportional to voltage. In practice, it has been found that a 5% reduction in voltage results in less than a 2% reduction in kilowatt load even though the distribution feeders tested had some degree of motor load, such as air conditioning, in addition to lighting and heating loads.

Table 1.4-1 Possible Effects of Load Management on Demand in 1981

1	Number of Residential Customers	35,518
2	Central Air Conditioner Saturation	53.2%
3	Total Central Air Conditioners	18,896
4	Percent of Installations Adaptable to Load Management	75%
5	Total Available Central Units	14,172
6	Number of Single Family Units (1)	9,212
7	Number of Apartment Units (1)	4,960
8	Diversified Controlled Single Family Load	1.35 kW
9	Diversified Controled Apartment Load	.65 kW
10	Total Controllable Single Family Demand (2)	12,436 kW
11	Total Controllable Apartment Demand (3)	3,224 kW
12	Total Effective Controllable Demand	15,660 kW
13	Projected System Summer Demand	208,000 kW
14	Estimated Summer Peak Reduction	7.5%

(1) Estimated 65% single family, 35% apartments
(2) Line 6 times Line 8
(3) Line 7 times Line 9

Naturally, there are limits below which voltage cannot be reduced without incurring customer complaints or risking damage to motors. A utility contemplating the use of voltage reduction during peak load times must ensure that customers far from the substation will receive adequate voltage at their service entrance.

Radio Control

Radio-controlled switches have been used in the United States for the past ten years for control of customer appliances in load management systems and have proven reliable and effective when properly applied. The basic Radio Control System consists of: (1) load-measuring or load-predicting devices; (2) a central controller; (3) a radio transmitter; (4) a radio control switch; and (5) communication channels, such as leased telephone lines, from load measuring points to the central controller and from controller to transmitter.

Load measuring or load predicting devices provide input to the programmed central controller, which interprets the input data and produces appropriate commands to the transmitter. The transmitter sends out brief audio tone signals to the radio switches. Approximately 40 tones are available, but usually only ten are used for control of radio switches and two or three others are used for auxiliary functions. Each switch is responsive to one or more of these tones. When the correct tone is received, the switch is activated and a relay contact inside the switch opens to interrupt the external circuit connected to it. The

systems in general use utilize a relay contact which remains open for five to nine minutes. If another tone is received in this interval, the timer is reset and the open interval is extended.

Ripple Control

In western Europe and many other countries in different parts of the world, so-called "Ripple Control" systems are in widespread use. Ripple control is just now being introduced into the United States as a method of load management. This belated interest has been caused by the energy crisis and increasing energy costs. Countries where ripple control has been in use for many years have either not had the full resources of the United States or have at least been more frugal in their use.

In the ripple control system, a coded audio-frequency signal can be injected into the power system at transmission or distribution service delivery points. This ripple signal appears at all points on the system, including the internal circuits within homes and businesses, and conveys switching commands to receivers, which in turn control the operation of air conditioners, water heaters, or other appliances.

The Ripple Control System comprises: (1) load measuring or load predicting devices; (2) transmitting equipment - a central controller, a static frequency converter, and a coupling circuit; (3) receivers with one, two, three or four independent relays; and (4) communication channels from load measuring points to the transmitter.

The type of injection mode is adapted to the network under consideration. Basically, there are two possibilities: (1) parallel injection; and (2) series injection.

Parallel injection is accomplished by coupling the three-phase ripple signal to the three phases of the power system through capacitors similar to the high voltage capacitors used for power factor correction. Series injection involves the use of three large high-voltage current transformers, one in each phase of the load circuit, to inject the signal. Both methods require a switching structure and appropriate disconnect and bypass switches to facilitate maintenance.

1.4.2 Other Energy Conservation Measures

RUB has made public appeals through the news media to reduce demand and consumption during critical peak load periods. Although the results were effective, a continual use of such appeals would most likely diminish their effectiveness.

More efficient energy use can be achieved by revising building codes to require increased insulation in new residential and commercial buildings and, where possible, upgrade the insulation of existing structures to reduce air conditioning and heating requirements. Minimum standards of efficiency for air conditioners and other appliances are under consideration at the Federal and state level, analogous to federal fuel consumption standards being considered for automobiles.

1.5 Projected Power Supply Requirements

The overall average annual growth rate of 5.9% projected in the Econometric Forecast (Section 1.3) is the basis for the history and forecast of demand and energy for RUB as shown in Table 1.5-1. Although energy growth rates of other major Florida utilities range from 2.9% to 6.7%, with an 5.4% aggregate rate (Table 1.5-3), the RUB projection is consistent with historical trends wherein RUB has had one of the higher growth rates in Florida.

1.5.1 Comparison of Previous Forecasts

Projections of expected summer peak demands on the RUB system prepared in 1974-1977 have been compared with historical peak summer demands (Figure 1.5-1) and with the aggregate of major Florida utilities forecasts for 1974-1977 (Figure 1.5-2). The average annual growth rates of the probabilistic forecast limits (Section 1.3.2) bound all of the past forecasts except the highest 1974 forecast.

1.5.2 Other Major Florida Utilities 1977 Forecasts

Tables 1.5-2 and 1.5-3 present the 1977 forecasts of summer peak load and net energy requirements for each of the major Florida utilities. The average annual growth rates for summer peak demand range from 3.9% to 11% but due to the large load influence of the Florida Power & Light system, the aggregate growth is 5.6%. The same effect is also present in comparing individual and aggregate forecasts of energy requirements. Because of the dominant effect of the projected requirements of the

Table 1.5-1 RUB History and Forecast of Seasonal Peak Demand and Annual Energy Requirements (DSP Form 4)

Fiscal Year Ending	Summer Peak Demand Net MW		Net Energy For Load - GWH	Load Factor %	Winter	Winter Peak Demand Net MW	
	Interruptible	Total				Interruptible	Total
1967	0	57*	251	50.3	1967-68	0	50
1968	0	71*	307	49.4	1968-69	0	52
1969	0	80*	349	49.8	1969-70	0	68
1970	0	91*	397	49.8	1970-71	0	71
1971	0	99*	438	50.5	1971-72	0	75
1972	0	117*	487	47.7	1972-73	0	92
1973	0	134	578	49.4	1973-74	0	103
1974	0	142	601	48.2	1974-75	0	113
1975	0	148	636	49.0	1975-76	0	133
1976	0	160	670	47.9	1976-77	0	156
1977	0	163	718	50.3	1977-78	0	160
1978	0	176	755	49.0	1978-79	0	171
1979	0	186	798	49.0	1979-80	0	183
1980	0	196	843	49.0	1980-81	0	196
1981	0	208	894	49.0	1981-82	0	210
1982	0	221	948	49.0	1982-83	0	225
1983	0	234	1,006	49.0	1983-84	0	241
1984	0	249	1,067	49.0	1984-85	0	258
1985	0	263	1,131	49.0	1985-86	0	276
1986	0	280	1,200	49.0	1986-87	0	296

*These peaks represent gross values adjusted by approximation of system auxillaries.

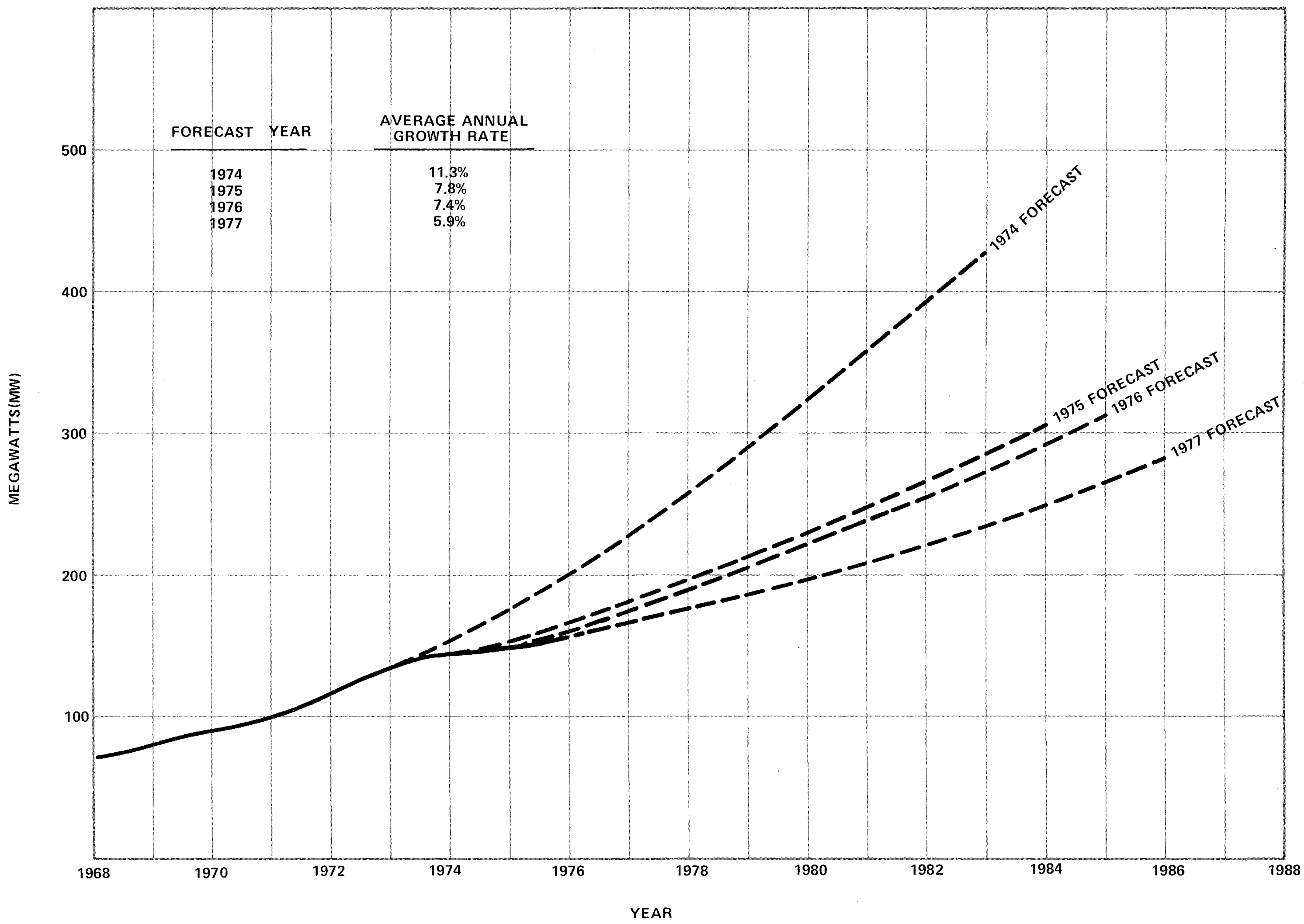


FIGURE 1.5-1 RUB HISTORY AND PROJECTED FORECASTS OF SUMMER NET PEAK DEMAND.

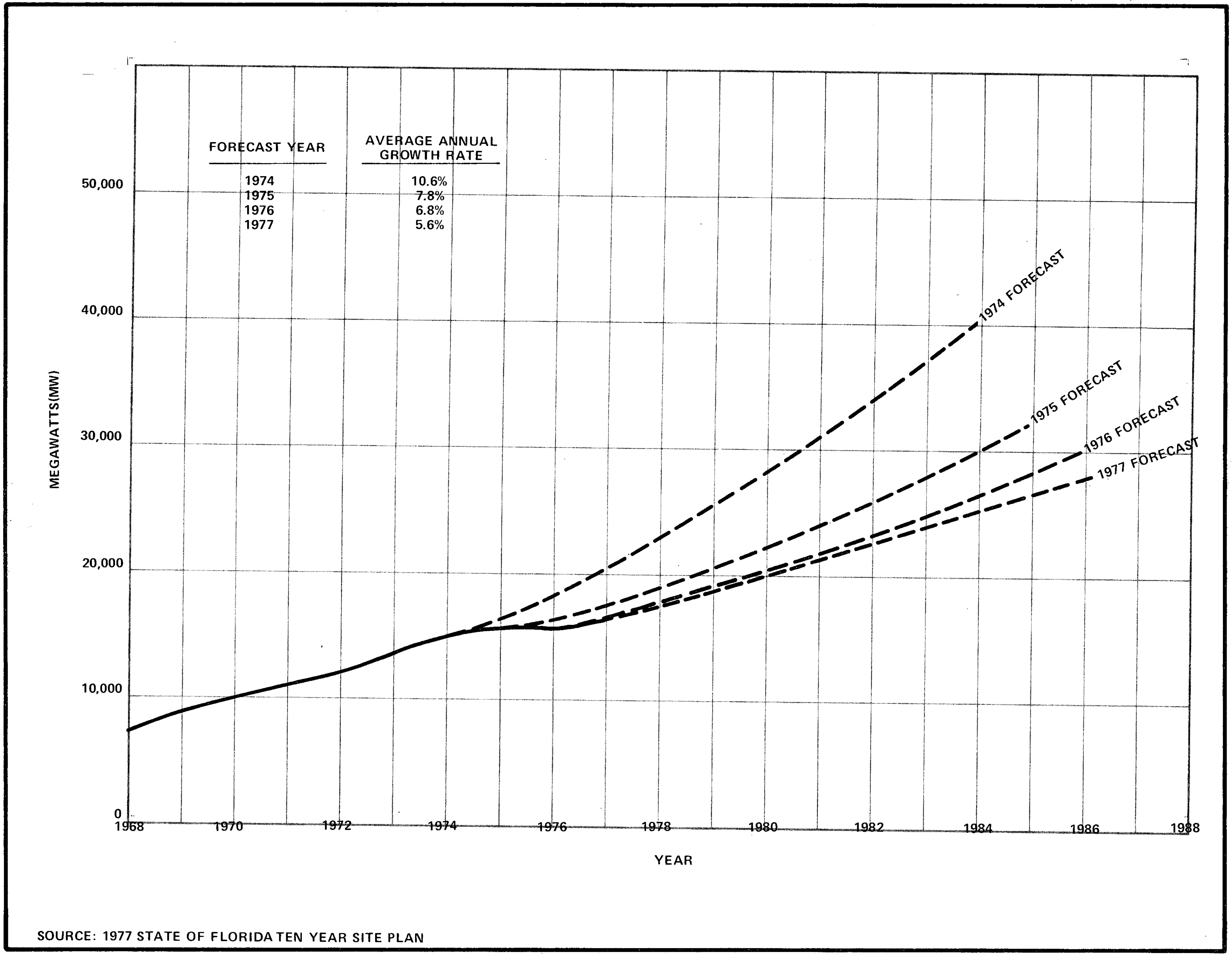


FIGURE 1.5-2 STATE COMPOSITE OF HISTORY AND PROJECTED FORECASTS OF SUMMER NET PEAK DEMAND.

Table 1.5-2 Major Florida Utilities Forecast of Summer Peak Load by Utility - Net MW (1)

Year	FPL(2)	FPC(2)	FTP(2)	GVL(2)(3)	GPC(2)	JEA(2)	LWU(2)	LAK(2)	OUC(2)	TAL(2)	TEC(2)	VER(2)	Total (3)
1977	8,090	3,440	66	163	1,256	1,252	56	216	432	244	1,664	72	16,951
1978	8,615	3,700	69	176	1,370	1,327	59	230	458	266	1,720	88	18,078
1979	9,160	3,990	72	186	1,486	1,407	62	245	493	285	1,786	97	19,269
1980	9,705	4,300	76	196	1,609	1,491	65	261	528	304	1,856	108	20,499
1981	10,250	4,630	80	208	1,723	1,580	68	278	556	326	1,919	121	21,749
1982	10,780	4,970	84	221	1,839	1,675	72	297	584	348	2,011	136	23,017
1983	11,295	5,280	88	234	1,925	1,776	75	317	607	372	2,089	152	24,210
1984	11,790	5,560	92	249	2,023	1,882	79	338	627	398	2,155	167	25,360
1985	12,260	5,800	97	263	2,139	1,995	83	361	646	424	2,244	176	26,488
1986	12,730	6,040	102	280	2,252	2,115	87	385	661	452	2,338	184	27,626
Avg. Annual Growth Rate:	5.2%	6.5%	5.0%	6.2%	6.7%	6.0%	5.0%	6.6%	4.8%	7.1%	3.9%	11.0%	5.6%
Winter Peak Load Growth Rates (1977-78/1986-87)													
	5.6%	6.2%	5.0%	7.1%	6.7%	7.0%	4.9%	6.7%	5.3%	7.1%	3.9%	8.6%	5.8%

(1) 1976 and 1977 Ten Year Site Plan for State of Florida - Table A3.
(2) FPL - Florida Power & Light Company
FPC - Florida Power Corporation
FTP - Fort Pierce Utilities Authority
GVL - Gainesville/Alachua County Regional Utilities Board
GPC - Gulf Power Company
JEA - Jacksonville Electric Authority
LWU - Lake Worth Utilities Authority
LAK - City of Lakeland
OUC - Orlando Utilities Commission
TAL - City of Tallahassee
TEC - Tampa Electric Company
VER - Vero Beach Municipal Utilities

(3) October 1977 Revision

Table 1.5-3 Major Florida Utilities Forecast of Net Energy for Load - GWH (Millions of KWH)(1)

Year	FPL(2)	FPC(2)	FTP(2)	GVL(2)(3)	GPC(2)	JEA(2)	LWU(2)	LAK(2)	OUC(2)	TAL(2)	TEC(2)	VER(2)	Total(3)
1977	40,220	17,074	310	718	6,083	5,911	250	1,030	2,050	1,054	9,968	310	84,978
1978	42,775	18,482	324	755	6,481	6,236	267	1,099	2,172	1,144	10,298	316	90,349
1979	45,470	20,005	339	798	6,949	6,579	278	1,173	2,338	1,218	10,597	322	96,066
1980	48,315	21,621	356	843	7,433	6,941	289	1,252	2,505	1,297	10,889	331	102,072
1981	51,175	23,349	374	894	7,949	7,322	300	1,336	2,651	1,382	11,206	342	108,280
1982	54,025	24,899	392	948	8,373	7,725	314	1,426	2,779	1,471	11,569	359	114,280
1983	56,620	26,428	411	1,006	8,741	8,150	329	1,522	2,890	1,567	11,893	377	119,934
1984	59,125	27,825	431	1,067	9,192	8,598	344	1,624	2,989	1,669	12,173	396	125,433
1985	61,510	29,146	452	1,131	9,670	9,071	360	1,733	3,078	1,777	12,547	416	130,891
1986	63,905	30,423	474	1,200	10,158	9,570	374	1,849	3,157	1,893	12,943	436	136,382
Avg. Annual Growth Rate:	5.3%	6.6%	4.8%	5.9%	5.9%	5.5%	4.6%	6.7%	4.9%	6.7%	2.9%	3.9%	5.4%

(1) 1976 and 1977 Ten Year Site Plan for State of Florida - Table A3.
(2) FPL - Florida Power & Light Company
FPC - Florida Power Corporation
FTP - Fort Pierce Utilities Authority
GVL - Gainesville/Alachua County Regional Utilities Board
GPC - Gulf Power Company
JEA - Jacksonville Electric Authority
LWU - Lake Worth Utilities Authority
LAK - City of Lakeland
OUC - Orlando Utilities Commission
TAL - City of Tallahassee
TEC - Tampa Electric Company
VER - Vero Beach Municipal Utilities

(3) October 1977 Revision

Florida Power & Light system, any change in its individual forecasted growth rate, which is among the lowest, will have a significant impact on the aggregate demand and energy requirements.

1.6 Planned Capacity Additions

Additions to a utilities system should be planned to satisfy expected future growth and to allow for replacement of older, uneconomical units. Because larger units offer economies of scale and greater operating efficiency, utilities usually prefer to add the largest economically feasible unit to their system. Selling the excess capacity or economy energy to other systems can, besides being a source of additional revenue, allow a utility to purchase larger units rather than add smaller units more often or purchase capacity from other systems.

The coal-fired Deerhaven Unit 2 is currently the only planned addition to the RUB system. The preliminary estimate for this Unit's continuous capability is 235 mW. Assuming a 5.9% yearly growth in demand and the accepted capacity reserve level of 20% above projected annual peak loads, existing reserves will be sufficient to carry the RUB system through 1981. But if the actual growth rate should exceed the projection, additional capacity will be imperative in 1981. The projected system reserves without the addition of this unit will be 24% in 1981 and 16% in 1982. The wide range of projected growth rates as reported by other Florida utilities indicates the uncertainties of the future.

Following sections analyze the effect of adding Unit 2 to the system by addressing the possible range of circumstances and potential options.

1.6.1 Contract Sale to Florida Power Corporation

Pursuant to a Letter of Commitment executed August 17, 1976, Florida Power Corporation is committed to a purchase of 75 mW of firm capacity for 3 years beginning June 1, 1980, or when Deerhaven Unit 2 begins commercial operation, whichever is later. Florida Power Corporation has an option to purchase an additional 75 mW of firm capacity, as well as an option to purchase any excess firm capacity for use during the same time period and under the same terms as the initial 75 mW. A third option is available for the purchase of any excess firm capacity from the end of the 3 year period up to May 31, 1986. Whether or not Florida Power Corporation exercises any option, it has refusal rights on any excess capacity from October 2, 1978, through May 31, 1986, at a price equal to another system's final offer. Effects of Florida Power Corporation's contracted purchase and exercising of options have been projected using the forecast 5.9% annual growth rate (Figure 1.3-1).

These projections indicate that RUB will meet its system requirements, the Florida Power Corporation contract, and the 75 mW option in 1981. With the coal-fired Unit 2 to displace oil-fired generation on interconnected systems, capacity would be available in 1981 for economy exchange to interconnected utilities. If Florida Power Corporation exercises the 75 mW option, a sufficient reserve would be available from

system capability, assuming that the maximum sale to Florida Power Corporation occurred during the RUB system peak. The reserve margin would fall to 28% in 1983 and it is likely that less capacity would be available for economy interchange.

1.6.2 Potential Markets for Excess Capacity and Economy Energy

A review of projected maximum peak demands, installed capacities, and expected reserves of other systems comparable to or larger than RUB reveals several potential markets for excess capacity lasting well beyond the 1981 planned commercial operation date (Table 1.6-1). Although Table 1.6-1 presents the most recent information presently available, it is anticipated that additional reserve calculations will be provided for agency review as soon as the required information is made available from other State utilities.

Florida Power Corporation's projected reserves range from 7.1% to 13.9% over 1981-1986. The larger Florida Power & Light system projects reserves of 12.8% and 14.2% for 1985 and 1986. Tampa Electric projects reserves of 16.8% and 12.1% in 1984 and 1985. Several smaller utility systems in the State are potential markets for excess capacity from the RUB system.

Even with no sale of excess capacity other than that contracted to Florida Power Corporation, coal-fired generation from Deerhaven Unit 2 could be used as economy energy to displace oil-fired generation on other Florida systems, assuming reasonable price differentials in coal and oil and taking wheeling charges into account.

Table 1.6-1 Forecast of Maximum Peaks, Installed Capacities, Additions/Retirements and Reserves for Major Florida Utilities of Comparable Size or Larger Than RUB (11)

Florida Power & Light Company

Year	Maximum Peak (MW)	Capacity (MW)	Additions and (Retirements) (MW)	Reserve (%)
1977	8,090	9,740	484 (1)	26.38
1978	8,615	10,224	775 (3)	27.67
1979	9,160	10,999		20.08
1980	9,705	10,999	483 (3)	18.31
1981	10,250	11,482	775 (3)	19.58
1982	10,780	12,257	775 (3)	20.89
1983	11,295	13,032	802 (2)	22.48
1984	11,790	13,834		17.34
1985	12,260	13,834		12.84
1986	12,730	13,834	700 (3)	14.17

Florida Power Corporation

Year	Maximum Peak (MW)	Capacity (MW)	Additions and (Retirements) (MW)	Reserve (%)
1977	3,899	3,895	0	0
1978	4,180	3,895	742 (2)	11.73
1979	4,470	4,637	515 (3)	15.26
1980	4,810	5,152	272 (4)	12.77
1981	5,170	5,424	200 (5)	8.78
1982	5,530	5,624	300 (5)	7.12
1983	5,870	5,924	600 (3)	11.14
1984	6,200	6,524	300 (1)	10.06
1985	6,520	6,824	600 (3)	13.87
1986	6,820	7,424	256 (6)	12.61

Jacksonville Electric Authority

Year	Maximum Peak (MW)	Capacity (MW)	Additions and (Retirements) (MW)	Reserve (%)
1977	1,252	1,550		23.80
1978	1,327	1,550	518 (3)	58.85
1979	1,407	2,108		49.82
1980	1,491	2,108		41.38
1981	1,580	2,108		33.42
1982	1,675	2,108		25.85
1983	1,776	2,108	490 (3)	46.28
1984	1,882	2,598		38.04
1985	1,995	2,598		30.23
1986	2,115	2,598		22.84

City of Lakeland

Year	Maximum Peak (MW)	Capacity (MW)	Additions and (Retirements) (MW)	Reserve (%)
1977	234	377		61.11
1978	252	377		49.60
1979	269	377		40.15
1980	287	377		31.36
1981	306	377		23.20
1982	326	377		15.64
1983	348	562	185 (7)	61.49
1984	371	562		51.48
1985	396	562		41.92
1986	423	537	(25)(3)	26.95

Orlando Utilities Commission

Year	Maximum Peak (MW)	Capacity (MW)	Additions and (Retirements) (MW)	Reserve (%)
1977	432	750	13 (2)	76.62
1978	458	763		66.59
1979	493	763		54.77
1980	528	763		44.51
1981	556	763		37.23
1982	584	763	100 (3)	47.77
1983	607	863	(40)(8)	35.58
1984	627	823		31.26
1985	646	823		27.40
1986	661	823		24.51

City of Tallahassee

Year	Maximum Peak (MW)	Capacity (MW)	Additions and (Retirements) (MW)	Reserve (%)
1977	244	278	11 (2)	18.44
1978	266	289	238 (3)	98.12
1979	285	527		84.91
1980	304	527		73.36
1981	326	527		61.66
1982	348	527		51.44
1983	372	527		41.67
1984	398	527	18 (9)	36.93
1985	424	545		28.54
1986	452	545	70 (10)	36.06

Tampa Electric Company

Year	Maximum Peak (MW)	Capacity (MW)	Additions and (Retirements) (MW)	Reserve (%)
1977	1,712	2,465	25 (3)	43.98
1978	1,774	2,601	111 (3)	46.62
1979	1,843	2,601		41.13
1980	1,916	2,601		35.72
1981	1,996	2,601		30.31
1982	2,075	2,601		25.35
1983	2,139	2,601		21.60
1984	2,227	2,601		16.79
1985	2,320	2,601		12.11
1986	2,410	3,026	425 (3)	25.56

Footnotes:
(1) Combined cycle.
(2) Nuclear.
(3) Fossil steam.
(4) Fossil steam - (28 MW), 6/79; Combustion turbine - 300 MW, 10/79.
(5) Combustion turbine.
(6) Combined cycle - 300 MW, 10/85; Fossil steam (44 MW), 4/85.
(7) Fossil steam - 236 MW, 9/82; (18 MW), 3/83; Combustion turbine - (33 MW), 3/83.
(8) Fossil steam - (90 MW), 12/82; Nuclear - 50 MW, /83.
(9) Combustion turbine - 50 MW, 5/84; Fossil steam - (32 MW), 5/84.
(10) Unknown.
(11) 1977 Ten Year Site Plan for State of Florida.

With these facts in mind, RUB is currently involved in negotiating interchange agreements with several of Florida's interconnected utilities. Such contracts will allow RUB to offer these utilities any energy in excess of system demands and reserve margins.

1.7 Consequences of Delay

The effect of a two-year slip of Deerhaven Unit 2 to commercial operation in 1983 has been analyzed against the assumed 5.9% annual growth forecast taking into account the Florida Power Corporation purchase.

With a slippage of the commercial operation date to 1983, there would be a projected peak of 208 mW in 1981 against a system capability of 257 mW. This would leave the system with 24% reserves, and no sales would be made to Florida Power Corporation under the contract since Deerhaven Unit 2 would not be in service.

In 1982 with a projected net peak demand of 221 mW, the reserve would be reduced below 20% to 16% and again no sales could be made to Florida Power Corporation.

In 1983, with a summer peak demand of 234 mW and a system capability of 492 mW with Deerhaven Unit 2 in service, sufficient capacity would be available to serve the 75 mW sale to Florida Power Corporation (Figure 1.7-1). However, the additional 75 mW option, if exercised through 1985, would reduce the reserve below 20% to 19% in 1985.

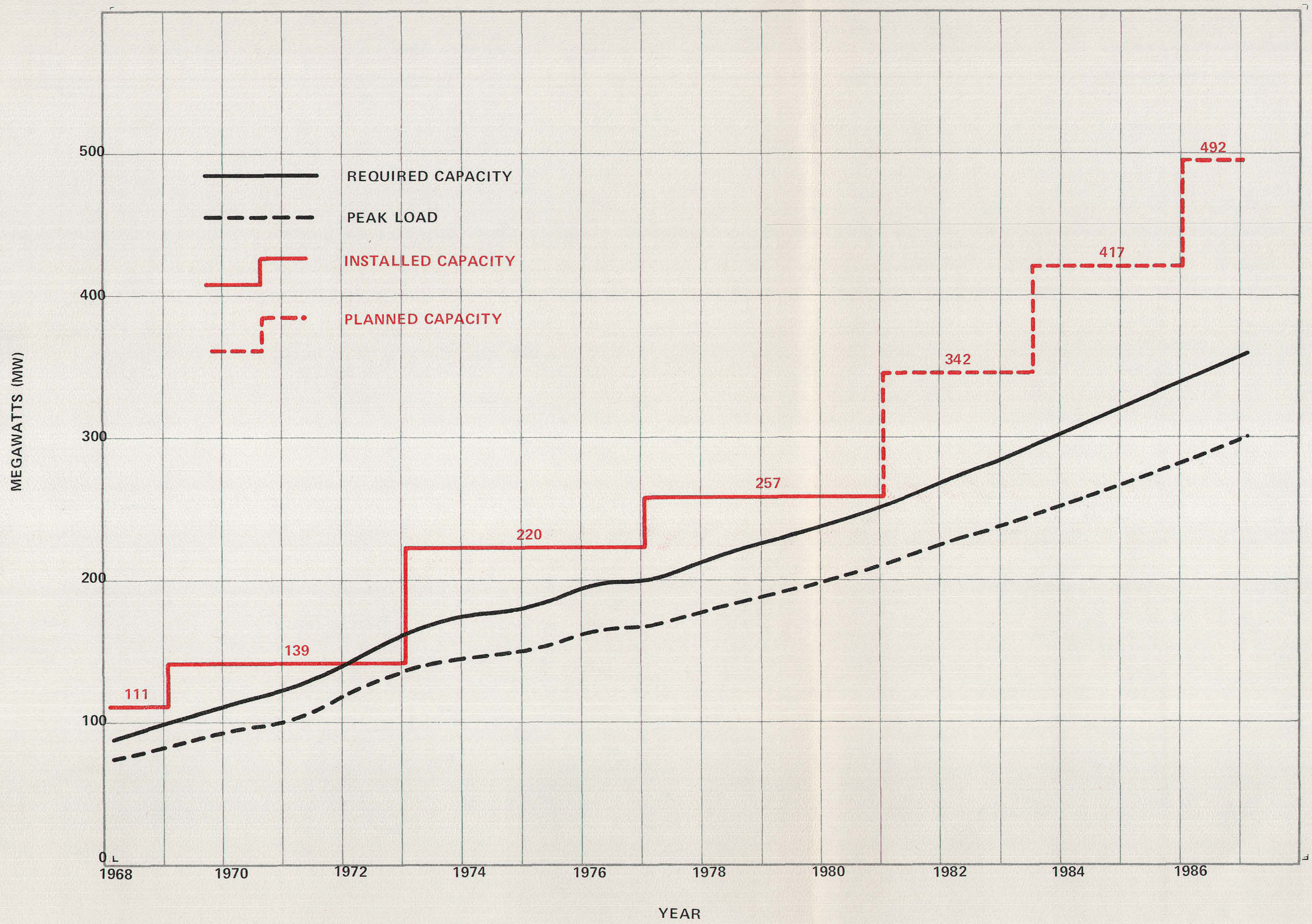


FIGURE 1.7-1 SUMMER NET LOAD AND GENERATION CAPACITY FOR DEERHAVEN UNIT 2 DELAYED TO 1983.

1.8 Effect on Statewide Reliability

The addition of Deerhaven Unit 2 in 1981 will enhance the reliability of the RUB system as well as the overall reliability of the peninsular Florida interconnected systems. This contribution to statewide reliability is significant in light of the low reserve margins predicted by Florida's utilities in the 1981-1986 period (Section 1.6).

1.9 Pertinent Factors Influencing Power Supply Planning

FCG, in response to Florida Public Service Commission (FPSC) Order 7080 issued on January 14, 1976, undertook a study to compare a method of generation planning proposed by the FPSC which excluded company boundaries to the present method by which each utility independently plans its own generation. The study began in May, 1976, and the Final Report was issued July 28, 1976. Although no definative results were obtained from this study, RUB believes that joint planning for future generation is necessary and economically advantageous, as is the utilization of economic dispatching for all generating units in peninsular Florida.

RUB, as a member of FCG, is involved in the Central Dispatch Study being developed to evaluate the economic benefits of dispatching all units in peninsular Florida against the statewide load. The results of this study may indicate an efficient and economically advantageous means of providing the electrical power requirements for peninsular Florida utilities and the customers they serve.

In considering the need for Deerhaven Unit 2 on the RUB system, a number of pertinent factors must be considered in light of past and recent events. Before 1974, RUB as well as other Florida utilities had been experiencing growth in electrical energy use in the range of 7% to 11% per year, and the planning for additional capacity was based on meeting this rate of growth. Since the 1973 oil embargo and the rapid rise in oil costs and resultant recession, the rate of growth for Florida utilities has reduced to approximately half of prior growth rates.

Based on these previously experienced growth rates, RUB initially proposed the addition of an oil-fired unit in the 235 mW range. Subsequent to that decision, the Federal Energy Administration ordered Unit 2 constructed such that it would be capable of burning coal and the subject application has therefore been revised accordingly. With that restriction, the consideration of a smaller unit on RUB's system would not be cost-effective because of the economies of scale associated with coal-fired plants.

As reported by the Ad Hoc Committee on Energy of the United States House of Representatives and as subsequently passed by the House of Representatives, the proposed National Energy Act has three principal themes: (1) energy conservation; (2) conversion to coal; and (3) incentives to production of domestic energy resources. The addition of the coal-fired Deerhaven Unit 2 is directly in concert with the conversion goal. Additionally, there will be generation available from Deerhaven Unit 2,

which, when not being utilized to meet the requirements and commitments of the RUB system, can be sold through economy energy transactions to other interconnected utilities. This will serve to further lessen the use of oil-fired generation in Florida.

The broader question of need for the unit must be assessed in light of relevant present circumstances, not only of the RUB system, but of the state and the Nation as well. When assessing additional capacity necessary to meet the RUB system's projected requirements over the five to eight-year period following the commercial operation of Deerhaven Unit 2, the fact that the unit is to be coal-fired is significant considering the existing and projected dependence on oil of RUB and other Florida utilities. The 1977 FCG Ten-Year Site Plan projects that oil will provide 45% to 55% of the annual energy requirements of other Florida utilities through 1986. The reduction of this dependence on oil is one of the major goals of the National Energy Act. This clearly indicates a need for a greater portion of Florida's electrical generating capacity to be produced by plants utilizing coal as a primary fuel to strike a reasonable balance among the three logical choices of nuclear, oil and coal fuel sources.

CHAP. 2-THE SITE

CHAPTER 2

THE SITE AND SURROUNDING AREA

Presented in this chapter are the detailed relevant data describing those physical, ecological, meteorological and man-made characteristics of the existing environment of the site and surrounding area. While the site and surrounding area within a five mile radius are presented in detail, emphasis is placed on those parameters of the existing environment that might be affected by the construction and operation of the project.

General categories presented are: (1) site location; (2) regional demography, land and water use; (3) historic, cultural and natural landmarks; (4) geology; (5) hydrology; (6) meteorology and climatology; (7) ecology; and (8) ambient air. Each of these categories are discussed in detail for both the site and surrounding area. It should be noted that this chapter primarily deals with the physical environment, therefore while briefly mentioned in this chapter, demography is discussed in greater detail in Chapter 7.

2.1 Site Location

Deerhaven Unit 2 will be located adjacent to Unit 1 on the existing 1,116 acre Deerhaven site, which lies on the northeast side of U.S. 441 approximately six miles northwest of Gainesville in Alachua County in north-central Florida. The rural community of Hague lies approximately one-half mile to the northwest of the site. Gainesville is the economic, educational and governmental focal point of north central Florida,

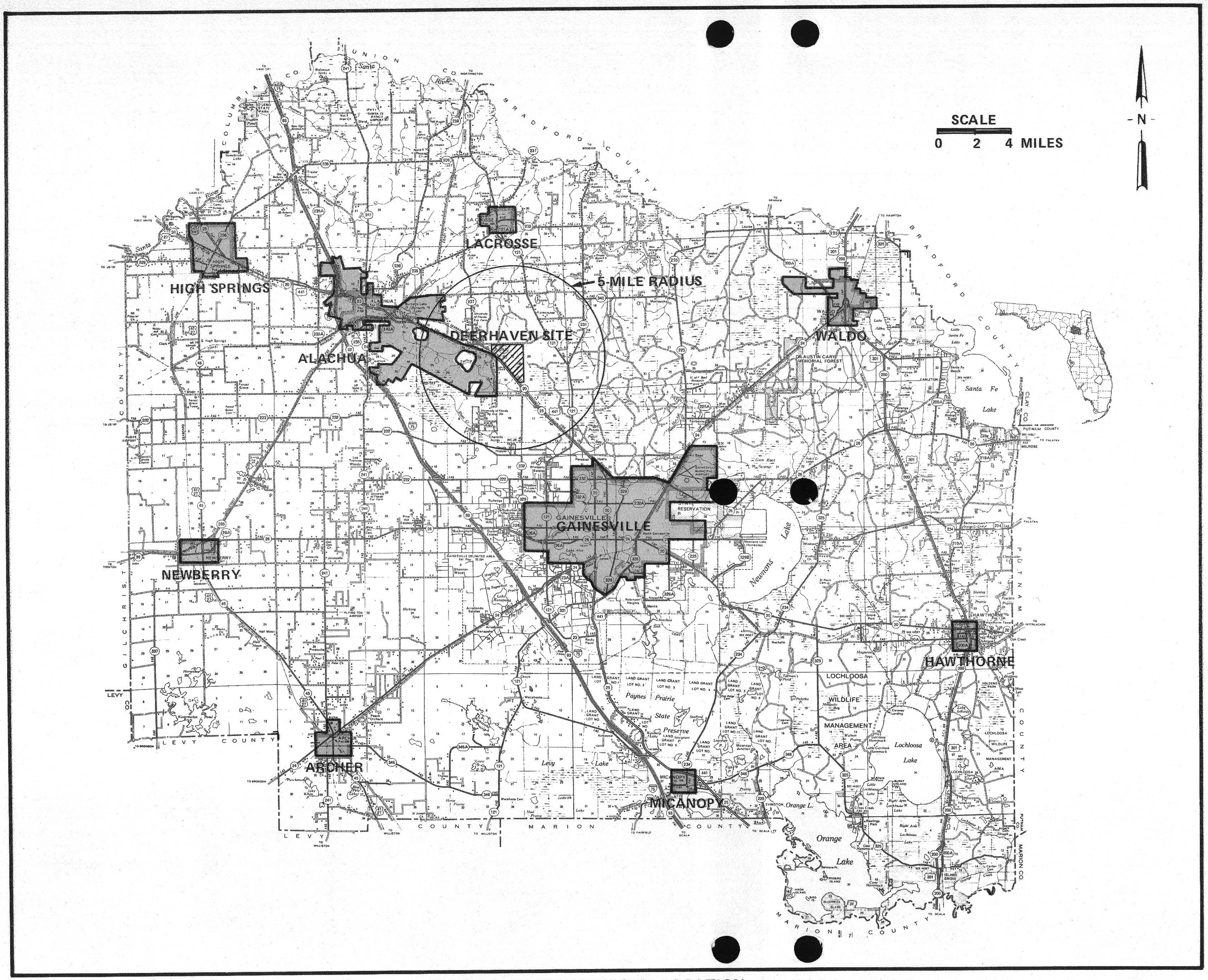


FIGURE 2.1-1 DEERHAVEN SITE LOCATION.

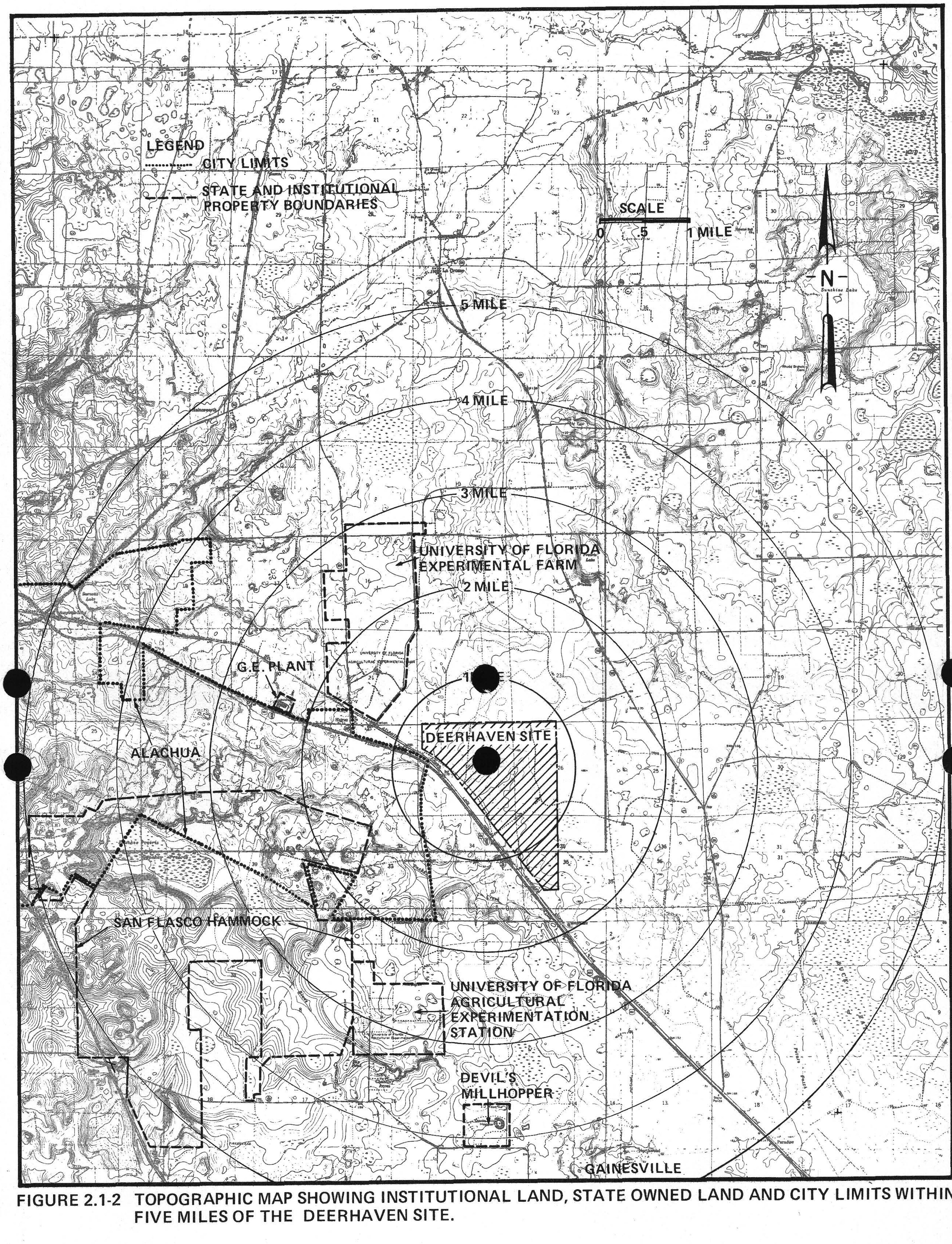


FIGURE 2.1-2 TOPOGRAPHIC MAP SHOWING INSTITUTIONAL LAND, STATE OWNED LAND AND CITY LIMITS WITHIN FIVE MILES OF THE DEERHAVEN SITE.

having the University of Florida, numerous branches of both state and Federal governmental agencies, and various commercial service oriented businesses and financial institutions within its confines or nearby. Alachua County lies almost equidistant from the Gulf of Mexico and the Atlantic Ocean (Figure 2.1-1).

Incorporated areas within the five mile radius of the site include Alachua, a small portion of Gainesville, and the unincorporated area of Hague (Figure 2.1-1). The area of Alachua is newly annexed and contains the residential developments now underway in the vicinity of Hague and Turkey Creek. At present, however, much of the area is still predominantly agricultural and natural land. Commercially developed land within Alachua (outside the Central Business District - CBD) is concentrated near the junction of I-75 and U.S. 441.

Governmental land within a five mile radius of the Deerhaven site includes the University of Florida Dairy Research Unit, the Horticulture Research Unit, San Felasco Hammock, and the Devil's Millhopper (a State Geological Site). A General Electric Company nickel/cadmium battery plant is located northwest of Deerhaven in Hague (Figure 2.1-2).

2.2 Regional Demography, Land and Water Use

2.2.1 Demography

While those portion of Gainesville and Alachua within a five mile radius of the site are sparsely populated, these cities are the largest population

centers within the general area of Deerhaven site and Alachua County (Figure 2.1-1 and 2.1-2). The 1976 populations of Alachua and Gainesville, as reported by University of Florida, Bureau of Economic Research, are 3,169 and 70,228, respectively. More detailed discussion of population statistics and characteristics of Alachua County are presented in Chapter 7.

2.2.2 Land Use

The majority of the land within five miles of the site is undeveloped or agricultural in nature with scattered concentrations of recent residential and commercial development (Figure 2.2-1, inserted in rear cover pocket). Some moderate scale housing developments are currently under construction and since the Alachua County 1995 comprehensive plan generally anticipates further such development, it seems reasonable to anticipate continued development. Industrial and commercial development is localized along U.S. 441 near Hague and near the junction of U.S. 441 and SR-121. This industrial and commercial development includes the General Electric plant, a small warehousing and commercial industrial park and some retail businesses southeast of the site. Within the past five years, new single family and multiple unit dwellings have been located in the area of Devil's Millhopper and SR-121. These residential developments are a northern expansion of the Gainesville suburban residential area.

Other major area land uses include: managed land for pulp and timber production to the north and east of the Deerhaven site, which are owned

by Owens-Illinois Corporation; San Felasco Hammock, a State owned tract southwest of Deerhaven, managed as a preservation and conservation area; and the Devil's Millhopper, a State Geological Site.

The Deerhaven Unit 2 site is zoned for agricultural use with a public use permit for power generation and accessory uses. It is the location of RUB's existing oil-fired Deerhaven Unit 1 and two combustion turbines. RUB applied for State Site Certification of Deerhaven Unit 2 as an oil-fired facility in March, 1974. A public hearing was held May 16, 1974, to consider the proposed expansion's compliance with applicable, local zoning and land use ordinances. The hearing examiner's report found the site properly zoned and in compliance with local land use plans. At the July 24, 1974, meeting of the then Florida Pollution Control Board (predecessor to the Environmental Regulation Commission) approved, adopted and confirmed, en toto, the hearing examiner's report (Board Order No. 74-23).

The following sections present in greater detail the land use within five miles of the site by drainage basin (Figures 2.2-1 and 2.2-2).

Turkey Creek

Land use in Turkey Creek basin is changing very rapidly. Until a few years ago agriculture was the predominant activity in the basin. Much of the central portion of the basin was improved pasture with hardwood stands along drainageways. In the western area, San Felasco Hammock was, and still is, heavily forested with mixed pine and hardwoods.

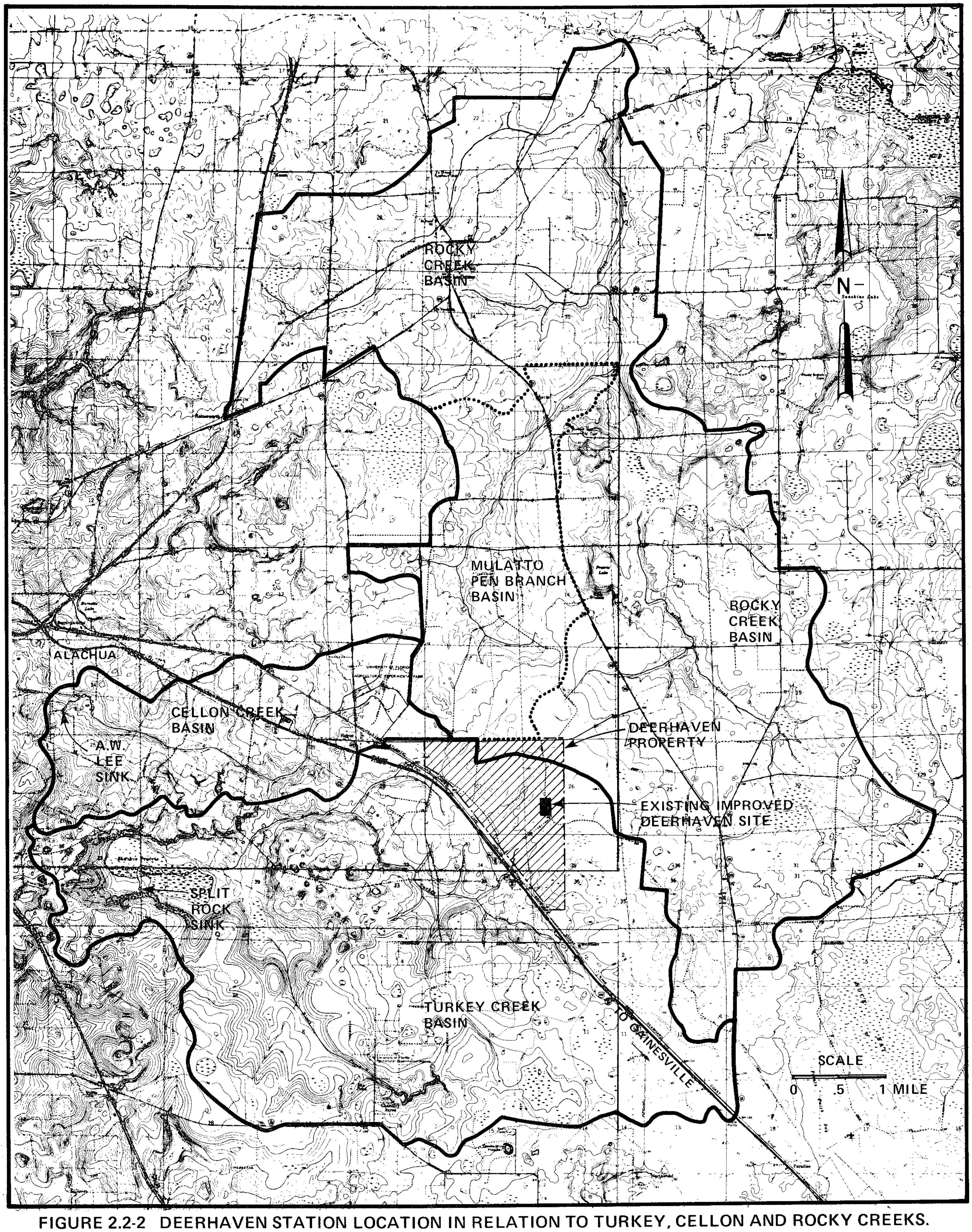


FIGURE 2.2-2 DEERHAVEN STATION LOCATION IN RELATION TO TURKEY, CELLON AND ROCKY CREEKS.

At the present time, urbanization in the basin is proceeding rapidly. Deerhaven Station, two industrial parks, a saw mill, and a mobile home park occupy large areas of the basin north and east of U.S. 441. The pine and palmetto flatwoods in the southeast corner have been cleared and drained for homesites. Other residential developments are opening between U.S. 441 and Turkey Creek. An extensive development that will include several hundred homesites and a full-size golf course and club-house is under construction along Turkey Creek just south of Hague. The hydrological and environmental implications of development are difficult to assess without a detailed, long term study in the area; however, urbanization tends to increase surface runoff, soil erosion, and losses of beneficial vegetation. Water quality tends to decline due to polluted storm runoff.

Cellon Creek

Present basin land use is predominately agricultural (Table 2.2-1). General Electric has operated its battery manufacturing plant for over 12 years near the basin center. A small industrial park has been opened adjacent to General Electric on the east bank of the creek. The community of Hague contains many small homes, mobile homes and agricultural buildings. Hague has become inactive as an agricultural processing and shipping point. The balance of the basin, including the experimental farm, is used for cattle grazing or remains as woodlands or scrub. A few homes and farmsteads are scattered across the basin. Several major power transmission lines cross the basin south of U.S. 441.

Table 2.2-1 Land Use[1] in Cellon Creek Basin

Land Use	Present Condition	Future Condition[2]
Woodlands	32%	16%
Croplands	5%	2%
Pasture	59%	19%
Water	1%	1%
Commercial	1%	5%
Residential (1 acre)	2%	2%
Residential (¼ acre)	--	55%

(1) Predominant localized land use affecting hydrology.

(2) Source: Alachua County Comprehensive Land Use Plan.

NOTE: Total basin area is 3,490 acres.

Future land use appears to be directed toward urbanization. Land development companies have purchased large tracts particularly in the area south of U.S. 441. Housing developments and retail stores are being opened along U.S. 441 from Gainesville to Alachua. It is reasonable to expect manufacturing and light industry to continue to grow in their present locations and to provide a demand for housing in the immediate area. Basin topography is naturally attractive and will easily accommodate urban development. The Alachua County Comprehensive Land Use Plan for 1995 indicates land use trends in this area as outlined above. Easy access via U.S. 441 and rail and utilities services provide additional advantages in developing this area.

Mulatto Pen Branch

The pine flatwoods in the high end of the basin are currently managed as commercial pine forest by Owens-Illinois, Incorporated. A significant portion of these lands have been cleared or harvested during the past few years. Those areas more recently cut over have much of the waste and unusable timber remaining on the site. Windrows of waste, generally perpendicular to Mulatto Pen Branch channel tend to cause shallow ponding of surface runoff and inhibit overbank flow in times of flood. This is particularly true of that reach immediately south of County Road NW 22. The higher, better drained lands, general lying north of Owens-Illinois holdings, are employed in crop production. Most of the land within a quarter mile of the channel itself serves as pasture and grazing land or remains as woodland. This zone along the channel includes the natural

floodplain. Soils in this zone tend to remain saturated for most of the year and grazing quality seems poor. Other improvements in the basin are limited to agriculturally related features such as stock ponds and farm buildings. Table 2.2-2 presents general land use in Mulatto Pen Branch drainage basin. The Alachua County Comprehensive Land Use Plan for 1995 indicates no changes in use for this basin.

Rocky Creek

The present land use of the improved acreage in Rocky Creek basin is predominately agricultural (Table 2.2-3). The western and northern parts of the basin contain a few large farms and many smaller farms, producing beef cattle and various crops. Commercial pine forests are found in the southern end of the basin along SR-121. Extensive areas of the eastern and southern parts of the basin remain heavily wooded. Pine and hardwoods are found in the better drained areas, with cypress and other water-tolerant trees in the swampy and low-lying areas.

Residential development in the basin is generally limited to a town called LaCrosse. However, scattered residences are found throughout the basin. According to the Alachua County Comprehensive Land Use Plan for 1995, all lands within the Rocky Creek basin, except for those within the LaCrosse city limits, are zoned only for agricultural, conservational, or recreational usage. No significant changes are anticipated in Rocky Creek basin land use before 1995.

Table 2.2-2 Land Use[1] in Mulatto Pen Branch Basin

Land Use	Present Condition	Future Condition[2]
Commercial Pine Forests	32%	N/C[3]
Other Woodlands	33%	N/C
Pasture	14%	N/C
Croplands	21%	N/C
Residential	less than 1%	N/C

(1)Predominant localized land use affecting hydrology.

(2)Source: Alachua County Comprehensive Land Use Plan.

(3)No change.

NOTE: Total basin area is 3,701 acres.

Table 2.2-3 Land Use[1] in Rocky Creek Basin

Land Use	Present Condition	Future Condition[2]
Woodlands	60%	N/C[3]
Croplands	26%	N/C
Pasture	13%	N/C
Water	1%	N/C
Residential	less than 1%	less than 1%

[1] Predominant localized land use affecting hydrology.

[2] Source: Alachua County Comprehensive Land Use Plan.

[3] No change.

NOTE: Total basin area is 21,142 acres.

2.2.3 Water Use

Water demand within the near vicinity of the Deerhaven site is changing in character due to the gradual urbanization of this area. Most private residences in this area have individual wells for potable water. Major users are listed and briefly described as follows:

Deerhaven Generating Station - Potable water is supplied to Deerhaven Station by the RUB's water system at an average rate of 0.2 million gallons per day. This water is utilized for domestic and certain process waters.

General Electric Battery Manufacturing Plant - This manufacturing plant pumps and treats raw water for both potable supply and manufacturing needs. The present pumping rate is approximately 1.8 mgd (Pers. Com., General Electric Staff, 1977).

Turkey Creek (Residential Development) - Eight hundred single family dwelling units are presently under construction at Turkey Creek subdivision, south of the community of Hague. Two 10-inch wells and a 200,000 gallon elevated storage tank have been constructed to provide for an ultimate demand of approximately 4.4 mgd (Pers. Com., Chief Engineer, Turkey Creek Development, 1977).

Agricultural irrigation and stock watering needs account for a major water use in this area. Demand and withdrawal for either wells or

surface streams is quite variable, depending on crop needs and rainfall. The University of Florida Dairy Research Unit at Hague typically withdraws only 5,000 gallons per day for stock watering (Pers. Co., Dr. Herbert Head, University of Florida Dairy Research, 1977). Mr. Larry Rogers, an area vegetable grower, typically pumps 600 gallons per minute from his 10-inch well for twenty-four hours per day for 20 days each year (Pers. Com., 1977). Major field crops, such as corn and soybeans, are not irrigated in this area. Vegetable crop irrigation is usually performed during late April through early June and during October and early November. Stock watering is accomplished by using both surface streams and wells.

Water sources within the near vicinity of Deerhaven Generating Station include a RUB potable water main, the Floridan Aquifer, a shallow water bearing stratum in the Hawthorn Formation and such surface streams as Turkey Creek, Cellon Creek, Rocky Creek, Mulatto Pen Branch, Monteocha Creek and Hatchett Creek. Table 2.5-9 presents a complete listing of water supply wells within a five mile radius of Deerhaven Station Site. Each well is located on Figure 2.5-12.

2.3 Regional Historic, Scenic, Cultural and Natural Landmarks

In accordance with Federal mandates including Executive Order 11593, the National Environmental Policy Act, and the National Historic Preservation Act, as implemented by Title 36, Code of Federal Regulations (CFR), Part 800, "Procedures for the Protection of Historic and Cultural Properties", a study was performed to determine the potential impact of the proposed

construction upon cultural resources. Information from such varied sources as personal interviews, county tax and deed records, United States section survey records, early aerial photography, museum files of recorded sites, and an archaeological field survey was assembled to document all sites found on the property, their significance, and degree of endangerment (Appendix Table A2-1).

2.3.1 Potentially Affected Areas of Historic, Scenic, Cultural or Natural Significance

Potentially affected areas were taken to include any land within the 1,116 acre site.

Sites Included in the National Register of Historic Places

The Florida Master Site File at the Division of Archives, History and Records Management lists eight properties in Alachua County included in the National Register of Historic Places. These are: Hotel Thomas, Rochelle School, Matheson House, Neilson House, Bailey House, Buckman Hall, Epworth Hall, and Marjorie Kinnan Rawlings House. All are located more than five miles from the Deerhaven property and discharge alternatives. Consultation with the staff of the State Historic Preservation Officer revealed no additional Alachua County nominations in preparation or pending approval.

Sites Included in the National Registry of Natural Landmarks

In consultation with the National Park Service, Southeast Regional Office, it was determined that three properties in Alachua County

currently enjoy Natural Landmark status. These are: Paynes Prairie, Devil's Millhopper, and San Felasco Hammock. Paynes Prairie is located more than five miles from the project site and will not be affected. Devil's Millhopper, situated 3.6 miles southwest of Deerhaven Unit 1's stack is a solution cavity some 500 feet in diameter at the surface and 120 feet deep. The sink is fed by surface water, primarily from the north and west, and contributes to the shallow aquifer system. Runoff from the Deerhaven tract is prevented from reaching Devil's Millhopper by the intervening drainage of Turkey Creek. Devil's Millhopper will receive neither visual nor audible impact from the proposed project.

San Felasco Hammock is located several miles west of the Deerhaven property and currently receives discharge from Deerhaven Unit 1 operations. The construction and operation of Unit 2 will result in Unit 1's discharge being removed from the Hammock and thus no foreseeable impacts on archeological sites within same should occur.

Sites Eligible for Inclusion in the National Register of Historic Places

According to "Procedures for the Protection of Historic and Cultural Properties", environmental assessments shall include consideration of impact upon sites eligible for inclusion in the National Register of Historic Places, in addition to those already listed on the Register. The archaeological and historical survey of the Deerhaven tract was designed to locate unknown sites and determine their eligibility according to the "National Register Criteria" (36 CFR 800.10).

During the study thirteen artifact loci were recorded and assessed (Table 2.3-1). In consultation with the staff of the State Historic Preservation Officer, it was determined that one of the eleven loci within the area of the undertaking's potential impact met criteria for National Register eligibility. Two are outside the area of impact and are therefore not considered.

The site eligible for inclusion in the National Register is prehistoric, dating perhaps to the Deptford period. It is located on-site in a small developing hardwood hammock. Cursory surface and posthole surveys of the area produced an artifact collection consisting of: three ceramic sherds, one of which appeared to be Deptford Simple Stamped; one chipped stone projectile point, perhaps late Archaic in age but not assignable to any defined type; and 39 flint waste flakes.

The site is interesting in several respects: its location on well drained soil supporting hardwood vegetation; the presence of Deptford series ceramics; and its undisturbed condition. These features are in contrast to characteristics of other sites in the area, and suggest that the site has value for increased understanding of several aspects of aboriginal culture on a regional level. Construction impacts to this site are discussed in Sections 4.1.2 and 4.2.2; excavation plans are also reported in Section 4.1.2.

Table 2.3-1 Artifact Loci

Number	Description	Location	Age	Nat. Reg. Eligible
1-3-A	Single projectile point from road surface near springhead	Deerhaven	Prehistoric	No
8A1368	Disturbed Archaic? flint surface scatter near Turkey Cr.	Deerhaven	Prehistoric	No
1-4-B	Two flint chips on power line cut	Deerhaven	Prehistoric	No
8A1369	Deptford? period site in hardwood hammock	Deerhaven	Prehistoric	Yes
1-5-B	Disturbed Archaic? flint surface scatter at plant site	Deerhaven	Prehistoric	No
1-6-A	Farmstead site at cleared 40 acre tract on north boundary	Deerhaven	Early 20th century	No
1-6-B	Sawmill site adjacent to U.S. 441	Deerhaven	ca. 1885-1905	No
2-8-A	Turpentine still site adj. to U.S. 441	Deerhaven	ca. 1925-1945	No
2-8-B	House site near north boundary	Deerhaven	Early 20th century	No
8A1370	One projectile point near trailer park	Alternate pipeline corridor	Prehistoric	No
8A1372	Archaic flint scatter 30 yds. north of U.S. 441	Alternate pipeline corridor	Prehistoric	No
2-9-A	Ceramic period site east of Rocky Creek Swamp	Alternate pipeline corridor	Prehistoric	Unknown
2-9-B	Mill pond dike on Rocky Creek	Alternate pipeline corridor	Early 20th century?	No

2.3.2 Historic Documentation

In an effort to locate significant cultural resources which might be mentioned in historical and documentary sources, a search was made of records at the Florida Bureau of State Lands, Alachua County courthouse, R. M. Strozier Library, Florida State Library, and P. K. Yonge Library of Florida History. While neither aboriginal nor historic sites of significance were revealed by the survey, the study was valuable in suggesting past land use and settlement patterns. In general, it was shown that the Deerhaven tract never supported intensive habitation, and that its primary exploitable resource was timber.

2.4 Geology

2.4.1 Surrounding Area

The Deerhaven Station site is underlain by approximately 3,200 feet of stratified sedimentary rocks which overlie a "basement" of dense crystalline and metamorphic rocks. The uppermost 110 feet of stratified deposits consist predominantly of fine to coarse grained sands mixed with clays, porous limestone, fine to coarse grained sandstone, and siltstone. Collectively these stratum make up the Hawthorn Formation and below lie formations consisting predominantly of limestone, dolostone, and dolomitic limestone. Layers of sandstones and shales are present in deep formations below a depth of about 2,600 feet. Figure 2.4-1 is a map indicating the location of deep exploratory wells in Alachua County and surrounding areas. Figure 2.4-2 is generalized geologic cross sections which were constructed using data obtained from these deep exploratory wells and the deep test injection well.

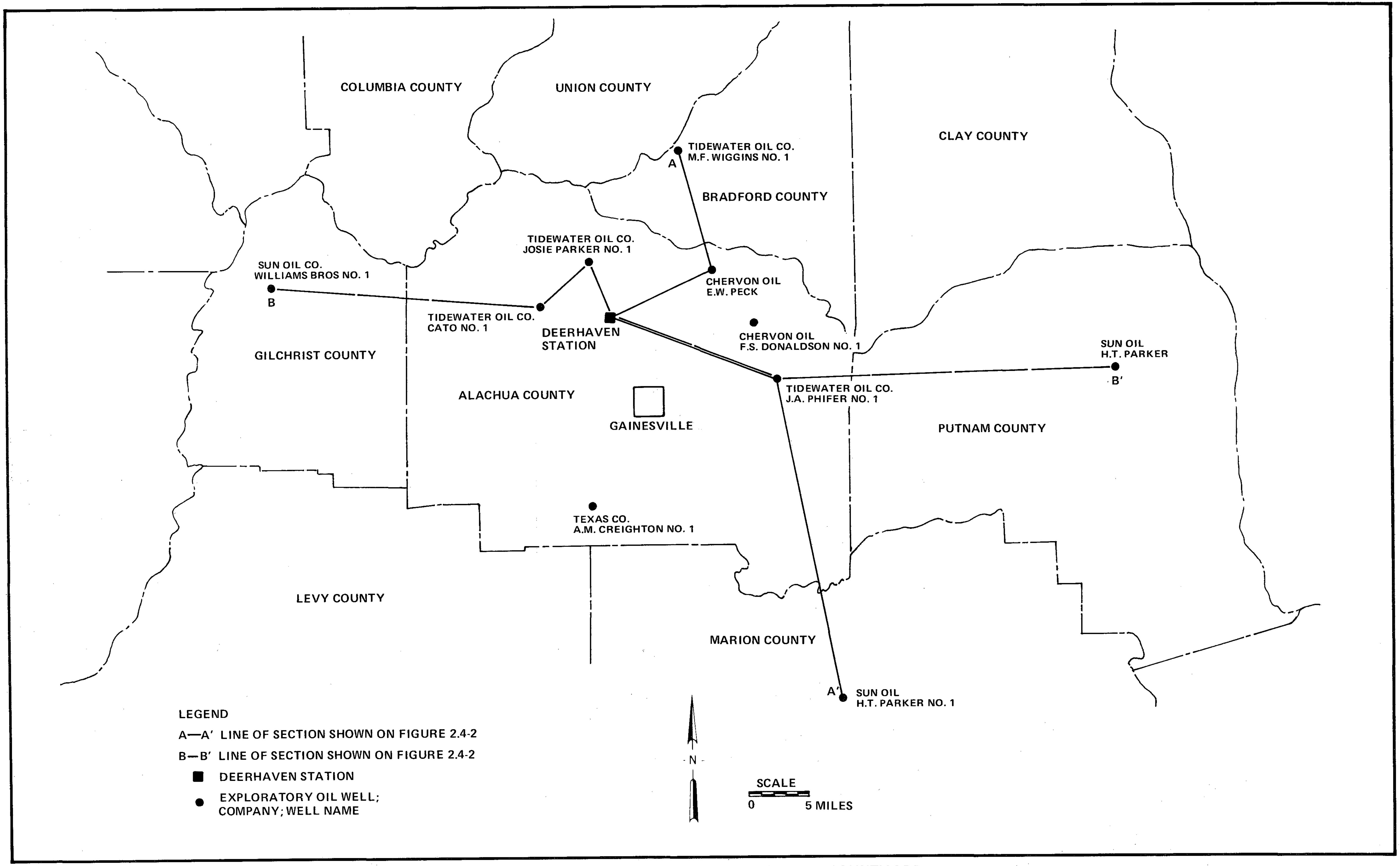


FIGURE 2.4-1 DEEP EXPLORATORY WELLS IN ALACHUA COUNTY AREA.

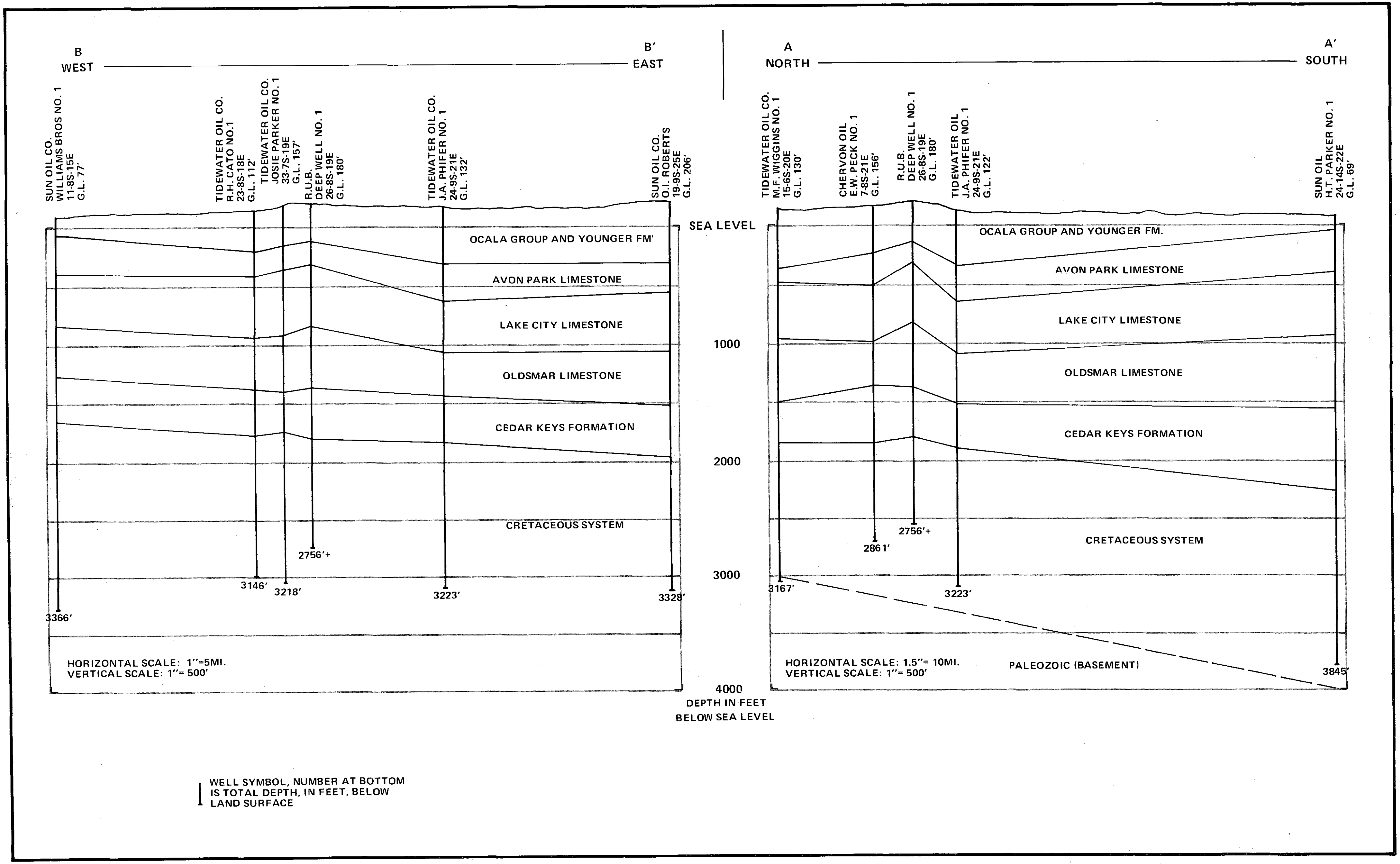


FIGURE 2.4-2 GEOLOGICAL CROSS-SECTIONS ALONG LINES A-A' AND B-B' PRESENTED IN FIGURE 2.4-1.

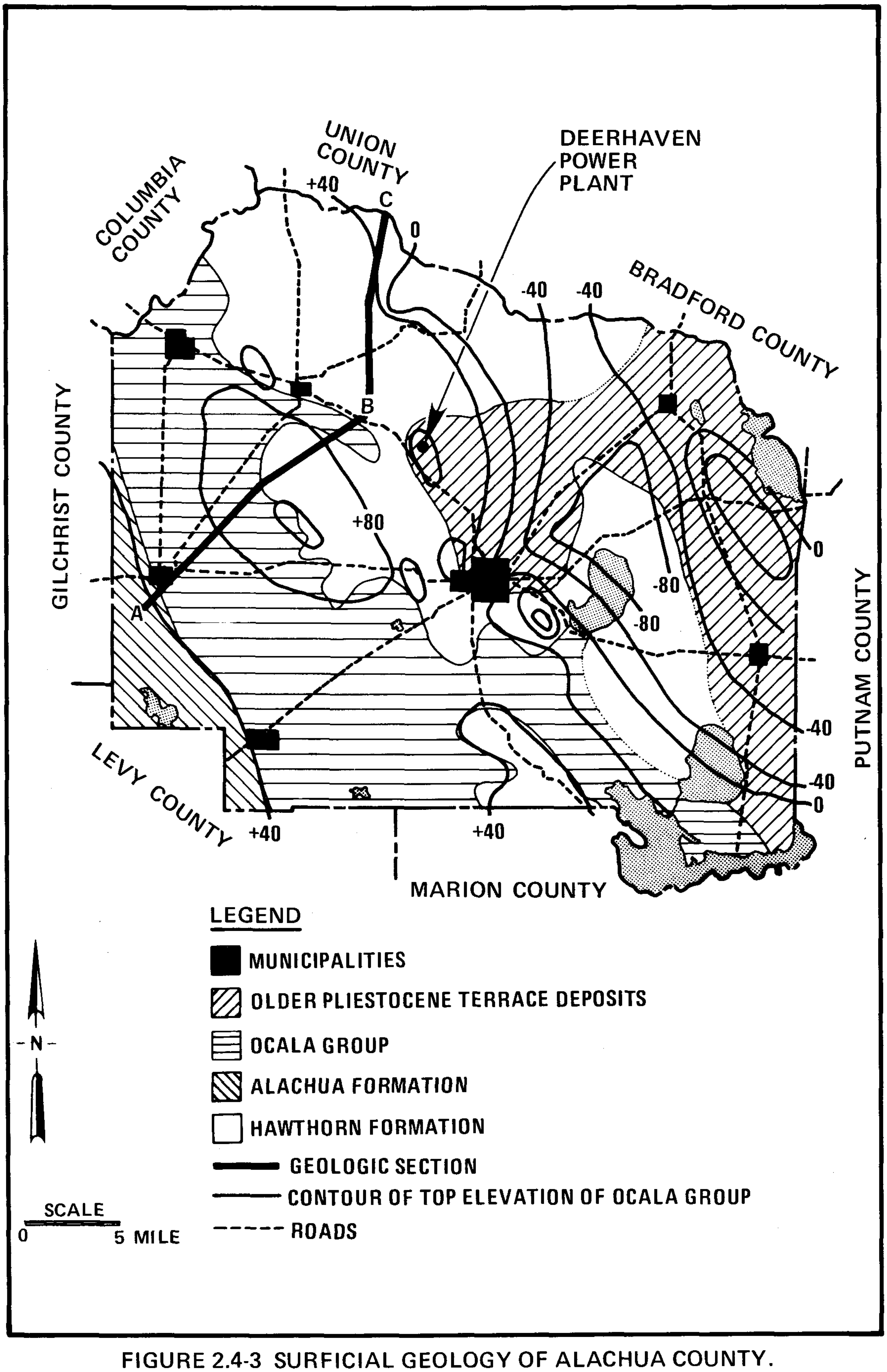


FIGURE 2.4-3 SURFICIAL GEOLOGY OF ALACHUA COUNTY.

Considerable information is available on the composition and permeability of the formations to depths of about 1,000 feet, because these are the beds utilized by most water wells in the region. Somewhat less is known about the geologic units below 1,000 feet because these units have been explored in only a few places in a search for oil and gas deposits and when the drilling of the test injection well is completed more definitive information about the deeper units will be available. In all of Alachua County, only about three wells have been drilled to the Paleozoic contact. The oldest formation known to be penetrated by water wells in Alachua County is the Lake City Limestone of the Eocene Age. In Alachua County area the Ocala Group, the Avon Park Limestone, the Lake City Limestone, and, to some extent, the Oldsmar Limestone, are thought to act as a single hydrologic unit and are termed the Floridan Aquifer. The geologic units composing the Floridan Aquifer consist of interbedded layers of soft to hard limestone, dolomitic limestone and dolostone which generally have high permeability in a lateral direction and low permeability in a vertical direction. The Cedar Keys Formation, which underlies the Oldsmar Limestone, contains beds of limestone and dolostone impreganted with gypsum and anhydrite and are relatively impermeable and therefore may function as confining layers below which saline or highly mineralized water exists. Below this, to the basement at about 3,200 feet are the Lawson Limestone, the Taylor Beds, and layers of limestone, sandstone and shale. Table 2.4-1 describes the geologic units as they exist below the Deerhaven Site. Definite detail at all geological levels has been developed subsequent to test injection well drilling and is discussed more completely in Chapter 6.

Table 2.4-1 Description of Geologic Units Encountered During Drilling of Test-Injection Well and Shallow Borings

ERA	System	Series	Formation	Approximate Depth and (Thickness)	Description
CENOZOIC	Quaternary	Pleistocene	Alachua	0 (8')	Sand and clayey sand, gray, brown and black, disseminated organic matter.
		Pliocene	Bone Valley	8' (9')	Sand, white to yellow, clayey sands, varicolored clays and phosphate grains and pebbles.
		Miocene	Hawthorn	17' (93')	Clay and sandy clay, white to tan interbedded lenses of sandstone, siltsone, and sandy phosphatic limestone, firm.
	Tertiary	Eocene	Ocala Group	110' (220')	Limestone, white to tan, gray, moderately indurated, porosity - moldic, vugular, micrite cement, fossiliferous, heterostegina.
			Avon Park Limestone	330' (185')	Limestone, dolomitic, microcrystalline to very fine, tan to dark brown, moderate to well indurated, porosity - solution channel, vugular; interbedded limestone buff to cream, porosity - vugular, saccharoidal, moderate induration.
			Lake City Limestone	515' (505')	Limestone, dolomitic, microcystalline to fine, euhedral, subhedral, cream to brown, porosity - moldic, moderate to well indurated; interbedded dolostone, microcrystalline to fine, euhedral, light brown to drak brown, porosity - vugular, well indurated; interbedded lignite, fractured, pasty.
			Oldsmar Limestone	1020' (530')	Dolostone, cryptocrystalline to medium, euhedral, subhedral, light tan to drak brown, porosity - intercrystalline, pin-point vug, calcite cavity filling, moderate to well indurated; interbedded limestone, white to gray, light tan, porosity - moldic, vugular, poor to moderate induration, cavity filling micrite.
		Palecene	Cedar Keys Formation	1550' (445')	Dolostone, microcrystalline, cream to gray, euhedral, subhedral, porosity - intercrystalline, vugs filled by gypsum, trace anhydrite; interbedded anhydrite oolitic limestone, poor to moderate induration.
MESOZOIC	Cretaceous	Gulf	Lawson Limestone	1995' (180')	Limestone, dolomitic, very fine to medium, euhedral, subhedral, white to tan, chalky, pasty, porosity intergranular, poor to moderate induration, gypsum impregnations throughout. Upper zone coquinoid.

Table 2.4-1 Description of Geologic Units Encountered During Drilling of Test-Injection Well and Shallow Borings (continued)

ERA	System	Series	Formation	Approximate Depth and (Thickness)	Description
MESOZOIC	Cretaceous	Gulf	Taylor Beds	2225' (500')	White to cream chalky limestone separated by thin beds and seams of tan, crystalline dolomite, gray marl.
			Austin Beds	2725' (400')	Marly shales; fine-grained, argillaceous sandstones; sandy, micaceous clay; and some limestone.
			Eagle Ford Shale	3125' (100')	Sandy, dense, hard, shaly limestone interbedded with thin seams of sandstone and flecks of lignite; poorly sorted, slightly calcareous sandstone; blocky, micaceous shale.
	Tertiary	Gulf	Woodbine Sandstone	3225'	Micaceous, calcareous sand overlying calcareous shale and shaly limestone with lignite and gypsum; irregularly inter-bedded in the shale are a quartz sandstone with thin shale partings and a coarse sand and gravel conglomerate.
		Comanche		3275' (50')	Red, green, and brown clastics, largely shales and sandstones. The base is a coarse sand containing pebbles of Paleozic sediments.
	Triassic			3325'	Quartz diabase and igneous intrusives.
PALEOZIC	Lower Devonian or Upper Silurian ...?...?...?... Lower Rodovician				Quartzitic sandstones and black, micaceous shales; slightly fossiliferous.

NOTE: Data on the Alachua through Lawson Limestone foundations are as found from the pilot program for deep injection well.

The principal geologic structure underlying this area is the Peninsular Arch which trends south-southeast. The dip of the formations on the flanks of the arch is to the east-northeast, however, as this structure is deeper than 2,500 feet in the Alachua County area the beds are dipping uniformly and uniaxilly away from its axial plane in a regional context. The subsurface geology and regional structure will be discussed more completely in Chapter 6.

In the vicinity of the Deerhaven Site, three types of terrain can be observed. These three types, basically controlled by stratigraphy are a limestone plain in the southwest, a high marine terrace in the northeast, and a transition zone separating these two areas. Figures 2.4-3 and 2.4-4 present the surficial geology of Alachua County in plan and section.

The limestone plain is the exposed surface at the Ocala Group of upper Eocene Age. This limestone is a soft, friable, fossiliferous, marine limestone, white to tan and is approximately 200 feet thick in the area where it is exposed.

The high marine terrace is characterized by the Hawthorn Formation of middle Miocene Age. This formation consits of interbedded clays, sandy clays, silty and clayey sands, and phosphatic limestones, and unconformably overlies the Ocala Group. The high terrace is generally poorly drained. The clays of the Hawthorn Formation are poorly conductive and

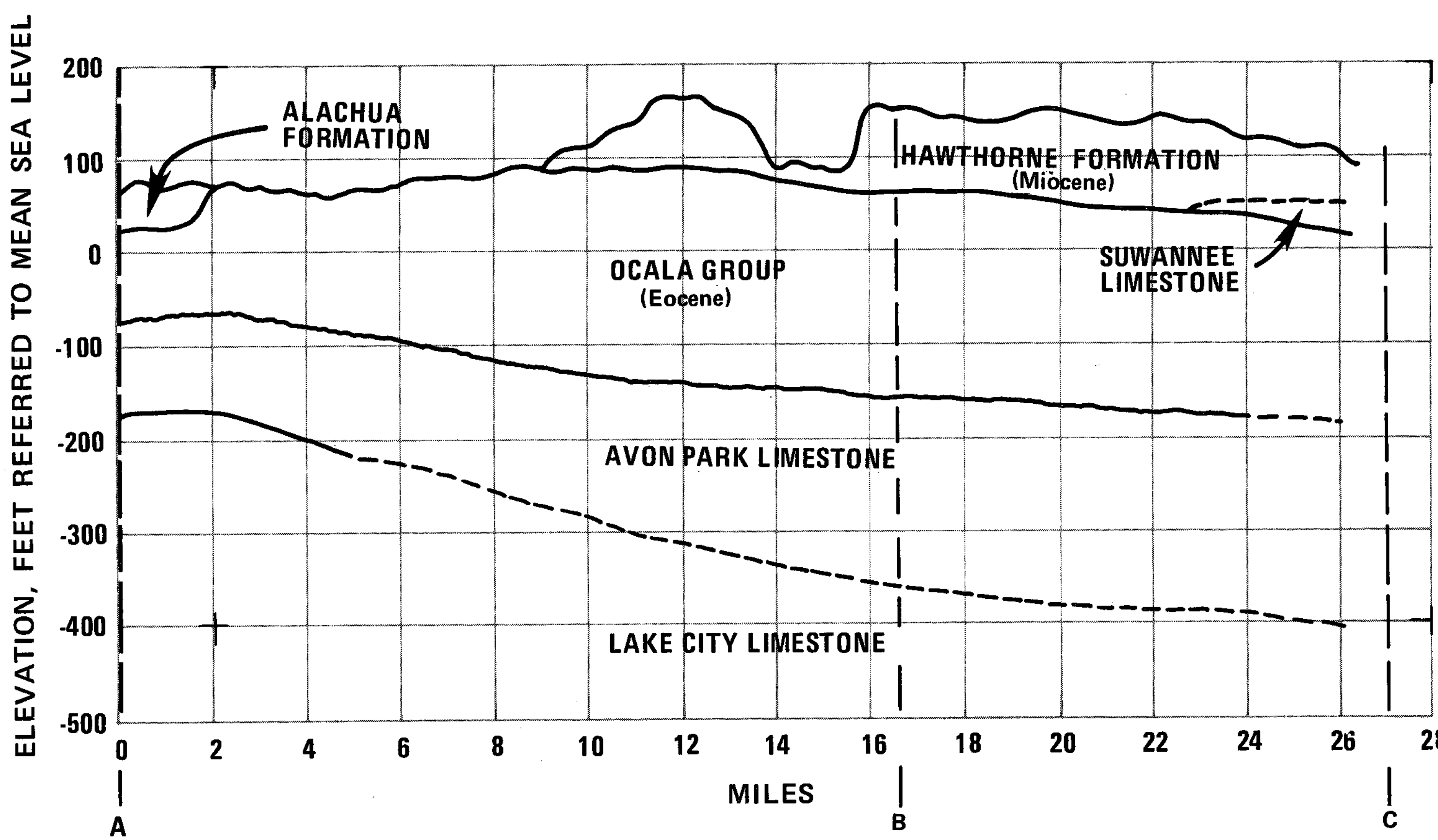


FIGURE 2.4-4 GEOLOGIC CROSS-SECTION THROUGH ALACHUA COUNTY.

tend to create a perched water table which, when exposed, is characterized by numerous cypress domes and swamps.

Between the limestone plain and the high terrace is a transition zone which is characterized by rolling hills, caves, solution basins, steep-sided sinkholes, and sinking streams. The Hawthorn Formation can be found capping the hills and along streambeds, while at locations on lower slopes and lower elevations, outcroppings of the Ocala Group occur.

The limestone plain is characterized by an almost complete lack of surface drainage. Most surface water infiltrates directly into the limestone of the Ocala Group. The Ocala Group is the dominant member of the Floridan Aquifer in the study area and the regional water table is within this formation.

Much of the rainfall runoff in the transition zone flows into streams which have developed in the clay strata. These streams flow to locations where the Hawthorn clays are breached by sinkholes. Millhopper Creek, Goose Creek, Turkey Creek, and Cellon Creek are perched streams which disappear from the surface at sinkholes, some of which, it is believed, directly recharge the Floridan Aquifer.

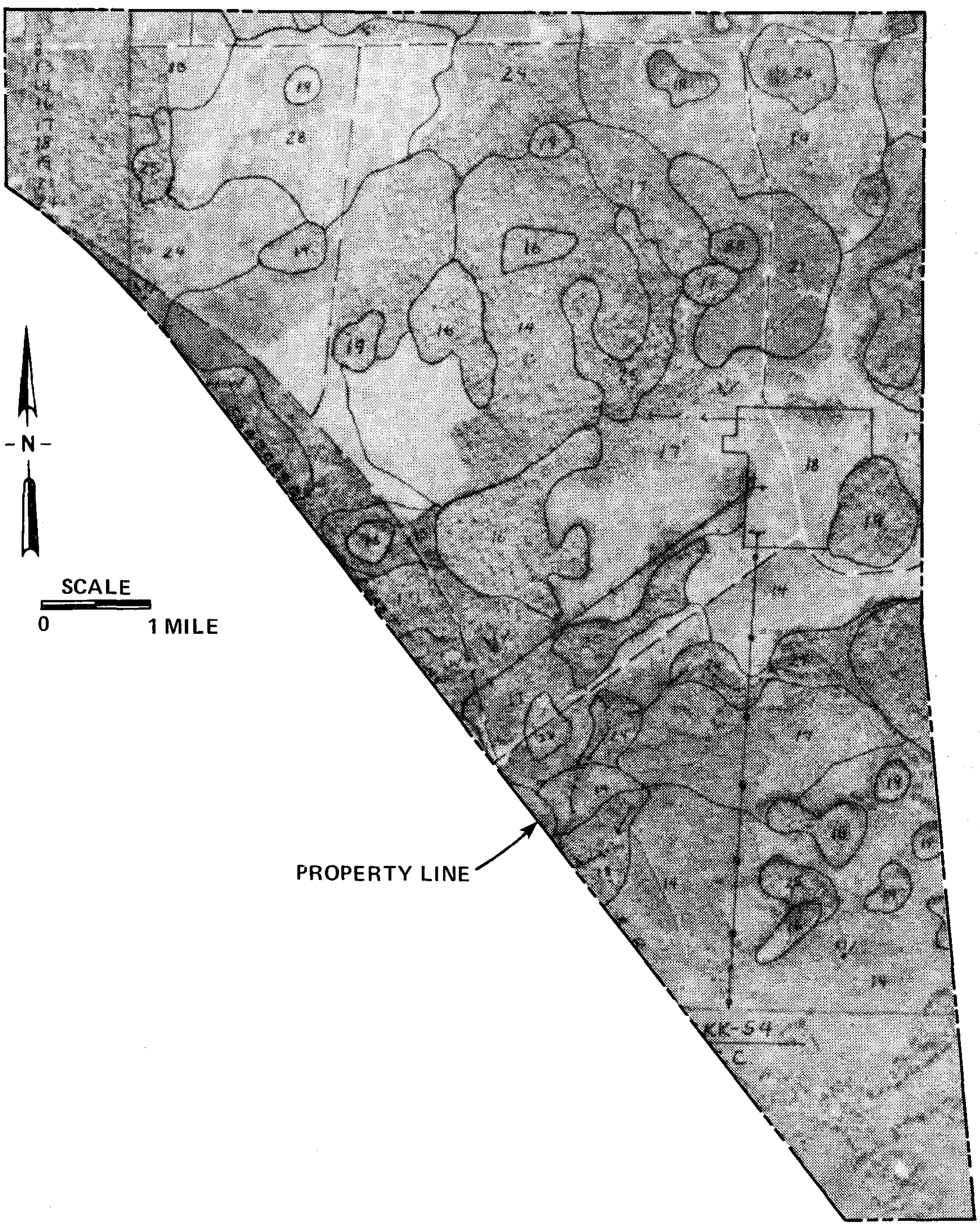
Seismic Activity

There are no records of any seismic events or earthquakes in Alachua County and there is no evidence that Alachua County has ever received any damaging earthquake waves.

2.4.2 Soils of the Deerhaven Site

Soils of the Deerhaven site have developed from the weathered products of the Hawthorn Formation. The natural drainage is poor because of the level or slightly depressed nature of the land surface and the presence of impervious layers of sandy-clay and clay. Figure 2.4-5 presents the U.S. Department of Agriculture Soil Conservation Service soil survey for the Deerhaven site. Table 2.4-2 presents the characteristics of the soil structure over the Deerhaven property. Nearly all soils are classified as poorly drained sands with varying silt and clay content. In general, the Basinger, Adamsville, Pomona, and Wauchula sands which underlie the higher and flatter pine-palmetto areas are poorly drained. The Electra and Sparr series found downslope are better drained because of their lower clay content and/or milder slope.

In a previous investigation, twenty-one auger borings were made at selected locations on the Deerhaven site to obtain subsurface information (Figure 2.4-6) (Breedlove, 1977). Figures 2.4-7 through 2.4-11 present soil stratification inferred from these borings at selected cross sections. As indicated, the soil tends to become less permeable with depth, forming an aquiclude on which the surficial groundwater is



NUMBERS REFER TO SOIL GROUPS,
SEE SUBQUENT TABLE 2.4-2 FOR
NOMENCLATURE AND EXPLANATION

FIGURE 2.4-5 U.S.D.A. SCS SOIL MAP OF DEERHAVEN SITE.

Table 2.4-2 Nomenclature and Characteristics of Soil Groups Shown on Figure 2.4-5

Map No.	Name	Hydraulic Category(1)	Stratum Depth (feet)	Permeability (feet/hour)
7B	Kanapaha Fine Sand (0 to 5% Slopes)	A/D	0 - 2	.5 - 1.7
			2 - 4.6	.05 - .17
			4.6 - 5.8	.017 - .05
			5.8 - 6.7	.017 - .05
8B	Sparr Fine Sand (0 to 5% Slopes)	A	0.0 - 4.0	0.67 - 1.67
			4.0 - 6.7	0.05 - 0.17
13	Pelham Sand	B/D	0.0 - 2.2	0.5 - 1.67
			2.2 - 5.7	0.05 - 0.17
14	Pomona Sand	B/D	0.0 - 2.2	0.5 - 1.67
			2.2 - 3.3	0.05 - 0.17
			3.3 - 4.3	0.5 - 1.67
			4.3 - 6.0	0.05 - 0.17
16	Surrency Sand	B/D	0.0 - 1.8	0.5 - 1.67
			1.8 - 2.6	0.5 - 1.67
			2.6 - 5.4	0.05 - 0.17
17	Wauchula Sand	B/D	0 - 0.6	0.5 - 1.67
			0.6 - 1.8	0.5 - 1.67
			1.8 - 2.3	0.05 - 0.5
			2.3 - 3.1	0.5 - 1.67
			3.1 - 6.7	0.05 - 0.5
18	Wauchula - Urban Land Complex	B/D	0 - 0.6	0.5 - 1.67
			0.6 - 1.8	0.5 - 1.67
			1.8 - 2.3	0.05 - 0.5
			2.3 - 3.1	0.5 - 1.67
			3.1 - 6.7	0.05 - 0.5
19	Pomona Variant Sand	D	0.0 - 1.4	0.5 - 1.67
			1.4 - 3.6	0.5 - 1.67
			3.6 - 5.1	0.5 - 1.67
			5.1 - 6.0	0.05 - 0.17
21	Electra Variant Sand	A	0.0 - 1.1	0.5 - 1.67
			1.1 - 4.3	0.5 - 1.67
			4.3 - 6.7	0.05 - 0.17

Table 2.4-2 Nomenclature and Characteristics of Soil Groups Shown on Figure 2.4-5 (continued)

Map No.	Name	Hydraulic Category(1)	Stratum Depth (feet)	Permeability (feet/hour)
24	Basinger Variant Sand	C	0.0 - 4.3 4.3 - 6.0	0.5 - 1.67 0.05 - 0.17
25	Basinger Variant Sand Depressional	C	0.0 - 4.3 4.3 - 6.0	0.5 - 1.67 0.05 - 0.17
28	Adamsville Sand (0 to 2% Slopes)	C	0.0 - 1.0 1.0 - 6.0	0.5 - 1.67 0.5 - 1.67

(1) A--High infiltration rate; low runoff potential
B--Moderate infiltration rate; moderately low runoff potential
C--Low infiltration rate; moderately high runoff potential
D--Very low infiltration rate; high runoff potential
A/D--Category D if natural; category A if drained
B/D--Category D if natural; category B if drained

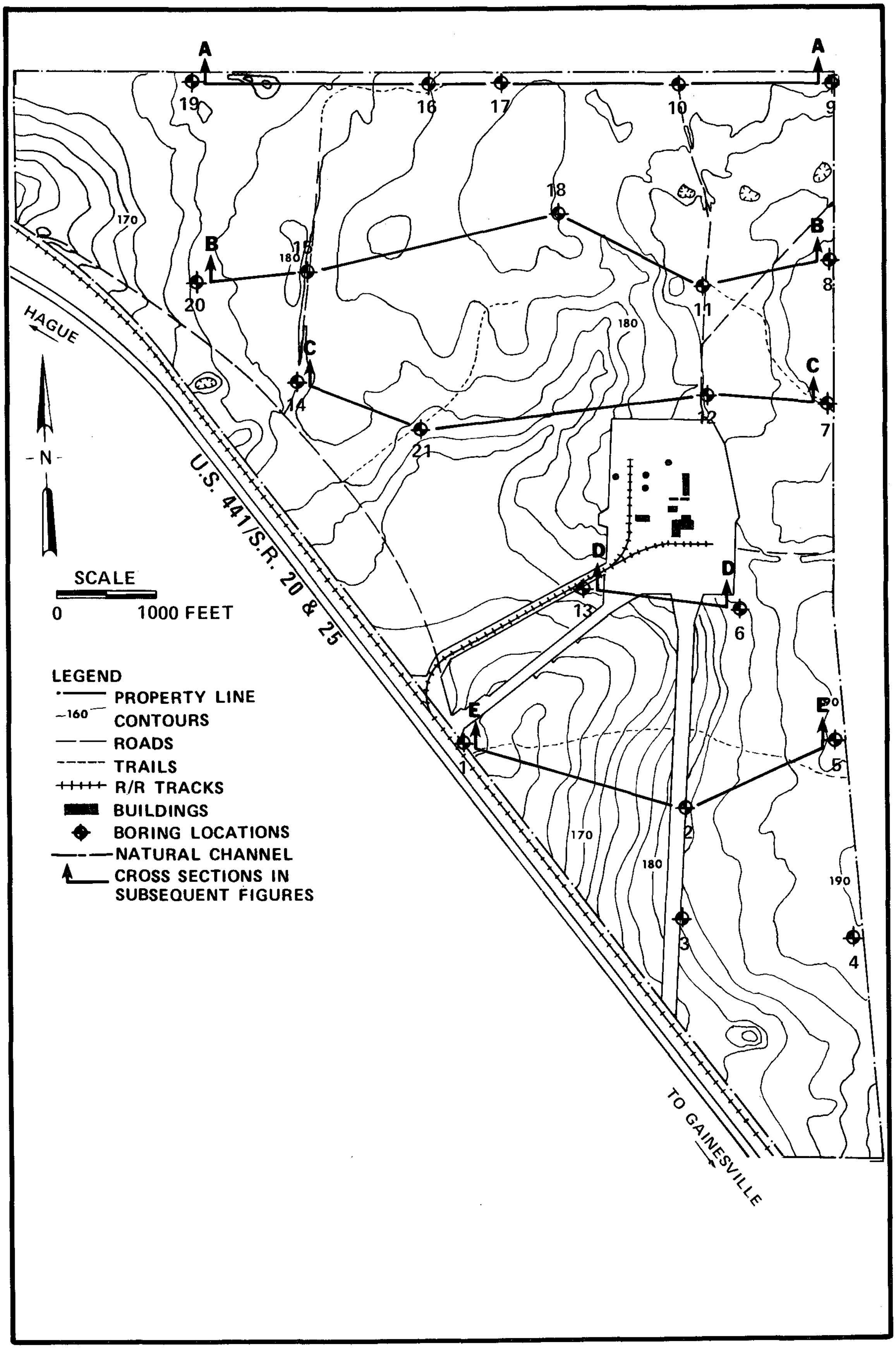


FIGURE 2.4-6 DEERHAVEN SITE BORING LOCATIONS.

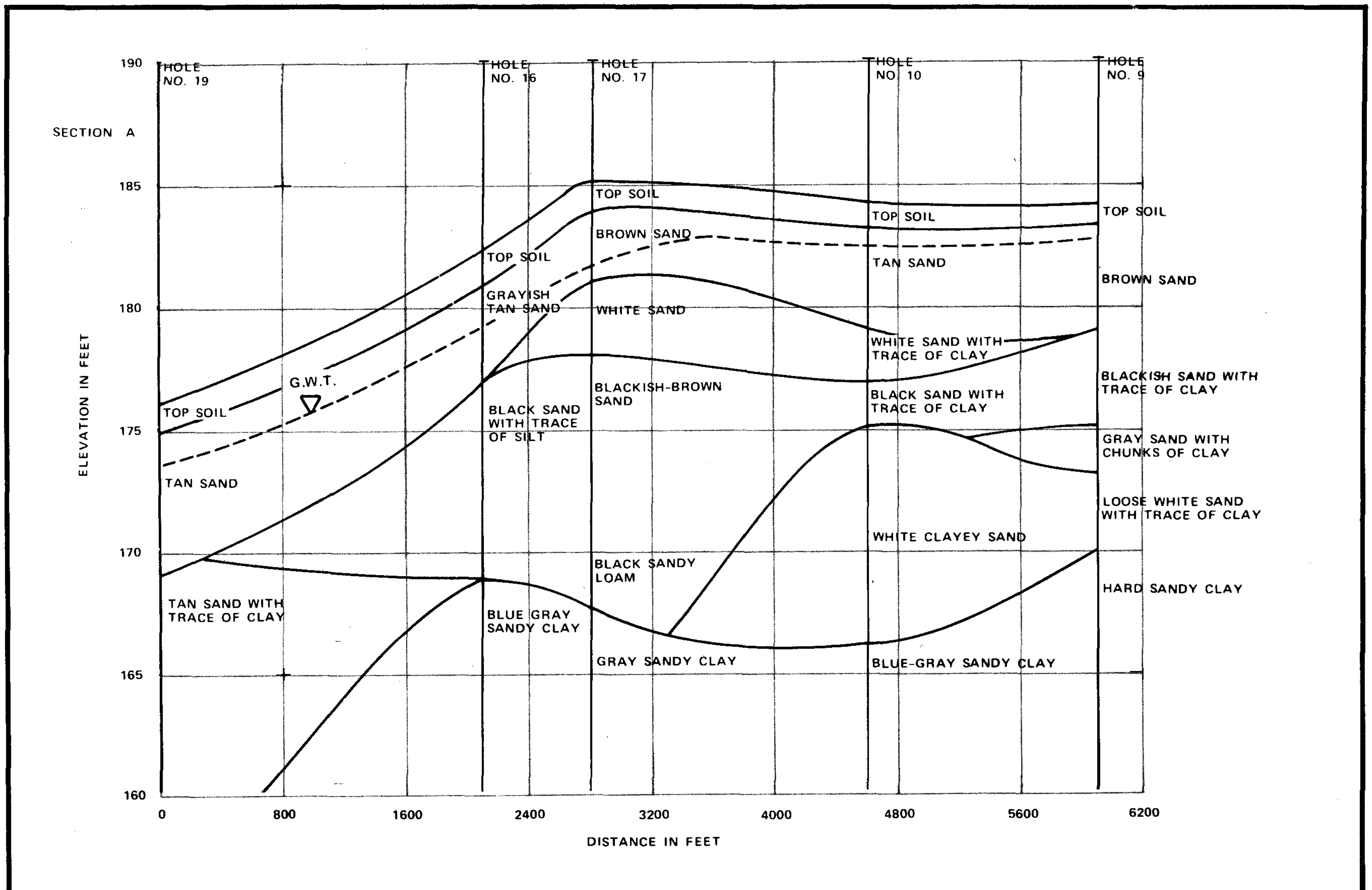


FIGURE 2.4-7 INFERRED STRATIFICATION IN SELECTED CROSS-SECTIONS OF DEERHAVEN SITE.

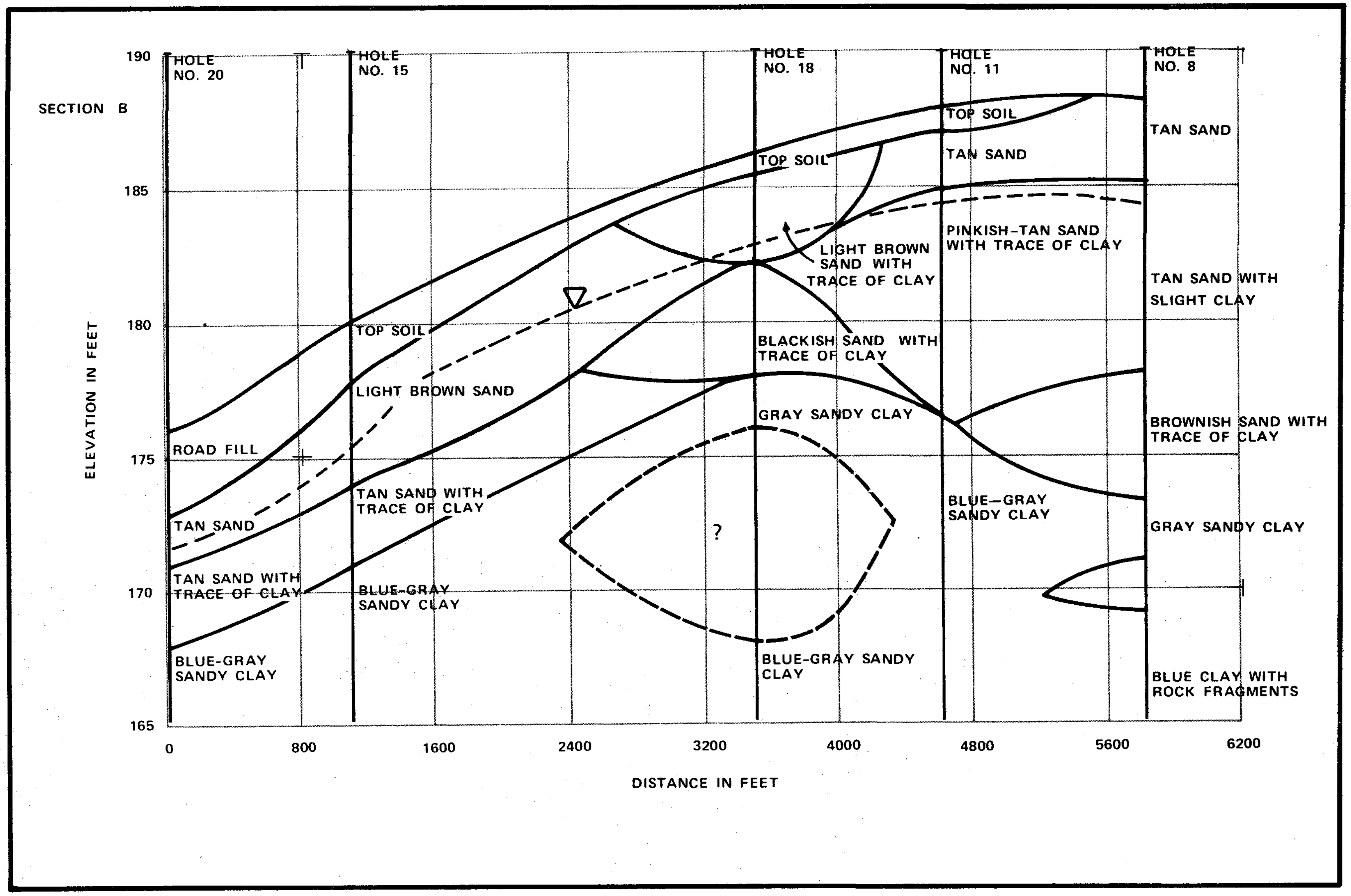


FIGURE 2.4-8 INFERRED STRATIFICATION IN SELECTED CROSS-SECTIONS OF DEERHAVEN SITE.

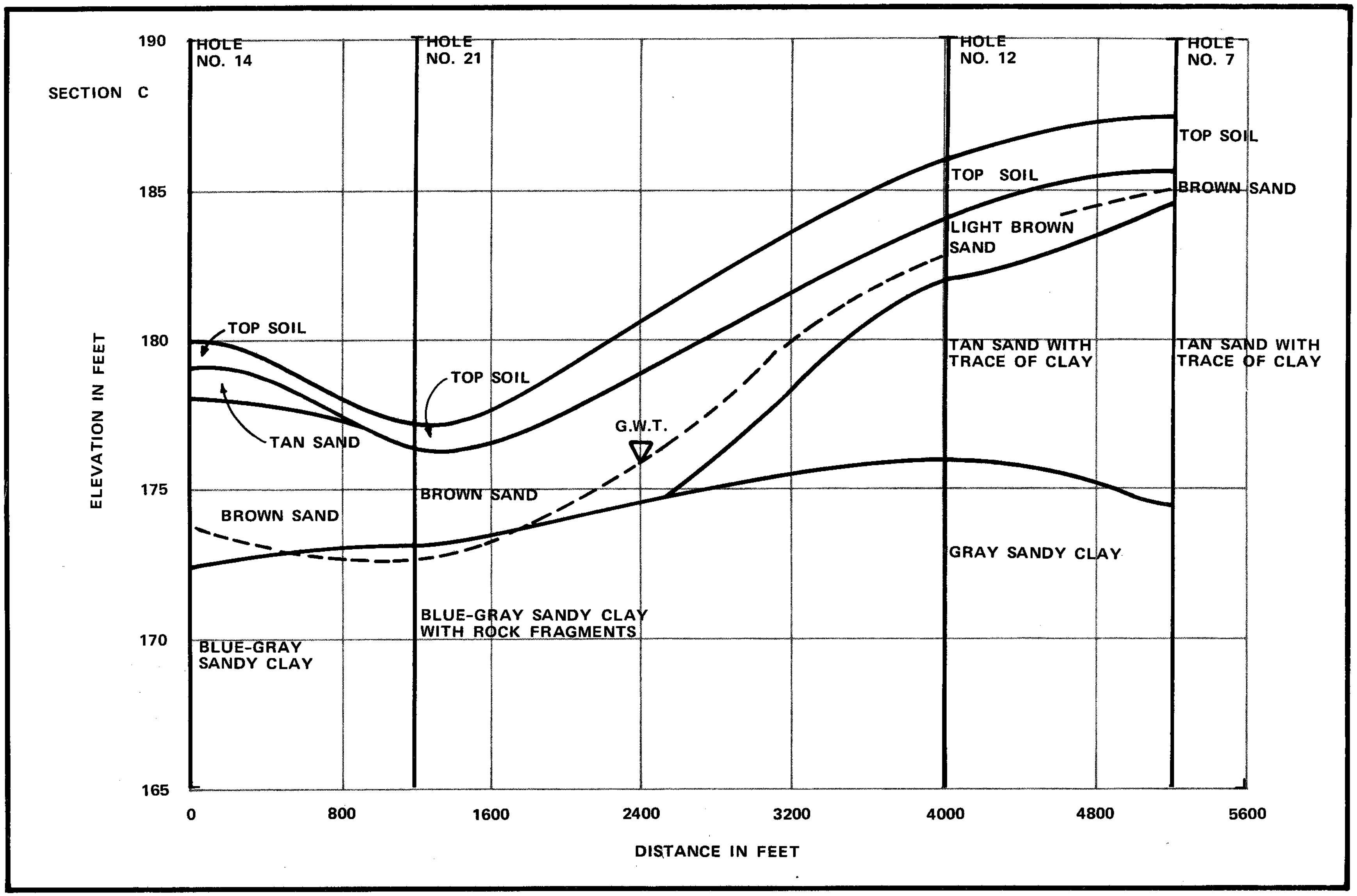


FIGURE 2.4-9 INFERRED STRATIFICATION IN SELECTED CROSS-SECTIONS OF DEERHAVEN SITE.

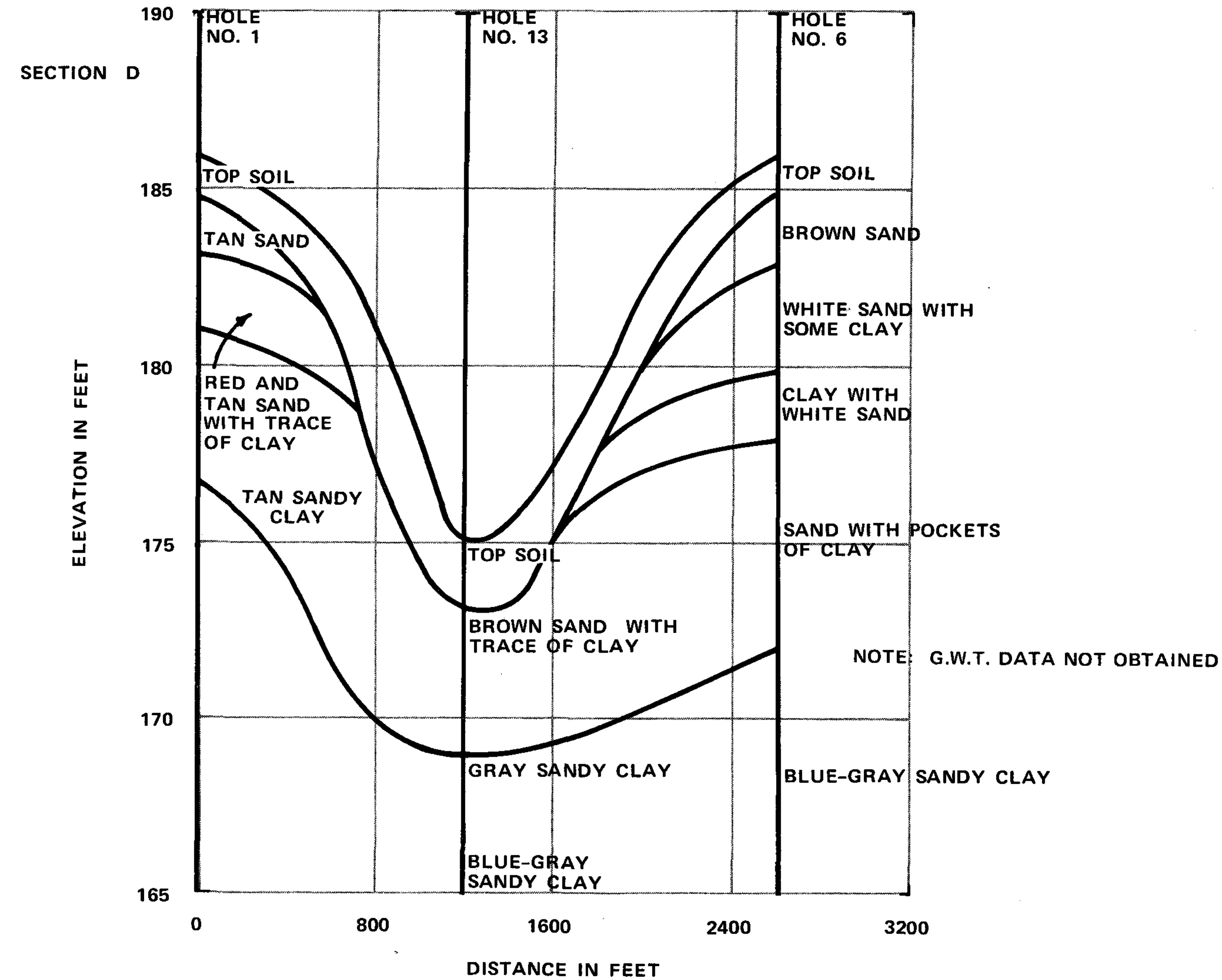


FIGURE 2.4-10 INFERRED STRATIFICATIONS IN SELECTED CROSS-SECTIONS OF DEERHAVEN SITE.

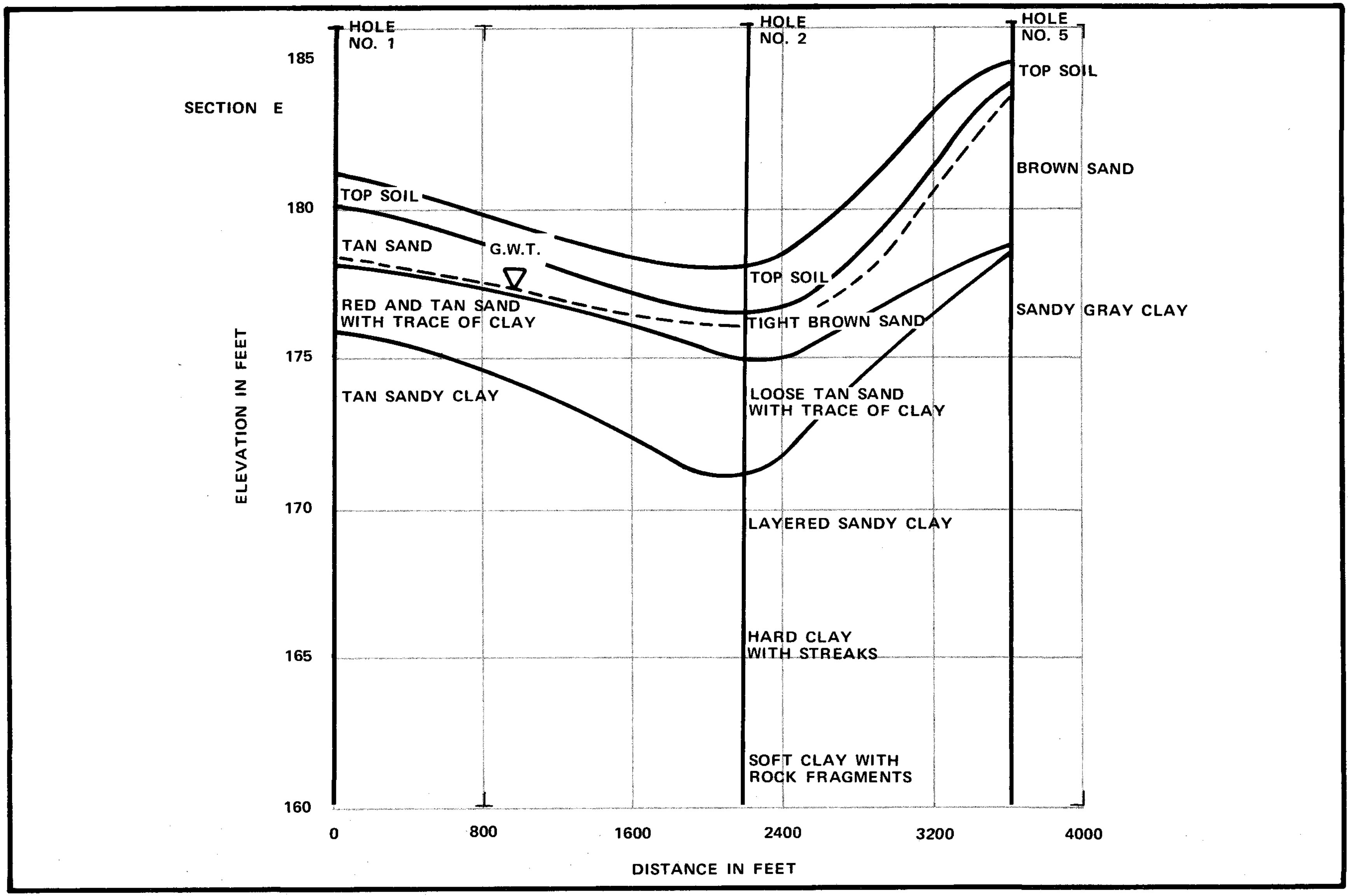


FIGURE 2.4-11 INFERRED STRATIFICATIONS IN SELECTED CROSS-SECTIONS OF DEERHAVEN SITE.

perched. Soils are sandier and better drained to the northwest as the water table is lower there. The greatest depth to the water table was found to be approximately six feet; however, in most borings the depth was found to be only two to three feet. In the southern end of the site, the groundwater depth was often within one foot of the surface. All groundwater observations were made following three successive days with no rainfall. It should be noted that groundwater levels fluctuate seasonally, and that deeper and shallower groundwater levels are dependant upon antecedent rainfall conditions. Auger borings and groundwater level measurements were performed in September, 1976.

In January, 1974, ten split-spoon borings were performed at selected locations on the improved site area, each boring penetrating thirty feet below grade. These borings indicated continuous clayey strata beginning from 3 1/2 feet below grade to 13 feet below grade, overlain by gray sand with traces of clay and dark-brown sand. The groundwater table was observed to vary from 4 to 6 feet below grade.

In August, 1974, nine split-spoon borings were taken in the improved site area, seven of which were performed adjacent to the existing generating guilding. Seven of the nine borings penetrated to 100 feet, while the other two were terminated at 30 feet below grade. Clay was encountered in each boring from 5 to 13 feet below grade and various clay strata were penetrated continuously down to the 100-foot depth. Encountered clays were extremely stiff, often requiring 100 blows of the

driving hammer to achieve less than a foot of split-spoon penetration. No significant limerock or sand deposits were found within the clay. The clay surface was overlain by gray clayey sand and brown topsoil. Water levels were found to vary from 6 inches to 4 1/2 feet below grade.

2.5 Hydrology of the Area

City of Gainesville and Alachua County lie along the peninsular drainage divide. The Hatchett Creek watershed is generally located east of Gainesville and south of Waldo, forming the headwaters of a surface drainage system which flows south through Newnan's Lake, Prairie Creek, Orange Lake, and Orange Creek to the Oklawaha River. From the Oklawaha, flow continues through the St. John's River to the Atlantic. The northern areas of the county, lying atop the Hawthorn Formation, generally drain through small surface streams such as Rocky Creek and Monteocha Creek to the Santa Fe River. The Santa Fe flows generally in a westerly direction to the Suwannee River and, thence, to the Gulf of Mexico. Major portions of the county lie along the transition zone between the high plateau of the Hawthorn Formation and the limestone plain of the Ocala Formation. Drainage in these areas and on the plain itself is accomplished through relatively small surface streams and wet weather runs that discharge surface runoff directly to sinkhole systems. It is believed that this subsurface system of caverns and solution conduits generally discharges runoff through an extensive series of springs and seeps along the Santa Fe River. The interchange of groundwater and surface waters is reversible in that the Santa Fe surface flow may

recharge portions of the limestone aquifer when the head differential is reversed. Hogtown Creek, Turkey Creek, Cellon Creek, and Burnett's Lake basins are typical examples of fairly small basins draining directly to limestone sinks. Figure 2.5-1 outlines the drainage basin systems adjacent to the Deerhaven site.

2.5.1 Surface Water Hydrology

2.5.1.1 Turkey Creek

Turkey Creek basin lies in the transition zone between the plateau of the Hawthorn Formation and the limestone plain of the Ocala Formation. This basin is centered about two miles south of the community of Hague (Figure 2.5-2). The major or long axis of this elliptically shaped basin is generally aligned in a northwest-southeast direction. Elevations in the basin range from 190 feet mean sea level (msl) to less than 80 feet msl. As Figure 2.5-2 indicates, Turkey Creek basin has been shown to include Blues Creek, since in times of flood these two creeks would respond as one hydrological system. The combined area of this system is approximately twenty square miles. Blues Creek serves as the principal drainageway for the south-central one-third of this basin while Turkey Creek and its tributaries drain the northern and eastern one-half. The remaining area drains directly to Sanchez Prairie and Split Rock Sink.

The western one-third of the basin falls within San Felasco Hammock, a reservation owned and managed by the State of Florida. It is believed

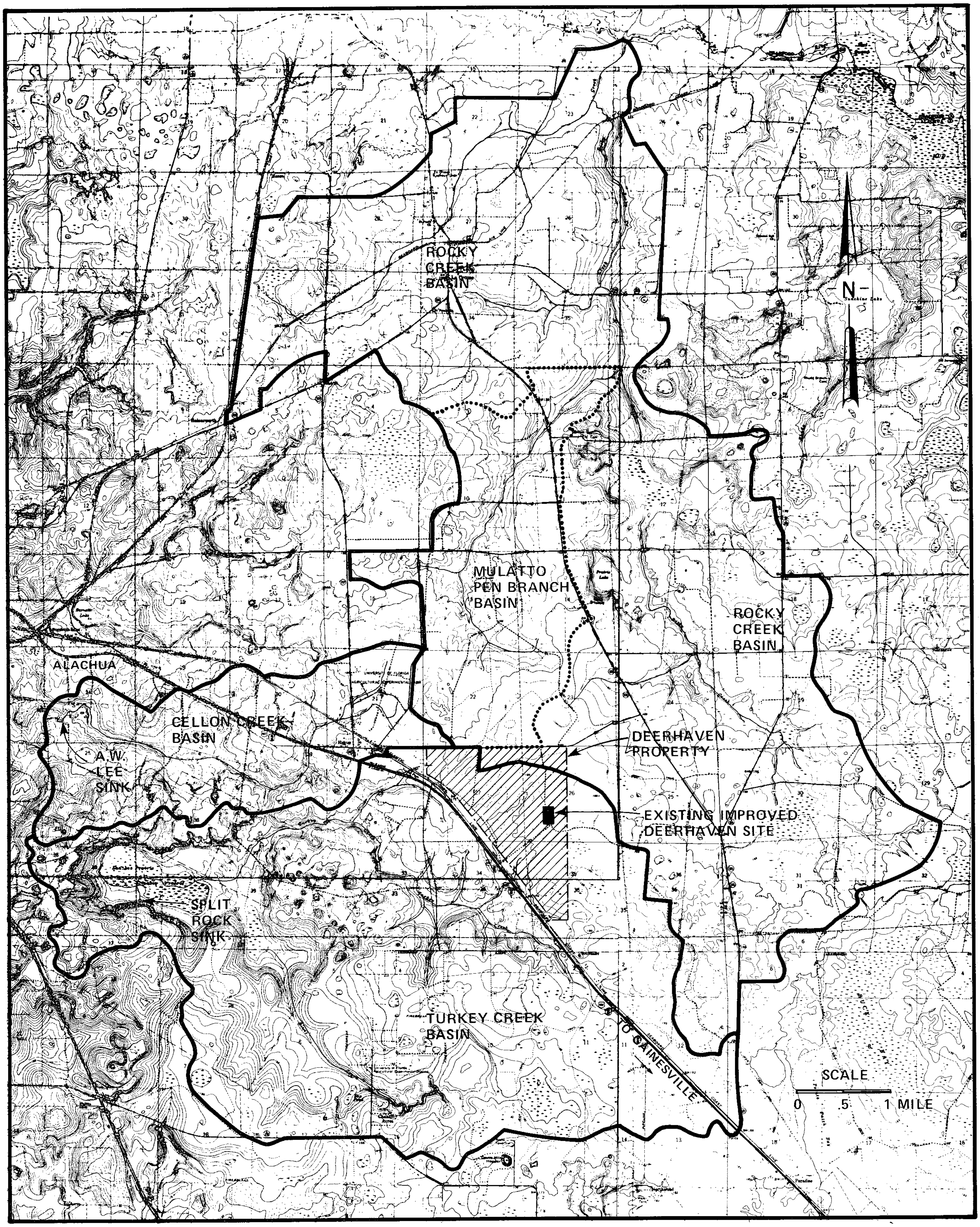


FIGURE 2.5-1 DRAINAGE BASINS ADJACENT TO DEERHAVEN SITE.

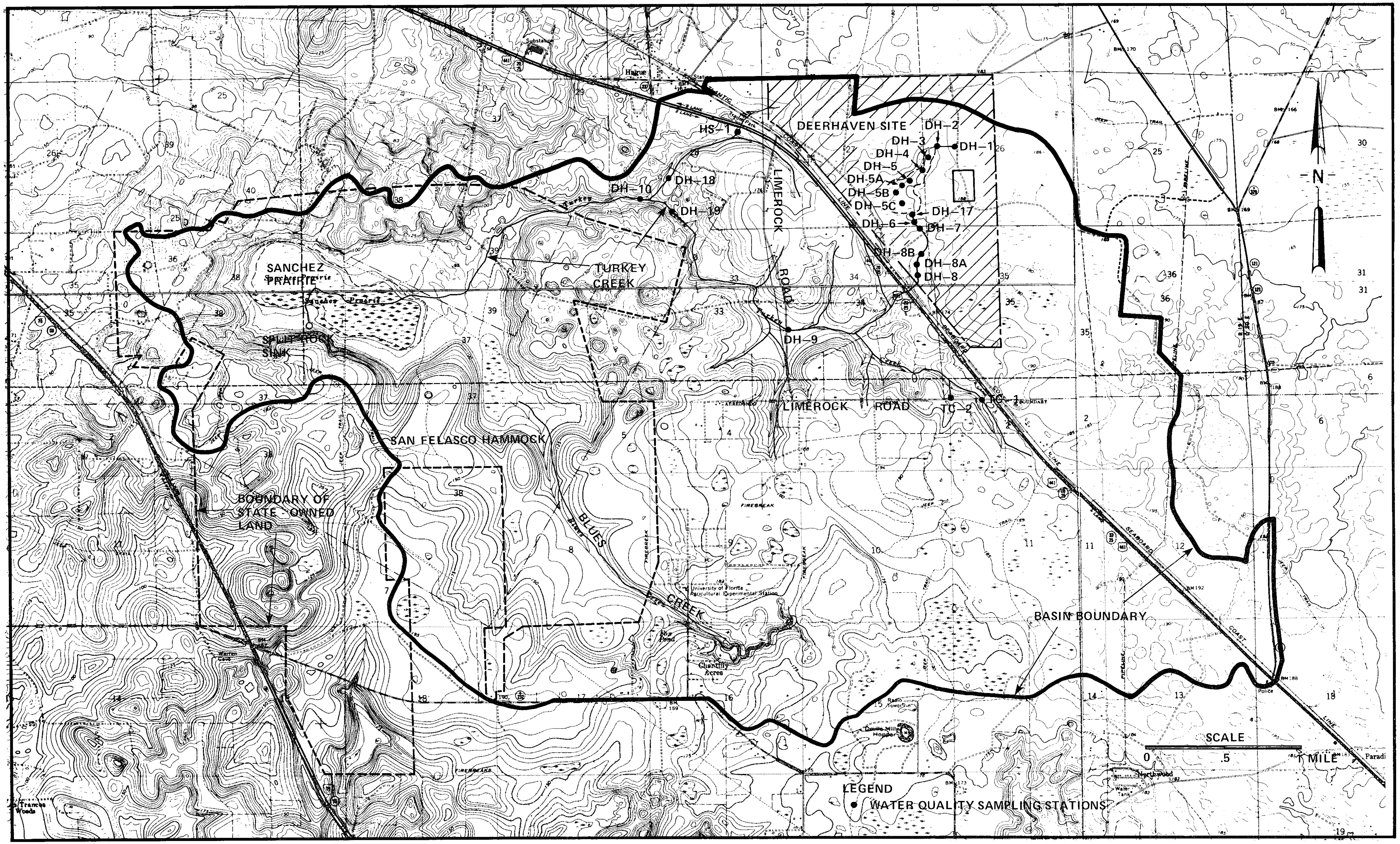


FIGURE 2.5-2 TURKEY CREEK DRAINAGE BASIN.

that Split Rock Sink, located within San Felasco Hammock at the edge of Sanchez Prairie, passes surface flow directly to the underlying Floridan Aquifer. This sinkhole is the principal outfall for flows from Turkey Creek.

Soils

Basin pine woods have soils that are typically poorly drained sands underlain by loams and clay layers. Pomona, Basinger, Surrency and Wauchula soil series are common to the flatwoods areas. Scattered cypress ponds contain deposits of organic muck such as the Samsula series.

Tavares and Arredondo series soils are somewhat better drained fine sands with loamy subsoils. These series are found along the eroded edges of the Hawthorn Formation, appearing in pasture and cropland areas within the basin; along with other fine sands and loams, they are also typical of the upland mixed hardwood and pine forests. Generally the lowland forests have poorly drained fine sands, loams, and clays. Organic muck deposits may be found in cypress ponds and other wetland areas.

Hydrology

Turkey Creek originates in a series of cypress heads found in the pine flatwoods in the eastern end of the basin. The main channel flows to the west in a meandering fashion over a distance of 5.5 miles before

entering Sanchez Prairie. Surface runoff from the pine flatwoods lying north and east of U.S. 441 flows to the main channel through a series of branches. Various other branches accept runoff from the central and southeasterly areas of the basin. Flows in these branches and in the upper reaches of the main channel are intermittent and dependent on rainfall and groundwater seepage; however, a well-defined spring flow can be found in the branch which originates near the curve in U.S. 441, south of Hague.

Within Sanchez Prairie, Turkey Creek rapidly spreads and becomes a slow-moving flow. Portions of this area contain cypress and other water tolerant vegetation indicating that the majority of the area contains standing water for long periods of time. Flow becomes briefly channelized again before entering a pool and swallow hole at Split Rock Sink.

In summary, Turkey Creek has three distinct channel segments: (1) the initial or headwater segments are low gradient sandy channels connecting cypress domes in the pine flatwoods; (2) the intermediate channels have clayey or loamy banks, are steeper sloped, well-defined and contain relatively high velocity flows through hardwood forests; and (3) the third segment is flat sloped and often flows in broad pools connected by marshy, low banked channels.

Water Quality

Turkey Creek, along with Cellon and Rocky Creeks, was sampled for those parameters characteristic of Deerhaven Unit 1 discharge, basin land uses, and natural system influences. Sediments were also collected and analyzed for heavy metals, sulfate and sulfide (Tables A2-2 through 9) (Figure 2.5-2).

The Turkey Creek base flow is primarily Deerhaven Unit 1 blowdown. The source of water for Deerhaven operations is groundwater from the Floridan Aquifer which has a high dissolved solids content and high specific conductance (Table 2.5-1). On occasion, the groundwater exceeds state water quality standards for specific conductance prior to utilization by Unit 1. Due to evaporative water loss in the cooling tower, heating during condenser passage, and the addition of sulfuric acid for pH adjustment, the blowdown exceeds state water quality standards (FAC Chapter 17-3) for total dissolved solids, conductivity and temperature. The concentrations of sulfate, total dissolved solids and conductivity decrease to some extent downstream (Table 2.5-1), but are still above acceptable limits at Split Rock Sink where surface flow re-enters the groundwater. Thermal effects are confined to a 28 acre on-site cypress swamp, through which the blowdown from Unit 1 is presently routed (Berger and Eichler, 1975).

The on-site swamp, because of water discharge from the cooling tower and low dissolved oxygen, contains a high concentration of hydrogen sulfide

Table 2.5-1 Deerhaven Unit 1 Water Quality. All data in mg/l except where noted.

Station No.	1	2	3	4	5
Date of Collection (1975)	5/30	5/30	5/30	6/12	6/12
Carbon Dioxide (CO_2)	--	--	--	--	--
Biochemical Oxygen Demand (BOD, 5 Day)	--	--	--	--	--
Nitrite (NO_2 as N)	--	--	--	0.01	0.01
Nitrate (NO_3 as N)	--	--	--	0.08	0.01
Calcium (Ca)	63	120	88	80	84
Magnesium (Mg)	23	46	31	32	33
Sodium (Na)	9.2	18	29	22	24
Potassium (K)	1.0	2.2	2.0	2.6	2.8
Silica (SiO_2)	2.8	53	34	23	20
Bicarbonate (HCO_3)	248	12	60	76	79
Carbonate (CO_3)	0	0	0	0	0
Sulfate (SO_4)	46	480	330	290	290
Chloride (Cl)	10	26	21	19	19
Fluoride (F)	0.6	0.3	0.8	0.6	0.6
Nitrate (NO_3)	--	--	--	0.4	0
Dissolved Oxygen (DO)	--	--	--	--	--
Dissolved Solids					
Calculated	280	750	570	510	510
Residue on evaporation @180°C	316	776	636	580	560
Hardness as $CaCO_3$	250	490	350	330	350
Alkalinity as $CaCO_3$	203	10	49	62	65
Iron	0.02	0.3	0.05	0.02	0.04
Specific conductance (micromhos at 25°C)	600	1200	900	850	850
pH (units)	7.8	6.8	7.9	7.4	7.2
Color (Platinum cobalt units)	0	5	45	45	45
Temperature (°C)	22.5	37	26	--	--
Strontium (Sr) (μg/l)	810	2400	1800	1600	1000
Turbidity (JTU)	--	--	--	2	1
Acidity (milliequivalents per liter)	--	--	--	--	--
Specific gravity	--	--	--	--	--
Phosphorus, total as P	--	--	--	0.42	0.54
Phosphorus, total Ortho	--	--	--	0.37	0.47
Boron (B) (μg/l)	--	--	--	--	--
Arsenic (As) (μg/l)	--	6	--	--	--
Cadmium (Cd) (μg/l)	--	0	--	--	--
Chromium (Cd) (μg/l)	--	<10	--	--	--
Cobalt (CO (μg/l)	--	--	--	--	--
Copper (CU) (μg/l)	--	67	--	--	--
Lead (Pb) (μg/l)	--	2	--	--	--
Zinc (Zn) (μg/l)	--	90	--	--	--

Table 2.5-1 Continued

Station No. Date of Collection (1975)	1 5/30	2 5/30	3 5/30	4 6/12	5 6/12
Manganese (Mn) (μg/l)	--	30	--	--	--
Polychlorinated biphenyls (PCB) (μg/l)	--	--	--	--	--
Insecticides and herbicides (μg/l)	--	--	--	--	--
Mercury (Hg) (μg/l)	--	0.0	--	--	--
Silver (Ag) (μg/l)	--	0	--	--	--

Station No.	Station Description
1	Deerhaven Power Plant - Well No. 1
2	Deerhaven Power Plant - Cooling Tower Discharge
3	Turkey Creek - At County Road T.8S, R.19E, Sec. 34
4	Turkey Creek - At Entry to Pond in Sanchez Prairie
5	Turkey Creek - Near Entry to Sink in Sanchez Prairie

Source: USGS letter to DER, May 14, 1975.

(Breedlove, 1975a, 1976a, and 1976b) (Table A2-7). The maximum total hydrogen sulfide concentration was 11.0 mg/l. Upper portions of the swamp have an oxygenated water column, but the sediments are anaerobic and high in sulfate, sulfide and nickel (Table A2-6). The sulfate is derived from cooling tower blowdown and the metals from low volume wastes. Hydrogen sulfide is rapidly lost from the water column as it leaves the on-site swamp (Table A2-7) (Breedlove, 1975a). However, due to the high sulfate load in Turkey Creek, any low oxygen environments would be potential hydrogen sulfide production zones.

Water quality changes very little after passing off site. Dilution of the discharge with seepage flow and runoff occurs (Breedlove, 1975a, 1975b, 1976b) (Table 2.5-1), but the parameter concentrations remain relatively constant with increased distance from the site. High concentrations of sodium, calcium, magnesium, arsenic and hardness were found in Turkey Creek. High levels of nickel and lead were observed in the sediments, and, on one occasion, in the water of the cooling tower discharge ditch and the on-site swamp (Table 2.5-1 and Tables A2-6 and A2-10 through A2-47).

Sediment sulfate and sulfide concentrations are quite variable but high in the on-site swamp and the flooded tree area of Sanchez Prairie within the San Felasco Hammock (Table A2-9). Production of hydrogen sulfide occurs in the stream bottom within Sanchez Prairie.

Pesticides and herbicides were not detected in any water or sediment samples (Tables A2-8 and A2-9).

2.5.1.2 Cellon Creek

Cellon Creek drainage basin covers some 5.5 square miles (Figure 2.5-3). The major axis lies in a northeast-southwest direction with the basin center approximately 3,500 feet southwest of the General Electric battery plant at Hague. The high end of the basin is occupied by the University of Florida Agricultural Experiment Farm at Hague. Cellon Creek originates in this area as several small rills or runs flowing in a southwesterly direction. As the channel becomes better defined, it passes underneath the Seaboard Coastline Railroad and intersects a tributary originating in a swampy, wooded area to the north of the General Electric plant. Flow continues to the south through drainage structures under U.S. 441. The channel bends to the west approximately one-half mile south of the highway and, paralleling the highway, flows in a west-northwest direction to its terminus at A. W. Lee Sink.

Disregarding local meanders, the channel is approximately 4.5 miles long. Elevations in this basin range from a high of 175 feet above mean sea level on the experimental farm to a low of 49 feet msl at Lee Sink. It is significant to note that ground-surface elevations fall 125 feet over the 4.5 mile channel length, a relatively steep slope for Florida. The basin begins in the high, mildly sloping pine and palmetto scrub along the east side of the experimental farm. Proceeding downslope, the

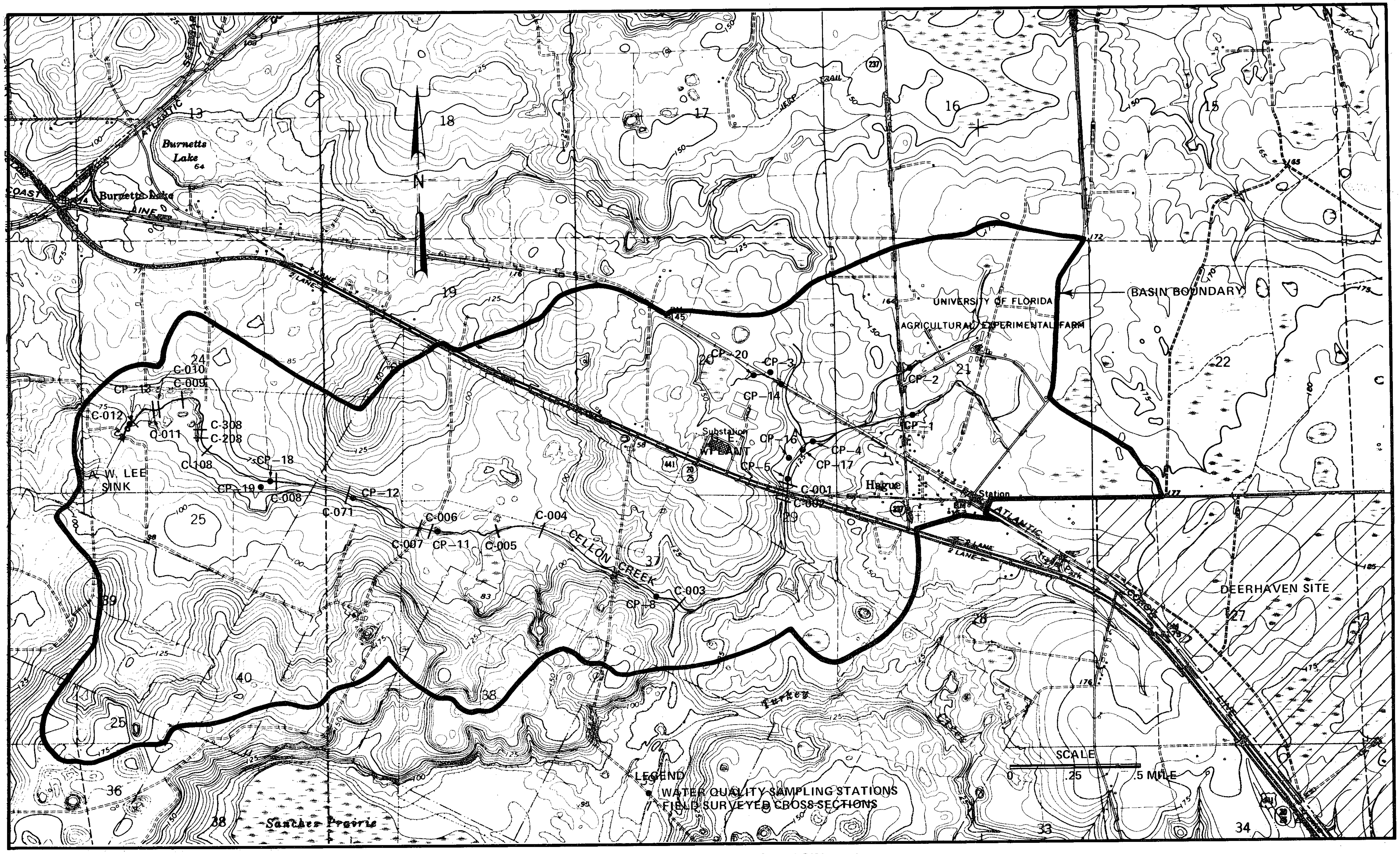


FIGURE 2.5-3 CELLON CREEK DRAINAGE BASIN.

farm is open pastureland in the area east of Highway S-237 and heavy scrub occurs along the creek to U.S. 441. Alternating woods and pastureland occur over the balance of the basin. The basin contains gently rolling ground south of U.S. 441. The ridges and knolls top out at 150 to 175 feet in elevation with the creek bottom predominant at 70 to 100 feet.

Overland flow distances from basin drainage boundaries vary from a few hundred feet to several thousand feet. Many shallow sinks and depressions intercept overland flow, providing substantial upland storage. In addition, several small ponds are scattered throughout the basin. The largest pond lies just north of the General Electric physical plant and covers about 10 acres. Several smaller ponds are found in the area south of the highway. Those ponds not directly connected to the creek channel are perched on impervious strata and are both nourished and relieved by lateral seepage in surficial sandy layers and by overland flow. Cavernous limestone substrata are evidenced by numerous active sinkholes, irregularly flowing springs and stable depressions resulting from past subsidences or collapses of solution cavities.

Flow in Cellon Creek is subject to seasonal variation. Prior to introduction of flow from the General Electric plant, this creek was probably subject to extended periods of extremely low flow during the dry winter months. Wet season flows apparently seldom exceeded two or three cubic feet per second in view of channel size, drainage structures and the

general condition of the creek bottom. General Electric began discharging into the creek during the early 1960's and presently discharges approximately 2.3 cfs (1.49 mgd), providing a continuous base flow downstream of the plant.

Shown on Figure 2.5-3 are locations where Cellon Creek channel cross-sections were field-surveyed during previous investigations. At each location an accurate cross-sectional profile of the stream bed, banks, and flood plain was obtained by close-order level traverse. Each cross section was chosen as being typical of the channel within its vicinity. "C" prefixed numbers, mentioned in the following text, refer to cross sections in this figure.

It is of interest to note that an excavated channel with raised embankments was constructed in the early 1950's to divert flow into the pond near the center of the basin. This diversion was constructed to maintain sufficient water in the pond for stock watering and irrigation (Pers. Com., Don Hough). The diversion embankment begins near Cross-Section C004 and continues along the creek before turning sharply south to the pond. The existing embankment has been breached near Cross-Section C005, resulting in a flow that presently continues along the natural creek channel.

Another prominent feature in this basin is the large depression just upstream of Lee Sink which was excavated as a borrow pit to provide

material for the U.S. 441 railroad overpass at Alachua. A haul road was constructed and the forty-eight inch corrugated metal pipe culvert installed by the contractor.

The channel of Cellon Creek varies in character and can be subdivided into several distinct reaches. That portion of the system upstream of U.S. 441 includes both slow-moving, ponded storage areas and well-defined channels with good slopes and flow velocities. From U.S. 441 to Cross-Section C004, the channel is relatively steep-sloped, has steep banks of cohesive material, sharp meanders which considerably lengthen flow distance, and occasional deadfalls and other growth projecting into the channel. This reach has been eroded; however, the meandering channel combined with strongly cohesive soils has minimized erosion effects. As previously noted, the channel has been improved between Cross-Sections C004 and C005. This reach is relatively straight and both banks and parallel embankments are in good condition. Downstream of Cross-Section C005, the slope flattens considerably and the channel is not well-defined. Wide, marshy deltas characterize this portion of Cellon Creek. The channel becomes more restricted near Cross-Section C071 and then alternates between a well-defined, meandering section and a broader, marshy channel. The final reach through the borrow pit and down into Lee Sink is well-defined with some meandering.

Soils

Some variation in soils exists across the basin. In the area of the experimental farm, the U.S.D.A. Soil Conservation Service's Soil Survey for Alachua County shows sandy soils classified in the Felda, Basinger, Adamsville and Tavares Series. Nearly all of these soils are poorly drained fine sands with varying percentages of silts and clays. These soils are typical of Florida's pine flatwoods. Further downslope, Kendrick, Arredondo, Sparr and Fort Meade Series are predominant. These soils are somewhat better-drained fine sands, silty-clayey sands, and loams. These soils have relatively high percentages of silts and clays beneath the surficial layers. The creek bottom and floodplain have similar materials along with occasional organic peat deposits and banks composed of silts and clays where natural erosion has cut deeply into existing materials. Vertical or undercut banks occur along substantial reaches of the creek. Lateral seepage in the surficial sand layers has been observed in several places. A clay hardpan is evident throughout the area of Lee Sink and the upstream borrow pit. Good ground cover throughout the area prevents erosion of most sandy soils.

Hydrology

The existing base flow in Cellon Creek was modeled using the U.S.D.A. Soil Conservation Service's WSP-II computer program (Breedlove, 1977). General Electric currently discharges 2.3 cfs (1.49 mgd) of treated process and cooling water into the creek. This flow was added to an estimated natural base flow of 0.7 cfs (0.45 mgd) for a calculated total

base flow of 3.0 cfs (1.94 mgd). Field measurements of channel velocities and discharges during September and October, 1976, showed some variation with 3.0 cfs being slightly higher than the mean of selected observations. Average channel velocities for a flow of 3.0 cfs varied from a low of 0.3 fps to a high of 1.4 fps, according to the results of computer simulation.

A statistical analysis of rainfall records is summarized and published in the "Rainfall Frequency Atlas" by the U.S. Department of Agriculture. Alachua County, according to this publication, receives approximately four inches of rainfall over a twenty-four hour period, once each year. Restated, a four-inch rainfall of twenty-four hours duration has a recurrence interval of one year in Alachua County. This storm event was selected for evaluation of existing basin hydrology during a previous investigation (Breedlove, 1977). Channel stage versus discharge relationships, generated by WSP-II, together with land use, soil type, available storage, overland flow times, existing base flow and Lee Sink discharge capacity (determined as part of the investigation) were incorporated into TR-20, a computer model for hydrology developed by the U.S.D.A. Soil Conservation Service.

The runoff from the four-inch, twenty-four hour rainfall was imposed on the existing baseflow through TR-20. Surface runoff and channel flow, arriving at Lee Sink during the sixty hour simulation, totaled 54.3 acre-feet, whereas total rainfall volume (4 inches over 3,490 acres)

amounts to 1,164 acre-feet. Thus, only 4.7% of the total rainfall was predicted to arrive as surface flow at Lee Sink for this event.

Water surface elevations in the pool at Lee Sink normally vary between 49.0 feet and 53.0 feet msl. The peak water surface elevation predicted by computer simulation was 64.0 feet for this event. Flooding of the sinkhole and borrow pit occurs as inflow exceeds the discharge capabilities of the sink. Temporary ponding or storage of stormwater is predicted to extend from Lee Sink upstream to Cross-Section C308. Flows above this cross section are contained within existing channel banks or in the immediate floodplain adjacent to the channel. Storm flows result in relatively broad overbank flooding in the reach above Cross-Section C071.

The peak inflow rate to the Lee Sink system was indicated to occur 26.5 hours after the beginning of the storm and to reach a maximum of 50.8 cfs (32.8 mgd). Extrapolations of field test data have implied that Lee Sink will pass 5.9 cfs (3.8 mgd) with a corresponding water surface elevation of 64.0 feet.

Land use parameters incorporated into this model were revised to reflect future conditions in the basin as discussed in Section 2.2-1 (Table 2.2-1). A second computer simulation was performed using the annual, twenty-four hour rainfall imposed on a 3 cfs (1.9 mgd) base flow. Total runoff arriving at Lee Sink during the sixty hour simulation increased from

54.3 acre-feet (existing land use) to 100.8 acre-feet. The peak water surface elevation was predicted to be 65.64 feet MSL, an increase of 1.64 feet for future conditions. Peak discharge through Lee Sink was 6.15 cfs (3.97 mgd). It should be noted that no changes were made in subbasin times of concentration, nor was any allowance made for stormwater detention-retention systems normally incorporated into residential developments.

Water Quality

The major water quality determinants for Cellon Creek are the University of Florida Agricultural Research Unit and the General Electric nickel/cadmium battery plant (Figure 2.5-3). The University of Florida dairy research unit waste ponds and herd lots drain into the upper part of Cellon Creek. Nitrate, ammonia, total nitrogen, calcium, hardness, sodium, conductivity, total dissolved solids and dissolved oxygen are higher in the upper creek area (Stations CP-3 and CP-4) (Tables A2-2 through A2-47) and are indicative of the presence of animal wastes. The stream segment below the General Electric plant has relatively high concentrations of arsenic, total dissolved solids, sodium, sulfate, chromium, chloride, cadmium, alkalinity, conductivity, calcium and hardness (Tables A2-10 through A2-47). Aluminum, potassium, oil and grease, nickel, total phosphorus, pH, copper, ortho-phosphorus, nitrates and total Kjeldahl nitrogen, although not significantly high, are higher in the lower creek segment than above the General Electric discharge point. These data are comparable to those collected by the Alachua County Pollution Control Department (Table 2.5-2).

Table 2.5-2 Water Quality of the General Electric Effluent Discharge and A.W. Lee Sink (data compiled from Alachua County Pollution Control Department test results)

Parameter	DER Station Number[1]	Sample Period/Date 5/2/75 - 6/7/76	7/22/76
		$\bar{x}$	$\bar{x}$
pH	013	7.25[2]	--
	014	8.04	--
Total solids	013	1437	387
	014	1273	400
Total filterable solids	013	1290	256
	014	1153	287
Total volatile solids	013	146	131
	014	130	113
Total suspended solids	013	12.5	14.0
	014	54.2	10.5
Filterable suspended solids	013	6.9	7.5
	014	40.2	7.0
Volatile suspended solids	013	5.6	6.5
	014	14.0	3.5
Dissolved solids	013	1424	373
	014	1229	389.5
Chemical oxygen demand	013	46.1	16.0
	014	26.7	24.0
Nitrate	013	92.7	138.1[4]
	014	55.4	38.0
Ortho-phosphorus	013	0.59	0.61
	014	0.67	0.64
Sulfate	013	678.2	100.3
	014	558.1	94.2
Chloride	013	62.4	17.9
	014	56.4	19.8
Total hardness	013	138.5	232.0
	014	141.0	200.0

Table 2.5-2 Water quality of the General Electric effluent discharge and A.W. Lee Sink (continued)

Parameter	DER Station Number[1]	Sample Period/Date 5/2/75 - 6/7/76	7/22/76
		$\bar{x}$	$\bar{x}$
Conductivity μmhos/cm	013	1870	550[5]
	014	1575	565
Nickel	013	0.04	0.04[4]
	014	0.03	0.03
Cadmium	013	0.03	0.08[4]
	014	0.01	0.06
Chromium	013	0.02[3]	--
	014	<0.02	--
Iron	013	0.14	<0.3
	014	0.26	<0.3

[1] 013 = G.E. combined effluent at discharge pipe (Breedlove and Associates, Inc. Station 20), 014 = A.W. Lee Sink (Breedlove and Associates, Inc. Station 13)

[2] All values in mg/l unless otherwise noted.

[3] 5/2/75 only

[4] Through 8/9/76

[5] From 9/23/76 through 1/5/77 conductivity average was 1960 μmhos/cm at Station 013 (Breedlove and Associates, Inc. data)

Of the fifty-seven sampled Cellon Creek parameters, twelve either equalled or exceeded water quality standards (DER, FAC 17-3; EPA, 1976; Tables A2-2 through A2-5 and A2-7 and A2-8). The segment upstream of the General Electric plant had six parameters which did not meet the standards, while the downstream segment had eleven parameters not meeting the standards. Of the six parameters within the upstream segment, arsenic, iron, ammonia and total dissolved solids increased in concentration, manganese decreased to acceptable levels and mercury remained the same after passing into the downstream segment. Cadmium, lead, nitrate, sulfate, conductivity and phenols also exceeded the drinking water criteria within the downstream segment. Of the eleven parameters that did not meet the standards in the downstream area, only mercury, ammonia and phenols exceeded fish and wildlife criteria (McKee and Wolf, 1963).

Sediment nickel, cadmium, sulfide and sulfate concentrations at areas below the General Electric plant were significantly higher than baseline conditions in an apparent control stream (Rocky Creek) (Table A2-6). Concentrations of nickel, cadmium, lead, sulfate and sulfide within the upper reaches of Cellon Creek were comparable to Rocky Creek baseline conditions.

Pesticides and herbicides were not detected in the creek in water or sediments (Tables A2-8 and A2-9).

To test for possible biological accumulation of heavy metals discharged into Cellon Creek, benthic macroinvertebrates were collected from the Cellon Creek marsh and analyzed for dry weight concentrations of nickel, cadmium and lead. In each case, concentrations in the biological samples exceeded those corresponding concentrations found in the sediments. Organism dry weight concentrations were 22.6, 70.0 and 3.5 ppm as compared to sediment concentrations of 1.5, 17.0 and 1.5 ppm for nickel, cadmium and lead, respectively (Table A2-6).

2.5.1.3 Mulatto Pen Branch

Mulatto Pen Branch drainage basin contains approximately 5.8 square miles of commercial pine forest, woodlands, pasture, croplands, and scattered farmsteads. This basin is generally oriented in a north-south direction along what is known as Mulatto Pen Branch, a tributary to Rockey Creek. As Figure 2.5-4 shows, the high end of the basin lies just north of the Deerhaven site while the low or north end merges with Rocky Creek about three-quarters of a mile south of SR-235. The basin length is about 4.5 miles with some variation in width along this length. Elevations in the basin range from a high of 180 feet above mean sea level to a low of 100 feet at the juncture with Rocky Creek. The south or high end of the basin is typical pine flatwoods terrain, occasionally interrupted by ponded areas dominated by cypress, gum, and other water-tolerant vegetation. The central portion of the basin, west of SR-121, has more of a rolling character along the channel. However, many small ponded areas are apparent, particularly along the western drainage

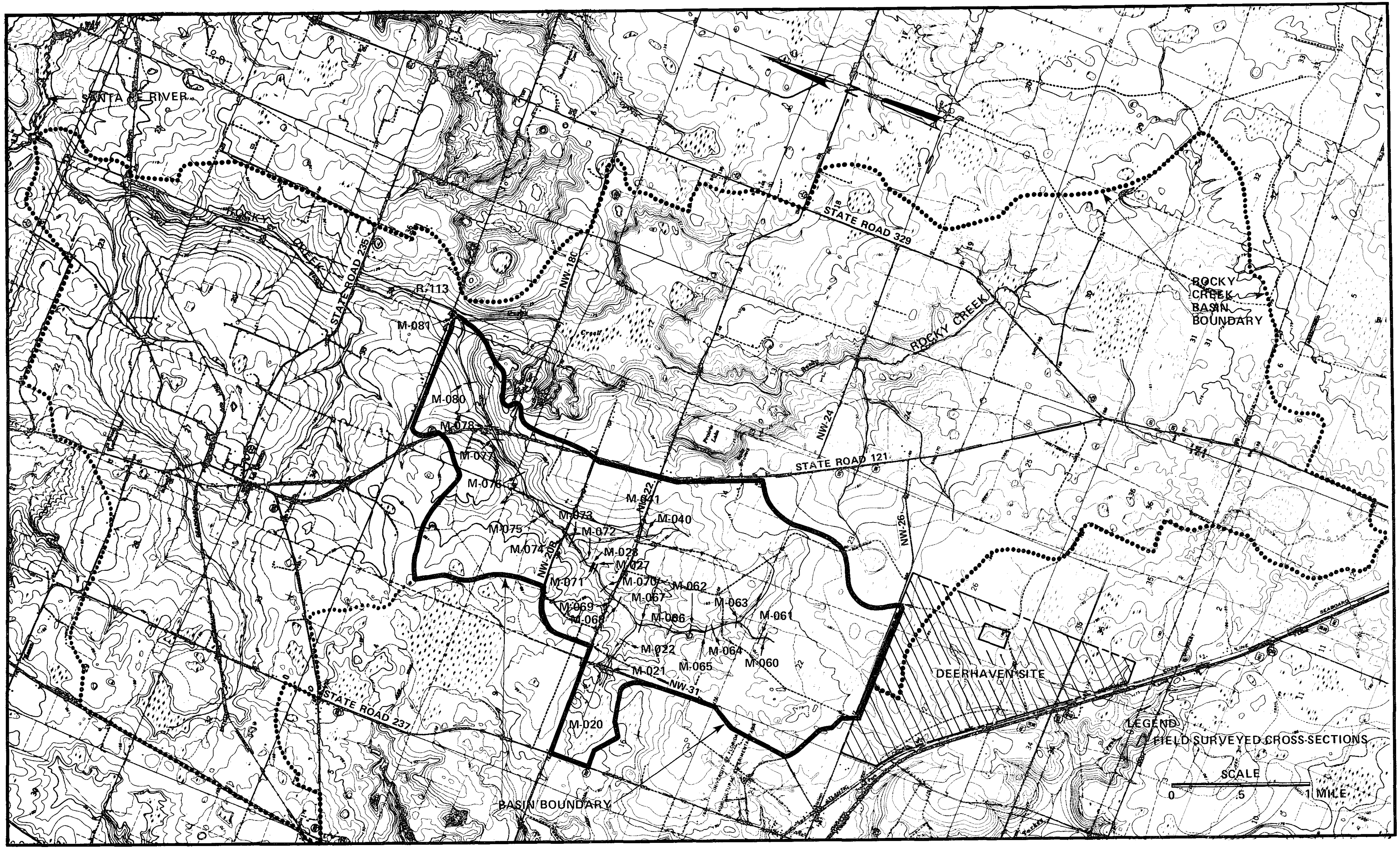


FIGURE 2.5-4 MULATTO PEN BRANCH DRAINAGE BASIN.

divide. That portion of the basin east of SR-121 is heavily wooded along the channel and near the confluence with Rocky Creek. Here, too, as these stream valleys join together, gently rolling ground is typical.

The high pine flatwoods in the southern end of the Mulatto Pen Branch basin are drained by a combination of small excavated channels, semi-improved natural channels and existing natural channels. This system converges (between Cross-Sections M060 and M064) to form Mulatto Pen Branch in the central and northern flatwoods. Disregarding local meanders, the channel length is about 4.5 miles in length beginning at Cross-Section M060 near the north line of Section 22 - Township 8 South - Range 19 East and ending at Rocky Creek (Cross-Section R114). The character of the channel varies in the upper reaches. Some portions are stable, well-defined sections while others, damaged during recent timber and farm clearing operations, are not well established. A relatively flat reach occurs between Cross-Sections M028 and M066. Much of this reach was originally broadly ponded and slow moving. Some portions have been cleared and partially improved; however, flow is sluggish and frequently breaks into overbank flow. The downstream end of this reach (at Cross-Section M028) is severely constricted by cypress trees and other wetland vegetation. The channel steepens and remains well-defined as it passes under County Road NW 20B. Mulatto Pen Branch follows a gradual arc to the northeast, passing under SR-121 as it approaches Rocky Creek. In the heavily wooded 'bottom' near the confluence, channel meanders become quite severe. The junction of flow at Rocky

Creek is through a series of small distinct channels breaking away from the branch and flowing easterly to the Rocky Creek main channel. Much of this delta-like area is totally inundated during high flows. The lower reaches of Mulatto Pen Branch are also characterized by shallow flood channels and past meanders of the main channel.

Many small tributaries to Mulatto Pen Branch are found throughout the basin. These tributaries tend to flow intermittently with incidental rainfall. Also, springs and seeps are found all along the channel, particularly in wet weather.

The primary structures along Mulatto Pen Branch are limited to three road crossings. County Roads NW 22 and NW 18C both cross the channel via wooden bridges with spans of about 46 feet and widths of about 26 feet.

Deposition of eroded material has occurred on the upstream side of both structures; however, these sandy deposits are not restrictive except at relatively high flows. The third structure is a double 10' by 10' by 60' concrete box culvert located where the branch passes beneath SR-121. In addition, several unimproved farm crossings are currently in use along this branch. These crossings are shallow fords in the stream that can be negotiated by light trucks.

Soils

Soils found in the pine forests of the southern end of the basin are typical of Florida pine flatwoods. They are poorly drained fine sands with at least 5% fines. These soils are classified in the Rutlege, Scranton and Leon series according to available soil surveys by the Soil Conservation Service and by the University of Florida. Further north, the croplands are mostly well-drained fine sands underlain by sandy clays such as Orlando fine sand and Blanton fine sand. Pasture soils vary but are typically fine sands with higher percentages of fines making them less well-drained. These soils are characteristically underlain by sand loam and/or limerock strata. The immediate channel banks and bottoms are of undifferentiated alluvial soils and are poorly drained. The hydrological characteristics of these soils are consistent with what has been observed elsewhere in Rocky Creek basin. Percolation is poor along streams and in the flatwoods while good infiltration and lateral seepage is apparent in the higher, rolling croplands.

Hydrology

Flows in Mulatto Pen Branch are dependent on several factors. Among these are incidental rainfall, season of the year and location in the basin. Substantial upland storage of rainfall runoff in the flatwoods, cypress ponds and other wetlands tends to both moderate and extend the duration of flows in Mulatto Pen Branch. Further, the sandy soils found throughout the basin act to absorb and slowly release percolated rainfall. However, dry season conditions result in extended periods of little or

no flow. Wet season conditions provide sustained flows with storm related discharges at the confluence of Mulatto Pen Branch and Rocky Creek in excess of 100 cfs (64.6 mgd) as determined through both computer analysis and applicable regression equations.

According to a statistical analysis of rainfall records a 4 inch, twenty-four hour rainfall will be equaled or exceeded at least once each year in this area. In previous investigations, this storm condition was used to investigate existing Mulatto Pen Branch flood potential (Breedlove, 1977).

It is apparent that significant overbank flooding is limited to the reach from Cross-Section M029 through Cross-Section M066. This flooding is a result of high flow resistance, a relatively flat bed slope and a low capacity, low banked channel. The channel between Rocky Creek and Cross-Section M029 is subject to limited overbank flooding except at the confluence where a backwater condition forces flow out over a broad area. The channel upstream of Cross-Section M066 has adequate capacity and slope for this storm event; however, this low relief area is subject to ponding of runoff.

Water Quality

Sampling station locations for Mulatto Pen Branch and Rocky Creek are shown in Figure 2.5-5. Mercury, manganese, iron, and phenolics concentrations equalled or exceeded state (DER, FAC Chapter 17-3) and/or

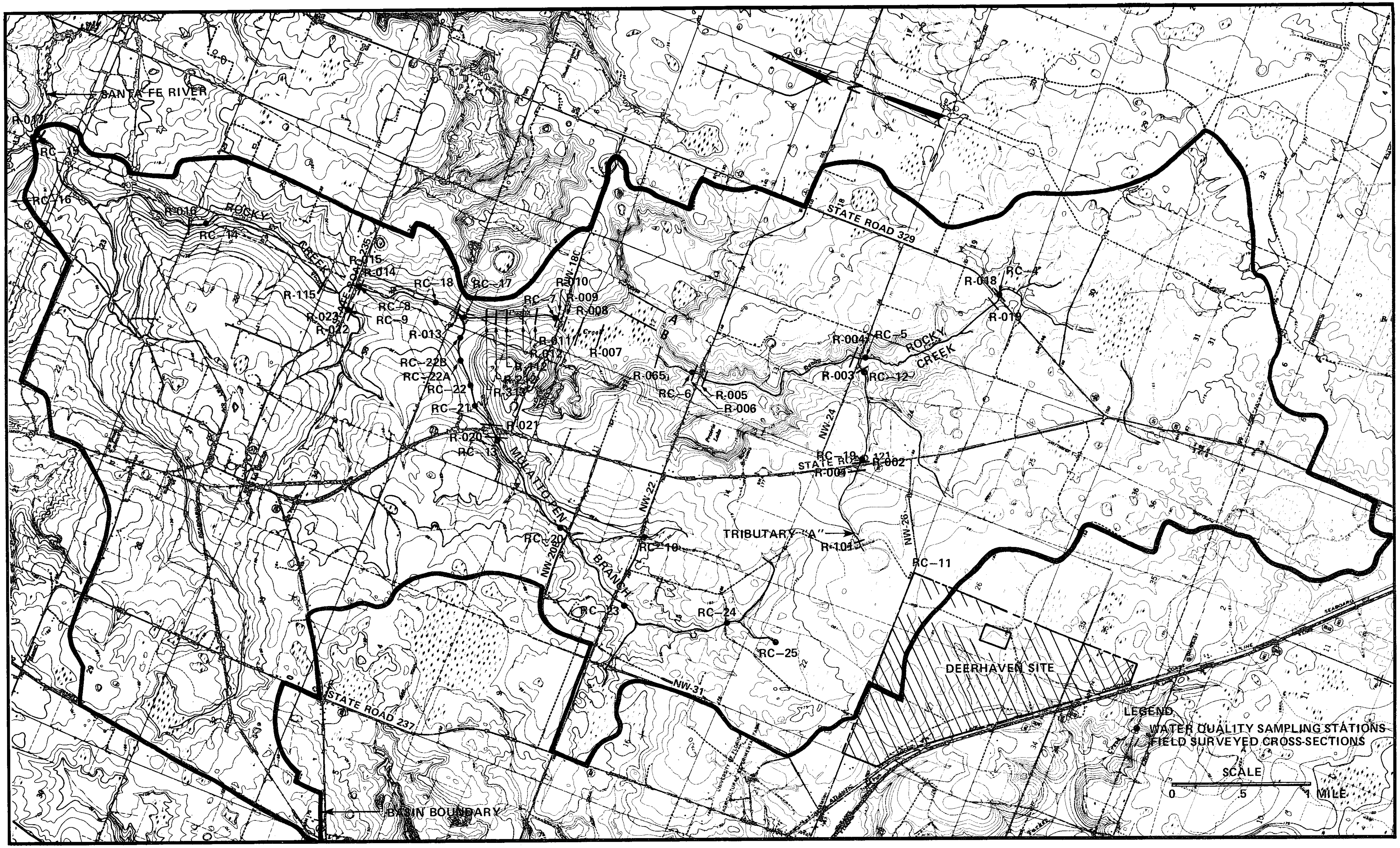


FIGURE 2.5-5 ROCKY CREEK DRAINAGE BASIN.

federal (EPA, 1976) water quality standards, but are within acceptable limits for the water's present agricultural use and for supporting local aquatic and wildlife (Tables A2-2 through 6) (McKee and Wolf, 1963). Therefore, Mulatto Pen Branch waters are considered to be of relatively high quality. Since the stream is relatively free of industrial and urban influences, these concentrations most likely are associated with leaching from plants and/or soil, rainfall, and other natural and agricultural inputs.

Sediment concentrations of sulfate, sulfide, nickel, lead and cadmium (Breedlove and Associates, 1976) were comparable to other high quality streams in the area, such as Rocky Creek and its other tributaries (Table 2.5-3 and Table A2-6) and are considered representative of natural background levels.

Mulatto Pen Branch water and sediments were not analyzed for pesticides or herbicides because these compounds were not detected in any samples collected from Cellon, Turkey, or Rocky Creeks.

2.5.1.4 Rocky Creek

As Figure 2.5-5 indicates, Rocky Creek drainage basin is a comparatively large watershed covering approximately 33 square miles. The center of the basin is approximately 6.5 miles due east of the City of Alachua. Ths basin averages three to four miles in width and is ten miles in length, with its primary axis in the north-south direction. SR-121 runs

Table 2.5-3 Surface Water Quality Data for Rocky Creek near LaCrosse, Florida[1]

Parameter	Units	No. Observed	Mean	Maximum	Minimum
Dissolved Iron	mg/l	2	75	80	70
Dissolved Calcium	mg/l	5	7.4	10.0	2.8
Dissolved Magnesium	mg/l	5	2.8	5.0	0.9
Dissolved Sodium	mg/l	5	5.6	8.7	2.9
Dissolved Potassium	mg/l	5	1.5	2.4	0.1
Total Sulfate	mg/l	5	6.0	9.0	2.8
Dissolved Chloride	mg/l	5	12.0	18.0	5.5
Dissolved Fluoride	mg/l	5	0.4	0.4	0.2
Hardness (Total)	mg/l	5	30.0	44.0	10.0
Non Carb. Hardness	mg/l	5	12.2	18.0	5.0
Alkalinity	mg/l	5	17.8	35.0	3.0
Conductivity	µmhos	5	89.8	126.0	40.8
Dissolved Solids	mg/l	5	54.2	80.0	22.0
HCO_3^-	mg/l	5	21.8	43.0	4.0
$CO_3^=$	mg/l	3	0.0	0.0	0.0
pH	SU	5	6.3	7.3	5.5
Temperature	°C	3	18.4	21.7	12.8
Nitrite Nitrogen	mg/l	3	0.01	0.02	0.00
Nitrite Nitrogen	mg/l	5	0.02	0.10	0.-0
Total Ortho-Phosphorus	mg/l	1	0.7	--	--
Dissolved Silica	mg/l	5	7.1	9.6	3.4
Color	Pt.-Co.	5	101.0	130.0	45.0
CO_2	mg/l	3	12.5	20.0	3.4

[1]Source: (Semi-Annual) Florida Geological Survey. 1964. Report of Investigations. No. 35 (July 1957 - Sept. 1960)

the full length of the basin along the north-south axis. Other roadways in the basin include S-231, S-237 and SR-235 and County Roads NW24, NW22, and NW18C.

The Rocky Creek basin is primarily composed of farmland, woodland, and swamp with scattered homes and farmsteads. The southern portion of Rocky Creek basin is relatively flat and contains numerous cypress heads, swamps, and ponds. This area provides substantial storage for storm runoff. Large tracts along SR-121 are composed predominantly of farmland, pine and hardwood forests with a few ponds and cypress heads. This area contains the highest land elevations in the basin, approximately 190 feet msl. The University of Florida Agricultural Experiment Farm straddles the western boundary of this section.

The central section of the basin, east of SR-121, consists largely of cypress swamp, hardwood forest, and farmland. Along Rocky Creek are numerous cypress heads, small ponds and a large cypress swamp located both to the north and south of NW18C. Prairie Lake, which covers approximately 30 acres, is located between Rocky Creek and SR-121 and is approximately 500 feet south of NW22. This depression receives only a limited amount of runoff and remains dry for most of the year. During large storms, water flows from Rocky Creek into the depression, which then slowly empties back into Rocky Creek when system storage capacity is exceeded. This saddle is roughly centered on the gas pipeline (Section 'A') (Figure 2.5-5). A large cypress swamp is located just south of

NW18C with a smaller swamp directly to the north across NW18C. The area adjacent to NW18C, between Rocky Creek and SR-121, contains numerous sinkholes, depressions and small ponds. These features intercept run-off, provide storage, and eventually overflow into Rocky Creek.

The northern or lower end of Rocky Creek basin, north of SR-235, is mixed agricultural, forest and wetlands. Swamps and wetlands west of the City of LaCrosse provide substantial stormwater storage in this area.

Rocky Creek generally flows in a northerly direction over a distance of approximately ten miles before discharging into the Santa Fe River at a point 2.5 miles downstream of SR-235. The creek originates at the south end of the basin as discharge from a marsh system located three-quarters of a mile east of the intersection of highways SR-121 and S-231. The channel bed falls from elevation 150 feet msl to elevation 65 feet msl at the Santa Fe River. For the greater part, Rocky Creek flows in a meandering, well-defined channel. This channel system is occasionally interrupted by cypress ponds and similar reaches of broadened flow. Numerous tributaries of greater and lesser significance intersect the primary channel along its full length.

A level traverse was performed at channel location to obtain an accurate cross-sectional profile of the stream bed, banks, floodplain and upland terrain (Figure 2.5-5). Each cross section was chosen as being typical

of the channel within its vicinity. "R" prefixed numbers mentioned in the following text refer to cross-section numbers on Figure 2.5-5.

The primary channel begins in a marsh system and flow to the northwest before intersecting a tributary from the west at Cross-Section R004. This tributary from the west originates at a logged out cypress pond approximately one mile north of Deerhaven Station. The tributary channel is well defined with a moderately steep bed slope. Flow passes beneath SR-121 by means of a concrete drainage structure, then continues downslope to the previously noted intersection at Cross-Section R004. Proceeding downstream from this intersection, Rocky Creek flows northwest and, then, north for approximately 1.25 miles in a well-defined, somewhat meandering channel with a mild bed slope. The immediate stream valley is wooded with occasional cypress trees scattered along the channel. At Cross-Section R005, the creek enters a large cypress swamp. The swamp's first one-quarter mile is characterized by severely meandering channel systems, low-lying wooded islands, swampy areas, and a broad variety of trees. The remainder of the swamp, north to Cross-Section R009, is at least partially inundated throughout the year. Wet season water depths generally run to 30 inches with occasional pools over four feet in depth. Rocky Creek becomes somewhat constricted at a point 400 feet north of County Road NW18C. Field observations and measurements have shown that this constriction limits flow from the swamp when the upstream water surface elevation is below 105 feet msl.

Approximately 800 feet north of NW18C, the creek is characterized by a meandering, low-banked, flood-prone channel. Then, at Cross-Section R011, it enters a large, triangular-shaped swamp which is not clearly shown on the U.S.G.S. quadrangle map from which Figure 2.5-5 was developed. Water depths in this swamp vary to 24 inches with some potholes over five feet deep. A small pond is located at the southeast corner of the swamp. At Cross-Section R212, there is an embankment, apparently constructed prior to 1900 as a mill pond dam. The creek flows through a 100-foot wide gap in this embankment. From this breach, Rocky Creek flows northward in a wide, shallow channel with mild bed slope. The surrounding area is heavily wooded, with numerous cypress trees near the channel. At Cross-Section R013, Mulatto Pen Branch, a significant tributary originating in the flatwoods west of SR-121, joins the creek. At Cross-Section R115, a smaller tributary joins. Both the main channel and this tributary channel have been dredged for a short distance above and below SR-235.

North from Cross-Section R115 to its outlet at the Santa Fe River, Rocky Creek channel meanders severely with a continued mild bed slope. Immediately north of Cross-Section R115, the channel banks are shallow, whereas near the Santa Fe River the channel is deeply cut, and is as much as ten feet below gound surface. Stream banks are generally bounded by woodlands. A few scattered cypress trees occur where the channel occasionally broadens. A major tributary, providing drainage for a large land area north and west of LaCrosse, joins the main channel approximately one mile south of the Santa Fe River.

Soils

A variety of soil series, as defined by the U.S.D.A. Soil Conservation Service, are present in the Rocky Creek basin. Most of the surface soils are fine sands or loamy fine sands. The southern end of the basin is composed primarily of Leon fine sand with lesser amounts of Plummer and Scranton fine sands. From Cross-Sections R013 to R005, stream bed parent material is either poorly drained Fellowship loamy fine sand or moderately drained Leon fine sand. Along NW18C, predominant soil types are Arredondo, Fort Meade, and Gainesville loamy fine sands which have fairly good infiltration characteristics. From Cross-Section R005 north to Cross-Section R014, the channel is composed of moderate to well-drained alluvial soil. Extensive areas of poorly drained Rutlege fine sand are found from Cross-Section R014 to the Santa Fe River. This basin also contains broad areas of Orlando fine sand, primarily along SR-121 and in areas both north and east of LaCrosse.

Hydrology

The discharge in Rocky Creek varies seasonally with the amount of rainfall received. During the winter months, portions of the creek and its high tributaries remain dry while the middle and lower reaches contain ponded water with slight flows. Lateral seepage from a few small springs produces minor main channel flow during the winter months. Typical small springs and seeps can be found near Cross-Section R115. The water level drops significantly in most of the cypress swamps during the winter months; however, the large cypress swamps between Cross-Sections R065 and R112 remain broadly ponded.

During the summer months, Rocky Creek flows may vary from zero to several hundred cubic feet per second during heavy storms. Some of the tributaries are intermittently flowing during the summer months. Cypress swamps between Cross-Sections R065 and R112 provide substantial storage volumes and attenuate downstream flow, especially during storm events preceded by dry spells. Although flows in Rocky Creek may be dramatically large following major storm events, they are normally quite low during most of the year. Consequently, for the purposes of the following discussion, Rocky Creek was considered to have no base flow.

Statistics reveal that a four-inch, twenty-four hour rainfall can be expected once a year in the basin. In previous investigations (Breedlove, 1977), this storm condition was used to investigate Rocky Creek's flood potential. Assuming average antecedent moisture conditions (i.e., neither a prolonged drought nor a prolonged wet spell prior to the storm being modeled), an annual twenty-four hour storm was modeled for the Rocky Creek basin. Predicted discharge rates, flow velocities and water surface elevations were obtained at regular intervals over the full length of Rocky Creek.

Limited flooding is predicted by the model to occur in the middle and upper reaches of Rocky Creek as a result of a four-inch, twenty-four hour rain. However, because of the steep channel bed slope, the model predicted very little flooding between Cross-Sections R001 and R003. A predicted 75 cfs (48.5 mgd) peak discharge occurs with a maximum depth of flow of 1.5 feet. Water velocities are correspondingly high, reaching over 2.5 fps.

Due to the extensive drainage area in the southern end of the basin, the peak discharge between Cross-Sections R019 and R004 is predicted to be approximately 220 cfs (143 mgd). It should be noted that stormwater storage in the southern end of this basin can be substantial. Limited topographic information combined with ongoing drainage improvements prevented a wholly accurate determination of available storage. Storage estimates were made on the basis of available topographic information and field observations, and may be considered conservative.

Although the predicted peak discharge in the reach between Cross-Sections R003 and R005 is high, 270 cfs (175 mgd), the computer model indicates little flooding due to the moderately steep channel slope and good conveyance. However, some flooding may be expected in the reach between Cross-Sections R006 and R065 where the channel bed slope flattens as Rocky Creek approaches the large swamp.

For this event, the water surface elevation in the cypress swamp between Cross-Sections R065 and R009 is predicted to rise from an elevation of 105.7 feet to 107.7 feet above msl. Flooding is predicted to occur throughout this low-lying area. The large wooded depression, lying to the east of Rocky Creek, acts as a reservoir for immediate upstream runoff and for overflow from the adjoining pond. This depression has an overflow elevation of 108.0 feet at Section 'A'. Considering this elevation and storm magnitude, no backflow into this tributary system from the primary channel of Rocky Creek will occur.

The channel in the vicinity of Cross-Section R010 floods moderately, simply because the channel is not very deep and the banks are mildly sloped. The storm is predicted to produce a water depth of approximately two feet and a flooded channel width of several hundred feet.

Predicted stormwater levels in the swamp north of NW18C are not excessive. The banks on both sides of this swamp are steeply sloped and the stormwater level of 105.7 feet inundates only a small additional area. The breached embankment at Cross-Section R212, at the northern end of this swamp, does not constrict storm flows associated with this event.

Between Cross-Sections R212 and R014, the channel is shallow with a mild bed slope and shallow side slopes. This reach is more prone to flooding. Additional flow from Mulatto Pen Branch adds significantly to the already high peak discharge of 350 cfs (226 mgd).

The area on either side of SR-235 at Rocky Creek is similarly flood-prone. However, continuing north, flooding between Cross-Sections R015 and R017 decreases as the creek channel becomes better defined. At Cross-Section R015, the peak storm discharge of approximately 350 cfs results in a flooded channel width of over 500 feet, while at Cross-Section R017, a peak storm discharge of 430 cfs (278 mgd) is contained within a 50-foot flooded channel width.

As described above, the resultant flooding from the twenty-four hour storm, statistically equalled or exceeded once each year, is confined primarily to the middle reaches of Rocky Creek. The peak storm discharge predicted for the creek is 430 cfs at Cross-Section R017. Thirty-six hours after the storm has ended, the discharge at Cross-Section R017 is predicted to be approximately 85 cfs (55 mgd). The total volume of storm water which flows through Cross-Section R017 due to the storm is predicted to be over 1,000 acre-feet out of a total rainfall volume of over 7,000 acre-feet.

Water Quality

The major inputs to Rocky Creek and its tributaries are runoff and seepage from pinelands, cypressheads, mixed hardwood stands, and agricultural lands. The majority of the parameters sampled yielded values comparable to other streams in Florida lacking industrial and urban discharges (Tables A2-2 through A2-6, A2-8, A2-9) (Figure 2.5-5). The stream is relatively free of industrial and urban influences and is typical of high-quality waters. Data collected by the Florida Geological Survey (1964) from Rocky Creek near LaCrosse (Table 2.5-3) were comparable to those collected by Breedlove (1976).

Although Rocky Creek water quality is representative of baseline conditions, lead, mercury, manganese, and iron concentrations exceeded state water quality standards and federal water quality criteria (Breedlove, 1976). However, the water is within acceptable limits for its present agricultural use and for supporting freshwater aquatic and wildlife.

Sulfate, sulfide, nickel, lead, and cadmium concentrations found in Rocky Creek sediments are assumed to be natural background levels for this basin (Table A2-6). Concentrations were not significantly different in sediments from swamp and stream stations. Pesticides and herbicides (Table A2-9) were not detectable.

2.5.1.5 The Santa Fe River

The Rocky Creek system is a direct tributary to the Santa Fe River. Turkey Creek and Cellon Creek are both believed to drain to the underlying limestone aquifer and are believed to contribute to the spring flows found along the Santa Fe. Thus, a brief synopsis of overall Santa Fe basin hydrology has been included to provide a broadened view of area hydrology.

The following description, taken from Water Resources of Alachua, Bradford, Clay and Union Counties, Florida (Clark et al, 1964), includes statistical information obtained from stream gage records.

> The Santa Fe River basin covers an area of 1,440 square miles. Flow from the basin reaches the Gulf of Mexico by way of the Suwannee River. The Santa Fe River starts in Santa Fe Lake and flows generally westward, picking up flow from the tributaries, Sampson River, New River, and Olustee Creek, before the river disappears into a sinkhole at O'Leno State Park, 5 miles north of High Springs. The river emerges abruptly from the ground after being underground for a distance of 3 miles.

The hydrology of the basin is very complex. The average runoff from the basin is about 22 inches per year. However, average runoff from subareas varies from 6 to 85 inches. On the average the basin receives 52 inches of rainfall per year. The ratio of runoff to rainfall varies by areas from about 0.1 to more than 1.5, which is an extreme variation within an area of 1,440 square miles. Topography and geology are among the causes of the unusual runoff conditions in this basin.

Major changes in streamflow characteristics occur in the vicinity of O'Leno State Park. Above this point surface streams are prevalent throughout Union and Bradford counties and the part of Alachua County.

Below O'Leno State Park there is a noticeable absence of surface streams. The stream channel has been cut into porous limestones. Sinkholes are prevalent and springs are numerous throughout this area. From the point where the river emerges from the ground downstream to the confluence with the Suwannee River, springs are visible along the channel, usually flowing from circular pools in the banks of the river. The large pickup in streamflow in this vicinity comes from springs. The lower half of the basin is covered with a relatively thin mantle of sands overlying porous limestone. Rain on this area seeps directly into the ground or is carried by short surface channels to sinkholes.

The flow of the Santa Fe River at Worthington Springs is indicative of the hydrologic conditions in the lower basin. The Worthington Springs station measures flow from the upper 630 square miles of the basin wherein surface streams receive a high rate of direct runoff, respond rapidly to rainfall, and recede rapidly to a low base flow. Streamflow at the Fort White station does not respond to rainfall as quickly, stays up for longer periods after rains, and has a much higher base flow. A comparison of extreme flows of the two stations will also point up the difference in streamflow characteristics. At the Worthington Springs station the average flow is 424 cfs (274 mgd), the maximum is 17,500 cfs (11,300 mgd), and the minimum is 0.5 cfs (0.3 mgd). At the Fort White station the average flow is 1,576 cfs (1,019 mgd), the maximum is 12,300 cfs (7,950 mgd), and the minimum is 609 cfs (394 mgd).

An average flow if 650 cfs (420 mgd) enters the ground at O'Leno State Park. This flow comes from four streams: 130 cfs (84 mgd), or 20%, from Olustee Creek; 240 cfs (155 mgd), or 37%, from New River; 100 cfs (65 mgd), or 15% from Sampson River; and 180 cfs (116 mgd), or 28%, from the main stem and smaller tributaries.

Rocky Creek intersects the Santa Fe River at a point five miles upstream (disregarding meanders) of the gaging station at Worthington Springs.

Water Quality

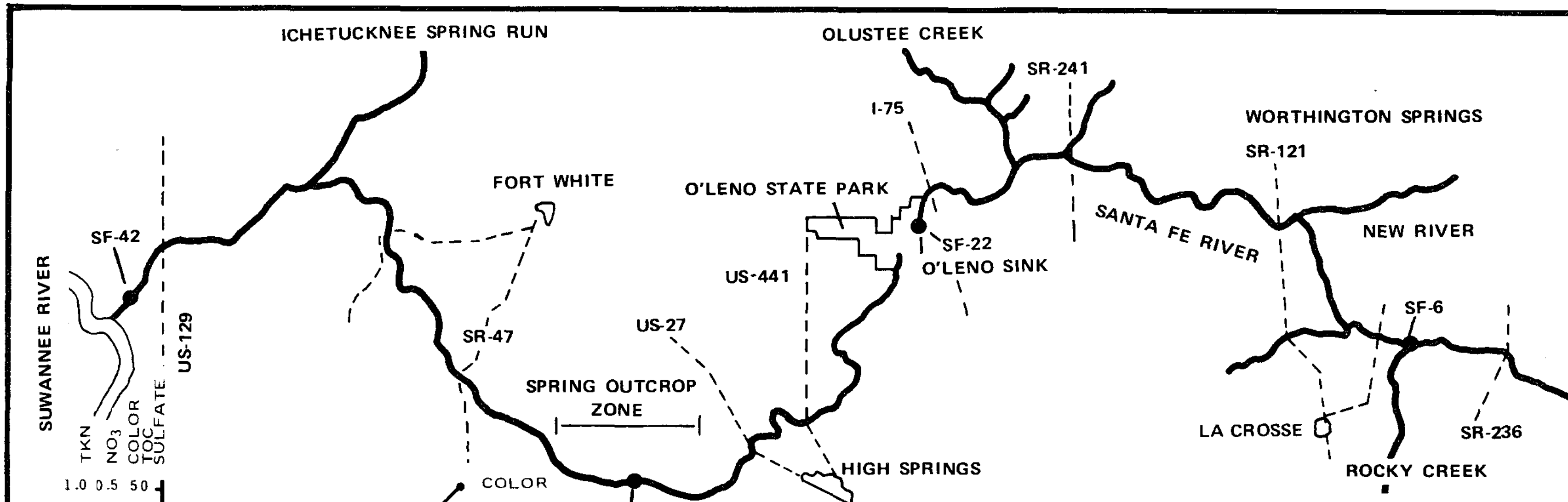
The upper Santa Fe River shows a large range of discharges (0.1 - 20,000 cfs) with a mean that is skewed toward the lower end of the discharge (Table 2.5-4). Likewise, the lower Sante Fe River shows a large range (31 - 20,000 cfs) and a mean discharge that is skewed toward the lower end of the range. The mean discharge in the lower Santa Fe River is considerably higher than that of the upper Santa Fe River and is the result of numerous spring outcrops which provide a more stable base flow. During periods of high runoff both the upper and lower river segments are characteristically brown, acidic river systems. During low flow conditions the upper Santa Fe remains a brown water river, while the lower Santa Fe becomes clear due to limited runoff and presence of numerous clear springs.

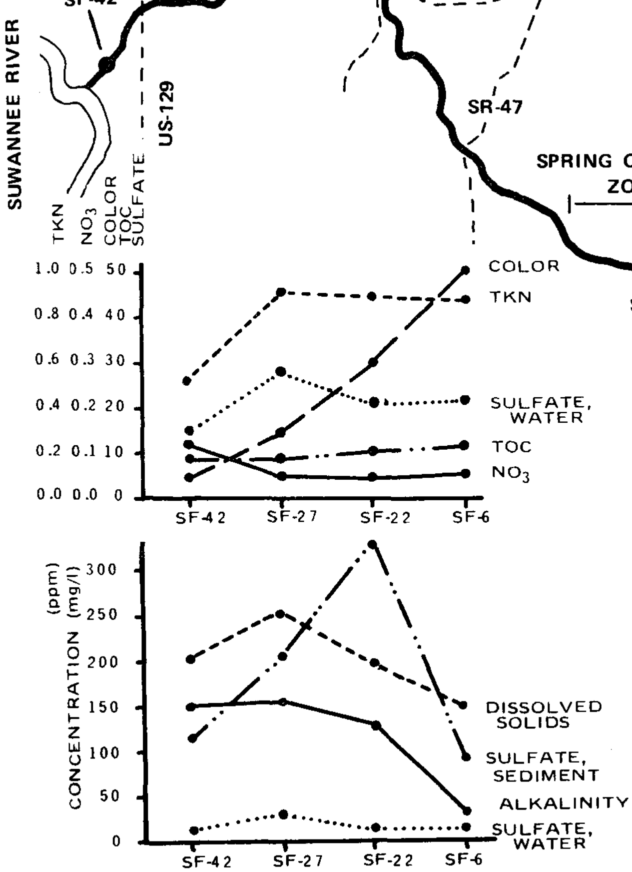
The water quality and discharge data for Worthington Springs indicate the following: (1) neither upper nor lower segments appear stressed by any chemical constituents; (2) discharge during low flow conditions in the upper Santa Fe is the major affector of a diverse and stable aquatic community; and (3) discharge during low flow conditions in the lower Santa Fe is sufficient to maintain a diverse and stable aquatic community (Table 2.5-5) (Figure 2.5-6).

Table 2.5-4 Mean, Maximum and Minimum Discharges of Various Portions of the Santa Fe River[1]

Station	Period of Record (yrs)	Drainage Area (sq. mi.)	Discharge Max (cfs)	Discharge $\bar{x}$ (cfs)	Discharge Min (cfs)
	(Upper Santa Fe River)				
Santa Fe River near Graham, Florida (above Rocky Creek)	8	95	2,360	76	0.1
Santa Fe River at Worthington Springs Florida (below Rocky Creek)	34	582	20,000	433	0.5
	(Lower Santa Fe River)				
Santa Fe River near High Springs, Florida	34	950	20,000	809	31
Santa Fe River near Ft. White, Florida	35	1,080	17,000	1,622	609

[1]Source of Data: U.S. Geological Survey. 1971. Selected Flow Characteristics of Florida Streams and Canals, Info. Cir. No. 69. State of Florida. Department of Natural Resources, Tallahassee, Florida 595 pp.





PARAMETER	UNITS	STATION NUMBER A SF-42	SF-27	SF-22	SF-6
WATER					
Temperature	° C	24.8	24.8	27.8	27.5
DO	ppm	7.0	6.7	6.0	5.7
ORP	mv	+130	+150	+150	+90
pH		7.9	7.7	7.6	6.8
Alkalinity, Total	mg/l	150	154	130	31
Conductivity	μmhos/cm	342	400	364	23
Dissolved Solids, Total	mg/l	205	251	198	147
Color	Pt.-Co	5	15	30	50
Organic Carbon, Total	mg/l	9	9	11	12
NH_3-N	mg/l	0.02	0.01	<0.01	0.16
NO_3-N	mg/l	0.12	0.07	0.05	0.06
TKN-N	mg/l	0.52	0.92	0.90	0.87
P-Total	mg/l	<0.01	0.02	0.13	0.07
Sulfate	mg/l	14.8	28.0	21.4	22.2
SEDIMENT					
Sulfate	ppm	123	206	329	82
Sulfide, Total	ppm	0.095	0.174q	0.023	0.015
% Moisture		35.46	59.48	48.96	28.63

FIGURE 2.5-6 SANTA FE RIVER SAMPLING STATION LOCATIONS AND WATER QUALITY DATA COLLECTED DURING JUNE, 1977.

Table 2.5-5 Surface Water Quality Data for the Santa Fe River at Worthington Springs

Parameter	Units	Santa Fe River at Worthington Springs[1] No. Observed	Mean	Maximum	Minimum
Total Aluminum	mg/l	1	160.0	--	--
Dissolved Arsenic	mg/l	1	10.0	--	--
Total Arsenic	mg/l	1	1.0	--	--
Dissolved Cadmium	mg/l	1	1.0	--	--
Total Cadmium	mg/l	1	0.0	--	--
Hexavalent Chromium	mg/l	1	0.0	--	--
Dissolved Copper	mg/l	3	1.5	3.0	0.0
Total Copper	mg/l	2	0.5	1.0	0.0
Dissolved Lead	mg/l	3	1.0	2.0	0.0
Total Lead	mg/l	2	6.0	12.0	0.0
Dissolved Manganese	mg/l	2	25.0	30.0	20.0
Total Manganese	mg/l	2	25.0	40.0	10.0
Total Mercury	mg/l	3	0.0	0.0	0.0
Dissolved Zinc	mg/l	3	10.0	20.0	0.0
Dissolved Iron	µg	3	370	--	--
Total Iron	µg	2	590	--	--
Total Nickel	mg/l	1	0.0	--	--
Dissolved Calcium	mg/l	4	7.2	8.6	6.2
Dissolved Magnesium	mg/l	4	2.7	2.9	2.6
Dissolved Strontium	mg/l	4	58.8	70.0	40.0
Dissolved Sodium	mg/l	4	6.8	7.5	6.0
Dissolved Potassium	mg/l	4	0.9	1.2	0.4
Total Sulfate	mg/l	4	12.8	15.5	9.6
Dissolved Chloride	mg/l	4	10.9	12.0	10.7
Dissolved Fluoride	mg/l	4	0.4	0.5	0.3
Hardness (Total)	mg/l	4	30.0	34.5	26.0
Non Carb. Hardness	mg/l	4	15.9	19.5	12.0
Alkalinity	mg/l	4	13.9	17.0	9.0
Conductivity	µmhos	Daily[2]	84.0	204.0	33.0
Dissolved Solids	mg/l	4	87.2	90.0	80.0
HCO_3^-	mg/l	4	17.0	21.0	11.0
$CO_3^=$	mg/l	4	0.0	0.0	0.0
pH	SU	4	6.7	--	--
Temperature	°C	Daily[2]	21.1	29.0	9.0
Ammonia Nitrogen	mg/l	8	0.06	0.10	0.04
Nitrite Nitrogen	mg/l	8	0.01	0.03	0.01
Nitrate Nitrogen	mg/l	8	0.07	0.20	0.00
Organic Nitrogen	mg/l	8	0.86	1.02	0.68
Total Ortho-Phosphorus	mg/l	8	0.17	0.23	0.11

Table 2.5-5 Surface Water Quality Data for the Santa Fe River at Worthington Springs

Parameter	Units	Santa Fe River at Worthington Springs[1] No. Observed	Mean	Maximum	Minimum
Total Phosphorus	mg/l	8	0.19	0.27	0.12
Dissolved Silica	mg/l	8	4.4	6.0	2.8
Turbidity	JTU	8	5	15	2
Color	Pt.-Co.	4	150	210	30
Total Organic Carbon	mg/l	2	20.0	22	19
BOD (5 day)	mg/l	3	0.5	0.7	0.4
Dissolved Oxygen	mg/l	2	7.3	7.3	7.3
Percent Saturation		2	79.0	80.0	79.0

[1]Source of Data: U.S. Geological Survey. 1975. Water Resources Data for Florida, Volume 1. Northern Florida. Water Data Report FL-75-1 (October 1971 - April 1975).

[2]Source of Data: (Daily) Florida Geological Survey. 1964. Report of Investigations. No. 35 (July 1957 - Sept. 1960).

2.5.1.6 Summary Comparison of Turkey, Cellon and Rocky Creek Water Quality

Comparisons of water quality data using cluster analysis suggest that Turkey Creek and Cellon Creek below the General Electric plant are similarly affected by industrial discharges. Rocky Creek and Mulatto Pen Branch water quality is similar to baseline conditions of other area streams not influenced by industrial discharges.

Calcium, magnesium and hardness were shown to be significantly higher in Turkey Creek than in Cellon Creek or the Rocky Creek system. In addition, sulfate, arsenic, sodium, and total dissolved solids were found in significantly greater concentrations and conductivity was higher in Turkey Creek than in any segment of Rocky Creek. The same parameters were high in Cellon Creek below the General Electric battery plant outfall.

Cluster analysis of the above parameters, plus alkalinity, chloride, cadmium and chromium (Figure A2-3 through A2-14), generally grouped the Deerhaven discharge and on-site stations with the segment of Cellon Creek below the General Electric plant discharge. A cluster analysis of all significantly variable parameters (Figure A2-1) also grouped DH-1, the cooling tower discharge, with the stations downstream of the General Electric discharge (CP-5, CP-8 and CP-13); and clustered Turkey Creek stations DH-6, DH-7, DH-8 and DH-9 with the stations located in the upper reaches of Cellon Creek (CP-4).

Nickel and lead concentrations were higher in the Deerhaven on-site discharge than in Rocky Creek. The discharge ditch and on-site swamp contained exceptionally high levels of nickel (439 mg/l maximum, $\bar{x}$ = 71.1 mg/l) compared to the remaining Turkey Creek Stations ($\bar{x}$ = 1.85). The highest levels of lead (19.0 mg/l maximum) were found in the on-site swamp sedimentation delta (Table A2-6).

Cluster analysis associated Station CP-3, which represents drainage from a small cypress gum swamp and agricultural lands, with the clean water stations of Rocky Creek. Station CP-3 is clustered at the first level with Station RC-6, RC-7 and RC-8, which are representative of cypress swamp water quality. Station CP-4, representing the combined drainage of upper Cellon Creek and runoff from the dairy research unit, is clustered with Stations DH-6, DH-8 and DH-9. This cluster is a function of those parameters which are higher in Turkey Creek and at Station CP-4 than in Rocky Creek. Parameters primarily responsible for the association are: conductivity, calcium, hardness and chloride.

2.5.2 Groundwater Hydrology - Floridan Aquifer

The Floridan Aquifer is the principal aquifer in Alachua County and extends throughout the State of Florida and parts of Alabama, Georgia, and South Carolina. In the study area the Floridan Aquifer includes parts or all of the middle Eocene (Avon Park and Lake City Limestone), upper Eocene (Ocala series), Oligocene (Suwannee Limestone), and Miocene (Tampa Limestone) groups. It also includes permeable parts of the Hawthorn Formation that are in hydrologic contact with the rest of the aquifer.

The Floridan Aquifer is one of the most productive aquifers in the country. Specific capacities of wells (i.e., well yield per foot of drawdown) range from less than 100 gpm/ft. to over 500 gpm/ft. The Floridan Aquifer is encountered 120 feet below the Deerhaven site and consists of approximately 700 feet of porous limestone and dolomite or dolomitic limestone. The lithologic and hydrologic character of the Floridan Aquifer is not uniform either horizontally or vertically. The limestones and dolomites have high permeability in lateral directions and low permeability in the vertical direction. No rock formation is absolutely uniform in structure, density, and hardness. Certain portions of limerock formations, particularly those which have been weakened by joints, are more susceptible to dissolution than others. These weakened zones are dissolved to form underground channels or caverns by enlargement of the joints. The structure of the limestone formations controls the direction of joints or cracks within the limestone and these joints control the orientation of solution conduits. In the areas south and west of Deerhaven, this joint-controlled dissolution can be observed in Warren's Cave. Within this cave the overall trend of passageways is northwest-southeast and northeast-southwest. Recent high altitude multispectral photographs of this area show a similar direction of alignment of sinkholes. It has been shown that modification of limestone by dissolution can result in groundwater flow being localized in the resulting solution conduit. Relatively fast-moving large-volume groundwater flow may take place in these conduits while flow through nearby rock of low permeability may be by diffuse flow.

In general, water recharges the Floridan Aquifer by percolating down from above. In the central highlands area, which contains the Deerhaven site, the clays of the Hawthorn Formation have a very low permeability and support a perched water table above the Floridan Aquifer. Water recharges the Floridan Aquifer in this area by leaking through breaches in the impervious clay strata of the Hawthorn Formation. In the transition zone and limestone plain in the southwestern part of the county, the aquifer has been breached by many sinkholes which develop when materials overlying limestone caverns collapse. Surface water may then flow directly into the aquifer as is believed to occur at Split Rock Sink, Lee Sink, and the Devil's Millhopper. Often materials wash into these sinks and they become partially clogged to form perched lakes. Water from these lakes is then slowly filtered through the sand and clay that forms the floor of the sinkhole. Sometimes such lakes "flush" rapidly and produce local contamination of the aquifer.

Concentration of dissolved solids is generally associated with major formational changes. Calcium and sulfate, apparently dissolved from gypsum sediments, generally increase near the top of the Ocala group and of the Avon Park Limestone. Total dissolved solids in county wells generally range from 150 to 300 ppm, hardness (expressed as calcium carbonate) generally ranges from 100 to 200 ppm, and sulfate and chloride concentrations are generally 10 ppm or less. The temperature of the water of the Floridan Aquifer generally increases with depth at a rate of about 0.5° F to 1° F for each 100 feet. The temperature of the water

in the Floridan Aquifer generally remains constant at a given location and depth throughout the year.

The potentiometric surface of an aquifer is a surface which defines the elevation, relative to mean sea level, that water levels can be expected to rise to under static conditions. The potentiometric surface fluctuates due to changes in the rate of recharge to, and discharge from, the aquifer. These are in turn due to fluctuations in the rate of rainfall, the rate of evapotranspiration, and changes in withdrawal from the aquifer. Figure 2.5-7 presents contours of the potentiometric surface in Alachua County measured in June, 1960, and in November, 1976. As noted, the potentiometric surface was generally approximately 10 feet lower in November, 1976, than in June, 1960. Figure 2.5-8 presents a hydrograph of a ten-inch water supply well in High Springs, Florida. This hydrograph illustrates the long term fluctuations in aquifer water level as well as short term fluctuations due to major storms and droughts. As indicated, the long term average water level fluctuated by about five feet during the period of record whereas the water level increased over a short time interval by nine feet due to a 1964 hurricane.

In wells where the static water level rises above impermeable strata at the top of the aquifer, the aquifer is said to be artesian. In parts of the aquifer where the water level lies within the limits of the aquifer, that aquifer is said to be a water-table aquifer. By comparing elevations of the top of the Ocala group presented in Figure 2.4-3 with the

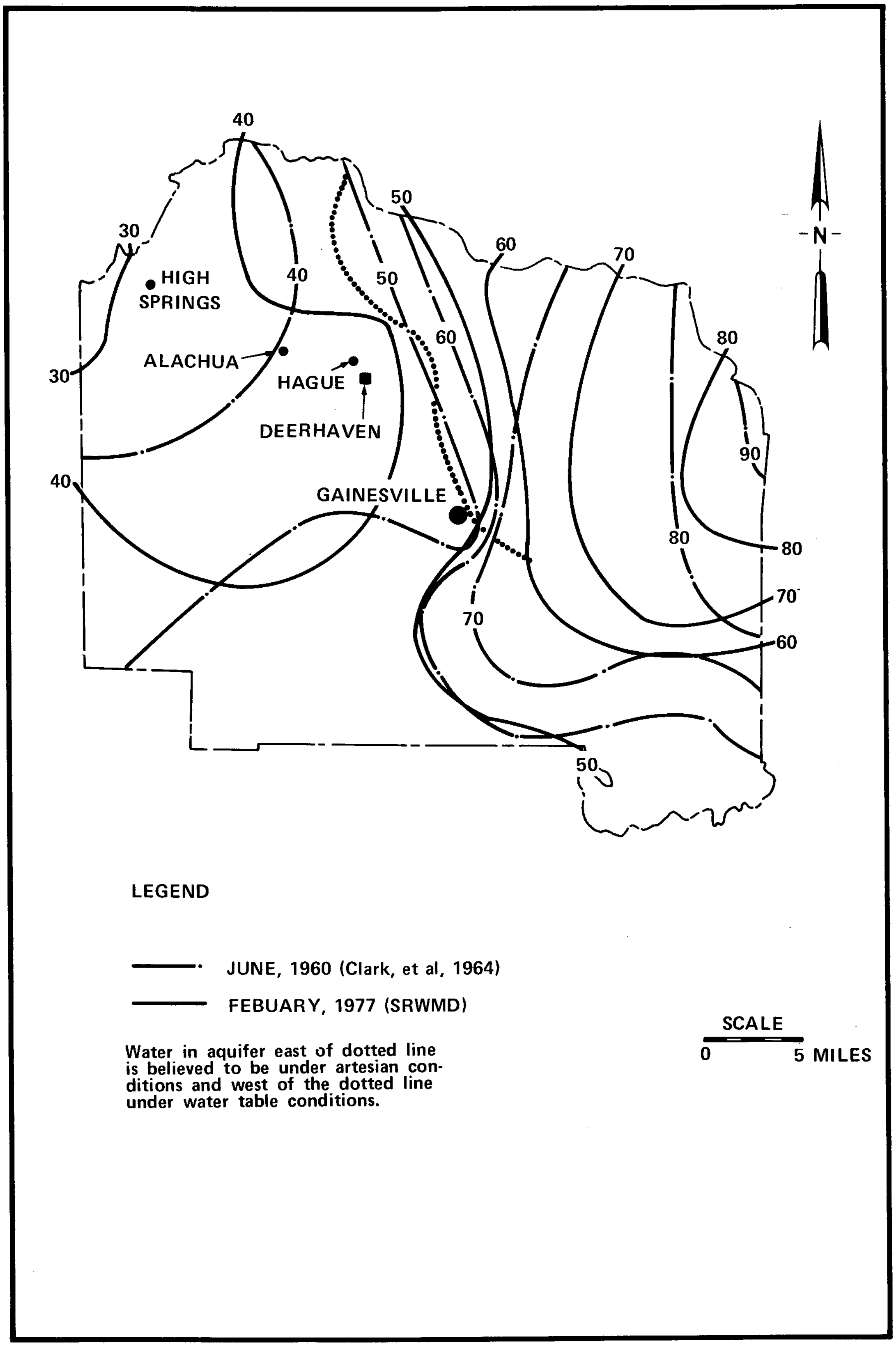


FIGURE 2.5-7 POTENTIOMETRIC SURFACE IN FLORIDIA AQUIFER.

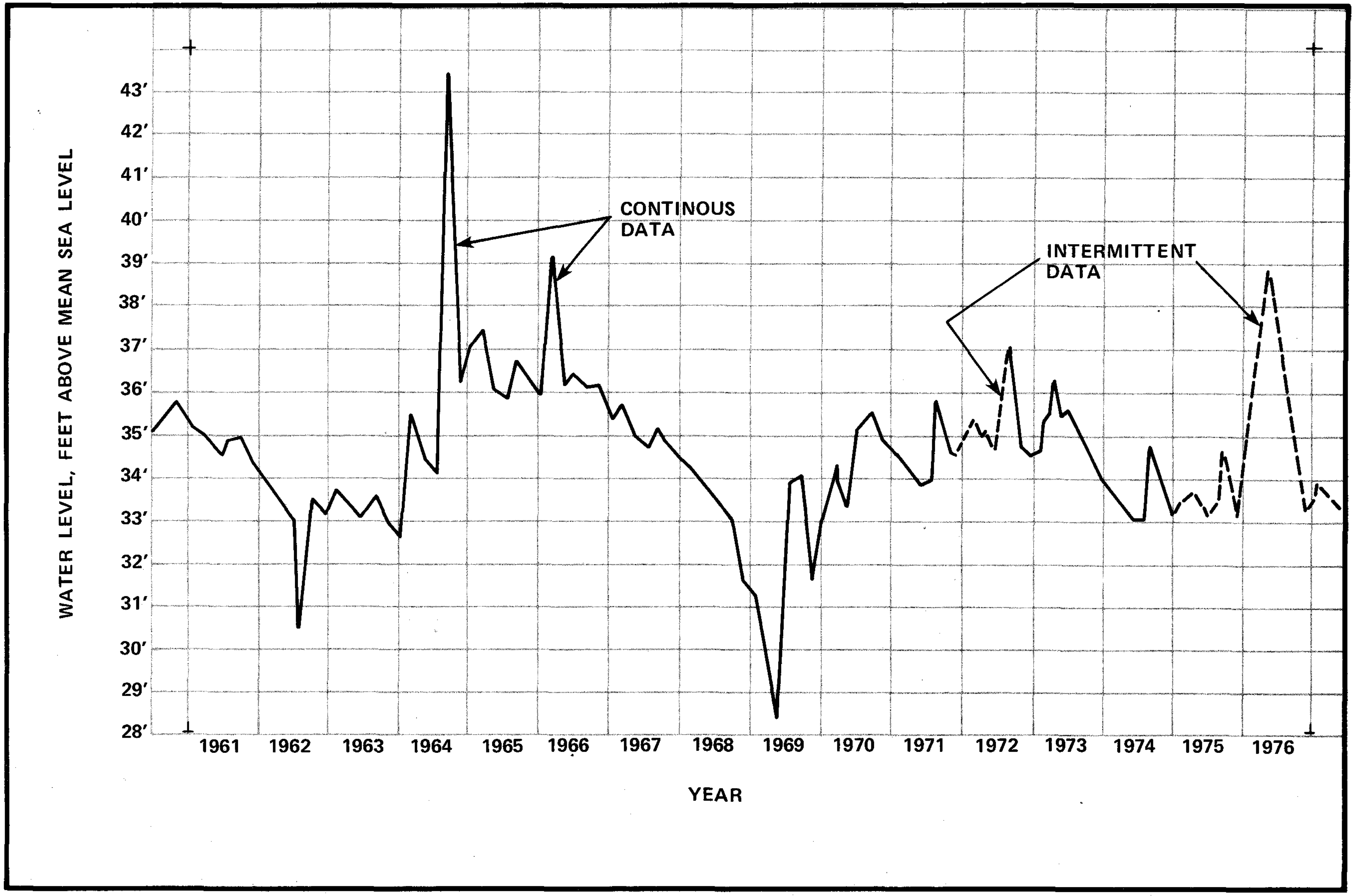


FIGURE 2.5-8 WATER LEVEL IN WATER SUPPLY WELL AT HIGH SPRINGS, FLORIDA.

potentiometric surface presented in Figure 2.5-7 some authors have suggested constructing a dividing line as shown to indicate that the Floridan Aquifer is artesian in the northeastern part of the county and a water-table type aquifer in the southwestern part of the county.

Figure 2.5-9 presents the water supply wells within five miles of the Deerhaven site. Table 2.5-6 presents information regarding these wells. The single major source of groundwater withdrawal in the Gainesville area is the RUB's new wellfield at its Murphree Water Treatment Plant, 6 1/2 miles southeast of the Deerhaven site. Groundwater withdrawal from this wellfield is presently between 11.0 and 15.0 mgd. A well test performed in this wellfield in 1969 produced a value for transmissibility of 212,000 gpd/ft. and a storage coefficient of .000207. This well penetrates the Floridan Aquifer by 270 feet with static water level reported to rise 100 feet above the top of the aquifer, thus confirming the artesian nature of the aquifer in that area and corroborating the low storage coefficient normally expected in an artesian aquifer. Several other well tests have been run in the Gainesville area. Aquifer coefficients from these tests are reported in Table 2.5-7.

Results from tests performed on the disposal wells at RUB's Kanapaha AWT plant can be used to estimate the hydraulic properties of the aquifer at depths between 450 and about 1,050 feet below land surface. Geologic logs from these wells indicate that each is open to the lowermost 25 feet of the Avon Park Limestone and to about 575 feet of the Lake City

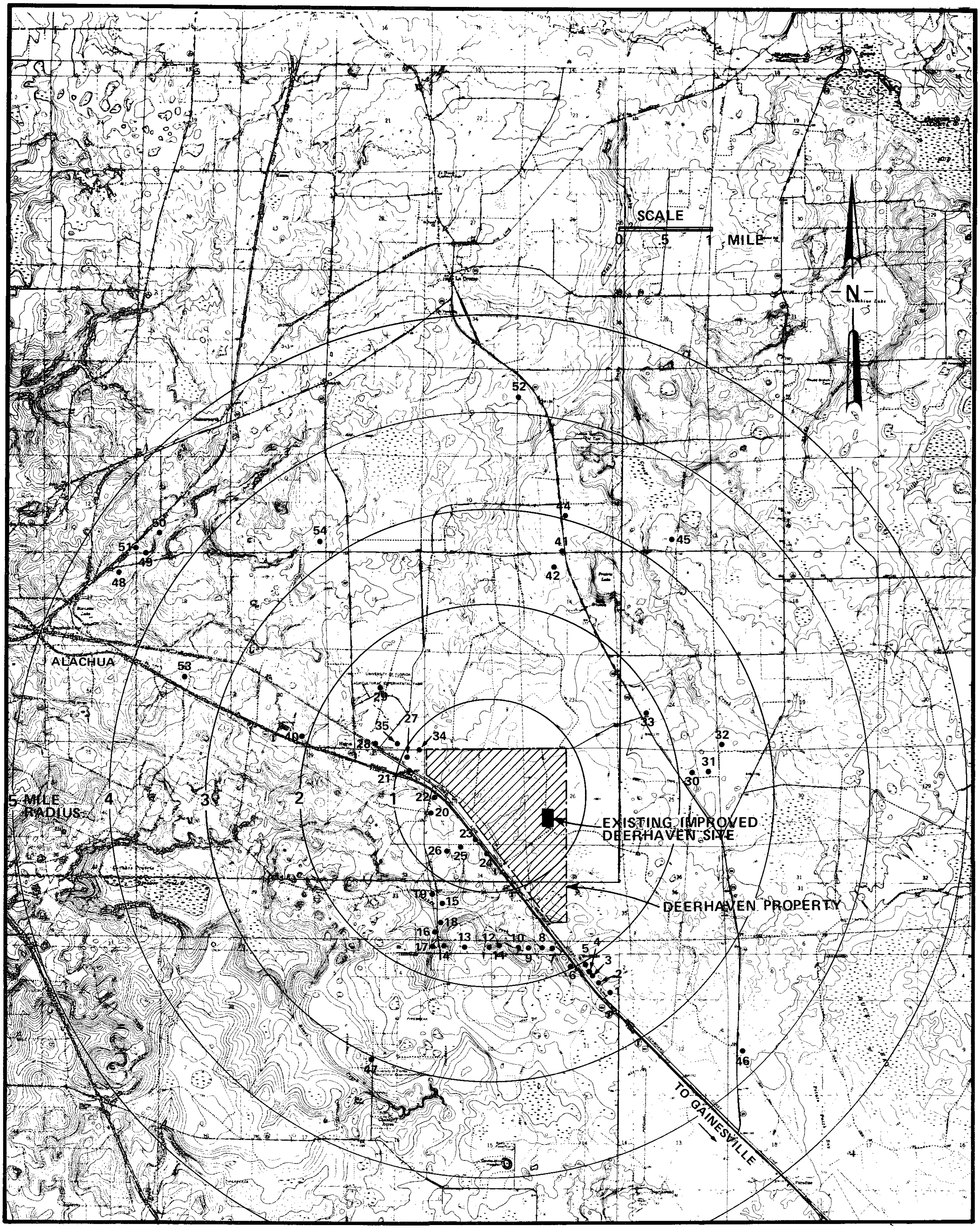


FIGURE 2.5-9 WATER SUPPLY WELLS WITHIN 5–MILE RADIUS OF THE DEERHAVEN SITE.

Table 2.5-6 Water Supply Wells within Five Miles of the Deerhaven Site

Well No.	Owner	Casing Diameter (in)	Casing Depth (ft)	Well Depth (ft)
1	Whitney Residential Park	6	135	180
2	Norman Watson	4	120	160
3	A.G. Fabrick	4	120	--
4	Robert Griffen	4	120	--
5	James Griffis Lumber Co.	4	135	198
6	Hipp Ford Tractor	--	--	18
7	Joe Tate	4	120	140
8	R.W. Rodgers	4	115	160
9	R.E. Lines	4	120	160
10	J.J. Pickerin	4	--	175
11	Randall Avery	4	90	195
12	John Walker	4	160	200
13	B. Oakley	4	--	210
14	B.D. Goff	4	150	174
15	M.L. Shea	6	189	200
16	W.A. McNally	4	--	195
17	H.W. Vories	4	--	190
18	Marshall Wright	4	--	185
19	Tommy Thomas	4	--	200
20	Woody Jasper	6	9½	12
21	Progress Trailer Park	6	150	219
22	Turkey Creek Utilities, Ltd.	10	130	300
23	Thompson's Nursery	4	148	185
24	Sans Souci Ranch	4	--	170
25	Mary Peterson	4	140	200
26	Danny Cave	4	--	180
27	Harry Hooey	4	--	165
28	Beverly Hills Plantation, Inc.	6	--	400
29	UF Agric. Experimental Farm	10	185	400
30	Hamp Holdeb	2	30	--
31	Lenard Holder	4	145	178
32	Earl Phips	1¼	9½	12
33	T.D. Kirby	4	110	162
34	J. Willis	1¼	--	22
35	J.D. Harrell	2	75	100

Table 2.5-7 Summary of Aquifer Coefficients for the Florida Aquifer in Alachua County

Well Name	Location	Depth of Well (ft)	Depth of Casing (ft)	Transmissivity (gpd/ft)	Storage Coefficient	Permeability (gpd/ft²)	Specific Storage[1] (ft⁻¹)
Murphree N-1	T9S,R20E,Sec 15	530	173	166,000	.00022	465	6.16×10^{-7}
Murphree N-2	T9S,R20E,Sec 15	475	185	165,000	.0002	569	6.90×10^{-7}
Murphree N-3	T9S,R20E,Sec 15	540	217	326,000	.00066	1,009	2.04×10^{-6}
Murphree N-4	T9S,R20E,Sec 15	545	190	262,000	.00091	738	2.56×10^{-6}
Murphree N-5	T9S,R20E,Sec 15	500	190	129,000	.00037	416	1.19×10^{-6}
Murphree N-6	T9S,R20E,Sec 15	521	189	203,000	.0006	611	1.81×10^{-6}
Murphree N-7	T9S,R20E,Sec 15	534	181	N.A.	N.A.	N.A.	N.A.
Murphree N-8	T9S,R20E,Sec 15	538	180	N.A.	N.A.	N.A.	N.A.
Kanapaha -1	T10S,R19E,Sec 16	1,047	450	500,000	N.A.	826	N.A.
Kanaphah -2	T10S,R19E,Sec 16	1,050	450	725,000	N.A.	1,208	N.A.
Kanapaha -3	T10S,R19E,Sec 16	1,028	450	525,000	N.A.	908	N.A.
Kanapaha -4	T10S,R19E,Sec 16	1,031	450	660,000	N.A.	1,136	N.A.
Sperry Rand[2]	T9S,R20E,Sec 13	350	160	165,000	.0001[a]	868	5.26×10^{-7}

[1]Calculated by dividing storage coefficient by length of open hole.

[2]USGS Well #942-216-2 as reported by Clark, et al, 1964.

[a]Estimated by Clark, et al., 1964.

Limestone (personal communication with Michael Knapp, 6/28/77). Testing in these wells resulted in estimates of T (transmissivity), ranging from 500,000 to 725,000 gpd/ft. Permeabilities for the zones, calculated by dividing the T by the length of open borehole in each well, ranging from 826 to 1,208 gpd/ft^2.

A test was performed on a well a mile or so west of the Murphee Water Plant (Clark et al., 1964). The well was open to about 200 feet of the aquifer, which, based on a survey of geologic logs, was probably mostly Ocala Limestone. Clark reports a T of 160,000 gpd/ft and estimates the storage coefficient to be 1×10^{-4}. The permeability is 800 gpd/ft^2.

Tests performed on six wells at the Murphee Water Plant in 1968 and 1969 showed values of T ranging from 129,000 to 326,000 gpd/ft and storage coefficients ranging from 2×10^{-4} to 9.1×10^{-4}. Each of the wells was about 500 feet deep and had about 200 feet of casing. They were probably open to all of the Ocala Limestone and to about 100 to 200 feet of the Avon Park Limestone.

At present three 14-inch water supply wells are installed at the Deerhaven site. Each well is served by a vertical turbine pump with 1,000 gpm (1.4 mgd) capacity. Present groundwater withdrawal at Deerhaven station for all purposes averages approximately 1,000 gpm (1.4 mgd). A six-inch on-site well has been recently logged with caliper, gamma-ray, and temperature logs and has been fitted out as an observation well. The

gamma-ray log indicates that the top of the Ocala formation is at elevation 70 feet above msl. The static water level in the well has been recorded at 42 feet above msl, after six hours without pumping. The water supply wells penetrate the Floridan Aquifer by approximately 300 feet. The observation well penetrates the Floridan Aquifer by 162 feet. Water temperature near the upper surface of the observation well's water level was measured at 71° F. The temperature log detected an increase in water temperature of 0.7° F over a vertical water depth of 140 feet. Chloride concentration in the observation well was measured to be 17 ppm. Water samples collected from Deerhaven water supply wells in April of 1975 indicated a pH of 7.4, total dissolved solids of 345 mg/l, hardness of 244 mg/l (calcium carbonate), and chloride concentration of between 18 and 20 mg/l.

2.5.3 Deerhaven Site Hydrology

Site Drainage

The 1,116 acre Deerhaven site occupies an area that may be described as typical pine flatwoods with considerable understory vegetation and scattered cypress domes. Much of the site is poorly drained and remains in a relatively natural state. Runoff from the site passes to the Turkey Creek basin on the south and west sides and to Rocky Creek basin on the north and east sides. Figure 2.5-1 shows the site with respect to major drainage basins. The low relief features of the Deerhaven site have resulted in a natural drainage system of broad, shallow depressions interconnected by poorly defined channels. These depressions remain

ponded for much of the year and are apparent as cypress domes and wetland areas. The predominant soil associations in this area are typically poorly drained fine sands with increasing percentages of silts and clays in the lower layers and with deposits of organic muck in the wetlands. The Hawthorn clays form a relatively impermeable aquiclude beneath the surface soils. Surface runoff occurs when surface soils become saturated and when rainfall exceeds available storage, as is the case during much of the year. On-site surface runoff velocities are very low due to the flat slopes and thick understory vegetation. Approximately 80% of the Deerhaven site drains to the south and west into Turkey Creek basin through two distinct channels. Prior to construction of Deerhaven Unit 1, the area was utilized as commercial pine forest. Minor improvements to site drainage were made as part of the forest management program. Small drainage swales were excavated to accelerate runoff from the pinelands to the many cypress domes and wetland areas on the site. Also, some graded roads were constructed on slightly raised embankments. These improvements have produced minor changes in drainage patterns. The construction of Deerhaven Unit 1 included the clearing and developing of approximately 80 acres, which included the plant site, railroad spur and entrance road. About 740 acres, or 65% of the site area, is drained by the south branch of Turkey Creek, the dominant watercourse on the property. This tributary rises in a pine-palmetto area north of the existing improved site area.

General characteristics of the surface hydrology of the existing Deerhaven site are illustrated in Figure 2.5-10. About 190 acres of the north portion of the site drain to Rocky Creek. Approximately 190 acres at the northwest corner drain to a Turkey Creek tributary which is herein termed the "north branch". This is a small, ephemeral channel that continues through a trailer park just west of the property, to cross beneath U.S. 441. A small portion of the northwest of the property might drain to Cellon Creek; this is not believed to be the case, but drainage in that area is very indistinct.

The improved site area is drained by means of a perimeter ditch system that directs flows to three drainage corridors:

1. the ditch at the north edge of the improved site area conveys both storm runoff and cooling tower blowdown (0.5 mgd) to a 28-acre cypress swamp where flow turns to the south;

2. runoff from the fuel handling area is directed to swales paralleling the entrance road and railroad spur; and

3. a wetland system that runs parallel to and on the south side of the entrance road.

This system receives much of the storm runoff collected in the immediate area of the plant and switch yard. Flows converge at area 5 (Figure 2.5-10). As indicated by the contours, there the basin steepens and a well-defined

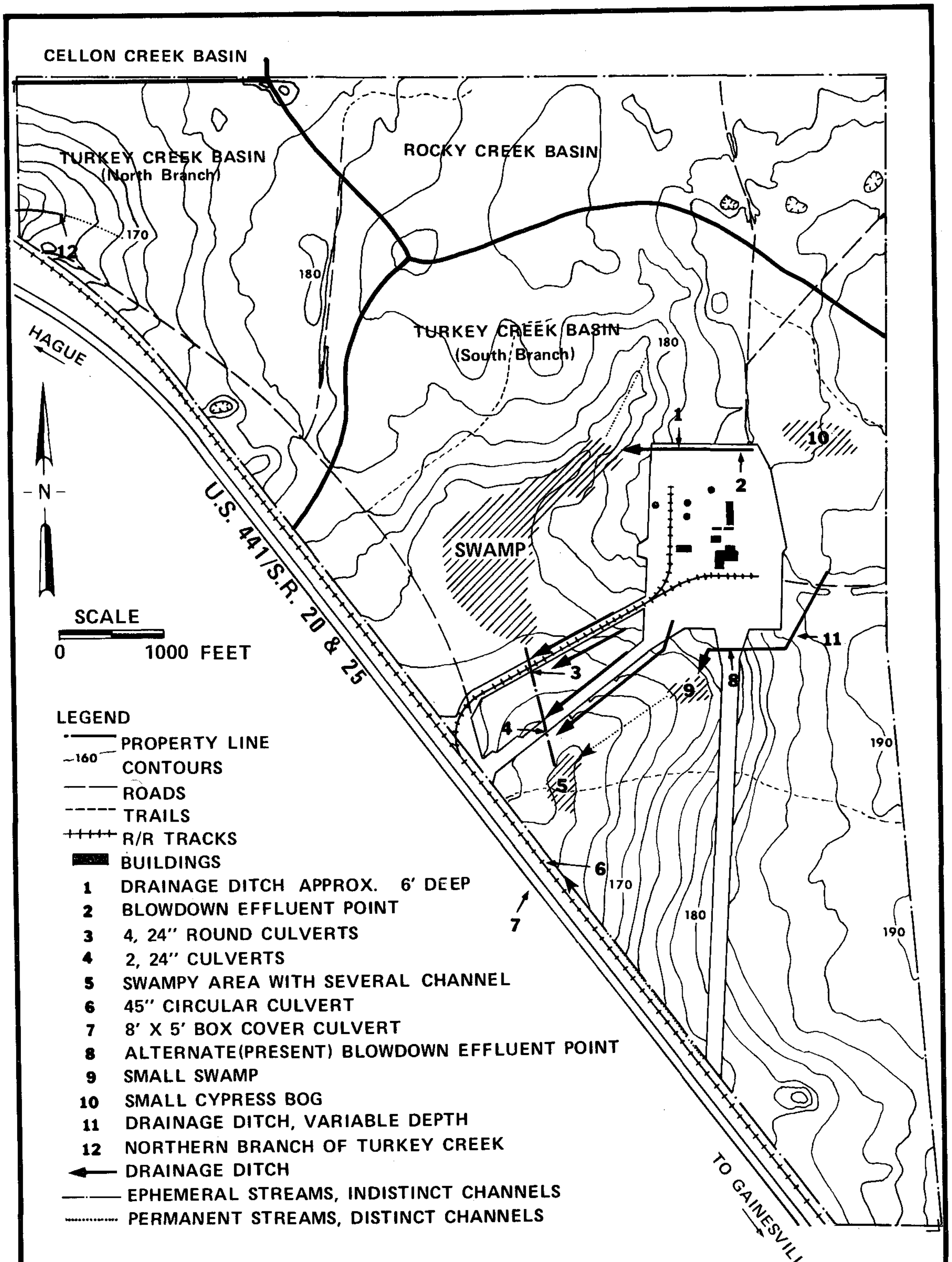


FIGURE 2.5-10 DEERHAVEN SITE EXISTING SURFACE DRAINAGE.

channel with clay and clay loam banks conveys combined flows to culverts under the railroad and under U.S. 441 to the main channel of Turkey Creek.

Drainage of the Existing Improved Site Area

Most surface runoff is directed by the topography and drainage ditches northward to the interceptor ditch, and thence westward to the south branch of Turkey Creek via the north end of the on-site swamp (Figure 2.5-11). The eastern border of the improved site area is about 189 feet above msl, and at the western end of the interceptor ditch is lowest or approximately 176 feet above msl. With only about 13 feet of relief, surface drainage is slow, and considerable ponding occurs.

Sealable stormwater inlets in the oil tank enclosures can be capped to prevent oil from entering the stormwater system in the event of a rupture. Water running off the oil truck unloading area is not presently detained; however, a plant-wide oil spill prevention program is now being designed. In accordance with existing NPDES permit requirements, all plant effluents except for cooling tower blowdown are being pumped into a 2-acre percolation/evaporation pond just north of the interceptor ditch.

Groundwater Hydrology of the Site

Figures 2.4-6 through 2.4-11 present stratification inferred from auger borings performed at selected locations at the Deerhaven site. Where possible, groundwater elevations were obtained. Permeability tests were

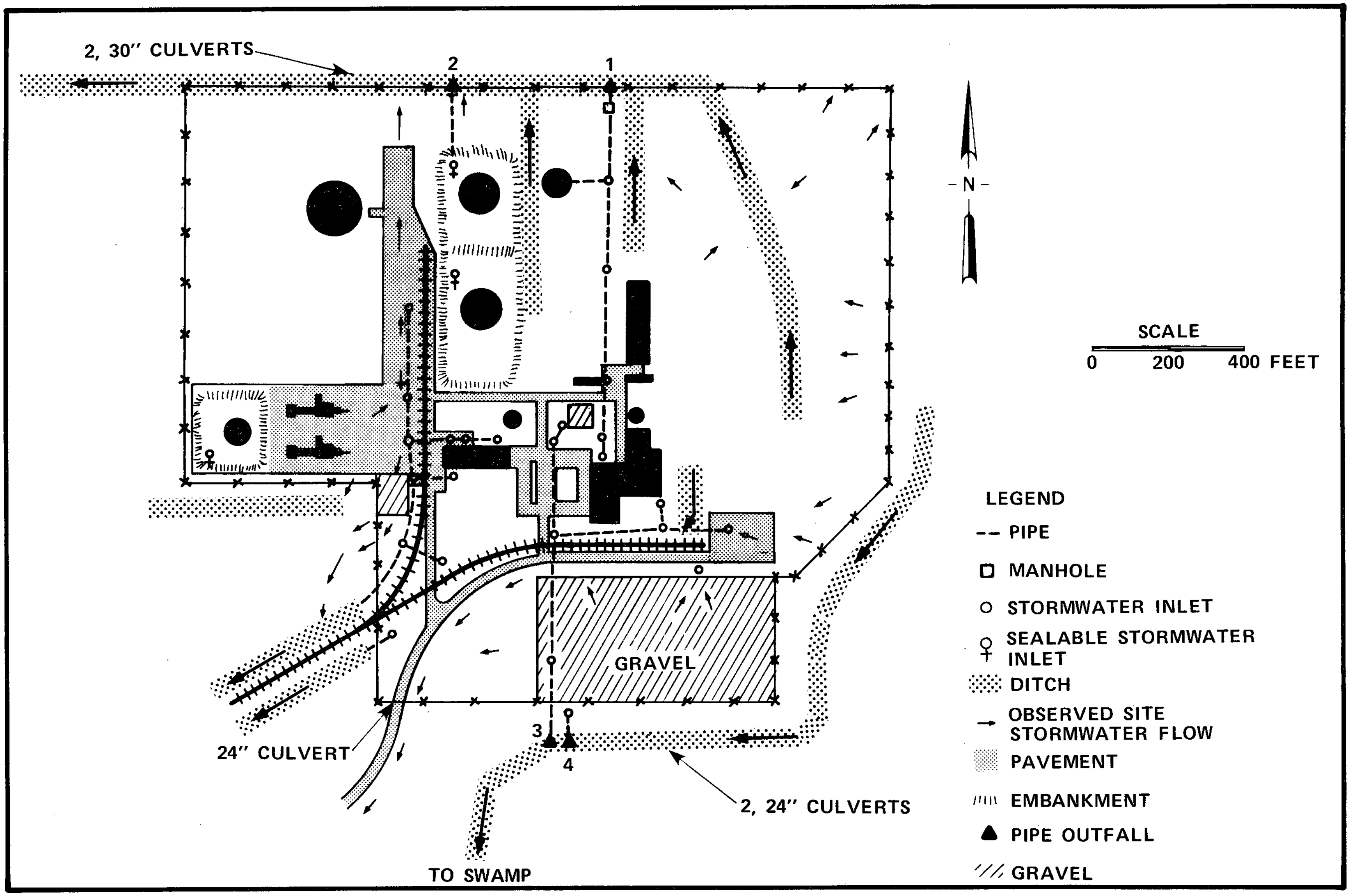


FIGURE 2.5-11 DRAINAGE OF THE EXISTING DEERHAVEN IMPROVED SITE AREA.

performed on sand samples retained at selected borings. As part of an investigation to determine the feasibility of cooling tower blowdown disposal on-site by means of spray irrigation, a simplified computer model was developed to infer the infiltration capacity of the study area. This model-assumed axisymmetrical radial flows from a 600-acre circular spray irrigation area with a radius of 2,884 feet. A sand stratum, fifteen feet deep with a coefficient of permeability of 0.43 feet per day was assumed to overlie an impermeable aquiclude. The groundwater level within this conductive sand was assumed to be five feet below grade prior to applying infiltration. The numerical model was performed to predict the allowable net infiltration. The numerical model was performed to predict the allowable net infiltration which would cause the groundwater mound to just reach ground surface and, thus, produce no surface runoff. Program results indicated that the groundwater mound would reach the ground surface at the edge of the recharge area when the net infiltration into the 600-acre irrigation area was between 900 gpd and 1,125 gpd. This model contained many simplifying assumptions and was used only to predict whether further analysis of spray irrigation feasibility was justified. However, it is felt that results from this computer model corroborate observations of Deerhaven Generating Station plant personnel that: (1) during the rainy season, the groundwater approaches the ground surface at many site locations, and (2) during such periods of saturation almost all incidental rainfall leaves the site as surface runoff.

2.6 Meteorology and Climatology

2.6.1 Climatology

The surface meteorology for the Deerhaven site is defined from data obtained from the Federal Aviation Authority (FAA) office at the Gainesville Municipal Airport and from the National Oceanic and Atmospheric Administration (NOAA) station in Jacksonville, Florida. The Gainesville FAA station is located approximately 8 miles (13 km) southeast of the Deerhaven site. The Jacksonville NOAA station is located approximately 65 miles (105 km) northeast of the site.

Wind data from Jacksonville have been used in earlier air quality studies conducted for the Deerhaven site (Wilson, 1974). Comparisons were made between the Jacksonville wind data and similar data collected in Gainesville. The data were found to be quite similar. Since EPA currently requires air quality modeling for annual average periods to incorporate a five year meteorological record (Burch, EPA, 1977), Jacksonville data were used since the Jacksonville NOAA station is a first order station and data from these stations are readily available from NOAA.

Gainesville is located in the central peninsula of Florida approximately 90 miles (144 km) south of the Georgia-Florida State line. It is near the northern boundary of the trade winds and is characterized by relatively dry winters and rainy summers, a high annual percentage of sunshine, and high humidities. The terrain of the area is level and produces no significant effect on local climatology. Being south of

the usual path of winter storms, the area seldom experiences strong winds or severe cold weather. Winds in the area are moderate, blowing from the southwest during the late spring and summer, the northeast in the fall, and the northwest during the winter and early spring. Ground fogs occur during the cool weather season. The fogs form in the late evening to early morning hours as a result of nighttime radiation cooling. Such fog occurs 30 to 40 days per year but is usually dissipated by early morning.

The greatest rainfall is usually in the form of local thundershowers and occurs primarily during the months June through September. During this period measurable amounts of rain can be expected one day in two. The relative humidity averages about 75%, ranging from 90% in the early morning to 55% during the afternoon.

The annual mean temperature for Gainesville is 70° F (21° C). June, July, and August are the hottest months with an average temperature of 81° F (27° C). During December, January, and February, the coldest months, the temperature averages 58° F (14° C). Temperatures fall below freezing about twelve times per year but in most cases the temperature rises above freezing during the daytime hours.

2.6.2 Descriptive Meteorology

Temperature

The annual average temperature for the Gainesville area, based on a 30 year record, is 70° F (21° C). This ranges from an average of 75° F

(24° C) in July to an average of 57° F (14° C) in January. Table 2.6-1 presents the average and extreme monthly and annual temperatures. The extreme temperatures recorded during the period of record (1939-1968) were 104° F (40° C) in June, 1952, and 12° F (-11.1° C) in December, 1962.

The average number of heating degree days per year is 1,108 (65° F base) with greater than 95% of these falling between November and March. The months May through September have no degree days.

Freezing temperatures are not uncommon, occurring about twelve times per year. The first winter freeze normally occurs in early December and the last freeze in mid February. The mean number of non-freeze days between these dates is 295.

Rainfall

The rainfall of the Gainesville area can be divided into two regimes: the wet summer months (characterized by thunderstorm activity) and the dry fall and winter months. Rainfall during the fall and winter is usually generated by the passage of frontal systems. On these occasions the rainfall is widespread and of low intensity.

During the months of June, July, August, and September rainfall is usually in the form of thundershowers. These will occur on the average of one day in two and account for over 50% of the annual rainfall.

Table 2.6-1 Average and Extreme Temperatures - Gainesville, Florida 1939-1968

Month	Average (°C)	MAXIMUM (°C) Average	MAXIMUM (°C) Extreme	MINIMUM (°C) Average	MINIMUM (°C) Extreme
Jan.	13.4	20.0	31.1	7.5	-8.9
Feb.	15.0	21.9	31.7	8.5	-8.3
Mar.	17.5	24.5	32.8	10.9	-5.0
Apr.	20.8	27.3	35.0	14.0	1.1
May	24.2	30.8	37.8	17.5	6.1
June	26.3	32.5	40.0	20.9	10.5
July	27.1	32.9	38.3	22.1	16.7
Aug.	26.9	32.6	37.2	21.9	16.7
Sept.	26.2	32.5	36.1	21.0	10.0
Oct.	21.9	27.7	35.0	15.6	1.1
Nov.	17.7	24.0	22.2	10.7	-6.1
Dec.	14.5	20.8	30.6	8.1	-11.1
AVERAGE:	21.0 (69.8°F)	27.3 (81.1°F)		14.9 (58.8°F)	
EXTREME:			40.0 (104°F)		-11.1 (12°F)

Rainfall data for the Gainesville area are presented in Table 2.6-2 and rainfall intensity data in Table 2.6-3.

Vertical Mixing and Ventilation

The vertical mixing depth is the thickness of the atmospheric layer, through which turbulent mixing occurs. It is limited at the base (usually) by the earth surface and at the top by a layer of stable air. In air pollution studies the vertical mixing depth defines the vertical dimension of the volume of air that pollutants can be dispersed into. The transverse dimension is defined by the fluctuations in wind direction and by horizontal dispersion. The longitudinal dimension is defined by wind speed and time. The combination of these factors defines atmospheric ventilation.

The vertical mixing depth has no significant effect on the maximum ground-level pollutant concentration until the mixing depth becomes less than twice the physical stack height. In the case of the Deerhaven facility this would be less than 210 meters (2 x 350 ft. stack height). According to Hosler (1961) this occurs approximately 33% of the total hours in the Gainesville area. The annual morning mixing depth averages 450 meters; ranging from 400 meters in the fall and winter to 580 meters in the summer. The annual afternoon mixing depth averages 1,450 meters; ranging from 1,100 meters in the winter to 1,700 meters in the summer (Holzworth, 1972).

Table 2.6-2 Monthly and Annual Rainfall Data - Gainesville, Florida 1954-1976

Month	Average Monthly Rainfall (inches)
January	2.84
February	3.70
March	4.26
April	3.02
May	3.50
June	6.81
July	8.03
August	8.25
September	5.67
October	3.67
November	1.92
December	2.88
ANNUAL:	54.59

Table 2.6-3 Rainfall Intensity Data (Inches of Rainfall for Duration Period) - Gainesville, Florida

Reoccurrence Period (yrs)	Rainfall Duration (Hours) 0.5	1	2	3	6	12	24
1	1.3	2.0	2.2	2.4	2.8	3.2	3.7
2	1.7	2.2	2.6	2.8	3.4	3.8	4.3
5	2.1	2.7	3.3	3.5	4.2	4.9	5.8
10	2.4	3.0	3.6	4.0	4.7	5.7	6.7
25	2.6	3.4	4.0	4.5	5.5	6.8	7.8
50	2.9	3.6	4.5	5.0	6.0	7.5	8.6
100	3.2	3.9	5.0	5.5	6.8	8.5	9.5

Holzworth reports that there was only one stagnation period (mixing depth <500 meters and wind speed <6m/s) in the Gainesville area in a five year period. This period lasted three days.

Severe Weather

Since 1885 there have been 75 hurricanes reported in Florida, 42 since 1900. Of the 42 hurricanes since 1900, 10 have passed through the Gainesville area. The storms usually approach from the south to southwest and, because of the relatively long overland travel distance, are usually reduced to tropical storms (wind speeds <73 mph) before reaching Gainesville. The chance of a hurricane force wind in the Gainesville area in any given year is less than 1 in 50 (Dunn, 1960).

In the period 1916-1969, a total of 590 tornadoes have been reported in Florida. Approximately 66 of these were associated with the passage of tropical storms. According to statistics compiled by Thom (1963), the mean annual frequency of a tornado occurring in a one degree square (4,145 square miles) centered at Gainesville is 0.65. The probability of a tornado hitting any given spot in the Gainesville area is 0.000442 or once in 2,260 years.

The extreme wind speed (Thom, 1967) expected to occur once in 100 years in the Gainesville area is 110 mph; that expected in 50 years is 90 mph; and that expected in 25 years is 80 mph. Based on a gustiness factor of 1.3 (Huss, 1946), the extreme gust expected in 100 years is 143 mph.

Hailstorms (Flora, 1956) occur quite infrequently in Florida. During the period 1904 to 1943 the frequency of occurrence statewide was less than one per year. During the period 1925-1954, 37 hailstorms were reported in Florida. Approximately 60% of these occurred in April and May and most occurred between the hours of 1400-1800. Of the 37 hailstorms reported during the 1925-1954 period, no severe storms (damage >$100,000) occurred in the Gainesville area.

Humidity and Fog

Humidity is of importance because of the fogging potential created by cooling towers. It has been reported (GPU Report, 1972) that the potential for artificially created fog occurs when there is a deficit between the actual and saturation moisture content of air of less than 0.1 gram per cubic meter. This deficit is related to air temperature and relative humidity as defined in Table 2.6-4.

In Gainesville such a deficit existed 422 total hours in 1975. The deficit was zero (100% relative humidity) in 155, or approximately 37% of the cases.

Fog normally occurs 30 to 40 days per year in Gainesville. The fog forms at night or in the early morning and is generally dissipated by mid morning. Periods of fog are usually five to six hours in duration.

Table 2.6-4 Relative Humidity at Various Air Temperatures to Give a Deficit Between Actual and Saturation Humidity of ≤0.1 gram/meter

Dry Bulb Temperature (°C)	(°F)	Relative Humidity (%)
>18	>65	≥99
16	60	≥98
13	55	≥98
10	50	≥97
4	40	≥96
-1	30	≥93
-7	20	≥86
-12	10	≥82

Wind and Atmospheric Stability

Wind and atmospheric stability are two of the three major factors affecting atmospheric ventilation, the rate of air pollutant dispersion. Wind direction and the horizontal dispersion rate (a function of stability) define the transverse dimension of the volume of air into which a pollutant is dispersed. Wind speed and time define the longitudinal dimension.

Wind and stability data from both Jacksonville and Gainesville were considered for the Deerhaven site evaluation. In earlier studies (Wilson, 1974) Jacksonville and Gainesville wind and stability data were input to a long-term air quality model at the request of the Florida Department of Environmental Regulation and the model outputs compared. This comparison showed that there was no significant difference in the meteorological data from the two locations.

The Jacksonville weather station is a first order station, and data are readily available from the NOAA National Climatic Center. The Gainesville station is an FAA Station and data are available only on original log sheets. Since EPA now requires long-term air quality models to be run with a five year record of meteorological data (Burch, EPA, 1977), and since the Jacksonville and Gainesville meteorological data are similar, the more readily available Jacksonville data were selected for use.

The atmospheric stability categories are defined from measurements of insolation and wind speed. Jacksonville data were used for this purpose

also. The atmospheric stability categories were defined by the system of Turner (1961). The area has an occurrence of unstable conditions 22% of the time, neutral conditions 37%; and stable conditions 41%.

For comparative purposes the wind direction distribution for 1973 in Gainesville and 1970-1974 in Jacksonville are shown in Figure 2.6-1. Winds are normally from the northeast in the fall, northwest in the winter and early spring and southwest in the summer. The annual average wind speed is 3.1 meters per second (7 mph), with 95% of the winds less than 5.9 meters per second (13 mph), 78% less than 4.4 meters per second (10 mph), and 56% less than 3.0 meters/second (7 mph) (Dohrenwend, 1974). The maximum wind speed, occurring with the passing of hurricane Donna in 1964, was 36.6 meters per second (82 mph).

Joint wind speed/wind direction/stability frequencies are presented in Table 2.6-5 for the five year period 1970-1974 for Jacksonville, Florida.

2.7 Ecology

The area terrestrial systems have been highly modified by development, farming, or forestry practices. Mixed upland and floodplain hardwoods occur primarily along streams and section lines in the area. Pine flatwoods with associated cypress domes and bay head occupy the headwaters area for all three streams (Turkey, Cellon and Rocky Creeks) (Breedlove, 1976b). Major portions of the pine flatwoods, north and east of the site, are owned by Owens-Illinois and are in planted pine (Figure 2.2-1).

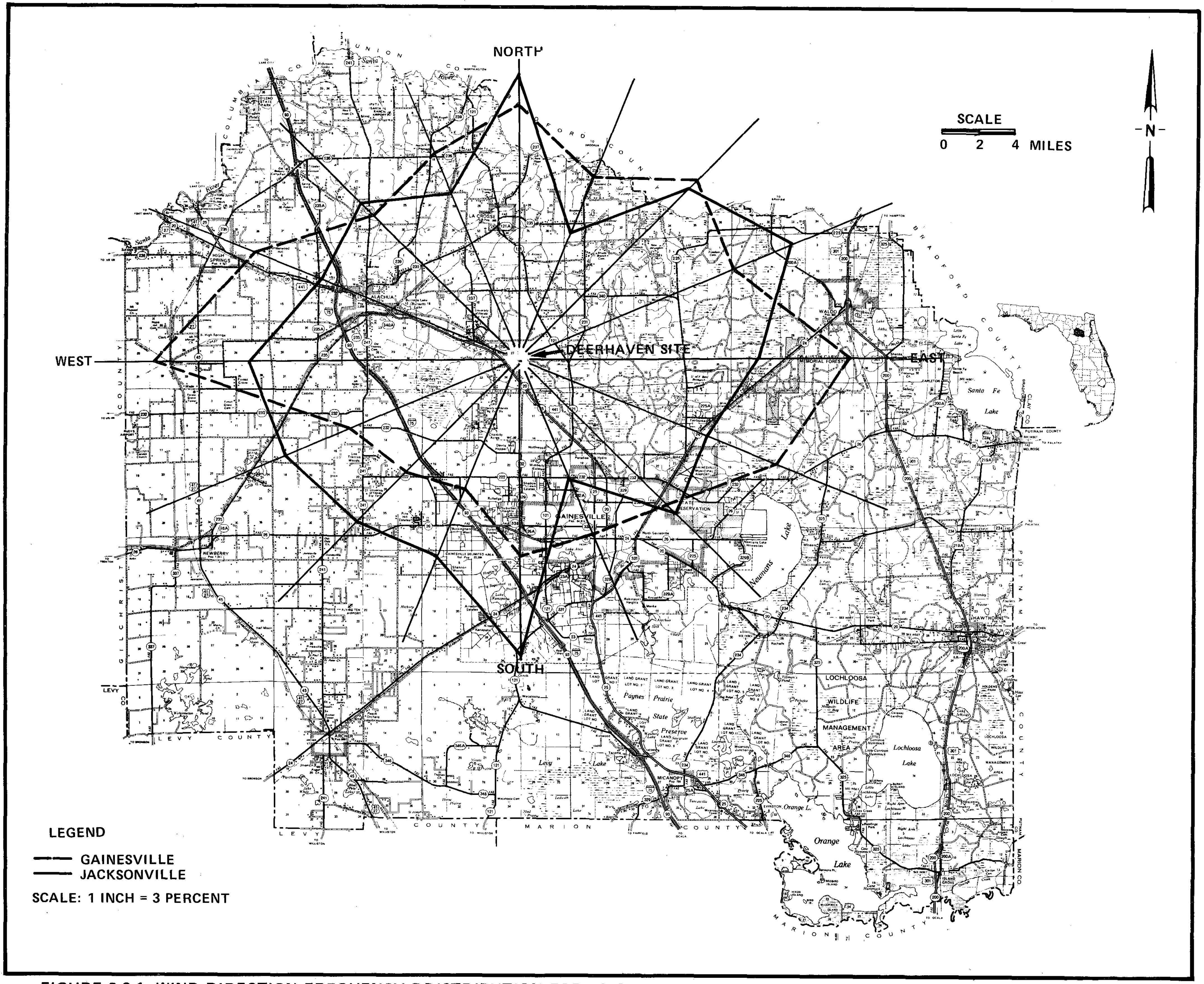


FIGURE 2.6-1 WIND DIRECTION FREQUENCY DRISTRIBUTION FOR 1973 ANNUAL PERIOD - JACKSONVILLE AND GAINESVILLE, FLORIDA.

Table 2.6-5 Meteorological Input Data for the Annual Season Five-Year Data Base (1970-1974) - Jacksonville, Florida - Stability Class 1

Wind Direction	Windspeed Class					
	1	2	3	4	5	6
N	0.0002	0.0002	0.0	0.0	0.0	0.0
NNE	0.0001	0.0001	0.0	0.0	0.0	0.0
NE	0.0003	0.0002	0.0	0.0	0.0	0.0
ENE	0.0003	0.0003	0.0	0.0	0.0	0.0
E	0.0005	0.0006	0.0	0.0	0.0	0.0
ESE	0.0002	0.0004	0.0	0.0	0.0	0.0
SE	0.0000	0.0001	0.0	0.0	0.0	0.0
SSE	0.0003	0.0003	0.0	0.0	0.0	0.0
S	0.0003	0.0004	0.0	0.0	0.0	0.0
SSW	0.0001	0.0002	0.0	0.0	0.0	0.0
SW	0.0002	0.0005	0.0	0.0	0.0	0.0
WSW	0.0003	0.0007	0.0	0.0	0.0	0.0
W	0.0001	0.0002	0.0	0.0	0.0	0.0
WNW	0.0002	0.0003	0.0	0.0	0.0	0.0
NW	0.0004	0.0003	0.0	0.0	0.0	0.0
NNW	0.0002	0.0002	0.0	0.0	0.0	0.0

NOTES: Mixing Depth = 1000. meters
Ambient Temperature = 293. degrees, Kelvin
Ambient Temperature = 1000. millibars

Table 2.6-5 Meteorological Input Data for the Annual Season Five-Year Data Base (1970-1974) - Jacksonville, Florida - Stability Class 2

Wind Direction	Windspeed Class 1	2	3	4	5	6
N	0.0022	0.0024	0.0008	0.0	0.0	0.0
NNE	0.0008	0.0011	0.0009	0.0	0.0	0.0
NE	0.0006	0.0010	0.0011	0.0	0.0	0.0
ENE	0.0010	0.0016	0.0012	0.0	0.0	0.0
E	0.0007	0.0025	0.0018	0.0	0.0	0.0
ESE	0.0006	0.0013	0.0014	0.0	0.0	0.0
SE	0.0013	0.0022	0.0014	0.0	0.0	0.0
SSE	0.0004	0.0010	0.0009	0.0	0.0	0.0
S	0.0014	0.0024	0.0015	0.0	0.0	0.0
SSW	0.0009	0.0014	0.0009	0.0	0.0	0.0
SW	0.0018	0.0025	0.0023	0.0	0.0	0.0
WSW	0.0013	0.0029	0.0019	0.0	0.0	0.0
W	0.0017	0.0027	0.0024	0.0	0.0	0.0
WNW	0.0010	0.0023	0.0012	0.0	0.0	0.0
NW	0.0014	0.0027	0.0013	0.0	0.0	0.0
NNW	0.0012	0.0014	0.0009	0.0	0.0	0.0

Table 2.6-5 Meteorological Input Data for the Annual Season Five-Year Data Base (1970-1974) - Jacksonville, Florida - Stability Class 3

Wind Direction	Windspeed Class					
	1	2	3	4	5	6
N	0.0012	0.0027	0.0033	0.0001	0.0	0.0
NNE	0.0006	0.0014	0.0021	0.0005	0.0	0.0
NE	0.0006	0.0013	0.0039	0.0005	0.0	0.0
ENE	0.0005	0.0016	0.0064	0.0018	0.0	0.0
E	0.0004	0.0011	0.0092	0.0028	0.0001	0.0
ESE	0.0002	0.0009	0.0062	0.0019	0.0	0.0
SE	0.0006	0.0016	0.0055	0.0017	0.0	0.0
SSE	0.0009	0.0012	0.0024	0.0003	0.0	0.0
S	0.0012	0.0023	0.0042	0.0006	0.0	0.0
SSW	0.0007	0.0018	0.0040	0.0009	0.0001	0.0
SW	0.0010	0.0025	0.0051	0.0012	0.0001	0.0
WSW	0.0011	0.0027	0.0079	0.0012	0.0	0.0
W	0.0010	0.0037	0.0074	0.0019	0.0002	0.0
WNW	0.0009	0.0014	0.0036	0.0010	0.0001	0.0
NW	0.0011	0.0019	0.0040	0.0006	0.0	0.0001
NNW	0.0007	0.0010	0.0022	0.0002	0.0	0.0

Table 2.6-5 Meteorological Input Data for the Annual Season Five-Year Data Base (1970-1974) - Jacksonville, Florida - Stability Class 4

Wind Direction	Windspeed Class 1	2	3	4	5	6
N	0.0025	0.0052	0.0123	0.0047	0.0001	0.0001
NNE	0.0008	0.0029	0.0075	0.0084	0.0005	0.0001
NE	0.0007	0.0033	0.0092	0.0156	0.0023	0.0003
ENE	0.0009	0.0034	0.0094	0.0125	0.0011	0.0
E	0.0013	0.0042	0.0103	0.0125	0.0007	0.0
ESE	0.0006	0.0027	0.0077	0.0077	0.0003	0.0001
SE	0.0007	0.0021	0.0090	0.0107	0.0006	0.0001
SSE	0.0008	0.0027	0.0064	0.0042	0.0005	0.0001
S	0.0016	0.0048	0.0122	0.0075	0.0005	0.0
SSW	0.0010	0.0029	0.0088	0.0055	0.0003	0.0
SW	0.0010	0.0041	0.0130	0.0101	0.0012	0.0
WSW	0.0010	0.0032	0.0090	0.0094	0.0010	0.0002
W	0.0011	0.0044	0.0080	0.0123	0.0026	0.0005
WNW	0.0011	0.0032	0.0041	0.0084	0.0023	0.0003
NW	0.0010	0.0027	0.0060	0.0075	0.0017	0.0001
NNW	0.0009	0.0027	0.0051	0.0041	0.0002	0.0

Table 2.6-5 Meteorological Input Data for the Annual Season Five-Year Data Base (1970-1974) - Jacksonville, Florida - Stability Class 5

Wind Direction	Windspeed Class 1	2	3	4	5	6
N	0.0146	0.0149	0.0048	0.0	0.0	0.0
NNE	0.0048	0.0051	0.0011	0.0	0.0	0.0
NE	0.0061	0.0069	0.0013	0.0	0.0	0.0
ENE	0.0086	0.0121	0.0017	0.0	0.0	0.0
E	0.0076	0.0104	0.0036	0.0	0.0	0.0
ESE	0.0068	0.0085	0.0045	0.0	0.0	0.0
SE	0.0087	0.0125	0.0050	0.0	0.0	0.0
SSE	0.0075	0.0077	0.0024	0.0	0.0	0.0
S	0.0149	0.0178	0.0034	0.0	0.0	0.0
SSW	0.0101	0.0138	0.0020	0.0	0.0	0.0
SW	0.0126	0.0165	0.0038	0.0	0.0	0.0
WSW	0.0124	0.0156	0.0062	0.0	0.0	0.0
W	0.0176	0.0164	0.0061	0.0	0.0	0.0
WNW	0.0149	0.0118	0.0036	0.0	0.0	0.0
NW	0.0112	0.0113	0.0040	0.0	0.0	0.0
NNW	0.0095	0.0082	0.0032	0.0	0.0	0.0

2.7.1 Site Ecology

Terrestrial Communities

Like most land in this area of Alachua County, the site is flat and poorly drained with vegetation consisting largely of pine flatwood plantations interspersed with cypress domes.

The flatwoods have an overstory of slash pine (*Pinus elliottii*) and an understory dominated by saw palmetto (*Serenoa repens*), gallberry (*Ilex galabra*), wax myrtle (*Myrica cerifera*) and *Vaccinium* sp. The principal ground cover is pineland threeawn (*Aristida stricta*), broom sedge (*Andropogon* sp.), and various ferns and lichens.

The cypress domes are dominated by pond cypress (*Taxodium ascendens*), interspersed with red maple (*Acer rubrum*), black gum (*Nyssa biflora*), sweet bay (*Magnolia virginiana*), red bay (*Persea* sp.) and loblolly bay (*Gordonia lasianthus*). Understory dominants are typically fetterbush (*Lyonia lucida*) and wax myrtle. Various ferns dominate the ground strata.

There are two minor exposures of well drained, fine sandy soil within the property boundary. One is located along the northern edge of the tract near the western boundary and includes a 40 acre field which was cultivated prior to site aquisition. The other area, approximately 7 acres north of the plant, is occupied by early successional, hardwood pines, and shrubs; grasses and sedges are found in open areas.

The wildlife characteristic of the site is typical of other pineland areas in the region (Section 2.7.2). Whitetailed deer are known to occur within the site boundary though their population size has not been determined. Deer movement across the property borders is restricted by the high fence which surrounds the site. Other commonly observed animals include raccoon, oppossum, armadillo and a variety of birds and small mammals. There are no significant breeding areas or endangered species habitats on the property and no utilization by an endangered species is known (Crider, 1976).

Aquatic Communities

There is no open, standing water on site other than a roadside ditch located along a portion of the eastern property boundary. Although relatively broad and deep, the ditch is not a significant aquatic habitat either in terms of fish production or use by upland wildlife.

Unit 1 blowdown is discharged into a small canal which flows for a distance of 300 yards before dispersing into a 28-acre cypress dome west of the facility. The canal is six to eight feet wide at the water surface and has steeply sloping banks five feet in height. Flow in Turkey Creek above the discharge canal is minor relative to the blowdown volume and is seasonally intermittent. The canal banks are partially clear of vegetation and presently eroded. Wax myrtle, blackberry and Carolina willow (*Salix caroliniana*) grow at the water edge.

Within the canal, cattail (Typha latifolia) and Ludwigia sp. are dominant upstream and downstream of the outfall but do not occur in the direct vicinity of the outfall. There are no submergent vascular plants. Gambusia, a hardy live-bearing fish common throughout the state, is abundant in the canal except adjacent to the outfall and for a short distance downstream. Periphyton and benthic invertebrates are also rare to non-existent along this stretch, though they are present elsewhere along the canal.

The canal empties into a 28-acre cypress swamp which is one of the farthest upstream swamps contributing to Turkey Creek. Water enters as a shallow flow over a sediment delta in the upper end of the swamp and leaves through a narrow outlet bordered by cypress trees. Cypress roots have prevented the outlet from eroding.

Since Unit 1 began operation in 1972, vegetation in the swamp has undergone adjustment to the increased water volume. The dome may be divided into three effect zones on the basis of plant reaction to the input of cooling tower blowdown. These are: (1) the sediment delta in the upper portion of the swamp; (2) the swamp center, which consists of water tolerant vegetation which was occasionally flooded prior to the constant Unit 1 input; and (3) the swamp edge, which characteristically did not flood and in which intolerant species have died following the addition of blowdown.

The sediment delta is three to four acres in size. It originally contained water intolerant vegetation such as sweet gum and several species

of oak and pine. In the period since the addition of blowdown, sustained soil saturation and deposition of sand eroded from the outfall canal have killed the former vegetation. Tolerant woody vegetation has not become established due to the short interval since the initiation of blowdown related effects. However, lizard's tail (Saururus cernuus), a species characteristic of shallow water systems, is prevalent and forms a dense cover over much of the delta.

The dome interior has a relatively open canopy of cypress and black gum, the majority of which are less than 20 inches in diameter at breast height. Sections of turpentine pine are found, indicating that dry conditions persisted in this area for a long time prior to Deerhaven operations.

Most of the understory vegetation is restricted to material projecting above the water level. Old tree stumps, logs, and boles of trees with matted organic matter around their bases serve as a sufficiently dry substrate to support a variety of plant species with varying degrees of water tolerance. These species include cinnamon fern (Osmunda cinnamomea), royal fern (Osmunda regalis), swamp rose (Rosa palustris), buttonbush (Cephalanthus occidentalis) and Virginia willow (Itea virginica).

The water surface serves as the other major substrate supporting vegetation in the dome interior. As the velocity of water over the sediment delta decreases, duckweed (Lemna sp.) begins to cover the surface. Other

species in the surface mat are Azolla wolffia and floating heart (Nymphoides sp.). The dome interior is covered with this mat of floating species except near the outfall of the dome. A patch of sawgrass (Cladium jamaicensis) has become established near the swamp exit.

The constant water input to the swamp has resulted in persistent shallow flooding of a narrow border of water intolerant vegetation around the periphery of the cypress dome. Water depth ranges from a saturated soil condition to standing water several inches deep. Species affected by the flooding include slash pine, wax myrtle, fetterbush and gallberry.

Animal species found in the cypress swamp include water moccasin, rabbits, raccoon, wood duck, tree frogs, Gambusia and crayfish. Benthic invertebrates have been sampled (Breedlove, 1975), and reveal low numbers of organisms and taxa.

Water leaves the dome through a channelized stream which extends for a distance of 300 yards, connecting the swamp to the natural stream channel at U.S. 441. The channel has moderate slopes, one to two foot banks and a width of six to eight feet. Soil banks along the side of the canal are covered with vegetation, which includes Juncus sp., Scirpus sp., wax myrtle, Carolina willow and rose. Smartweed (Polygonum sp.) and Ludwigia sp. dominate the canal itself. Principal invertebrate species along the canal include dragonfly larvae and bloodworms. Vertebrate species which utilize the canal include Gambusia, snakes, amphibians and small mammals and birds.

2.7.2 The Project Area Within a Five Mile Radius

2.7.2.1 Plant Communities

Of the seven major forest communities characterizing north central Florida (Monk, 1968), six are represented within five miles of the project area (Figure 2.1-3). These include: (1) pine flatwoods; (2) sandhills; (3) cypress swamps; (4) mixed hardwood swamps; (5) bayheads; and (6) southern mixed hardwoods. In the following sections, each of these community types is described in terms of its general physiography, vegetation, successional status, wildlife relationships, existing land use, and environmental stress factors. The production characteristics and wildlife relationships of agricultural land within the area of concern are also discussed.

Pine Flatwoods and Pine Plantations

The pine flatwoods are the most abundant vegetation type in Florida and the most common community in the project vicinity. Flatwoods occupy level to gently rolling sites. Surface soils are sandy, acid and low in plant nutrients. There are few flatwoods sites within the area which are not under intensive pulpwood management. Since the composition and density of vegetation within each stand is directly related to age and management intensity, the community exhibits considerable local variation.

The dominant tree (overstory) species is slash pine, although Longleaf pine (Pinus palustris) is occasionally dominant on drier sites. Commonly encountered woody understory species include saw palmetto, gallberry, wax myrtle, huckleberry (Gaylussacia sp.) and several species of Vaccinium.

Ground cover species are wire grass (Aristida stricta), broom sedge, several ferns and a lichen (Cladonia sp.).

Pine flatwoods and pine plantations are sub-climax communities which require periodic burning or management intervention to prevent succession into southern mixed hardwoods.

Where understory and ground cover are well established, the flatwoods provide suitable habitat for a variety of herbivorous and omnivorous animal species such as whitetailed deer, armadillo, rabbits and various rodents and songbirds. Predatory animals include various frogs, lizards, snakes, hawks, owls and occasionally bobcat and gray fox.

Pine plantations are notably devoid of diverse wildlife populations when the canopy of densely planted pines reaches sufficient size to shade out understory and ground cover vegetation. Recently planted plantations, however, develop a ground cover similar to that of abandoned agricultural fields and are capable of supporting sizeable small mammal and bird populations. Large sections of the pine plantations within the project area have been recently planted. In addition, the intensely managed pinelands are interspersed with swamps and strands of mixed hardwoods which aid in improving the habitat diversity of the area through the provision of valuable edge and ecotone habitats.

Sandhills

Sandhills are a community type which occupy well-drained, sandy sites with undulating to gently sloping relief. This community is of limited extent in the project vicinity and is largely confined to the San Felasco Hammock. There are two recognized variants or phases of the community: (1) the pine-southern red oak forest; and (2) the longleaf pine-turkey oak forest (Alachua Audubon Society, 1973).

The pine-southern red oak phase has an open canopy dominated by longleaf pine, red oak (Quercus falcata), mockernut hickory (Carya floridana), and occasionally sand post oak (Quercus stellata var. margaretta) and turkey oak (Quercus laevis). The longleaf pine-turkey oak phase is dominated by longleaf pine, turkey oak and occasionally blue jack oak (Quercus incana), sand post oak and southern red oak. Immature overstory trees comprise the majority of the woody understory. The ground stratum is dominated by wire grass, although sassafras (Sassafras albidum) and running chinquapin (Castanea alnifolia) are common in some locations.

Both of these communities are fire-maintained sub-climaxes. Succession is toward the mesic or xeric phase of the southern mixed hardwoods. The pine-southern red oak forest is considered to be successionally intermediate between mesic hammock and longleaf pine-turkey oak forest (Monk, 1968).

Due to high evaporation rates and the rapid percolation of rainwater through sandy soil, sandhill communities are characteristically dry and subject to extremes in temperature. As a result, much of the associated fauna is adapted to a burrowing existence. The pocket gopher and gopher tortoise are common. A variety of snakes, lizards and amphibians, which are incapable of burrowing, inhabit the gopher tortoise burrows. Included among these are the diamond-backed rattlesnake and the threatened indigo snake and gopher frog (Alachua Audubon Society, 1973). Unusually high acorn production in the sandhills provides food for such primary consumers as whitetailed deer, gray squirrel and the threatened fox squirrel. Predators such as bobcat, gray fox, skunk, hawks and owls frequent these areas.

Cypress Swamps

Cypress swamps occur within the area as isolated communities occupying pineland depressions and as strands along the sluggish headwaters of various streams. Soils consist of acidic organic peat and muck. The smaller, more isolated sites are commonly referred to as cypress heads or domes. These depressions are seasonally flooded by rainfall and lateral seepage and contribute to the drainage of surrounding flatwoods. Water loss in depressions occurs primarily through evapotranspiration, though slow lateral drainage occurs into the headwater areas.

Plant species found in cypress swamps are generally tolerant of a high water table and can withstand prolonged seasonal flooding. However, most

of these species require a dry seed bed to germinate and become established. Therefore, a fluctuating water table is necessary for the long-term existence of the community.

The cypress dome dominant overstory species is pond cypress. Other species, such as red maple, black gum, sweet bay, red bay, loblolly bay and slash pine become more common at drier sites or along the community edges. Important woody understory species include fetterbush and wax myrtle. Herbaceous ground cover includes sphagnum (*Sphagnum* sp.) and several ferns.

Cypress swamps are a sub-climax community which gradually succeed into a bayhead or mixed hardwood swamp as the organic substrate accumulates and seasonal inundation becomes less prolonged. Improved drainage through channelization can speed this successional process. Most of the cypress swamps within the managed pineland areas have been channelized and lumbered.

As an integral part of the flatwoods system, cypress swamps provide nesting, breeding and escape cover and additional food to raccoon, oppossum, deer, rabbit and a variety of snakes and wading birds. The aquatic habitat supports a variety of amphibians and reptiles.

Mixed Hardwood Swamps

Mixed hardwood swamps occupy seasonally flooded sites along creeks and basin headwater areas. Their surface soils are moderately acidic and high in organic matter and nutrients.

Broad-leaved deciduous trees dominate the community. The more commonly encountered species include black gum, bald cypress (Taxodium distichum) pop ash (Fraxinus caroliniana), red maple and sweet gum (Liquidambar styraciflua). Laurel oak (Quercus laurifolia), water oak (Quercus nigra), Florida elm (Ulmus floridana), dahoon (Ilex cassine), sweet bay, wax myrtle, button bush (Cephalanthus occidentalis), and American horn beam (Carpinus caroliniana) are important subdominants. The ground cover is variable and usually dominated by seedlings and a variety of ferns.

The best examples of this community type within the project area include two relatively large (132 acres) mixed hardwood creek swamps located along Rocky Creek about three miles southeast of LaCrosse, and an 80 acre hardwood/bald cypress swamp at the mouth of Blue's Creek within the San Felasco Hammock. A relatively rare variant of the community type, a water elm swamp, occupies about 100 acres in Sanchez Prairie and a few other small areas within the San Felasco Hammock (Alachua Audubon Society, 1973). This community is dominated by water elm (Planera aquatica) found in conjunction with Carolina ash (Fraxinus caroliniana).

Mixed hardwood swamps are considered a climax stage in wetland plant succession. However, drainage improvements can bring about transformation into a moist southern mixed hardwood community (Monk, 1968).

Mixed hardwood swamps provide valuable nesting habitat to local breeding birds, which include wood ducks, woodpeckers, hawks, owls and a variety

of songbirds. They are also important feeding and refuge areas for deer, rabbits, wild turkey, oppossum, raccoon, gray fox, bobcat, gray squirrel, rats and mice. A well developed, insect-based food chain, which includes most local amphibians and a variety of aquatic and upland snakes, is also characteristic of these swamps.

Bayheads

Bayheads are another swamp community occupying depressions and headwater sites within the project area. These communities are seasonally flooded though not to the depth characteristic of the cypress or mixed hardwood swamps. The soils are peaty, highly acid and relatively sterile.

The vegetation is dominated by broad-leaved evergreens. Typical dominants include sweet bay, swamp bay (Persea palustris), loblolly bay and cypress. Sweet gum, red maple, loblolly pine, slash pine, and black gum are either locally dominant or subdominant. Wetter areas contain a higher percentage of cypress and black gum. Fetterbush is the most prevalent shrub and sometimes forms dense thickets, although Virginia willow and buttonbush are also abundant.

Bayheads are the climax stage of succession in peaty areas. However, like the mixed hardwood swamp, they may, with improved drainage, be gradually transformed into a moist southern mixed hardwood community.

Like the other wooded swamplands in the area, bayheads are important feeding and refuge sites for local upland wildlife. This evergreen dominated community type is especially important for cover and forage during winter months when the cypress and hardwood dominated swamps lose their deciduous foliage.

Southern Mixed Hardwoods

Southern mixed hardwoods are a highly variable, hardwood dominated upland community type found where limestone and phosphatic deposits outcrop or in less fertile areas where fire has been suppressed long enough for hardwoods to assume dominance over pines (Monk, 1965). These areas are also commonly referred to as "hammocks" and are further distinguished on the basis of soil moisture into hydric (wet), mesic (moderate), and xeric (dry) hammock types. The San Felasco tract contains the largest stand (approximately 3,300 acres) of mesic hammock in the State of Florida. Hydric hammock is the predominant community type within the Sanchez Prairie area of San Felasco Hammock. Other less extensive stands of upland mixed hardwoods are scattered throughout the surrounding area bordering swamps and creeks, along section lines and in uplands not being intensely managed for pine or agriculture.

The southern mixed hardwoods community has the highest plant diversity found in the State. Monk (1968) reported finding a minimum of 71 different important tree species. Typical species include: southern magnolia (Magnolia grandiflora), live oak (Quercus virginiana), laurel oak, water

oak, red maple, Florida maple (Acer barbatum), Florida elm, hickory (Carya sp.), spruce pine (Pinus glabra), and loblolly pine (Pinus taeda). The understory includes wax myrtle, American holly (Ilex opaca), dahoon, American horn beam, dogwood (Cornus sp.), several hawthorn species (Crataegus sp.) and a variety of flowering shrubs. Generally, the mesic and hydric sites are dominated by a greater proportion of deciduous species, while drier and sterile sites are dominated by a greater percentage of evergreens (Monk, 1966). In addition, the density of trees increases from dry to mesic sites and slightly decreases from mesic to wet sites (Monk, 1966 and 1968).

The southern mixed hardwoods are the climax of upland succession in north-central Florida (Monk, 1968). Their development is initiated whenever the pine dominated communities are protected from periodic burning, or when the swamp communities are protected from prolonged flooding.

The community displays such a wide variety of habitats that most local upland wildlife species may be expected to inhabit a mixed hardwoods forest. Mast production is high and is extensively utilized by deer, turkey, squirrel, raccoon and other small mammals. The large size of the San Felasco tract makes it an especially good habitat for such wide ranging species as deer, bobcat, and fox.

Agricultural Land

Alachua County is a leading county in the state in terms of agricultural diversity and among the top five in total agricultural production (Andrews, 1977). Agricultural lands comprise about 385,000 acres, or 67% of the total county land area. Approximately 52% of the county is in commercial timber production, 31% in improved pasture or pasture crops such as hay and improved pasture, and 16% in vegetable, fruit, and field crops. Current production statistics for the major crops are given in Table 2.7-1.

Within the five mile radius of the existing Deerhaven facility, agricultural development occurs on the well drained areas north and west of the site. Crops produced on active farmlands vary from year to year but largely reflect the production characteristics of the county.

The University of Florida operates a dairy farm three miles northwest of the Deerhaven plant and an Agricultural Experiment Station four miles to the southwest. The experiment station produces vegetables, turf, and a variety of fruits, including peaches, nectarines, tangelos, apples, pears, blueberries, avocados, and plums.

There are ten commercial horticultural and fruit crop operations within the five mile area (Figure 2.2-1). They currently produce blueberries, strawberries, blackberries, grapes and a variety of fruit trees and ornamentals.

Table 2.7-1 Agricultural Production Statistics for Alachua County, 1976

Crop	Production (Acres/Yr)	Production (Per Acre)	Total Value
Corn	35,000	70 Bu.	$5,000,000
Tobacco	2,000	2,000 Lb.	$4,000,000
Peanuts	2,000	3,500 Lb.	$2,000,000
Soybeans	10,000	35 Bu.	$2,000,000
Watermelon	4,500	30,000 Lb.	$1,500,000
Hay Crops	20,000	300 Bales	$2,250,000
Improved Pasture	100,000	0.5 Cow	---
Fruits and Nuts	4,000	Variable	$1,000,000
Vegetable Crops*	7,500	Variable	$3,500,000
Timber	200,000		$4,500,000

*Principal vegetable crops include peppers, cucumbers, squash, beans and eggplant.

Source: Mr. A.T. Andrews, County Agricultural Agent, Alachua County.

As a wildlife habitat, crop and pasture lands can supply an abundance of food, though utilization of these areas by less mobile upland species is limited by a lack of plant diversity and/or cover. The principal species are insectivorous and granivorous birds. Less mobile mammal species require adequate cover, making their use of these areas dependent upon the size of the plot and its relation to wooded refuges.

2.7.2.2 Other Natural Features and Considerations

2.7.2.2.1 Rare, Threatened and Endangered Species

The Florida Audubon Society Committee on Rare and Endangered Plants and Animals (Florida Audubon Society, 1974), the Florida Game and Fresh Water Fish Commission (FGFWFC, 1975), and the U.S. Department of the Interior (USDI, 1976) lists of species whose existence is endangered or threatened have been reviewed and an inclusive area specific list developed.

The Florida Committee on Rare and Endangered Plants and Animals lists five categories of concern for rare and endangered plants and animals. Other sources of species lists present similar definitions.

Endangered

Plants or animals in imminent danger of extinction or extirpation if the deleterious factors affecting them continue to operate. These are forms whose numbers have already been so drastically reduced or degraded that immediate action is required to prevent their loss.

Threatened

Forms believed likely to become endangered in the near future if the causal factors now at work continue to operate. Included in this category are taxa in which most or all populations are decreasing because of over-exploitation or environmental disturbance; taxa whose populations have been heavily depleted by adverse factors and, while not actually endangered, are still in critical condition; and taxa which may still be relatively abundant but are under threat from serious adverse factors throughout their range.

Rare

Species, subspecies, or unique local populations which, though not presently endangered or threatened as defined above, are potentially at risk because they are only found within a restricted geographic range. They may be insular or otherwise isolated forms or relict populations with wider distribution.

Species of Special Concern

Forms that do not clearly fit into any of the foregoing categories, yet which warrant special attention. Included are forms that, although presently relatively abundant, are particularly vulnerable to certain types of exploitation or environmental modifications and have experienced long-term population decline and forms whose status in Florida may have significant impact on endangered or threatened species elsewhere.

Status Undetermined

Species, subspecies, or local populations that are suspected of falling in one of the above categories but for which the available data are not adequate to provide the basis for a decision.

Vertebrates

Vertebrate species and subspecies that have been placed in one of the above categories that are known or expected to occur in Alachua County and their habitat preference are presented in Table 2.7-2. Table 2.7-3 provides summary statistics for vertebrates listed in Table 2.7-2. Included are eight endangered, 13 threatened, 12 rare, and 12 species of special concern. Additional information on those species which may be affected by any or all of the discharge alternatives is provided below.

Endangered Vertebrates

Woodstork

The woodstork is not currently listed by the USDI (1976) as either endangered or threatened; however, the Florida Committee lists it as endangered, and the FGFWFC lists it as threatened. Although the closest known rookeries are in Micanopy and near Newnan's Lake, this bird will travel as far as 40 miles one-way between rookeries and feeding sites. Therefore, the woodstork may presently or potentially utilize portions of Rocky Creek Swamp, Cellon Creek marsh, and/or Sanchez Prairie for feeding. Due to their specialized feeding technique, storks are adversely affected by any alteration in hydro-period or water quality which reduces total fish biomass in wetlands.

Table 2.7-2 Rare and Endangered Vertebrates of Alachua County, Florida, Their Status, Preferred Habitat and Occurrence

Species	Status USDI[1]	Status FGFWFC[2]	Status FC[3]	Habitat Preference	Occurrence in Alachua County
BIRDS					
Wood Stork (Mycteria americana)	--	T	E	Primarily cypress and mangrove swamps; areas where fish become concentrated during periods of falling water are attractive feeding sites.	Locally common resident; Micanopy and Newnan's Lake.
American Peregrine Falcon (Falco peregrinus)	E	E	E	Opportunistic, may exploit among others the birdlife of agricultural areas.	Extremely rare transient, winter resident. Highly unlikely in area of concern.
Red Cocaded Woodpecker (Dendrocopus borealis hylonomus)	E	E	E	Mature to overmature stands of southern pines (especially longleaf).	Uncommon resident.
Florida Grasshopper Sparrow (Ammodramus savannarum floridanus)	--	E	E	Stunted growth of saw palmetto and dwarf oaks. May be adapting to cattle pastures.	Uncommon to rare.
Southern Bald Eagle (Haliaeetus l. leucocephalus)	E	T	T	Primarily associated with the coast or lake and river shores, usually nesting near where they feed along shore or over shallow water bodies. Some interior pairs nest on tree islands in large marshes or in mainly dry prairies with small marshes and ponds, far from open water. Outside nesting season not as closely limited to shores. Gathers where food is most easily available.	Rare resident. Formerly bred.
Osprey (Pandion haliaetus carolinensis)	--	T	T	Nests placed in tops of living or dead cypress, mangrove pine, or swamp hardwoods near sea coasts, interior lakes, large swamps, or large rivers. Quite tolerant of people where not disturbed and may locate on utility poles, radio towers, channel markers, etc. near water. Occur anywhere in state where there is a water body with abundance of fish for food.	Fairly common resident.

Table 2.7-2 Rare and Endangered Vertebrates of Alachua County, Florida, Their Status, Preferred Habitat and Occurrence (continued)

Species	Status: USDI[1]	Status: FGFWFC[2]	Status: FC[3]	Habitat Preference	Occurrence in Alachua County
American Kestrel (*Falco sparverius palus*)	--	T	T	Open field oriented - prefers open pine forests where dead trees found.	Vagrant. Does not occur in area of concern.
Audubon's Caracara (*Caracara cheriway auduboni*)	--	T	T	Dry prairies with scattered cabbage palms and wetter areas. Also occurs in improved pasture land and in relatively wooded areas with limited stretches of open grassland.	Vagrant. Does not occur in area of concern.
Sandhill Crane (*Grus canadensis pratensis*)	T	T	T	Prefers wet prairies, lake margins, low-lying improved cattle pastures, sparsely vegetated marshes, shallow-flooded open areas. Avoids forests, deep marshes, and areas of heavy human utilization.	Common winter visitor. Few breed on Paynes Prairie.
Florida Scrub Jay (*Aphelocoma coerulescens coerulescens*)	--	T	T	Resides permanently in oak scrub consisting of live oak, myrtle oak, Chapman oak, along with saw palmetto, sand palmetto, and scattered sand pine and rosemary. Avoids wet habitats and forests (including canopied sand pine stands).	Uncommon resident. Does not occur in the area of concern.
Great White Heron (*Ardea herodias occidentalis*)	--	T	SC	May feed in interior wetlands.	Sporadic. Does not occur in the area of concern.
Antillean Night Hawk (*Chordeiles minor vicivus*)	--	--	R	Feeds in the air over open terrain and nests in any large area of bare or lightly vegetated ground.	Common summer resident.
American Redstart (*Setophaga ruticilla ruticilla*)	--	--	R	Preferred breeding habitat is second growth deciduous woodland, usually with a canopy of larger, mature trees. Usually found in low, wet areas. Habitat tolerance much greater in migration.	Fairly common transient.
Louisiana Waterthrush (*Seiurus motacilla*)	--	--	R	Confined to wooded streams and swamps; can nest in cavity of roots of fallen trees or cavities in steep banks.	Uncommon summer resident.

Table 2.7-2 Rare and Endangered Vertebrates of Alachua County, Florida, Their Status, Preferred Habitat and Occurrence (continued)

Species	Status USDI[1]	Status FGFWFC[2]	Status FC[3]	Habitat Preference	Occurrence in Alachua County
Short-tailed Hawk (*Buteo brachyurus fuliginosus*)	--	--	R	Mature cypress, riparian hardwoods, mangroves, or pines, particularly adjacent to broad open prairie or marshland. Hunts over open or open-woodland interface, over clean, modern pasture or clearcut woodland edges.	Vagrant. Does not occur in the area of concern.
Little Blue Heron (*Florida caerulea*)	--	--	SC	Ponds, swamps, ditches, marshes.	Common resident.
Snowy Egret (*Egretta thula*)	--	--	SC	Marsh, swamp.	Common resident.
Louisiana Heron (*Hydranassa tricolor*)	--	--	SC	Lakes, marshes, cypress swamps, ditches, streams.	Common resident.
Black Crowned Night Heron (Nycticorax nycticorax)	--	--	SC	Swamps, lagoons.	Fairly common resident.
Yellow Crowned Night Heron (*Nyctanassa violacea*)	--	--	SC	Creeks, swamps.	Fairly common resident.
Least Bittern (*Ixobrychus exilis*)	--	--	SC	Marshes, ponds, swamps.	Not uncommon summer resident.
White Ibis (*Eudocimus albus*)	--	--	SC	Freshwater and estuarine wetlands. Nests on islands in lakes, marshes, or mangroves. Feeding requires shallow water (<8"). Nesting success depends on utilization of sequentially available feeding locations.	Locally common resident.
Cooper's Hawk (*Accipiter cooperii*)	--	--	SC	Breeds in wooded river bottoms and hammocks, generally near mixed woods and open country it prefers for hunting. May move to more open country out of the breeding season.	Unvommon resident.
Burrowing Owl (*Speotyto sunicularia floridana*)	--	--	SC	High sandy ground with little growth, particularly prairies, sandhills and pastures, less commonly sparse pine-lands with eroded limestone substrate containing pockets of sand.	Locally common resident. Does not occur in the area of concern.

Table 2.7-2 Rare and Endangered Vertebrates of Alachua County, Florida, Their Status, Preferred Habitat and Occurrence (continued)

Species	Status USDI[1]	Status FGFWFC[2]	Status FC[3]	Habitat Preference	Occurrence in Alachua County
White-breasted Nuthatch (*Sitta carolinensis carolinensis*)	--	--	SC	Prefers mature woodlands or at least large trees. In Florida prefers pines and probably does not breed in purely hardwood situations; may, however, forage there, especially during the breeding season.	Rare resident.
Hairy Woodpecker (*Dendrocopus villosus audubonii*)	--	--	SC	Various forested areas, pinelands, cypress stands, deciduous swamp forest and high areas.	Uncommon resident. Not presently in area of concern.
Worm-eating Warbler (*Helmitheros vermivorus*)	--	--	SC	In breeding season largely confined to steep slopes of deciduous woodlands and undergrowth. In migration (and presumably winter) likely to be found in a greater variety of wooded or even brushy areas.	Possible resident in winter. Probably a rare transient.
Merlin (*Falco columbarius*)	--	--	SU	Open country, seldom in forested areas unless large open areas exist for hunting. Most often seen near edges of open woodlands, salt marshes, mangroves, and along sea coasts.	Likely resident in winter.
MAMMALS					
Sherman's Fox Squirrel (*Sciurus niger shermani*)	--	T	T	Longleaf pine-turkey oak of sandhills. Remains in reduced numbers in turkey oak forests, especially where bayhead meets slash pine flatwoods and on margin of flatwoods cypress ponds.	Probable in suitable habitat.
Florida Mouse (*Peromyscus floridanus*)	--	T	T	Primarily sand pine scrub in an early successional stage but also occurs in longleaf pine-turkey oak, south Florida slash pine-turkey oak, and scrubby flatwoods assns. All are relatively xerix, open tree stands, clumps of scrubby oaks and other shrubs with scattered patches of bare ground, and well-drained sandy soils.	Likely, but only in areas of suitable habitat. Very tolerant of other than suitable conditions.

Table 2.7-2 Rare and Endangered Vertebrates of Alachua County, Florida, Their Status, Preferred Habitat and Occurrence (continued)

Species	Status USDI[1]	Status FGFWFC[2]	Status FC[3]	Habitat Preference	Occurrence in Alachua County
Southeastern Weasel (*Mustela frenata olivacea*)	--	T	R	No distinct preference. Found in sand pine scrub, cypress swamps, pine-palmetto flatwoods, live oak-cabbage palm hammocks, and old fields.	Rare in all locales.
Southeastern Shrew (*Sorex longirostris longirostris*)	--	--	R	Swamp forests and moist river floodplain forests, usually dominated by bald cypress, various bay trees, sweet gum, water tupelo and water oaks.	Probable resident.
Big Brown Bat (*Eptesicus fuscus*)	--	--	R	Buildings, bridges, hollow trees. Uncommon in caves.	Rare, presence unknown.
Hoary Bat (*Lasiurus cinereus cinereus*)	--	--	R	Roosts in the foliage of trees with dense cover above - open below.	Migrant, common in river swamps.
Southeastern Big-eared Bat (*Plecotus rafinesquii*)	--	--	R	Heavily forested regions. Roosts in old buildings in pine or hardwood forests. Also utilizes hollow trees but never found in Florida caves.	Sparingly present.
Round-tailed Muskrat (*Neofiber alleni*)	--	--	SU	Shallow emergent marshes. Prefers dense stands of maidencane and pickerelweed.	Common where present, possible in all but southwestern part of county.
REPTILES					
Short-tailed Snake (*Stilosoma extenuatum*)	--	E	E	Restricted chiefly to longleaf pine-turkey oak assns. Occasionally in upland hammocks, but only adjacent to longleaf pine-turkey oak stands.	Possible in areas of suitable habitat.
American Alligator (*Alligator mississippiensis*)	E	T	SC	Edges of large lakes and ponds, rivers, and interiors of swamps and freshwater marshes.	Located throughout county.

Table 2.7-2 Rare and Endangered Vertebrates of Alachua County, Florida, Their Status, Preferred Habitat and Occurrence (continued)

Species	Status USDI[1]	FGFWFC[2]	FC[3]	Habitat Preference	Occurrence in Alachua County
Suwannee Cooter (*Chrysemys concinna suwanniensis*)	--	T	T	Restricted to certain rivers and spring runs draining into the Gulf of Mexico. Reaches highest densities in areas of heavy *Naias* and *Sagittaria* growth including grassy flats off of river mouths. Apparently tolerant to broad variations of salt concentrations.	Possible, but not to any large extent. Lower portion of Rocky Creek, if at all.
Gopher Tortoise (*Gopherus polyphemus*)	--	T	T	Dry, well drained soils, especially beach scrub, sand pine, longleaf pine-turkey oak and live oak hammock and old field successional stages leading to these.	Resident in suitable habitats.
Striped Newt (*Notophthalmus perstriatus*)	--	--	R	Most frequently in flatwoods ponds in pine-palmetto habitats. Also in sinkhole ponds and in ponds in scrub or sandhill areas. Terrestrial newts usually found in well-drained sandy areas under debris. Only occasionally in same ponds with the spotted newt.	Reported resident.
Gulf Hammock Dwarf Siren (*Pseudobranchus striatus lustricolus*)	--	--	SU	Occurs in cypress and flatwoods ponds, drainage ditches and smaller floodplain lakes, independent of terrestrial plant assns. Principle habitat is water hyacinth (where is occurs).	Possible in southwestern part of county.
FISH					
Mud Sunfish (*Acantharchus pomotis*)	--	--	R	Low gradient, often blackwater, streams and ponds with heavy growths of submergent aquatic vegetation and a bottom of mud and organic detritus.	Possible occurrence throughout county. Found near Gainesville.
Suwannee Bass (*Micropterus notius*)	R	R	R	River and shoal areas having a moderate to swift current, a bottom comprised of limestone, and water of high pH and hardness. Also springs and spring runs.	Common in the Santa Fe River, especially the lower portion.

[1]USDI's FWS Endangered and Threatened Wildlife and Plants. Federal Register, Vol. 41, No. 208, Wednesday, October 27, 1976. Part IV.
[2]Florida Game and Fresh Water Fish Commission (FGFWFC), Endangered and Threatened Species Included in the Wildlife Code. Effective July 1975.
[3]Florida Committee on Rare and Endangered Plants and Animals (FC), Florida Audubon Society, 1974.

Table 2.7-3 Summary of the Number of Classified Species of Vertebrates

Status	Birds	Mammals	Reptiles/ Amphibians	Fish
Endangered	6	0	2	0
Threatened	6	3	4	0
Rare	4	3	3	2
Special Concern	12	0	0	0
Status Undetermined	1	1	2	0

Threatened Vertebrates

Sherman's Fox Squirrel

This subspecies is listed as threatened by both the Florida Committee and the FGFWFC, but remains unlisted by the USDI (1976). Most of the primary habitat of this fox squirrel has been lost through logging or planting in citrus crops. Mostly suboptimal habitats remain, such as pure turkey oak forests, flatwoods/cypress ponds, and bayhead/flatwood ecotones. These suboptimal habitats are, and will continue to be, under intense pressure for development.

Eastern Indigo Snake

Listed by the State of Florida as threatened, by the Florida Committee as a species of special concern, and by the USDI as neither endangered nor threatened, this snake inhabits dry, sandy areas, but is characteristic of moister habitats, such as flatwoods.

Florida Gopher Frog

The Florida Committee lists this amphibian as threatened. It has been recorded as moving well over a mile to reach suitable breeding sites which are generally recorded as grassy cypress ponds.

Rare Vertebrates

Southeastern Shrew

In Florida, this mammal has been found to inhabit moist river floodplain forests or swamp forests. Moist and well vegetated soil along streams is a preferred habitat.

Hoary Bat

This rare mammal is a migrant to the study area; however, it is common in the river swamp habitat for three weeks in autumn and three weeks in spring.

American Redstart

The recorded nesting habitat in Florida for this rare bird is mature deciduous woodlands (with undergrowth) along streams.

Louisiana Waterthrush

This rare bird is confined to wooded streams and swamps.

Spotted Turtle

This reptile is listed as rare by the Florida Committee. Habitat preference is generally boggy or swampy areas of shallow water. Its occurrence in marshy areas of Turkey Creek and Sanchez Prairie or lowland cypress areas of Rocky Creek is a possibility.

Striped Newt

This amphibian is listed as rare by the Florida Committee. It is frequently collected in flatwood ponds and sinkhole ponds.

Mud Sunfish

The mud sunfish is in no immediate danger of being endangered or threatened, but it is regarded as rare (Dr. Carter Gilbert, Florida State Museum). It is commonly associated with low gradient black water streams and ponds.

Suwannee Bass

The Suwannee bass, a popular game fish, is the only species of fish yet discovered that is endemic to the Suwannee and Ochlockonee river systems. It is classified as rare because of its restricted range, though there is little reason to suspect that this species is substantially less common than it ever was.

Vertebrate Species of Special Concern

Little Blue Heron, Snowy Egret, Yellow Crowned Night Heron

These herons, and possibly others listed as species of special concern, may utilize the low wet areas of all three creek basins. Sanchez Prairie contains a little blue heron rookery and the Rocky Creek swamps are potentially useful foraging sites for all three species.

White Ibis

This bird is listed as a species of special concern by the Florida Committee. White ibis feed in shallow water and are common residents of the area.

Copper's Hawk

This raptor is classified as a species of special concern by the Florida Committee. Copper's hawk may use portions of Sanchez Prairie and the Rocky Creek swamps as breeding habitat. The bird is, however, an uncommon resident in the project area.

Hairy Woodpecker

This uncommon area resident is classified as a species of special concern by the Florida Committee. The hairy woodpecker inhabits various forest types, including swamp forests.

Plants

There are two plants listed as endangered, two as threatened, and eight as rare by the Florida Committee on Rare and Endangered Plants (1974) which are known to occur in Alachua County. The habitat preference and occurrence of these twelve plants are summarized in Table 2.7-4. Both of the endangered plants - the dwarf spleenwort (Asplenium pumilum) and the sinkhole fern (Blechnum occidentale) are not known to occur to any of the three drainages; however, their occurrence is highly possible within the calcareous ravine at Split Rock Sink.

Needle palm (Rhapidophyllum hystrix) and the cycad coontie (Zamia integrifolia), which are listed as threatened, have been reported to occur within San Felasco Hammock (Alachua Audubon Society, 1973). Needle palm has been found within deep ravines, while coontie has been found within one of the longleaf pine/turkey oak forests of the hammock (Ward, 1977).

Of the rare plants listed by the Florida Committee, Venus'-hair fern (Adiantum capillus-veneris), pond-spice (Litsea aestivalis), poppy mallow (Callirhoe papaver), and green adder's-mouth (Malaxis unifolia) are the species most probably occurring in the area of concern. The deep ravines

Table 2.7-4 Endangered, Threatened, and Rare Plants Known to Occur in Alachua County, Their Habitat Preference, and Occurrence in the Project Area

Species	Habitat Preference	Occurrence in Alachua County	Occurrence in Project Area
ENDANGERED			
Asplenium pumilum (Dwarf Spleenwort)	Only found on limestone or other calcareous rocks in moist hammocks.	West of Interstate 75 near Newberry.	Not known to occur in area; possible.
Blechnum occidentale (Sink-hole Fern)	Deep shaded ravines or elsewhere in moist and dense hammocks; occassionally on sheer rock walls of deep sinkholes.	Deep sinkholes north of Newberry.	Not known to occur in area; possible.
THREATENED			
Rhapidophyllum hystrix (Needle Palm)	Sinkholes and ravines; shaded spots.	Near Millhopper and San Felasco Hammock.	Found in shaded ravines in San Felasco Hammock.
Zamia integrifolia (Coontie)	Nigh, dry pine area.	Found in southern and central Alachua County which is northeastern-most range.	Found in San Felasco Hammock in one longleaf pine-turkey oak community.
RARE			
Adiantum capillus-veneris (Venus'-hair Fern)	Shady, calcareous slopes and rocks; sinkholes.	Paynes Prairie and Millhopper.	Not known to occur in area; possible.
Brickellia cordifolia (Flyr's Nemesis)	Dry upland woods and at times under large live oaks.	Known from the southern portion of San Felasco Hammock.	Known to occur in San Felasco Hammock.
Callirhoe papaver (Poppy Mallow)	Dry sandy woods and edge of woods.	Known from southern portion of San Felasco Hammock.	Not known to occur in area; may occur in Mulatto Pen Branch basin.
Drosera intermedia (Water Sundew)	Bogs, savannahs and wet ditches; often in standing water.	Known only from a prairie in eastern Alachua County.	Not known to occur in area.
Litsea aestivalis (Pond-spice)	Found along pond and swamp margins and low wet woodlands.	Known from San Felasco Hammock.	Possible in Sanchez Prairie.
Malaxis unifolia (Green Adder's-mouth)	Bogs, meadows, and moist slopes of forests.	Millhopper and San Felasco Hammock.	Possible in Sanchez Prairie.
Peltandra sagittifolia (Spoon-flower)	Bogs.	Single specimen known from edge of Newnan's Lake.	Not known to occur in area.
Polygonum meisnerianum (Mexican Tearthumb)	Moist muck soil and swamp areas.	Known in Florida only on portion of Newnan's Lake.	Not known to occur in area.

and limestone boulders within San Felasco Hammock provide suitable habitat for Venus'-hair fern, and the Sanchez Prairie fringe offers suitable habitat for pond-spice and green adder's-mouth. Poppy mallow has been reported in mixed woods in the southern portions of San Felasco Hammock. This rare plant is not expected to occur in Sanchez Prairie; however, it may occur within suitable mixed woods along all three creeks. The four remaining rare species listed are not expected to occur in the area of concern. Flyr's nemesis (Brickellia cordifolia) is not expected in Sanchez Prairie, but has been found in another part of San Felasco Hammock (Ward, 1977).

In addition to the above plants, the proposal to purchase San Felasco Hammock submitted to the State of Florida by the Alachua Audubon Society (1973) mentions that a sizable proportion of the entire population of bluff oaks (Quercus austrina) is within San Felasco Hammock. This rare white oak is associated with the rich well drained soils of mesic hammocks.

The proposal also mentions the occurrence of a "relatively rare forest type", the water elm swamp. This swamp is dominated by water elm and Carolina ash and "occupies about 100 acres ... of ... Sanchez Prairie and a few other small tracts". The proposal also reports that a very rare spleenwort, one-sorus spleenwort (Asplenium monanthes) occurs on limestone boulders in several ravines. Lt. K. C. Alvarez (Department of Natural Resources, 1973) on a reconnaissance of San Felasco Hammock reported the presence of this spleenwort and the bead fern (Onoclea sensibilis). The bead fern is unusual to the south and was found to be abundant in a ravine outside the areas of interest.

No other endangered, threatened, or rare plants are known to occur in the Sanchez Prairie area. None of the above species were recorded outside of San Felasco Hammock during field surveys. With the exception of the water elm swamp, none of the above species has been affected by present Deerhaven Unit 1 operations, nor have they been observed in the area affected by Deerhaven Unit 1. The water elm is in those portions of Sanchez Prairie affected by present Deerhaven operations (Section 2.7.3.1).

2.7.2.2.2 Unique or Sensitive Areas - San Felasco Hammock and Sanchez Prairie

The San Felasco Hammock, which includes Sanchez Prairie, is a 5,200 acre parcel of land located southwest of the proposed plant site between Gainesville and High Springs. In 1974, the area was purchased by the State of Florida under Environmentally Endangered Lands Program in order to protect the unique combination of geological and biological features from cultural modification.

Geologically, the San Felasco area contains an exceptional localization of solution and erosion features which illustrate the formation of Karst topography and groundwater recharge in Karstic areas (Alvarez, 1973). As a biotic area, it includes a sample of almost every natural community and animal habitat in the north-central part of the state. Included among these are 220 acres of longleaf pine flatwoods, 340 acres of sandhills, 980 acres of southern red oak forest, 2,640 acres of mesic hammock (the largest remaining example of this community type in Florida), 360 acres

of hydric hammock, 180 acres of forested swamp, 10 acres of marsh, 100 acres of ponds, and 50 acres of planted pine (Alvarez, 1973). A detailed description of the floral and faunal communities, geology, and other significant features of San Felasco Hammock is provided in the Florida Audubon Society Proposal to purchase these lands which was submitted to the State Department of Natural Resources in 1973.

The Sanchez Prairie is an excellent example of the successional development of larger prairies in the region. The area is about 330 acres in size and is occupied by hydric hammock and swamp communities.

Several species of plants and animals classified as endangered, threatened, rare, or "status undetermined" inhabit San Felasco Hammock and Sanchez Prairie. These include several small herbaceous plants, three trees, and two birds (Alvarez, 1973). A detailed consideration of endangered, threatened, and rare species is provided in Section 2.7.2.2.1.

The existing encroachments on San Felasco Hammock include two roadways, a power line, the present cooling tower blowdown and surface drainage from several housing communities which drain via Turkey Creek into Sanchez Prairie. The effects on Sanchez Prairie of current Deerhaven discharge are considered in detail in Section 2.7.3.1.

Wetlands

Wetlands are of considerable value in maintaining natural hydrologic systems and in supporting diverse food chains and fish and wildlife resources. However, they are particularly sensitive to alteration by drainage, filling, and pollution (USDI, 1975).

The most significant wetland type encountered within five miles of the Deerhaven station is the wooded swamp. These are predominantly cypress swamps, with mixed hardwood and bayhead swamps also occurring but occupying less total acreage (Section 2.7.2.1). Most (particularly those in the managed pinelands east of the site) have been channelized to promote drainage. However, there are several swamps in the area which, because of certain unique features, are deserving of special mention.

Along Rocky Creek are two mixed hardwood swamps (132 acres) located about three miles southeast of LaCrosse. These swamps, which are perhaps the most significant feature along Rocky Creek, are encircled by a thin fringe of southern mixed hardwood forest and by crop and pasture land (Section 2.7.3.3). There are also several large (greater than 100 acres) cypress "heads" to the east and north of the site. Due to their isolation from human activity and/or their size and maturity, each of these swamps offers an especially suitable breeding and refuge habitat for local wildlife.

There are two swamps worthy of note in the San Felasco Hammock area. One is an 80 acre, hardwood-bald cypress swamp located at the mouth of Blue's Creek. It supports a closed canopy of trees, some of which are more than 100 feet tall. The other is a relatively rare type in Florida, a water elm swamp, which occupies about 100 acres in Sanchez Prairie.

A scattering of small ponds and a few shallow freshwater marshes are also found within five miles of the site. The ponds vary considerably in both size and vegetation. Many are covered with floating plants such as duckweed (*Lemna* sp.), floating heart (*Nymphoides aquatica*) and frog's bit (*Limnobium spongia*). Freshwater marshes are occasionally found where streams pass through level, low-lying depressions. The vegetation consists of buttonbush and various grasses and sedges. Although these wetlands are too small and isolated to be of individual importance, they do contribute to the habitat diversity of associated land areas and aquatic systems.

There are no permanent lakes within the five mile radius. An intermittantly flooded 30 acre basin known as Prairie Lake is located on private agricultural land about three miles north of the site. This lake receives water from Rocky Creek during high flow conditions and upon a drop in water level forms a small lake. The lake bed is currently dry (July, 1977) and is used as pastureland.

Devil's Millhopper

Because of the predominance of agricultural land and pine plantation in the project area, few other sensitive features need be noted. The Devil's Millhopper, a large sinkhole two miles northwest of Gainesville on S-232 and 3.6 miles southwest of the Deerhaven stack, is now designated a State Geological Site. This bowl-shaped sink has a diameter of 500 feet and a depth of about 120 feet. It was formed through erosion of underground limestone deposits and the subsequent collapse of the resulting cavern. The Devil's Millhopper is a valuable site for geologists and paleontologists, because of the exposure of rock strata and the abundance of fossils. Much of the flora and fauna are typical of ravines in the southern Appalachians. This area is physically isolated from present Deerhaven operations.

Rookeries

There is a rookery for cattle egrets and little blue herons, 250-700 breeding pairs, in Sanchez Prairie (Nesbitt, 1977), but no other rookeries or nesting sites exist in the project area (Nesbitt, 1977 and Owens, 1977).

2.7.3 Drainage Basins and Stream Ecology Within the Project Area

The Deerhaven site is located in the upper reaches of several small watersheds (Figures 2.2-1 and 2.2-2). Most of the site and all of the blowdown water from Deerhaven Unit 1 currently drain into Turkey Creek. Rocky and Cellon Creek basins meet near the northern property boundary. Several other watersheds are within five miles of Deerhaven, but are not linked directly with the site. Cursory descriptions of these streams

are presented in Section 2.7.3.4. Descriptions of the watersheds, surface water hydrology, and water quality of Turkey, Cellon and Rocky Creeks are presented in Section 2.5. Sections 2.7.3.1 through 2.7.3.3 present ecological analyses of Turkey, Cellon and Rocky Creeks.

Streams within the project area are detritus - forced systems; that is, organic debris from terrestrial and aquatic vegetation provides energy for aerobic and anaerobic bacteria and detritivorous macroinvertebrates, which in turn are fed upon by predatory invertebrates and vertebrates. The vertebrate food chain includes such higher order consumers as fish, amphibians, reptiles, and terrestrial forms such as wading birds and small predatory mammals.

Detritus input from terrestrial sources is determined by vegetation, topography and land use adjacent to the stream. Pastureland, for instance, contributes little detritus, though it may add to the nutrient loading of the water. Growth of aquatic herbaceous vegetation is influenced by the relative degree of shading, the amount and consistency of flow, and the depth of water. Where aquatic herbs grow in abundance, their contribution into the detritus pathway is significant.

Local conditions may vary greatly along a stream, creating distinct aquatic habitats or subsystems, each of which contributes uniquely and in sequence to the stream's overall character. For each of the three drainage systems linked to the Deerhaven site, functional aquatic sub-

systems and their forcing functions (those factors responsible for directing materials or energy through components of a system) have been identified (Breedlove, 1976) and are described in sequence from the headwaters to the point of stream discharge. The extent and taxonomic composition of benthic macroinvertebrate populations have also been examined in Turkey, Cellon and Rocky Creeks and subjected to analysis using Beck's Biotic Index (Beck, 1955), Shannon-Weaver diversity, and equitability (EPA, 1973). Higher order consumers - fish, amphibians, and reptiles - have been described for the three streams. Finally, those amphibians and reptiles regarded as endangered (E), threatened (T), rare (R), of special concern (SC), or of undetermined status (SU) are mentioned as to their probable occurrence in each creek basin.

2.7.3.1 Turkey Creek

Figures 2.7-1 and 2.7-2 present the creek channel profiles, associated ecological subsystems and major vegetation associations for Turkey Creek. The creek has several distinct segments. The headwater segment is characterized by low gradient sandy channels connecting cypress domes within the pine flatwoods community. Deerhaven is located at the headwaters of one of the various branches that forms Turkey Creek. The intermediate channel is more steeply sloped and surrounded by a mixture of pasture and mixed hardwoods forest. This channel is well-defined with relatively high velocities. Within this segment a small spring originating near Hague provides additional water to the creek. The third segment is occupied by a part of the Sanchez Prairie hydric hammock forest.

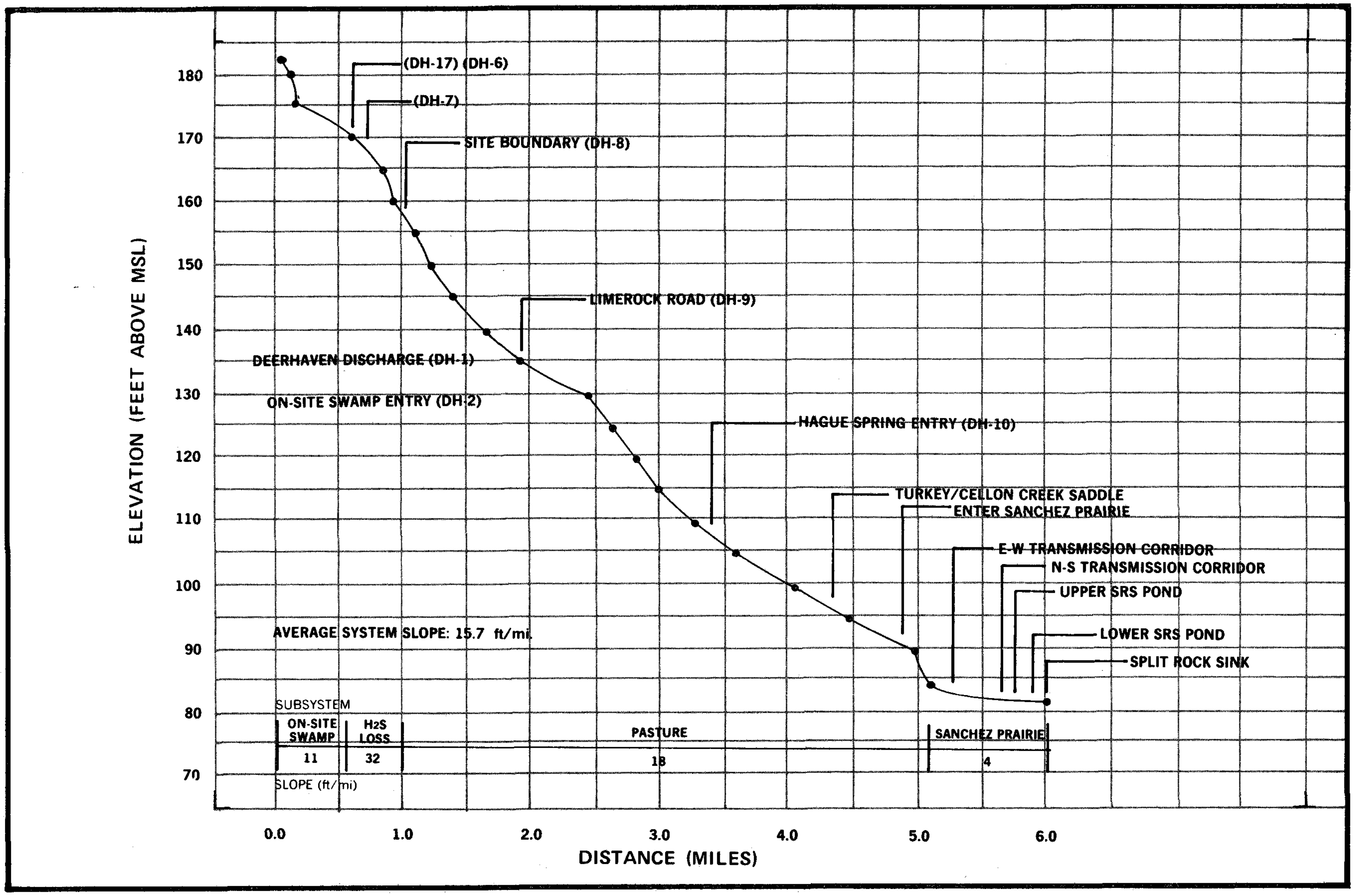


FIGURE 2.7-1 TURKEY CREEK CHANNEL PROFILE, ASSOCIATED ECOLOGICAL SUBSYSTEMS AND SLOPES.

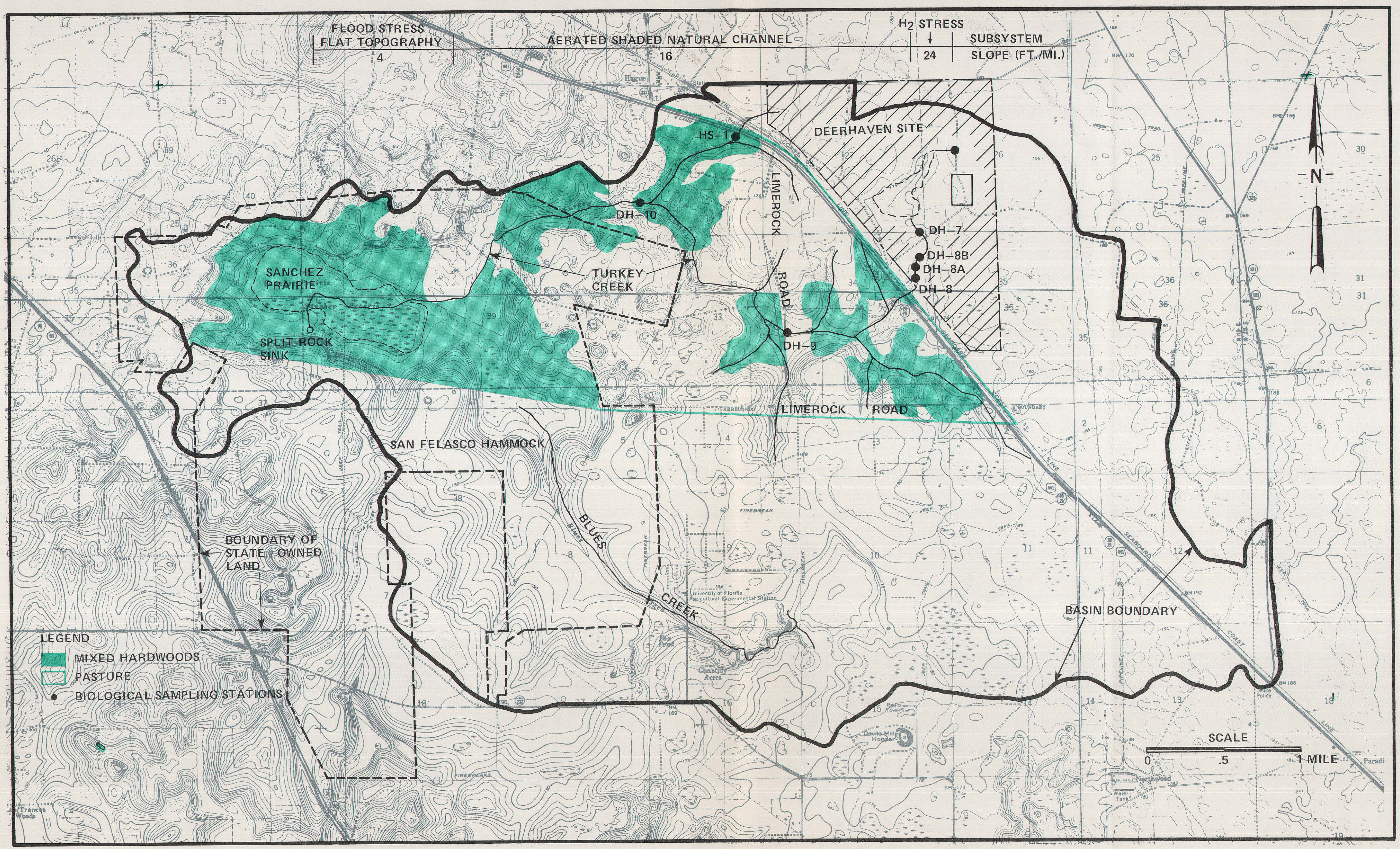


FIGURE 2.7-2 TURKEY CREEK ECOLOGICAL SUBSYSTEMS AND VEGETATION ASSOCIATIONS.

This portion of Turkey Creek is a low gradient stream characterized as a slow-moving sheet flow connected by marshy, low banked channels. Prior to entering Split Rock Sink the creek flows into a shallow pond surrounded by water elm, pop ash and willow.

Aquatic Subsystems and Forcing Functions

Turkey Creek is considered to have three distinct subsystems: (1) The Deerhaven site subsystem; (2) the natural well-defined channel segment; and (3) the Sanchez Prairie subsystem. Each of these subsystems may have one or more forcing functions which largely govern its character and composition and energy flow through it.

The Deerhaven discharge canal, on-site cypress swamp, and exit canal comprise an aquatic system that is largely influenced by blowdown released from Deerhaven Unit 1. The discharge canal is a steep-sided ditch containing a soft sand substrate, cattails, and a bank growth of wax myrtle and broom sedge. The flow is shallow, warm, well-oxygenated and has high sulfate, dissolved solids, conductivity, and temperature.

A 28 acre cypress dome receives the blowdown from the discharge canal. Chronic flooding due to a relatively constant increased discharge within this portion of a naturally intermittent creek and conversion of sulfate to hydrogen sulfide due to anaerobic conditions in the swamp have resulted in the stressing of water tolerant cypress and blackgum and a lack of benthic macroinvertebrates (Breedlove, 1975 and 1976a). Hydrogen sulfide

concentrations within portions of the Deerhaven site are considerably above toxic levels for virtually all aquatic organisms. Berger and Eichler (1975) have shown in addition that the dome acts as an effective heat sink.

The discharge stream from the cypress dome to the site boundary is well mixed and oxygenated and serves to remove hydrogen sulfide from the water. The upper part of this zone has been channelized, is well shaded and has a white substrate coating of sulfide-oxidizing bacteria. In a study of upper portions of Turkey Creek Breedlove (1975) did not detect hydrogen sulfide below the site boundary. The point of zero hydrogen sulfide concentration is 1,000 feet upstream of the site boundary. The loss rate of hydrogen sulfide was calculated to be 1.0 mg/l per 185 feet of stream channel (Figure 2.7-3).

From the Deerhaven site to Sanchez Prairie, Turkey Creek passes through permanent pasture and mixed hardwoods. Area land use is shifting toward suburban development (Section 2.2). Discharge into this subsystem is derived from Deerhaven Unit 1, cypress dome runoff, the developing area west of U.S. 441, pasture runoff, and a small spring run. However, in terms of volume, Deerhaven Unit 1 blowdown is presently the major source of water and, due to its constant input, prevents seasonal drying of the creek. The velocity of water is relatively high and tends to keep the creek well mixed and oxygenated. Erosion and scour is not thought to be a major factor in the upper portion of this segment.

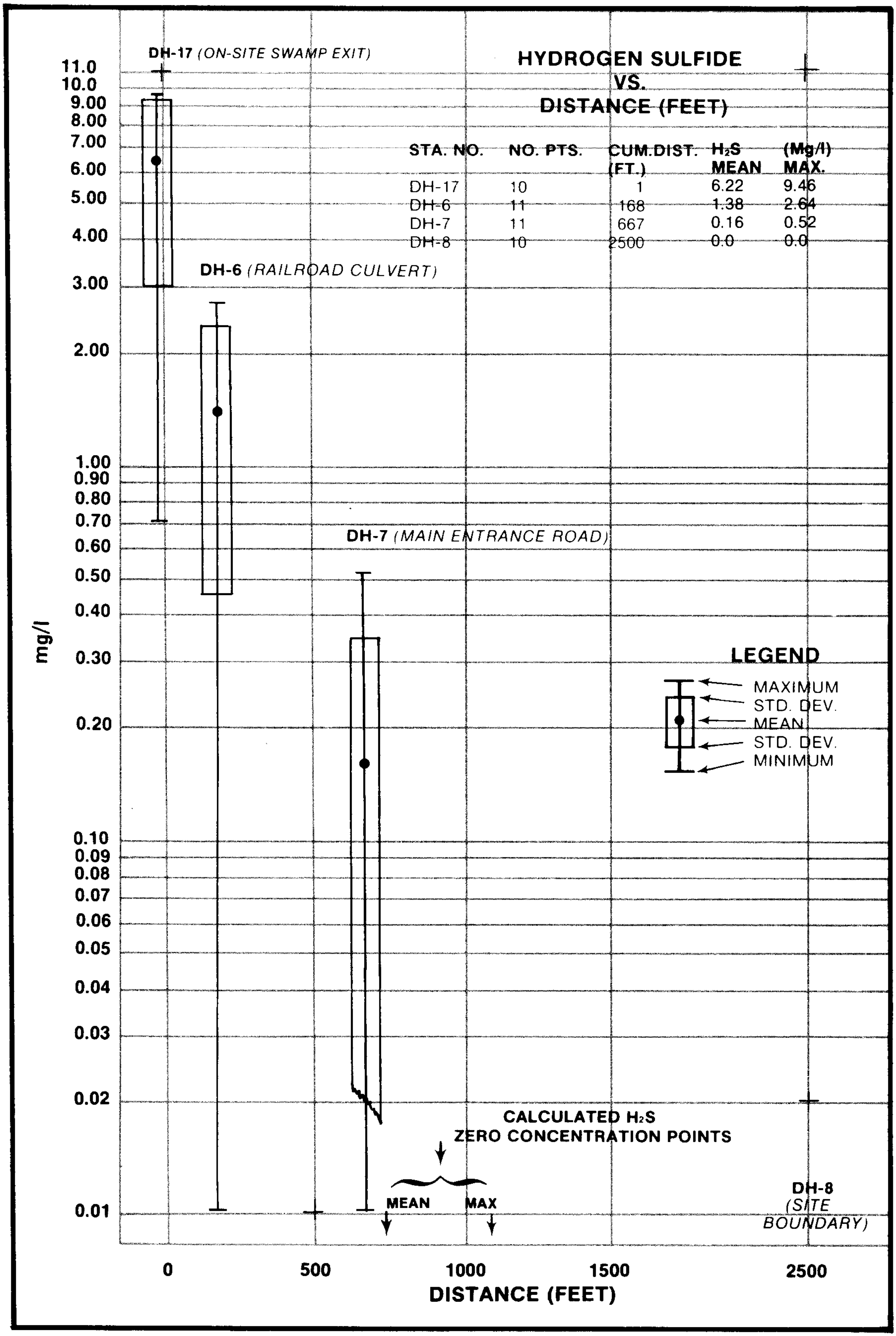


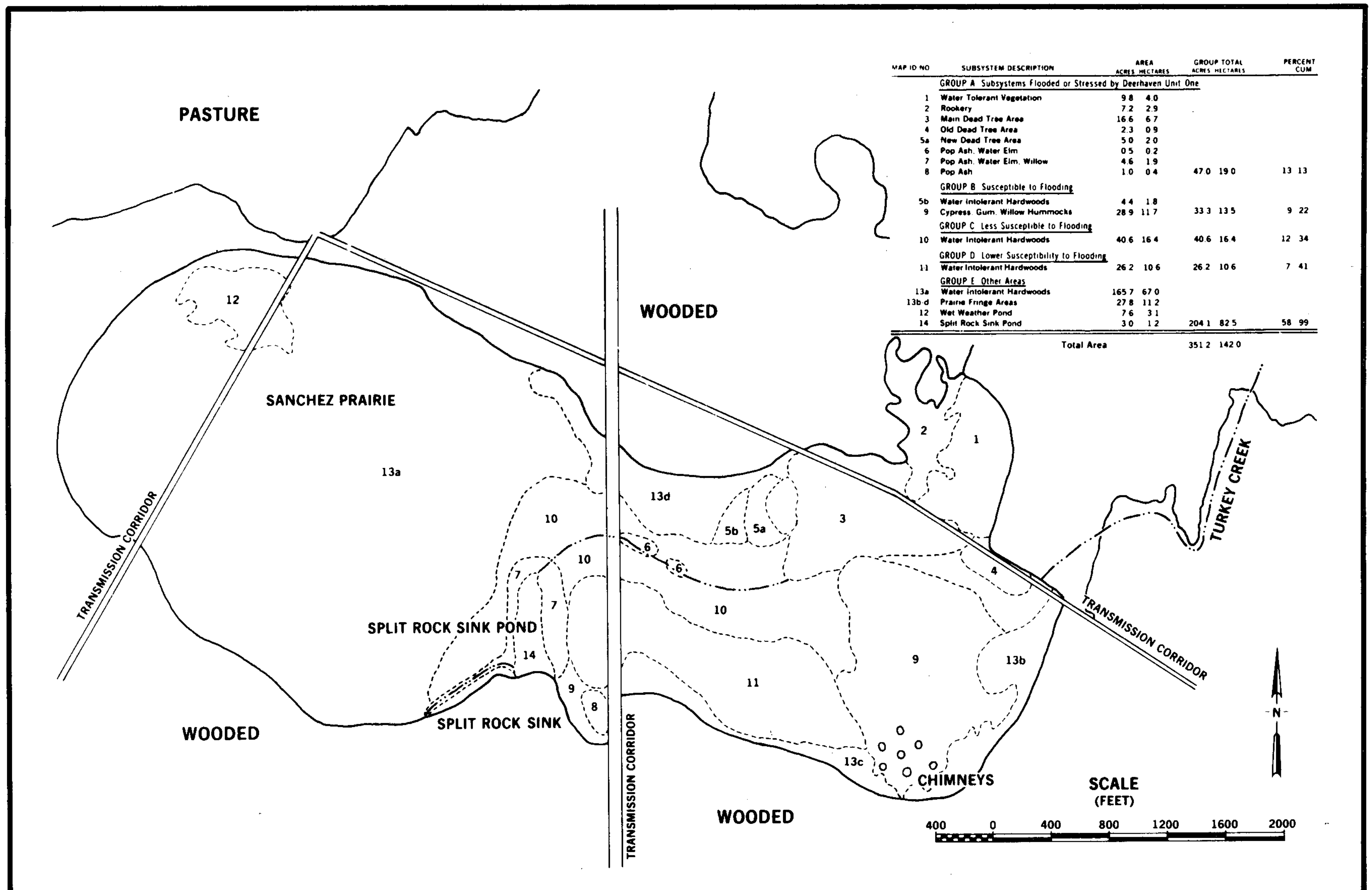
FIGURE 2.7-3 RELATIONSHIP BETWEEN DISTANCE AND HYDROGEN SULFIDE CONCENTRATION BELOW THE DEERHAVEN STATION ON-SITE SWAMP.

Aquatic vegetation grows along the stream edge and aufwuchs (growths of periphyton, i.e. algae and associated invertebrates) cover the available substrates. Coarse and finely-divided detritus occurs in pools and as layers in sand bars.

At the point of entry into the Sanchez Prairie hydric hammock, Turkey Creek stream gradient decreases (Figure 2.7-1) and the water spreads out of its banks and begins to move as sheet flow. Apparently, the channel has been recently filled with sediment and aquatic herbs.

Flow spreading in the area, adjacent to and downstream of the channel, has chronically flooded an area of water-intolerant woody vegetation (Figure 2.7-4, map I.D. Number 3; Figure 2.7-5) and maintained shallow standing water in areas of water-tolerant woody vegetation (Figure 2.7-4, map I.D. Number 4). In addition, a newly flooded area (Figure 2.7-4, map I.D. Number 5) has been recently created. Several small areas also show limited signs of stress on some trees (Breedlove, 1977). Around Split Rock Sink Pond, the water elm patches (Figure 2.7-4, map I.D. Number 6) and the pop ash and willow stands are dead or stressed as a result of chronic flooding.

It is not known presently whether hydrogen sulfide production in this portion of Sanchez Prairie due to low oxygen concentrations is responsible for any of the stressed areas. High concentrations do exist in the sediment of Sanchez Prairie (Breedlove, 1977).



MAP ID NO	SUBSYSTEM DESCRIPTION	AREA ACRES	AREA HECTARES	GROUP TOTAL ACRES	GROUP TOTAL HECTARES	PERCENT	CUM
	GROUP A Subsystems Flooded or Stressed by Deerhaven Unit One						
1	Water Tolerant Vegetation	9 8	4.0				
2	Rookery	7.2	2.9				
3	Main Dead Tree Area	16.6	6 7				
4	Old Dead Tree Area	2.3	0 9				
5a	New Dead Tree Area	5 0	2 0				
6	Pop Ash, Water Elm	0 5	0.2				
7	Pop Ash, Water Elm, Willow	4.6	1.9				
8	Pop Ash	1.0	0 4	47.0	19 0	13	13
	GROUP B Susceptible to Flooding						
5b	Water Intolerant Hardwoods	4 4	1.8				
9	Cypress, Gum, Willow Hummocks	28 9	11 7	33 3	13 5	9	22
	GROUP C Less Susceptible to Flooding						
10	Water Intolerant Hardwoods	40.6	16 4	40.6	16.4	12	34
	GROUP D Lower Susceptibility to Flooding						
11	Water Intolerant Hardwoods	26 2	10 6	26.2	10 6	7	41
	GROUP E Other Areas						
13a	Water Intolerant Hardwoods	165 7	67 0				
13b-d	Prairie Fringe Areas	27 8	11 2				
12	Wet Weather Pond	7 6	3 1				
14	Split Rock Sink Pond	3 0	1 2	204 1	82 5	58	99
	Total Area			351 2	142 0		

FIGURE 2.7-4 SANCHEZ PRAIRIE VEGETATION ASSOCIATIONS AND PROBABLE SEQUENCE OF FLOODING.

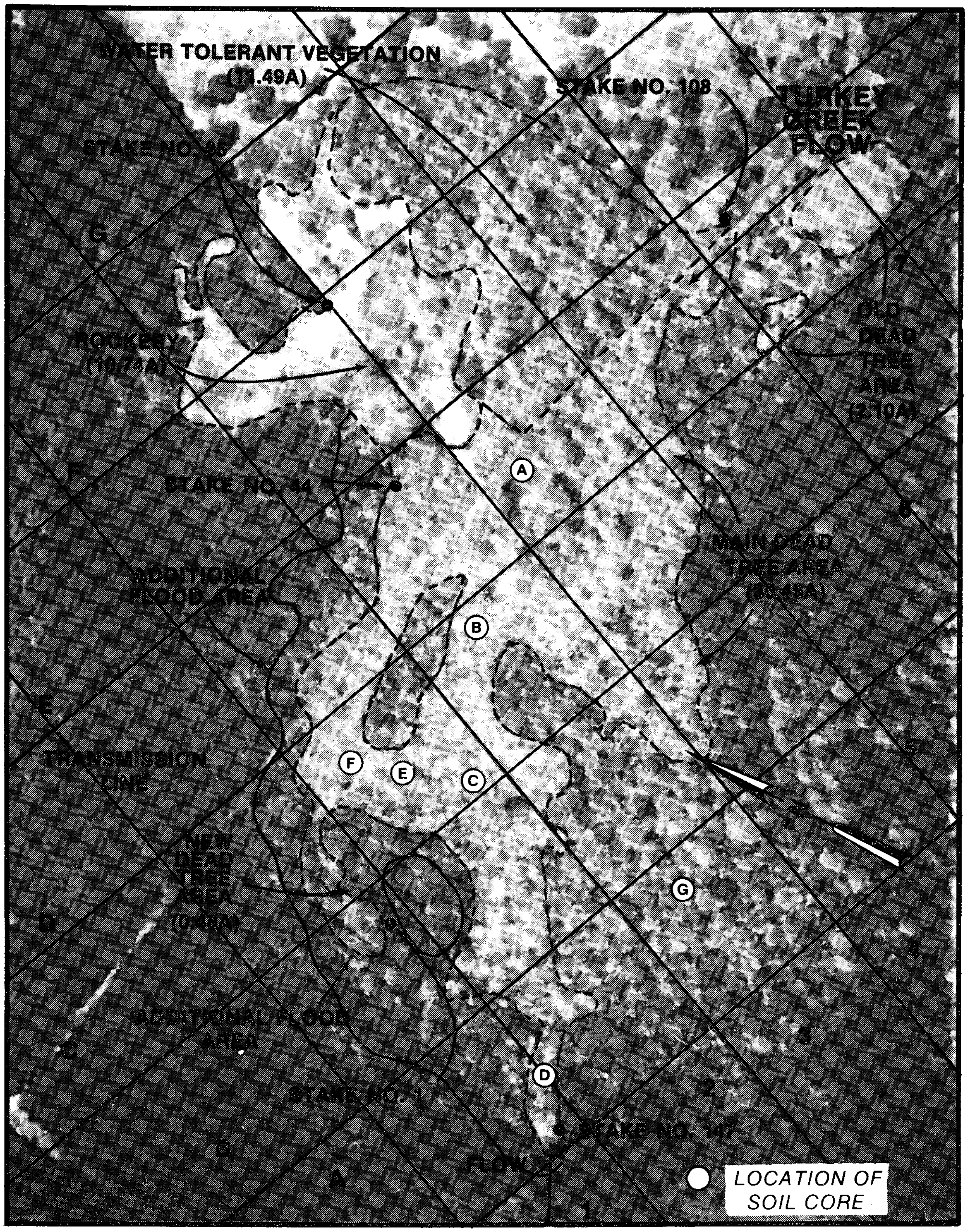


FIGURE 2.7-5 UPPER SANCHEZ PRAIRIE FLOODED AREA.

Animal Life

Macroinvertebrates - Benthic macroinvertebrates are generally characterized as relatively long-lived and relatively immobile. Therefore, they are commonly used as indicators of water quality conditions. As mentioned previously, Turkey Creek has a stable base flow and high sulfate, total dissolved solids, and specific conductance as a result of Deerhaven Unit 1. Hydrogen sulfide is produced under the low oxygen levels of the on-site cypress dome and Sanchez Prairie aquatic sediment.

Figure 2.7-6 shows the station locations for benthic macroinvertebrate collections. A summary of the macroinvertebrates collected at these stations is presented in Tables A2-48 through 61 and Table 2.7-5.

Breedlove (1975) showed that the species composition and biotic indices of macroinvertebrates collected at the on-site swamp were quite low. Breedlove (1977) later showed that no intolerant organisms were collected from the on-site stream with high hydrogen sulfide concentrations. Those species present are predominantly pollution tolerant Oligochaetes and Chironomids, which tolerate low dissolved oxygen conditions. From the site boundary to Sanchez Prairie the species composition and biotic indices of macroinvertebrates were indicative of clean water conditions, or of essentially baseline faunal conditions in Florida streams (Breedlove, 1975, 1977).

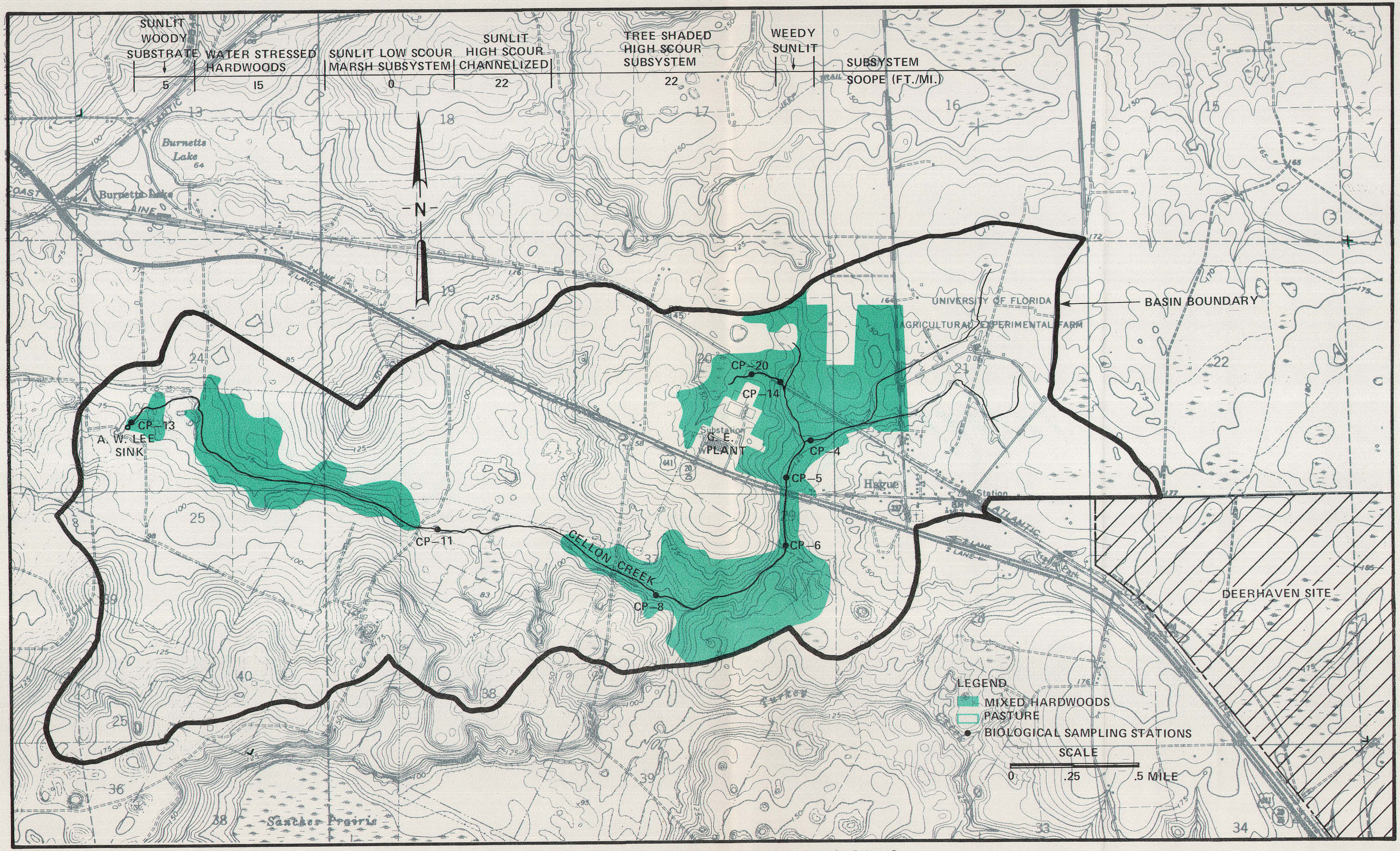


FIGURE 2.7-6 CELLON CREEK ECOLOGICAL SUBSYSTEMS.

Table 2.7-5 Benthic Macroinvertebrate Taxa Collected From Turkey Creek and Ranked According to Beck's Tolerance Classifications

	Class I (Intolerant)	Class II (Facultative)	Class III (Tolerant)	Class IV (Air-breathing)	Class V
	Agria sp	Stenelmis sp.	Physa sp.	Belostoma sp.	Aeschna sp.
	Corydalus cornutus	Polypedilum tritum	Oligochaeta	Dineutus sp.	Boyeria sp.
	Macromia sp.	Gomphus sp.	Sphaerium sp.	Trichocorixa sp.	Tetragoneuria sp.
	Polypedilum halterale	Cheumatopsyche sp.	Bezzia sp.	Peltodytes sp.	Campeloma sp.
	Progomphus obscurus	Dubiraphia sp.	Chironomus attenuatus	Ranatra sp.	Chromagrion sp.
	Pyralididae sp.	Procambarus sp.	Chironomus fulvipilus	Tipulidae sp.	Hyponeura sp.
	Steanonema sp.	Calopteryx sp.		Veliidae sp.	Cordulagaster sp.
		Agrion sp.			
		Dicrotendipes sp.			
		Lampsilis sp.			
		Microcyllaepus sp.			
		Nematoda			
		Enallagma sp.			
No. Taxa:	7	13	6	7	7
Percent of Total:	17.5%	32.5%	15.0%	17.5%	17.5%

Total No. Taxa = 40

Turkey Creek BI = 27

The appearance of Stenonema (mayfly) and Acrocuria (stonefly) near Sanchez Prairie indicated that present conditions would support a diverse fauna (Breedlove, 1975). Similar findings were reported by Breedlove (1977) when burrowing dragonfly species (Gomphus sp. and Progomphus sp.) were collected.

Collection replicate diversity and equitability values were quite variable because of the low number of organisms collected (Table 2.7-6); however, no diversity equal to or greater than three was obtained for any sample replicate or composite of replicates for any station or subsystem of the creek (Table 2.7-6). Equitability values may range from 0-1.00 with levels below 0.5 indicative of some degree of pollution. Equitability values greater than one are indicative of an insufficient number of organisms collected (EPA, 1973). Compositing by subsystems appeared to improve the usefulness of the equitability value and the system composite of 0.37 appears to be valid.

Fish - Four species of fish were collected in Turkey Creek, all of which are considered relatively tolerant of pollution (McKee and Wolf, 1971). The dominant species was Gambusia affinis (Table 2.7-7). Largemouth bass (Micropterus salmoides) and bowfin (Amia calva) have been observed in the pond area around Split Rock Sink (Breedlove, 1975). Low standing crop (Table 2.7-7) and the presence of bass and bowfin in the only significant area of pooled water indicate that habitat is a major limiting factor in Turkey Creek. The standing crop values indicate that the creek is not capable of supporting a sport fishery.

Table 2.7-6 Turkey Creek Benthic Macroinvertebrate Shannon-Weaver Diversity and Equitability Based on Replicated Ekman Grabs

Sta. No.	No. Species	Shannon-Weaver Diversity DBAR	Equitability	
11	1	0.0	1.00	DH-1
15	1	0.0	1.00	
61	3	1.27	0.98	
62	2	0.68	0.92	
63	2	0.91	1.11	DH-6
64	1	0.0	1.00	
65	3	0.85	0.69	
71	4	1.52	0.91	
72	5	1.00	0.48	
73	4	1.68	1.02	DH-7
74	4	1.53	0.91	
75	6	1.61	0.64	
81	2	0.92	1.11	
82	1	0.0	1.00	DH-8
84	5	2.19	1.22	
85	5	2.16	1.19	
91	5	1.90	0.97	
92	5	1.41	0.66	
93	6	2.22	1.04	DH-9
94	4	1.57	0.94	
95	10	2.55	0.80	
101	1	0.0	1.00	
102	2	0.92	1.11	
103	3	1.50	1.19	DH-10
104	1	0.0	1.00	
105	3	1.20	0.93	
981	5	1.54	0.73	
982	4	1.22	0.71	Subsystem
983	4	1.67	1.02	DH-6, 7
984	4	1.53	0.91	H_2S Impact
985	5	1.58	0.76	
991	6	2.21	1.03	
992	6	1.80	0.75	
993	8	2.46	0.94	Subsystem
994	6	2.32	1.12	DH-8, 9, 10
995	12	2.85	0.84	
1001	10	1.72	0.42	Subsystem DH-1,
1002	9	1.84	0.52	6, 7, 8, 9, 10
1003	11	2.03	0.49	All Turkey
1004	9	2.00	0.58	Creek Stations
1005	15	2.05	0.37	

Notes:

1) Nos. 1-4 in unit position of Sta. No. column are replicates.

2) No. 5 in unit position of Sta. No. column is a station diversity calculated from composited replicate data.

3) Nos. 96-100 represent subsystems composed of indicated stations.

4) Number of organisms collected was usually <100 at replicate level.

Table 2.7-7 Standing Crop of Fish Collected in Turkey Creek By Block Seine Sampling

St. No.	Fish	No.	Wt.(g)	Area Sampled Ha	Area Sampled A	Station Standing Crop Kg/Ha	Station Standing Crop Lb/A
DH-8B	*Gambusia affinis*	25	4.5794	0.003	0.007	1.5265	1.3615
DH-9	*Notemigonus crysoleucas*	1	3.8926	0.013	0.031	0.2994	0.2670
	Gambusia affinis	253	27.4750	0.013	0.031	2.1135	1.8850
	Heterandria formosa	10	0.6859	0.013	0.031	0.0528	0.0471
	Lepomis punctatus	4	0.1270	0.013	0.031	0.0098	0.0087
DH-10	*Gambusia affinis*	31	6.9326	0.018	0.043	0.3851	0.3435

Reptiles and Amphibians - An eastern cottonmouth (Agkistrodon piscivorous piscivorous) and bronze frog tadpoles (Rana clamitans clamitans) were collected from Turkey Creek and Hague Spring Run, respectively. In addition, green tree frogs, green anoles, a coral snake, alligators, and gopher tortoise have been sighted in the Turkey Creek basin (Breedlove, 1977). Based on range maps and habitat preference (Conant, 1958), a list of aquatic, semiaquatic and terrestrial herptiles expected to occur in northern Alachua County is presented in Tables A2-48 through 61.

Endangered Species - With the exception of the Suwannee cooter (R), the alligator snapping turtle (SU) and the Gulf Hammock dwarf siren (SU), all other herptiles listed in Table 2.7-2 are expected to utilize portions of the Turkey Creek drainage. Sanchez Prairie presently provides potentially suitable habitat for the alligator (E) and one is usually present at the culverts under the Deerhaven entrance road (Station DH-7). Although the gopher tortoise (T) was sighted in the hammock, it is primarily restricted to uplands. The gopher frog (T), which utilizes the burrow of the gopher tortoise, may find the Sanchez Priarie marsh suitable for laying its eggs; however, grassy cypress ponds are its primary breeding sites. The spotted turtle (R) and striped newt (R) might also find this marsh habitat suitable.

2.7.3.2 Cellon Creek - General

Cellon Creek varies in character and can be broadly subdivided into several distinct reaches. The portion upstream of U.S. 441 varies from

a slow-flowing pooled area to a small creek with well defined channels and moderate flow velocities. South of U.S. 441 to a point below CP-9 the channel slope is relatively steep, possesses incised banks and has sharp meanders (Figure 2.7-7). Below this point the channel gradient lessens and in some places the channel is poorly defined. However, near the A. W. Lee Sink the stream changes to a relatively fast flowing stream within a deeply incised channel.

Aquatic Subsystems and Forcing Functions

Cellon Creek has several aquatic subsystems within each of the broadly defined segments described above (Figure 2.7-6). The upper reaches of the stream, above U.S. 441, are small and largely composed of southern mixed hardwoods (Figure 2.7-6). The University of Florida Dairy Research Unit and General Electric nickel/cadmium battery plant are the two major influences on the stream (Figure 2.7-8 and Section 2.5). Within the dairy research unit, improved pastures are mowed for hay. Forage crops have been planted in some areas. Stream flow is largely due to runoff and the water quality is presently within the criteria set for livestock use (Section 2.5.1.2). Industrial discharge from the General Electric battery plant enters the creek between the railroad and U.S. 441 (Figure 2.7-8). The discharge enters the stream through a deep grassy channel to the north and east of the plant and flows through a flooded wooded area prior to entering the creek. This discharge provides a continuous flow to Cellon Creek and has affected water quality (Section 2.5.1.2).

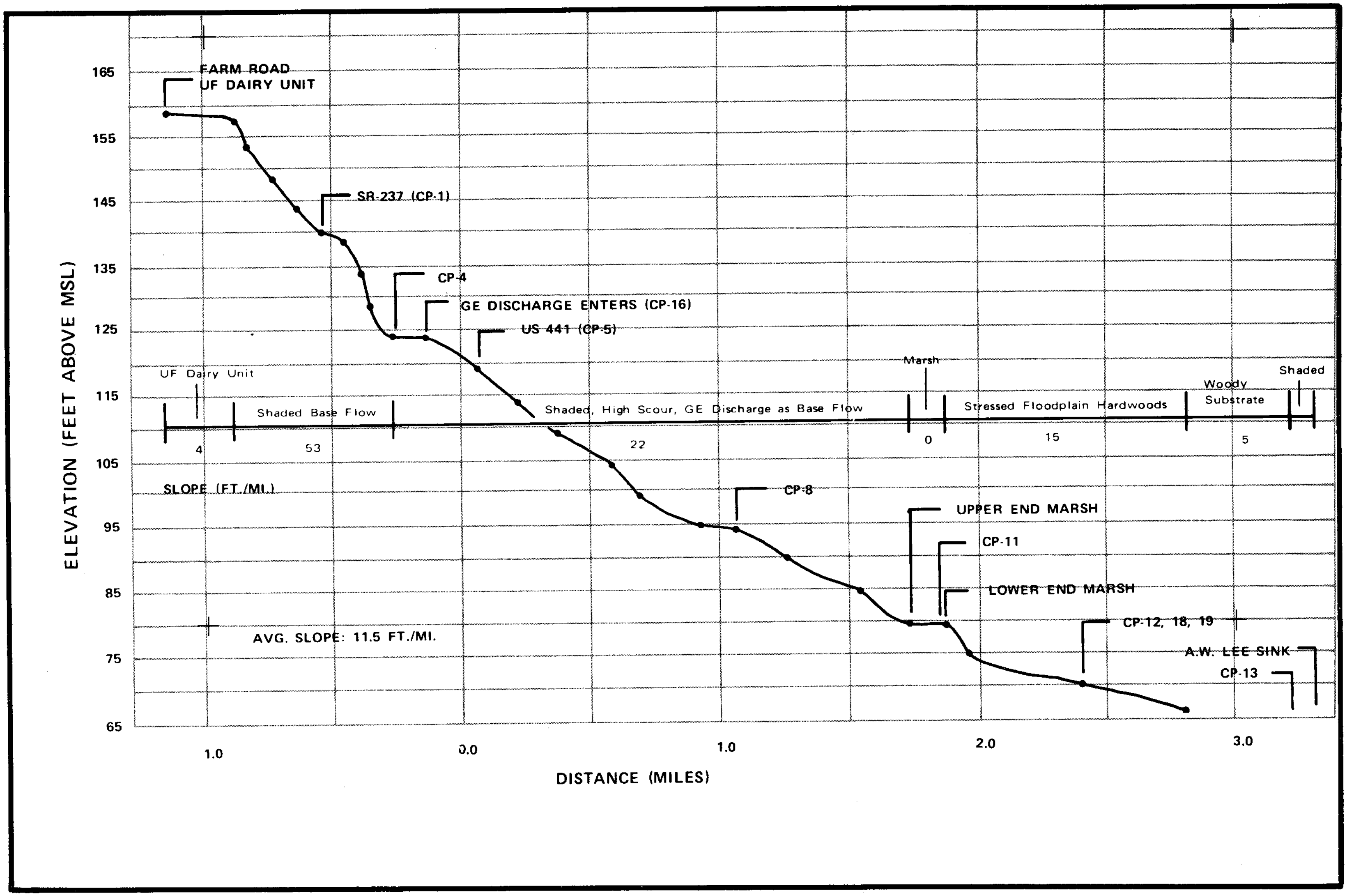


FIGURE 2.7-7 CELLON CREEK CHANNEL PROFILE, ASSOCIATED ECOLOGICAL SUBSYSTEMS AND SLOPES.

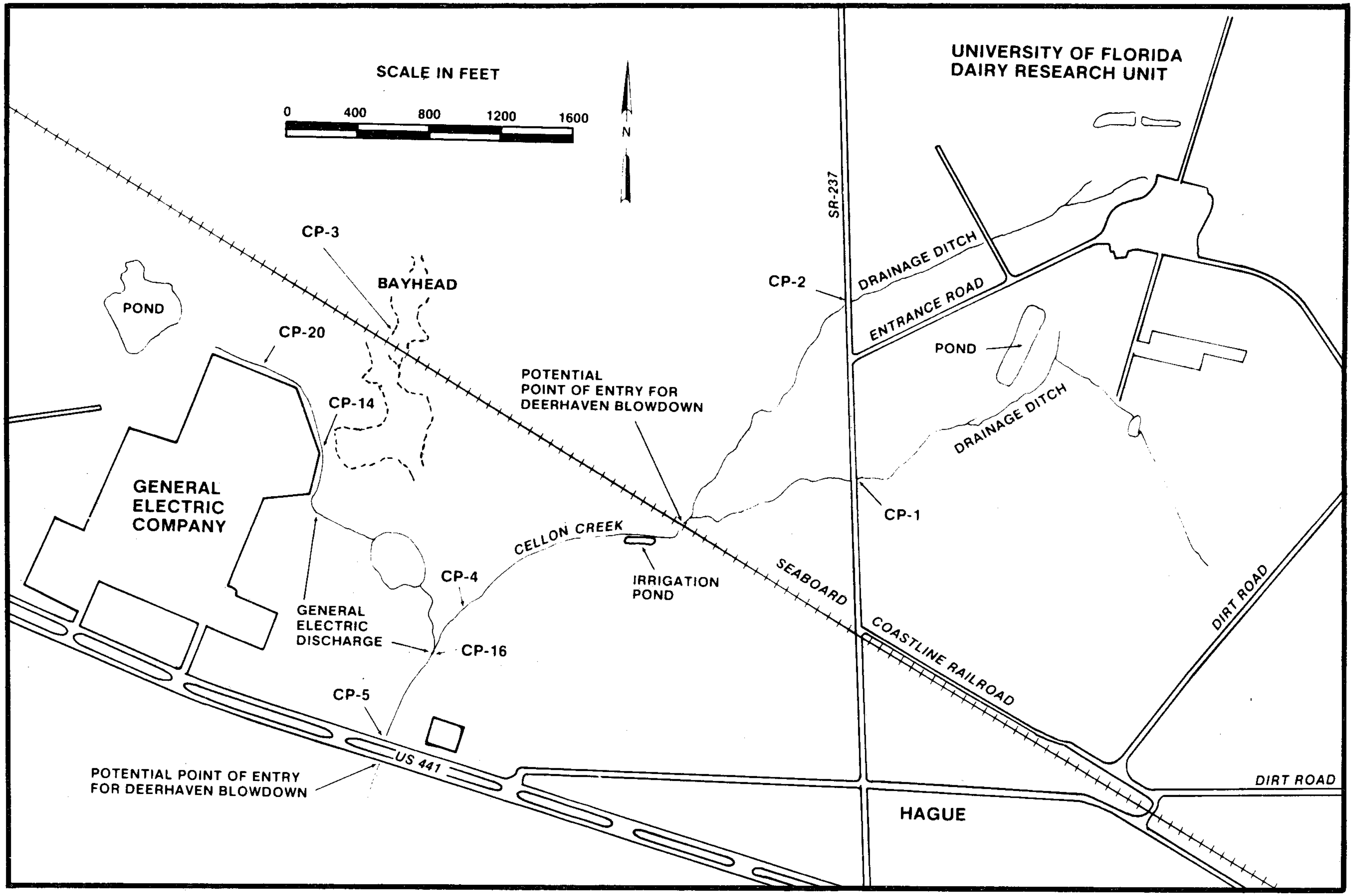


FIGURE 2.7-8 CELLON CREEK HEADWATERS NEAR THE UNIVERSITY OF FLORIDA DAIRY RESEARCH UNIT AND THE GENERAL ELECTRIC COMPANY.

Below U.S. 441 southern mixed hardwoods occur along the stream (Figure 2.7-6) in the area with incised banks and sharp meanders. The General Electric discharge is retained within the present bank system. However, due to the high stream gradient and meanders, the aquatic system is unstable and continues to adjust to the imposed flow regime. This is evidenced by: (1) caved and undercut banks; (2) a marl or clay based stream bottom below an actively moving bedload; and (3) sediment deposition within a downstream marshy area. This relatively high energy/high scour system is substrate-limited due to scour and associated particle destruction and to the rapid transport of detritus downstream. Primary production by aquatic plants is negligible due to the hardwood canopy and absence of a stable substrate.

At station CP-11 a marsh subsystem exists in a low gradient portion of the stream (Figure 2.7-7). As a result of a decrease in stream velocity and poorly defined channel banks, spreading of water and sheet flow occurs. Sediment eroded from the upstream segment is deposited within the marsh. High light intensity has favored the establishment of shrubs and herbs among which are Hydrocotyle sp., water hyacinth (Eichornia crassipes), wax myrtle, sea myrtle (Baccharis halimifolia), buttonbush, and various grasses, sedges and rushes. Dead pines and oaks in various stages of decay occur within the marsh. Older dead specimens occur in the lower end of the marsh while recently killed trees occur in the upper end, indicating that the marsh is extending upstream as sediment is deposited. The marsh has a large detritivorous macroinvertebrate population which

is preyed upon by a variety of birds. Cattle egrets, white ibis, Wilson's snipe, and blue winged teal have been observed in the area (Breedlove and Associates, 1977).

Below the marsh the stream channel continues to be ill-defined as it flows through a southern mixed hardwood stand. Chronic stress of flood-plain hardwoods adjacent to the stream has occured (Figure 2.7-9) and appears to be of recent origin as only a few fallen or dead standing trees were observed.

Below the stressed tree zone is an open area of the stream along which willow is common (Figures 2.7-6 and 2.7-9). This habitat is free from the scour of upstream segments. Autotrophic and consumer populations occur on the willow trunks and exposed root systems.

The stream enters another zone of southern mixed hardwoods as it once again changes from a low scour/low bank system to a fast flowing system with eroded banks (Figures 2.7-6 and 2.7-9). However, herbaceous and grassy vegetation occur in a few isolated areas with reduced current and low scour.

The terminus of Cellon Creek is a sink pond (Figure 2.7-9). It is shallow and has a short retention time and a well developed aquifer connection. No aquatic plants occur in the pond. Livestock utilize the pond frequently, causing the water to remain turbid and the steep-sided banks to erode. Southern mixed hardwoods occur as overstory vegetation.

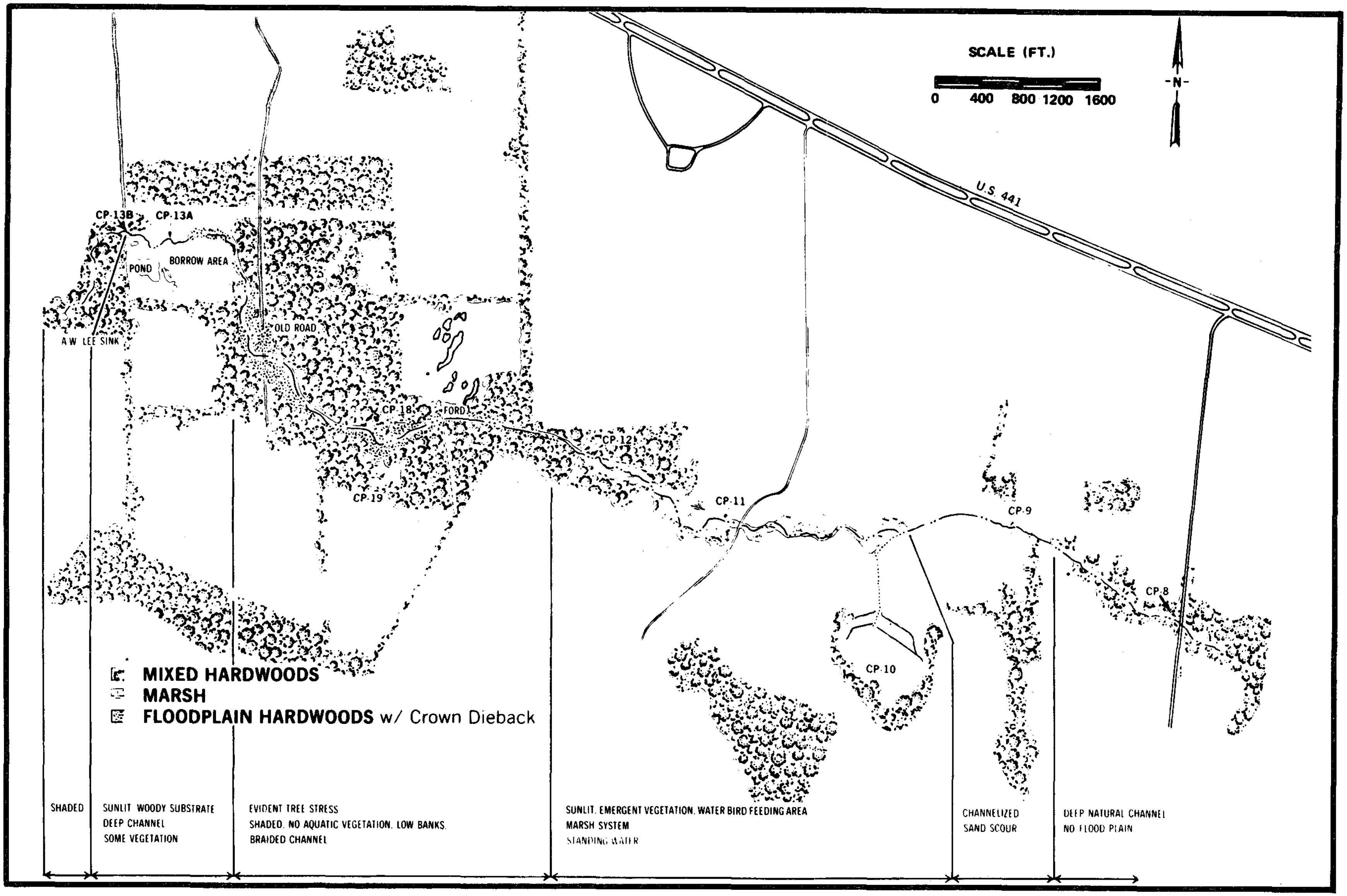


FIGURE 2.7-9 CELLON CREEK MARSH AND STRESSED TREE ZONE.

Animal Life

Macroinvertebrates - Figure 2.7-6 shows the station locations for benthic macroinvertebrate collections. A summary of the invertebrates collected is presented in Tables A2-48 through 61 and Table 2.7-8.

The macroinvertebrate faunal composition of Cellon Creek is a function of: (1) livestock usage and subsequent modification of aquatic habitat in the upper, middle and lower reaches; (2) dense aquatic weed growth in the upper reaches near the General Electric plant; (3) the habitat limitation imposed by an augmented flow below the General Electric plant in areas with a high stream gradient; (4) the presence of a densely vegetated marsh area and accumulation of organic debris; and (5) the accumulation of woody substrate in the open willow area. These forcing functions have acted to influence the number of taxa, number of organisms, and the stress tolerance characteristics of the stream macroinvertebrate community.

Oligochaetes are numerically dominant in Cellon Creek as a whole though this dominance may be misleading. They are tolerant of poor water quality but intolerant of scour, although specimens collected in high scour areas are small enough to inhabit sheltered niches. Their numerical dominance may also be due to other macroinvertebrates' lack of scour tolerance rather than to oligochaetes' particular suitability to the environment.

Approximately 44% of the collected taxa are facultative (Class II) and 25% are classified as tolerant (Class III). Fifteen percent of the taxa are intolerant to stress (Class I) (Table 2.7-8).

Water quality in Cellon Creek is largely influenced by the General Electric battery plant (Section 2.5.1.2). However, an analysis of the macroinvertebrate community reveals that continual bedload movement and scour may be equal to or greater in magnitude than water quality as a forcing function on the invertebrate community. *Progomphus obscurus*, a large dragonfly naiad, is a dominant species in terms of biomass, though not numerically. It burrows in clean shifting sand near stream margins and feeds primarily on dipteran larvae. It is considered intolerant of poor water quality but tolerant of scour due to its structure and burrowing ability. *Corydalus cornutus* is another large intolerant organism which is common in the lower parts of Cellon Creek, though it inhabits pieces of submerged wood and not the sand, thus removing scour as a limiting factor. This may be true of other collected scour intolerant genera such as *Polypedilum*, *Rheotanytarsus*, and *Tanytarsus*. *Hyalella azteca* is found under debris or vegetation and thus requires high dissolved oxygen. It was a numerical dominant at one station (CP-4). The caddis worm (*Cheumatopsyche* sp.) tolerates organic loading but not toxic materials; it is numerically dominant in the weedy subsystem behind the General Electric plant and in the sunlit subsystem with woody substrate.

Table 2.7-8 Benthic Macroinvertebrate Taxa Collected From Cellon Creek Near Hague, Florida Ranked According to Beck's Tolerance Classifications

	Class I (Intolerant)	Class II (Facultative)	Class III (Tolerant)	Class IV (Air-breathing)	Class V
	Agria sp	**Hyalella azteca*	**Oligochaeta*	*Belostoma* sp.	*Paratendipes* sp.
	**Progomphus obscurus*	*Procambarus* sp.	*Bezzia* sp.	*Dineutus* sp.	
	Polypedilum halterale	*Gomphus* sp.	*Cryptochironomus fulvus*	*Tropisternus* sp.	
	Corydalus cornutus	*Pachydiplax longipennis*	*Polypedilum scalaenum*	*Chrysops* sp.	
	Acroneuria sp.	*Dicrotendipes nervosus*	*Sphaerium* sp.	*Tipulidae* sp.	
	Macromia sp.	*Rheotanytarsus* sp.	*Pisidium* sp.	*Helisoma duryi*	
	Asellus sp.	*Tanytarsus* sp.	*Palpomyia tibialis*	*Helisoma* sp.	
		Nematoda	*Physa* sp.		
		Calopteryx sp.	*Chironomus stigmaterus*		
		Stenelmis sp.	*Chironomus decorus*		
		Clinotanypus sp.	*Helobdella* sp.		
		**Cheumatopsyche* sp.	*Glyptotendipes* sp.		
		Procladius sp.			
		Polypedilum illinoense			
		Pseudosuccinea sp.			
		Cladotanytarsus sp.			
		Microcylleopus sp.			
		Ablabesmyia peleensis			
		Enallagma sp.			
		Odontomyia sp.			
		Oecetis sp.			
No. Taxa:	7	21	12	7	1
Percent of Total:	14.6%	43.8%	25.0%	14.6%	2.1%

Total No. Taxa = 48

Cellon Creek BI = 35

*Demotes a dominant taxa (occurring at more than 20% of stations/collections).

The Ekman grab diversity and equitability values were influenced by the low number of organisms collected at any given station. Composited replicate data often did not result in the collection of a sufficient number of organisms for a valid calculation (EPA, 1973). Therefore, a rigorous analysis or acceptance of the values is unwarranted. However, compositing resulting in a significant lowering of station equitability (Table 2.7-9) compared to replicate variability. Station diversity values, based on composited data, tended to be greater than the replicate mean. The diversity and equitability values for individual stations, the high scour subsystem, and the entire stream system indicated a lower diversity environment and a non-equitable distribution of organisms among the low number of species present. The equitability values are quite low and tend to confirm that the creek is significantly stressed.

Fish - Three fish species were collected from Cellon Creek (Table 2.7-10). These species are regarded as stress tolerant (McKee and Wolf, 1971). The mosquitofish is considered highly tolerant of a wide variety of materials and conditions. Absence of fish in the high gradient stream subsystem is considered to be due to: (1) high scour; (2) a lack of pools or deep water; (3) high water velocity; and (4) absence of organic substrate. Isolation of the stream from other lakes, streams or rivers also precludes the possibility of a diverse fishery. Cellon Creek has a very low standing crop of fish at a creek or subsystem level (Table 2.7-10) and the creek therefore has a low potential as a sport fishery.

Table 2.7-9 Cellon Creek Benthic Macroinvertebrate Shannon-Weaver Diversity and Equitability Based on Replicated Ekman Grabs

Sta. No.	No. Species	Shannon-Weaver Diversity DBAR	Equitability	
41	5	1.95	1.01	
42	4	0.95	0.57	
43	10	2.99	1.12	CP-4
44	7	2.33	0.97	
45	15	2.79	0.64	
51	3	0.45	0.52	
52	1	0.0	1.00	
53	6	1.53	0.61	CP-5
54	2	0.32	0.70	
55	10	1.17	0.27	
81	2	0.47	0.79	
82	3	0.55	0.56	
84	3	0.92	0.74	CP-8
85	4	0.68	0.46	
111	11	1.53	0.33	
112	10	0.53	0.17	
113	3	0.10	0.37	CP-11
114	4	0.29	0.34	
115	17	0.72	0.11	
131	3	0.23	0.43	
132	2	0.16	0.60	
133	3	0.51	0.54	CP-13
134	3	0.14	0.39	
135	7	0.27	0.19	
141	3	0.16	0.40	
142	5	2.20	1.23	
143	2	1.00	1.19	CP-14
144	4	1.35	0.79	
145	10	1.18	0.28	
991	10	1.57	0.38	
992	5	0.86	0.42	Subsystem
993	12	2.59	0.69	CP-4, 5, 8
994	9	1.77	0.49	
995	20	2.06	0.28	
1001	18	1.71	0.23	
1002	18	0.95	0.13	Subsystem
1003	19	0.96	0.12	CP-4, 5, 8,
1004	15	0.81	0.13	11, 13, 14
1005	37	1.48	0.10	

Notes:

1) Nos. 1-4 in unit position of Sta. No. column are replicates.

2) No. 5 in unit position of Sta. No. column is a station diversity calcualted from composited replicate data.

3) Nos. 96-100 represent subsystems composed of indicated stations.

4) Number of organisms collected was usually <100 at replicate level.

Table 2.7-10 Fish Standing Crop in Cellon Creek Based on Block Seine Samples

Sta. No.	Species	Fish No.	Fish Wt.(g)	Area Sampled Ha.	Area Sampled A.	Station Standing Crop kg/Ha.	Station Standing Crop lb/A	Subsystem	Sample Area Standing Crop kg/Ha.	Sample Area Standing Crop lb/A	Subsystem Standing Crop kg	Subsystem Standing Crop lbs	Creek System Standing Crop kg	Creek System Standing Crop lbs
CP-5	*Gambusia affinis*	1	0.0131	0.010	0.024	0.0013	0.0015							
CP-6	NONE			0.008	0.018	0	0							
								Scoured Stream	0.0013	0.0012	0.0011	0.0024		
CP-14	*Gambusia affinis*	40	10.0879	0.006	0.014	1.6813	1.4996							
	Heterandria formosa	8	0.3071	0.006	0.014	0.0512	0.0457							
CP-20	*Gambusia affinis*	15	6.7991	0.006	0.015	1.1332	1.0107							
	Heterandria formosa	6	0.7780	0.006	0.015	0.1297	0.1157							
	Lepomis macrochirus	5	19.1650	0.006	0.015	3.1942	2.8489							
								Weedy, Deep Subsystem	6.1896	5.5205	0.3714	0.8187		
								CELLON CREEK STANDING CROP					7.4142	16.3453

Reptiles and Amphibians - The marsh area at CP-11 and the A. W. Lee Sink provide suitable habitat for some of the amphibians and reptiles listed in Appendix D. However, observations to date suggest a herptile fauna of low diversity and numbers. A bronze frog tadpole (Rana clamitans clamitans) was collected at Station CP-4 which is above the General Electric plant discharge. A southern leopard frog tadpole (Rana utricularia) and a squirrel tree frog (Hyla squirella) were collected at Station CP-8. Other herptiles sighted included young alligators (Alligator mississippiensis), a banded watersnake (Natrix sipedon fasciata), and an unidentified turtle. The alligators were observed in the discharge ditch immediately downstream of the battery plant outfall; the banded watersnake was found in a hollow stump adjacent to Station CP-4; and the turtle was spotted within the creek channel between Station CP-5 and CP-8.

Rare and Endangered Species - Herptiles expected to occur in this portion of Alachua County which are endangered (E), threatened (T), rare (R), of special concern (SC), or status undetermined (SU) (Florida Audubon Society, 1974) are listed in Table 2.7-2. With the exception of the alligator, none of these classified species were either collected or sighted during the field reconnaissance and surveys of this creek. Of those species listed, the following could occur in suitable habitat adjacent to or within the Cellon Creek drainage: the indigo snake (T) - in drier upland areas; the spotted turtle (R) - in the marsh area; and the striped newt (R) - in the sinkhole ponds. The gopher tortoise (T) and the Florida gopher frog (T) are also possible inhabitants of this

drainage; however, since no burrows were observed and the mixed hardwood areas adjacent to the creek are suboptimal habitat, the probability of present use is low.

The alligators in the General Electric discharge ditch are probably part of a population in an adjacent pond. The alligator is classified as endangered by the USDI (1976) (threatened in three Louisiana Parishes), as threatened by the FGFWFC (1975), and as a species of special concern by the Florida Committee on Rare and Endangered Animals (1974). In Florida, however, populations have recovered and the alligator is in neither a threatened nor endangered status.

2.7.3.3 Rocky Creek

Rocky Creek drainage basin is a comparatively large watershed for small streams in central Florida. The northeastern portion of the Deerhaven site is in the watershed although no process waters from Deerhaven Unit 1 are connected to the creek. Figures 2.7-10, 2.7-11, and 2.7-12 show the ecological subsystems and channel profile for Rocky Creek. The headwaters are located within pine flatwoods interspersed with cypress heads. The creek flows northeast enroute to the Santa Fe River through a mixture of flatwoods, mixed hardwoods and agricultural lands. Most of the creek is contained within a well-defined channel; stream gradients are higher in the upper reaches and moderate in the lower reaches.

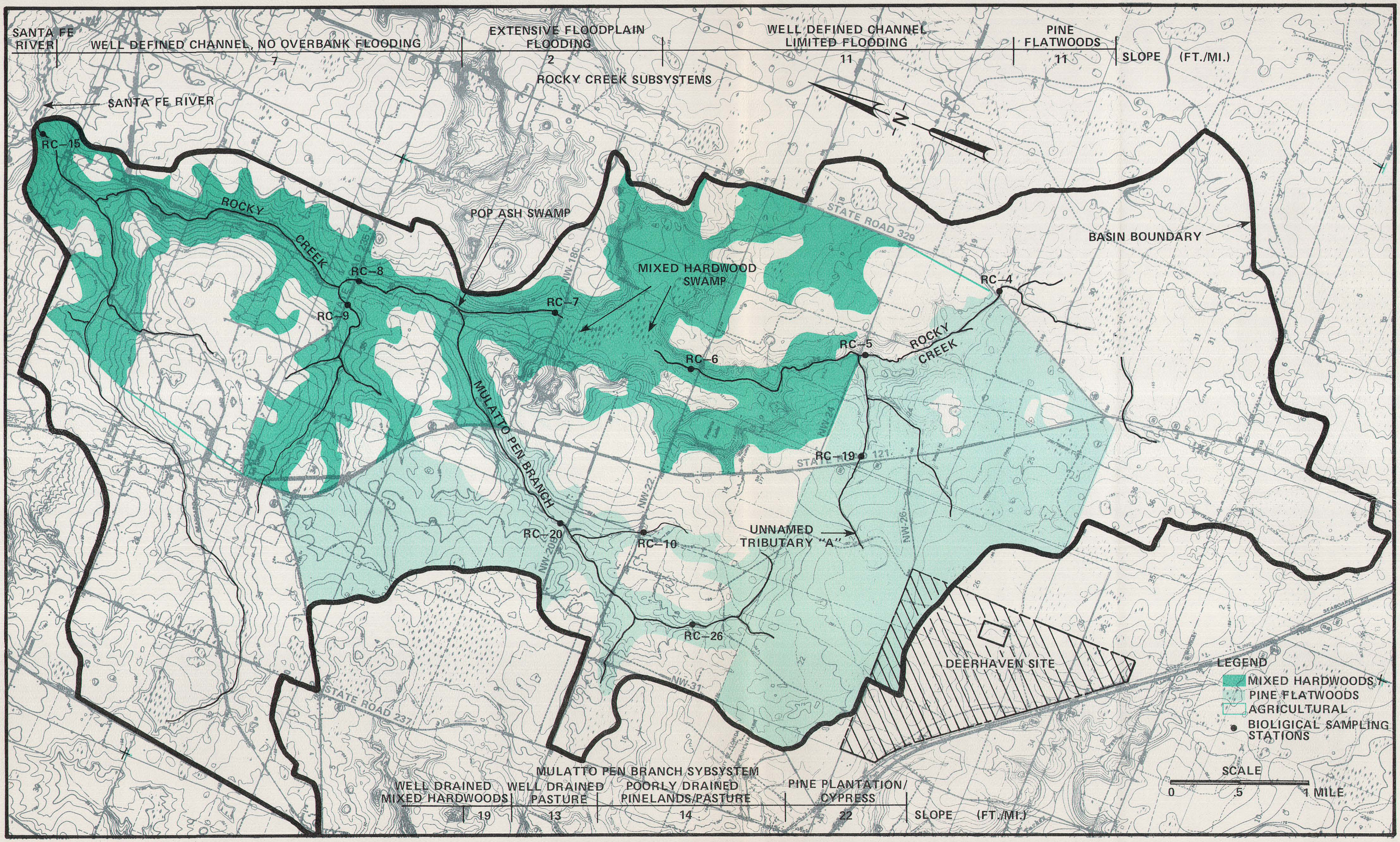


FIGURE 2.7-10 ROCKY CREEK AND MULATTO PEN BRANCH ECOLOGICAL SUBSYSTEMS AND VEGETATION ASSOCIATIONS.

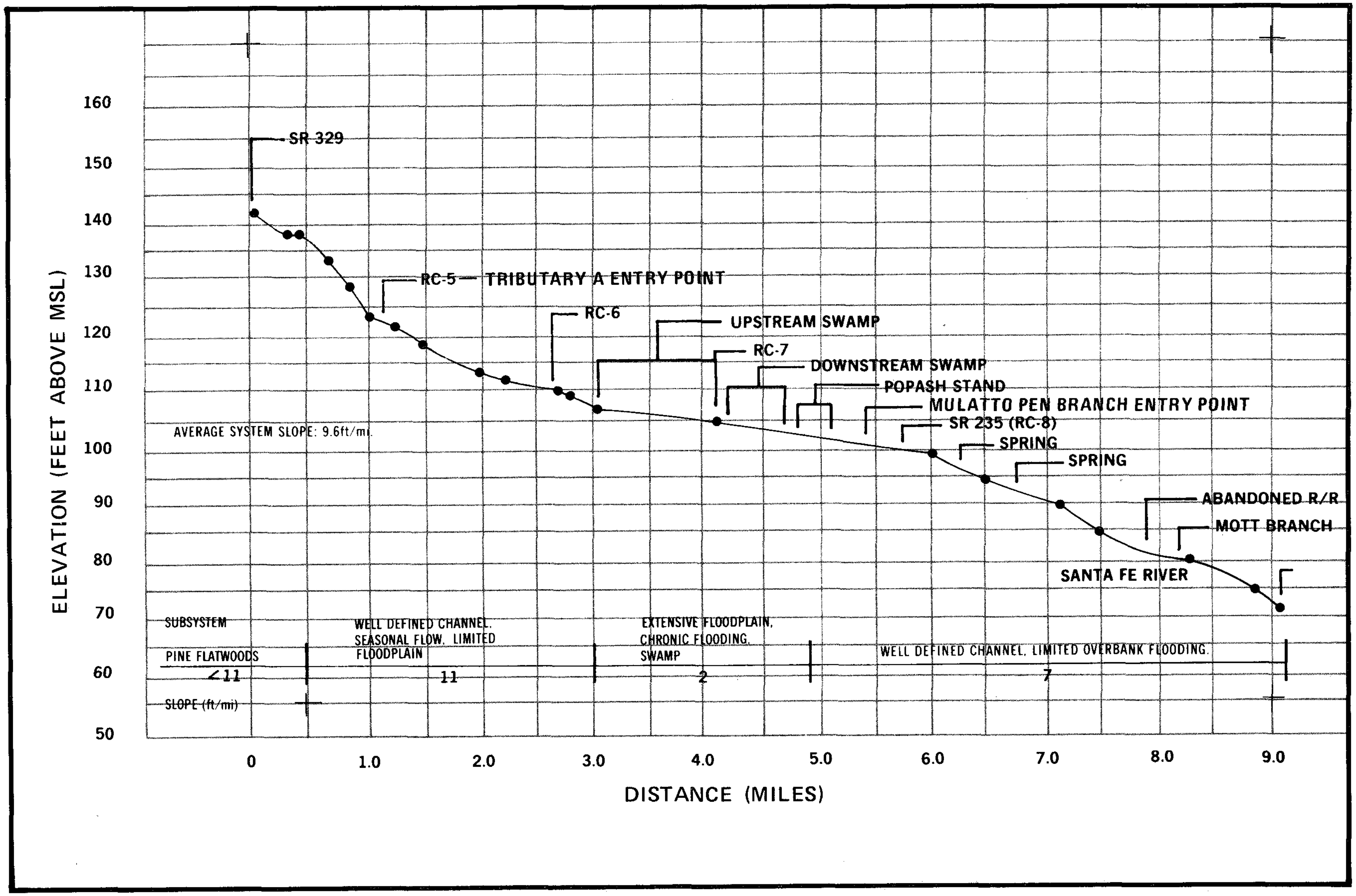


FIGURE 2.7-11 ROCKY CREEK CHANNEL PROFILE, ASSOCIATED ECOLOGICAL SUBSYSTEMS AND SLOPES.

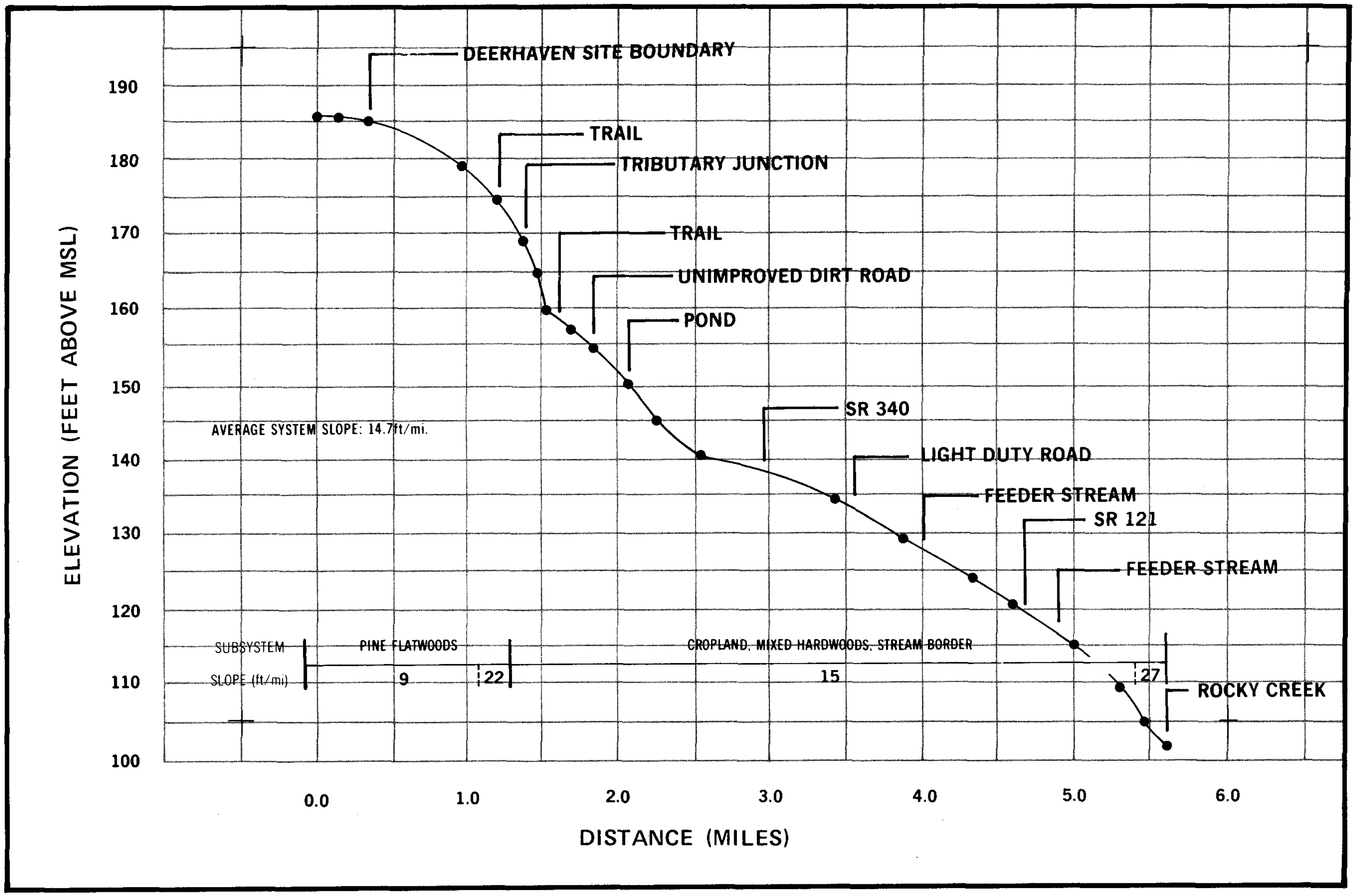


FIGURE 2.7-12 ROCKY CREEK DISCHARGE UNNAMED TRIBUTARY "A" CHANNEL PROFILE, ASSOCIATED ECOLOGICAL SUBSYSTEMS AND SLOPES.

During previous investigations (Breedlove, 1977), two tributaries to Rocky Creek were considered as discharge alternatives for Deerhaven blowdown. These were Mulatto Pen Branch and an unnamed tributary (Rocky Creek Unnamed Tributary "A") (Figure 2.7-10). Ecological subsystems and channel profiles for these tributaries are shown in Figures 2.7-12 and 2.7-13.

Aquatic Subsystems and Forcing Functions

Rocky Creek, Mulatto Pen Branch and unnamed tributary headwaters are derived from cypress heads, bayheads and pine flatwoods (Figure 2.7-10). Much of the headwater area is in commercial pine production and, therefore, has been extensively channelized to promote drainage. The major forcing function to the aquatic environment in this area is the widely fluctuating water level. During normal and dry conditions discharge is zero, whereas under heavy rainfall events considerable water is discharged from the cypress heads and surrounding area.

Below the cypress/pine headwater area of Rocky Creek and its two principal tributaries exist the following subsystems: (1) a shaded intermittent stream (Rocky Creek); (2) a poorly drained pineland/pasture stream (Mulatto Pen Branch); and (3) a shaded intermittent stream (Tributary "A") (Figures 2.7-11, 2.7-12 and 2.7-13). The shaded intermittent stream segments have a narrow floodplain area with mixed hardwood vegetation. The pineland/pasture segment of Mulatto Pen Branch contains a meandering channel interspersed with remnant cypress and blackgum.

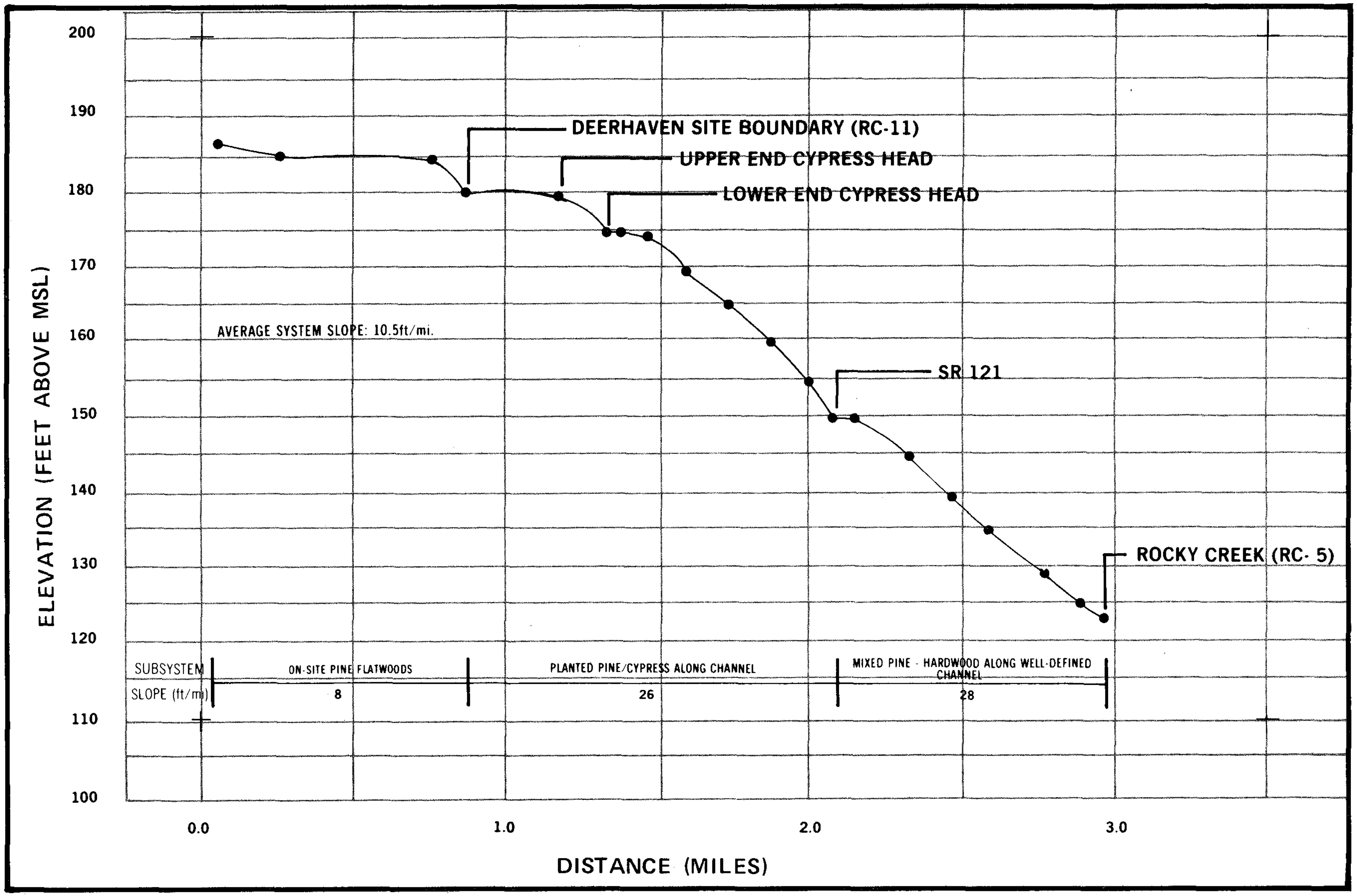


FIGURE 2.7-13 MULATTO PEN BRANCH CHANNEL PROFILE, ASSOCIATED ECOLOGICAL SUBSYSTEMS AND SLOPES.

The channel is open and has numerous pool and riffle areas which support streamside herbaceous vegetation. Each of these segments is strongly pulsed by seasonal drainage. Most of the streams in these areas dry completely during certain times of the year, but pool areas and seeps may remain wet and provide habitat for mobile aquatic species.

The final reach of Mulatto Pen Branch is well shaded by mixed hardwoods and contains occasional pool areas. This subsystem is also strongly pulsed by seasonal drainage. A pop ash swamp occurs just above the confluence with the main channel of Rocky Creek (Figure 2.7-13). The Mulatto Pen channel becomes braided, forming a delta. An accumulation of woody debris and muddy soil and the absence of a main channel indicate that this is a sedimentation area.

Two mixed hardwood swamps occur on the main stem of Rocky Creek above the confluence of Mulatto Pen Branch (Figures 2.7-10 and 2.7-14). The swamps are separated by a constriction on which the Antioch Baptist Church Road was constructed. The swamps are encircled by a thin fringe of southern mixed hardwood forest and by crop and partureland. The vegetative composition of the mised hardwood creek swamps is comparable to that of mixed hardwood swamps of northern Florida described by Monk (1966). Black gum, bald cypress, sweet gum, and red maple are common. The floristic composition of the surrounding mixed hardwood community is somewhat variable, whereas that of the swamp is fairly constant. Generally, the steeper-sloped, drier portions of this mixed hardwood community

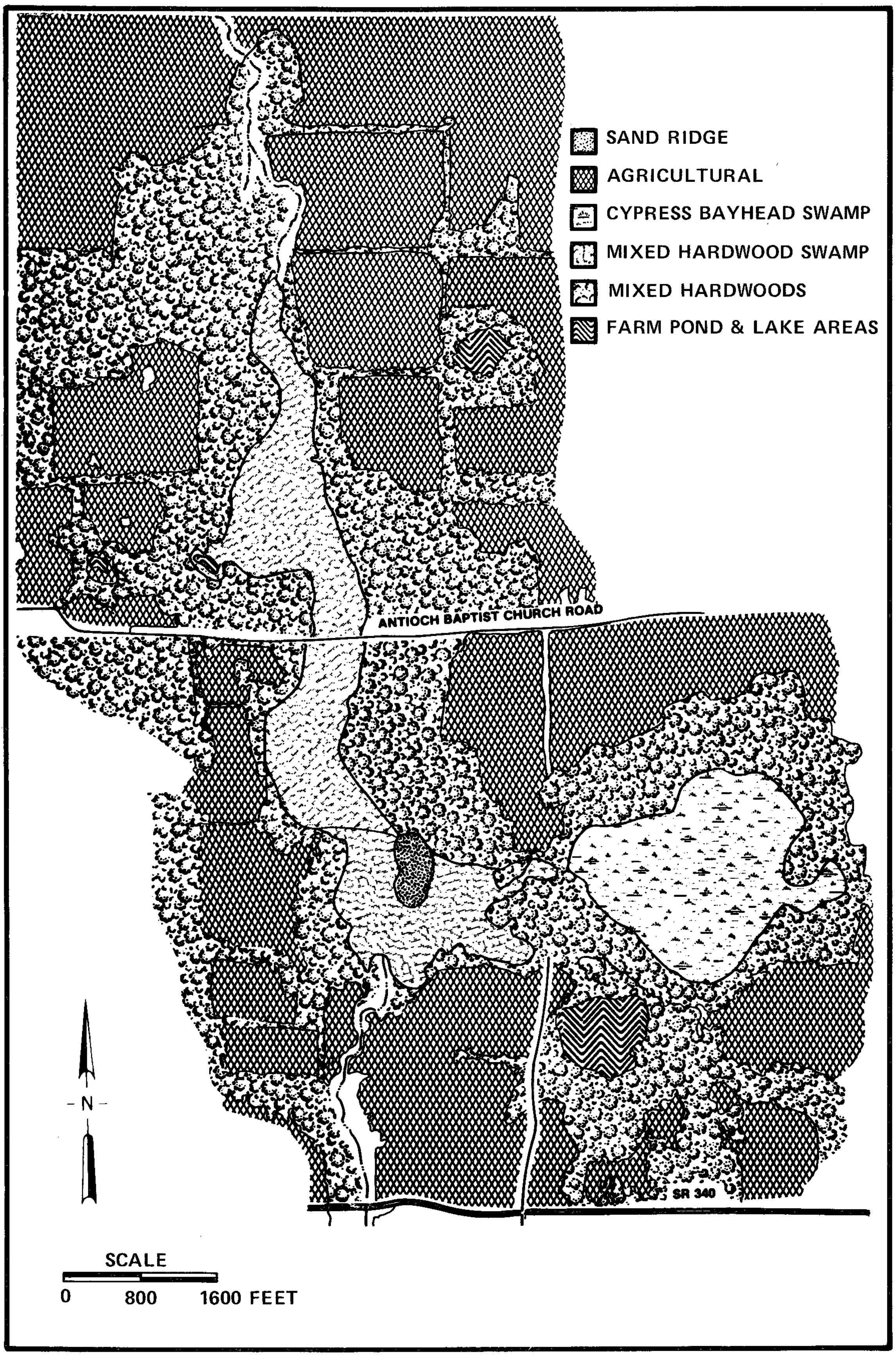


FIGURE 2.7-14 ROCKY CREEK SWAMPS VEGETATION ASSOCIATIONS.

support a greater percentage of live oak, laurel oak, magnolia, and loblolly pine, while the flatter and wetter portions support a higher percentage of sweet gum, red maple, and water oak.

The transition zone between the mixed hardwood swamp and forest is dominated by red maple, sweet gum, water oak, and laurel oak. Buttonbush, bald cypress, pop ash, black gum, magnolia, palmetto, wax myrtle, dahoon, loblolly pine, spruce pine and Florida elm are common associates. The floristic composition of the transition zone is more similar to that of the mixed hardwood forest than to that of the swamp.

Each swamp has a central area which is always flooded, and therefore provides excellent aquatic habitat. The water is usually 1.0-1.5 feet deep. Bottom substrate is relatively firm in both swamps; however, the downstream swamp has areas in which the organic material is 4 feet deep.

Below Mulatto Pen Branch, Rocky Creek is essentially a shaded, small woodland stream with a strong seasonal flow and seepage input during dry seasons. Several small, clear tributaries entering from the east provide base flow. The channel is well defined and it appears that overbank flooding occurs infrequently. No floodplain or hydric hammock vegetation occurs adjacent to the stream. Below the abandoned railroad (Figure 2.7-10) most of the land has been cleared and converted to pasture.

Prior to the confluence with the Santa Fe River, Rocky Creek changes into a deeper, slow flowing pool system.

Animal Life

Macroinvertebrates (Rocky Creek) - Figure 2.7-10 shows the station locations for macroinvertebrate collections. Tables A2-48 through 61 present the summary data for organisms collected at these stations. Table 2.7-11 presents summary data for the creek as a whole.

Rocky Creek, which may be dry over much of its length during part of the year, has pool areas which appear stagnant (Station RC-6) during the dry season; a swamp pool area (Station RC-7) which is weedy, deep and apparently wet at all times; a seep-fed section which generally has water and appears to contain a diverse fauna (Station RC-8); and a section within the Santa Fe River flood zone (Station RC-15). The five dominant species of the 67 collected macroinvertebrate taxa were distributed among the intolerant, facultative and tolerant classifications. Half of the taxa were classified as intolerant or facultative. Species not characterized for stress tolerance accounted for 19.4% of the taxa, with intolerant and air-breathing species comprising 13.4% and 16.4% of the taxa, respectively. More taxa were collected from Rocky Creek than from either Cellon or Turkey Creeks.

The fauna of Rocky Creek is typical of brown water streams in the north-central Florida region. Expected in such streams are crustaceans

Table 2.7-11 Benthic Macroinvertebrate Taxa Collected From Rocky Creek Ranked According to Beck's Tolerance Classifications

	Class I (Intolerant)	Class II (Facultative)	Class III (Tolerant)	Class IV (Air-breathing)	Class V
	Stictochironomus sp.	*Dubiraphia sp.	*Oligochaeta	Chrysops sp.	Elliptio sp.
	Acarina	Lampsilis sp.	Sphaerium sp.	Hydaticus sp.	Corbicula manilensis
	Macromis sp.	Cheumatopsyche sp.	Helobdella sp.	Notonecta sp.	Sialis sp.
	Polypedilum halterale	Stenelmis sp.	*Bezzia sp.	Pelocoris sp.	Phylocentropus sp.
	*Tribelos sp.	Nematoda	Caenis diminuta	Dineutus sp.	Cordulagaster sp.
	Agria sp.	*Palaemontes paludosus	Physa sp.	Tipulidae sp.	Psychodidae sp.
	Asellus sp.	Procambarus sp.	Polypedilum scalaenum	Trichocorixa sp.	Paratendipes sp.
	Corydalus cornutus	Gomphus sp.	Chironomus attenuatus	Belostoma sp.	Lauterborniella sp.
	Progomphus obscurus	Clinotanypus sp.	Palpomyia tibialis	Peltodytes sp.	Boyeria sp.
	Ablabesmyia aspera	Hyalella azteca		Gerris sp.	Tetragoneuria sp.
	Stenochironomus hilaris	Calopteryx sp.		Hexatoma sp.	Limnephilus sp.
		Ablabesmyia peleensis			Tauriphila sp.
		Microcylleopus sp.			Aeschna sp.
		Polypedilum illinoense			
		Cladotanytarsus sp.			
		Procladius sp.			
		Pachudiplax longipennis			
		Parachironomus sp.			
		Polypedilum tritum			
		Placobdella sp.			
		Rheotanytarsus sp.			
		Dicrotendipes sp.			
		Agrion sp.			
No. Taxa:	11	23	9	11	13
Percent of Total:	16.4%	34.3%	13.4%	16.4%	19.4%

Total No. Taxa = 67

Rocky Creek BI = 45

*Demotes a dominant taxa (occurring at more than 20% of stations/collections).

(*Hyalella azteca*, *Palaemontes paludosus*, *Asellus*, and *Procambarus*), odonates (*Progomphus*, *Gomphus* sp., *Pachydiplax*, *Macromia*, and *Calopteryx*), air-breathing hemipterans and beetles, elmids (*Dubiraphia*, *Stenelmis*, and *Microcylloepus*), megalopterans (*Corydalus cornutus* and *Sialis*), caddis larvae (*Phylocentropus placidus* and *Cheumatopsyche*), and mayflies (*Caenis diminuta*, *Callibaetis*, *Stenomena*, *Paraleptophlebia*, *Leptophlebia*, and *Baetis*). All expected taxa were collected in late 1976 except for mayflies, only one of which, the tolerant *Caenis diminuta*, was found.

Oligochaetes were numerically dominant in Ekman grabs, with *Palaemontes paludosus*, *Bezzia* sp., *Dubiaphia* sp., and *Tribelos* sp. also occurring frequently enough to be considered important.

Replicate values for the number of species collected, Shannon-Weaver diversity, and equitability were highly variable within station collections, as well as among stations, due to the relatively low number of organisms collected (Table 2.7-12). Stations RC-4 and RC-8, located in the pine flatwoods and below the swamp, respectively, had generally higher diversity values and more species than other stations. The swamp system had relatively low values for each parameter.

Composited values for diversity and equitability indicated that the Rocky Creek system and subsystems were of higher quality than either Cellon or Turkey Creeks.

Table 2.7-12 Rocky Creek Benthic Macroinvertebrate Shannon-Weaver Diversity and Equitability Based on Replicated Ekman Grabs

Sta. No.	No. Species	Shannon-Weaver Diversity DBAR	Equitability	
41	8	1.73	0.53	
42	11	2.46	0.68	
43	11	1.90	0.44	RC-4
44	9	1.81	0.50	
45	21	2.42	0.35	
51	6	1.22	0.47	
52	6	2.02	0.90	
53	5	0.94	0.45	RC-5
54	1	0.0	1.00	
55	11	1.52	0.33	
61	14	3.50	1.17	
62	6	0.96	0.39	
63	9	2.61	0.93	RC-6
64	7	2.32	0.96	
65	20	3.18	0.64	
71	7	1.89	0.69	
72	2	0.48	0.80	
73	6	1.63	0.65	RC-7
74	4	0.69	0.46	
75	10	1.59	0.38	
81	7	2.61	1.20	
82	9	2.02	0.59	
83	15	3.20	0.87	RC-8
84	13	3.46	1.21	
85	26	3.61	0.68	
151	5	1.25	0.58	
152	3	1.29	0.99	
153	5	1.52	0.73	RC-15
154	5	2.01	1.06	
155	12	2.26	0.54	
961	9	2.31	0.74	Subsystem
962	11	2.59	0.75	RC-8, 15
963	18	3.22	0.74	Alternative B
964	14	3.46	1.13	Blowdown
965	31	3.73	0.62	Discharge

Notes:

1) Nos. 1-4 in unit position of Sta. No. column are replicates.

2) No. 5 in unit position of Sta. No. column is a station diversity calculated from composited replicate data.

3) Nos. 96-100 represent subsystems composed of indicated stations.

4) Number of organisms collected was usually <100 at replicate level.

Table 2.7-12 Rocky Creek Benthic Macroinvertebrate Shannon-Weaver Diversity and Equitability Based on Replicated Ekman Grabs (continued)

Sta. No.	No. Species	Shannon-Weaver Diversity DBAR	Equitability	
971	23	3.10	0.53	Subsystem
972	19	2.77	0.50	RC-5, 6, 8, 15
973	21	3.07	0.57	Alternative A
974	17	3.42	0.90	Stream Sub-
975	39	3.61	0.45	systems only
981	27	3.08	0.44	Subsystem RC-5,
982	20	2.62	0.42	5, 7A, 8, 15
983	23	3.03	0.50	Alternative A
984	21	3.08	0.57	Blowdown
985	42	3.41	0.36	Discharge
991	24	2.69	0.37	
992	23	2.85	0.44	Subsystem
993	28	3.11	0.44	RC-4, 5, 6,
994	21	3.29	0.66	8, 15
995	43	3.40	0.35	
1001	28	2.87	0.36	Subsystem
1002	22	2.83	0.45	RC-4, 5, 6,
1003	30	3.14	0.42	8, 15, 7A
1004	22	2.83	0.45	All Rocky
1005	48	3.36	0.31	Creek Stations

Macroinvertebrates (Mulatto Pen Branch) - Macroinvertebrate composition in Mulatto Pen Branch is primarily influenced by seasonal drying of much of the channel length, the presence of sandy substrates with adequate detritus, and the relatively high water quality. The dense aquatic weed growth and open sunlit channel also contributed to the large number of taxa found at Station RC-20.

Approximately 12% of the taxa collected from Mulatto Pen Branch are classified as stress intolerant, 47% as faculatative and 24% as stress tolerant (Table 2.7-13). Collections were taxonomically dominated by Oligochaetes, which are considered highly tolerant of stress.

The collected fauna are typical of small, sandy bottomed, low energy streams. The numerical dominance of Oligochaetes is probably due to the seasonal drying of most of the stream channel. During zero flow, Oligochaetes follow the waterline and exist under a relatively high oxygen stress. Other species indicative of these stream conditions include: the elmid bettles - Dubiraphia sp. and Stenelmis sp. - which are typically found in sandy bottomed flowing streams; the mayfly - Caenis diminuta - which is a tolerant, slow water species; the dragonfly - Progomphus sp. - which burrows in flowing areas near stream margins; and other Odonata - Gomphus sp. and Pachydiplax sp. - which are usually found in slower flowing areas. Other collected scour intolerant taxa included: Polypedilum sp., Rheotanytarsus sp., and Tanytarsus sp.

Table 2.7-13 Benthic Macroinvertebrate Taxa Collected From Mulatto Pen Branch and Ranked According to Beck's Tolerance Classifications

	Class I (Intolerant)	Class II (Facultative)	Class III (Tolerant)	Class IV (Air-breathing)	Class V
	Cricotopus bicintus	*Agrion* sp.	*Oligochaeta	*Agabus johannis*	*Elliptio* sp.
	**Polypedilum halterale*	*Cladotanytarsus* sp.	**Bezzia* sp.	*Chrysops* sp.	
	Progomphus obscurus	*Clinotanypus pinguis*	*Caenis diminuta*	*Dytiscidae* sp.	
	Rheotanytarsus exiguus	*Dicrotendipes* sp.	*Chironomus crassicaudatus*	*Hexatoma* sp.	
		Dubiraphia sp.	*Cryptochironomus fulvus*	*Holorusia* sp.	
		Endochironomus sp.	*Helobdella* sp.		
		Gomphus sp.	*Palpomyia tibialis*		
		Hyalella azteca	*Physa* sp.		
		Pachydiplax longipennis	*Sphaerium* sp.		
		Polypedilum illinoense			
		Polypendilum tritum			
		Procambarus sp.			
		Procladius sp.			
		Rheotanytarsus sp.			
		Stenelmis sp.			
		**Tanytarsus* sp.			
No. Taxa:	4	16	9	5	1
Percent of Total:	11.4%	45.7%	25.7%	14.3%	2.9%

Total No. Taxa = 35

Mulatto Pen Branch BI = 24

*Denotes a dominant taxa.

Due to the relatively low number of organisms collected, Shannon-Weaver diversity and equitability values were highly variable and a rigorous analysis of these values is not warranted (Table 2.7-14 and Tables A2-48 through 61). Stations RC-20 and RC-21, which are located in the northern half of the basin, are less prone to channel drying and had higher diversity values and an equitable (even) distribution of species. Station RC-26, which is located in the headwaters area and is more prone to channel drying than Stations RC-20 and RC-21, had low diversity values and an overabundance of Oligochaetes (93%). In comparison, Stations RC-20 and RC-21 had 35% and 19% Oligochaetes, respectively. The overabundance of Oligochaetes, especially at Station RC-26, is probably most indicative of stress from channel drying.

Fish - Rocky Creek - Twenty fish species were collected from Rocky Creek (Table 2.7-15). Three species caught on trot lines (bowfin, bullhead and redfin pickerel) are not presented in Table 2.7-15. The mosquitofish was the numerical dominant. Species typical of warm, slow-moving, brown water systems, e.g. Heterandria formosa, Notropis sp., and Lepomis auritus, were prominant in collections at all stations. The pool area within the downstream swamp (Figure 2.7-11) was the only point in the system deep enough to be considered a significant habitat for the larger fish species. Because this habitat was atypical for the system but represented the only area containing a recreational fishery, it was considered important to sample for species not likely to be caught during block or sweep seining.

Table 2.7-14 Mulatto Pen Branch Benthic Macroinvertebrate Shannon-Weaver Diversity and Equitability Based on Replicated Ekman Grabs

Sta. No.	No. Species	Shannon-Weaver Diversity DBAR	Equitability	
201	16	3.29	0.88	
202	17	3.42	0.92	
203	11	2.56	0.73	RC-20
204	11	2.68	0.81	
205	10	3.64	0.60	
211	7	2.60	1.24	
212	12	3.29	1.17	
213	7	2.44	1.10	RC-21
214	10	2.98	1.10	
215	22	3.91	1.00	
261	3	0.67	0.55	
262	1	0.0	1.00	
263	4	0.39	0.24	RC-26
264	7	0.58	0.21	
265	30	0.55	0.14	

Notes:

1) Nos. 1-4 in unit position in Sta. No. column are replicates.

2) No. 5 in unit position of Sta. No. column is a station diversity calculated from composited replicate data.

3) Number of organisms collected was usually <100 at replicate level.

Table 2.7-15 Fish Standing Crop in Rocky Creek Based on Block Seine Samples

Sta. No.	Species	Fish No.	Fish Wt.(g)	Area Sampled Ha.	Area Sampled A.	Station Standing Crop kg/Ha.	Station Standing Crop lb/A.	Subsystem	Sample Area Standing Crop kg/Ha.	Sample Area Standing Crop lg/A.	Subsystem Standing Crop kg	Subsystem Standing Crop lbs	Creek System Standing Crop kg	Creek System Standing Crop lbs.
RC-4 (A&B)	Gambusia affinis	4	0.5385	0.013	0.033	0.0414	0.0369							
	Aphredoderus sayanus	1	1.2602	0.013	0.033	0.0969	0.0865							
	Lepomis auritus	1	3.7707	0.013	0.033	0.2901	0.2587							
RC-5	None			0.009	0.022	0.0	0.0							
RC-6	Ictalurus natalis	1	0.0709	0.013	0.033	0.0055	0.0049							
	Gambusia affinis	24	2.5791	0.013	0.033	0.1984	0.1770							
	Heterandria formosa	4	0.0946	0.013	0.033	0.0073	0.0065							
	Aphredoderus sayanus	1	1.1040	0.013	0.033	0.0849	0.0757							
	Lepomis auritus	1	3.1280	0.013	0.033	0.2406	0.2146							
	Elassoma okefenokee	1	0.0319	0.013	0.033	0.0025	0.0022							
	Labidesthes sicculus	11	1.9739	0.013	0.033	0.1518	0.1354							
RC-8 (A&B)	Lepomis auritus	1	4.4707	0.011	0.028	0.4064	0.3625							
	Notropis hypselopterus	3	1.1277	0.011	0.028	0.1025	0.0914							
	Notropis chalybaeus	2	0.6027	0.011	0.028	0.0548	0.0489							
	Gambusia affinis	1	0.0796	0.011	0.028	0.0072	0.0064							
	Labidesthes sicculus	1	0.3322	0.011	0.028	0.0302	0.0269							
RC-15A	Notemigonus crysoleucas	1	0.0852	0.014	0.034	0.0061	0.0054							
	Gambusia affinis	1	0.0525	0.014	0.034	0.0038	0.0034							
	Etheostoma edwini	1	0.1422	0.014	0.034	0.0102	0.0091							

Table 2.7-15 Fish Standing Crop in Rocky Creek Based on Block Seine Samples (continued)

Sta. No.	Species	Fish No.	Fish Wt.(g)	Area Sampled Ha.	Area Sampled A.	Station Standing Crop kg/Ha.	Station Standing Crop lb/A.	Subsystem	Sample Area Standing Crop kg/Ha.	Sample Area Standing Crop lg/A.	Subsystem Standing Crop kg	Subsystem Standing Crop lbs	Creek System Standing Crop kg	Creek System Standing Crop lbs
RC-15B	Notropis petersoni	1	1.1168	0.016	0.040	0.0698	0.0623							
	Notropis chalybaeus	1	0.4647	0.016	0.040	0.0290	0.0259							
	Fundulus crysotus	1	0.8684	0.016	0.040	0.0541	0.0482							
	Gambusia affinis	6	1.2848	0.016	0.040	0.0803	0.0716							
	Lepomis	7	12.8374	0.016	0.040	0.8023	0.7156							
								3.35 Ha. Shaded Stream	2.7761	2.4760	9.2999	20.5026		
RC-7A	Gambusia affinis	4	0.2502	0.031	0.077	0.0081	0.0072							
	Aphredoderus sayanus	2	2.9609	0.031	0.077	0.0955	0.0852							
	Etheostoma fusiforme	2	0.6128	0.031	0.077	0.0198	0.0176							
RC-7B	Gambusia affinis	29	5.4353	0.001	0.002	5.4353	4.8477							
	Heterandria formosa	6	0.3642	0.001	0.002	0.3642	0.3248							
RC-7C	Gambusia affinis	91	10.6879	0.001	0.003	10.6879	9.5325							
	Heterandria formosa	78	2.1924	0.001	0.003	2.1924	1.9554							
	Aphredoderus sayanus	1	0.5627	0.001	0.003	0.5627	0.5019							
	Micropterus salmoides	2	1.9423	0.001	0.003	1.9423	1.7323							
	Lepomis gulosus	1	1.8868	0.001	0.003	1.8868	1.6828							
	Enneacanthus gloriosus	1	0.5044	0.001	0.003	0.5044	0.4499							
								38.77 Ha. Swamp	23.6994	21.1375	918.8257	2025.6432		
									ROCKY CREEK STANDING CROP				928.1256	2046.1457

Table 2.7-15 Fish Standing Crop in Rocky Creek Based on Block Seine Samples (continued)

Sta. No.	Species	Fish No.	Fish Wt.(g)	Area Sampled Ha.	Area Sampled A.	Station Standing Crop kg/Ha.	Station Standing Crop lb/A.	Subsystem	Sample Area Standing Crop kg/Ha.	Sample Area Standing Crop lg/A.	Subsystem Standing Crop kg	Subsystem Standing Crop lbs	Creek System Standing Crop kg	Creek System Standing Crop lbs

Alternative A (Northeast - Blowdown passes through the Rocky Creek swamps)

RC-5 to Santa Fe Area Standing Crop: 928.0607 kg 2046.0026 lbs
DH to RC-5 Area Stading Crop: 1.6233 kg 3.5787 lbs

(Based upon stream width at DH-9
and SC figures from DH-9 & DH-10 combination.)

Total--929.6840 2049.5813

Alternative B (North - Blowdown bypasses Rocky Creek swamp.)

Jct. of creek to Santa Fe ASC: 1.6567 kg 3.6524 lbs
DH to RC ASC: 3.1038 kg 6.8426 lbs

(Based upon stream width at DH-9
and SC figures from DH-9 and DH-10 combination.)

Total-- 4.7605 10.4950

The shaded stream subsystem was the dominant habitat type in Rocky Creek. It consisted of pools along cut banks, sandy bottomed riffles, and occasional long pools. The low scour subsystem retains much of the leafy and woody detritus which passes into it. However, the cross-sectional area was generally too shallow to maintain larger fish species. The pool areas were also relatively small. Therefore, the subsystem was dominated by smaller fish species. The total subsystem standing crop was 20.5 lbs. (9.3 kg) (Table 2.7-15). Rocky Creek has been observed to not flow or to flow only slightly at certain times of the year (Breedlove, 1976b). Pool areas were significantly smaller and some probably dried up during such periods, which would further limit the subsystem's ability to support a standing crop of larger fish.

In contrast, the weedy swamp pool areas (Station RC-7) supported a standing crop of 21.1 lbs./ac. (23.7 kg/ha). Because swamp interior areas contained Cabomba and Utricularia, submersed aquatic vegetation in open areas, and because small fish were noted in these areas, the chronically flooded swamp subsystem was considered a suitable fishery habitat. Therefore, the swamp area was estimated to contain 2,026 lbs. (919 kg) of these smaller fish species. Although the extrapolation probably results in figures that are high, the station standing crop indicates that the weedy pool areas have a much higher standing crop than does the Rocky Creek shaded stream subsystem or any of the Turkey Creek stations.

Fish (Mulatto Pen Branch) - Fish sampling has not been conducted on Mulatto Pen Branch. However, it is expected to have a similar assemblage of fish due to comparable water quality, land use, terrestrial vegetation, and its connection with Rocky Creek. As such, Mulatto Pen Branch should be characterized by species typical of warm, slow moving, shallow, brown water systems.

Reptiles and Amphibians (Rocky Creek) - Herptiles collected from Rocky Creek consisted primarily of tadpoles of the southern leopard frog, the bronze frog, the river frog (Rana heckscheri), and a bull frog (Rana catesbeiana) (Table 2.7-16). Central newts (Notaophthalmus viridescens), two-toed amphiuma (Amphiuma means), greater siren (Siren lacertina), and a loggerhead mush turtle (Sternothaerus minor minor) were collected from Rocky Creek swamp, and an eastern cottonmouth (Agkistrodon piscivorus) and banded watersnake (Natrix sipedon fasciata) were observed.

Collected upland herptile forms included the green anole (Anolis carolinensis), the southern black racer (Coluber constrictor priapus) and the yellow rat snake (Elaphe obsoleta quadrivittata).

The majority of the aquatic herptiles were collected in pool areas having silty or loose sediments and in streamside or aquatic vegetation. The others were collected in slow-moving water areas, puddles, or debris along or within the stream channel (Table 2.7-16).

Table 2.7-16 Location, Species, Number Collected, and Habitat of Herptiles Collected Within Rocky Creek and Rocky Creek Swamp

Sta. No.	Species	Number Collected	Habitat
RC-4	Unidentified Frog	0	Puddle
RC-5	<u>Rana clamitans</u> (Bronze frog)	3 (Tadpoles)	Pools
	<u>Rana catesbeiana</u> (Bull frog)	1	Puddle
RC-6	<u>Amphiuma means</u> (Two-toed amphiuma)	2*	Pool
	<u>Sternothaerus minor</u> (Loggerhead musk turtle)	1*	Pool
	<u>Rana utricularia</u> (Southern leopard frog)	2 (Tadpoles)	Standing water
	<u>Notophthalmus viridescens</u> (Central newt)	1	Pool sediments
	<u>Anolis carolinensis</u> (Green anole)	1	Brush near creek
RC-7	<u>Amphiuma means</u> (Three-toed amphiuma)	5*	Pool area cypress swamp
	<u>Siren lacertina</u> (Greater siren)	1*	Pool area cypress swamp
	<u>Rana utricularia</u> (Southern leopard frog)	2 (Tadpoles)	Pool area cypress swamp
	<u>Rana clamitans</u> (Bronze frog)	4 (Tadpoles)	Pool area cypress swamp
	<u>Notophthalmus viridescens</u> (Central newt)	2	Sediments cypress swamp
RC-8	<u>Rana heckscheri</u> (River frog)	21 (Tadpoles)	Pool area near highway bridge
RC-15	<u>Rana clamitans</u> (Bronze frog)	7	Low flow areas of creek channel
	<u>Rana heckscheri</u> (River frog)	1	Low flow areas of creek channel
	Unidentified frog	0	Low flow areas of creek channel
RC-19	<u>Rana utricularia</u> 9Southern leopard frog)	5	Puddles and low flow areas of creek channel

*Taken on trot line during fishing effort.

All but two of the species of turtles, none of the lizards, and about two-thirds of the snakes expected to occur in Alachua County (Tables A2-10 through 47) are either aquatic or semiaquatic forms and could be expected to utilize portions of the Rocky Creek drainage.

Endangered Species - Herptiles expected to occur in this portion of Alachua County which are endangered (E), threatened (T), rare (R), of special concern (SC) or status undetermined (SU) are: the eastern indigo snake (T), mole snake (R), alligator (E, T, SC), spotted turtle (R), and striped newt (R). These species probably occur in suitable habitats adjacent to or within Rocky Creek and its tributaries. The remaining species are less likely to occur in these areas for the following reasons: suboptimal habitat - gopher tortoise (T, SC) and associated gopher frog (T); on fringe of known range - Gulf hammock dwarf siren (SU); or low creek flow and shallow depth - the Suwannee cooter (T) and alligator snapping turtle (SU). None of the above listed species were either collected or sighted during the field surveys.

Reptiles and Amphibians (Mulatto Pen Branch) - Reptiles and amphibians found along Mulatto Pen Branch would be the same species collected or expected to occur along Rocky Creek.

Rare and Endangered Species (Mulatto Pen Branch) - Rare and endangered species expected to occur along Mulatto Pen Branch are the same species expected to occur along Rocky Creek.

2.7.3.4 Santa Fe River

Because Rocky Creek drains into the Santa Fe River the following overview of the ecology of the Santa Fe River is presented.

The Santa Fe River watershed displays distinct differences in character between the upper and lower portions. The upper portion, above O'Leno State Park, drains flatland areas through numerous surface streams. Vegetation surrounding the upper Santa Fe River is virtually unbroken floodplain forest (hydric hammock) containing bald cypress, water tupelo, water ash, water elm, red maple, and river birch. The river bed is sandy with pockets of deep organic muck in sluggish reaches.

A combination of factors in the upper portion tend to maintain low primary production within the river's aquatic system. Among these are: (1) shading by the surrounding forest; (2) dark staining of the water by tannins leached from decaying vegetation; and (3) the accumulation of organic material on the bottom which tends to cover substrata that could otherwise be colonized by aquatic plants. As a result, the aquatic system is predominately heterotrophic, deriving most of its biological energy from outside sources such as detritus from terrestrial vegetation.

In the lower portion of the river there is a noticeable absence of surface streams. Banks become steeper and the surrounding floodplain forest is replaced in many areas by upland southern mixed hardwoods. This vegetation community is dominated by oaks and interspersed with pines and other

hardwoods (Section 2.7.2.1). Throughout much of this section the river bed cuts through limestone. In several areas the limestone creates small shoals and shallow riffles. Below High Springs, numerous clear springs discharge into the river, clarifying its waters, especially during periods of low flow.

The lower portion of the river has a more autotrophic character than the upper portion, as evidenced by beds of freshwater eel grass (Sagittaria sp.) and other macrophytes which exist along shallow banks and in riffle areas, and a coating of attached epiphytes over the limestone outcroppings in the river bed. Light intensity is greater as a result of greater channel width and water clarity. The extensive limestone bed which provides a suitable permanent substrate for epiphytes and the improved lighting are the principal factors responsible for the increased autotrophic activity.

Energy flow in the river community is primarily through a detritus food chain similar to that described in Section 2.7.3. Another important food chain in the lower portion of the river is the herbivore pathway based on the consumption of aufwuchs by small invertebrates and turtles. Unlike the smaller streams in the region, however, the river system provides a more stable environment capable of supporting a higher diversity of organisms. It also provides refuge for aquatic organisms during periods of low flow.

The river's vertebrate fauna includes all of the fish and aquatic amphibians, reptiles, birds and mammals listed in Tables A2-48 through 61. In addition, the heavily forested banks and surrounding areas provide excellent habitat for upland species including game animals. Rare and endangered vertebrates expected to utilize aquatic habitats along the Santa Fe River are the wood stork, southern bald eagle, osprey, Louisiana waterthrush, little blue heron, snowy egret, Louisiana heron, black crowned night heron, yellow crowned night heron, least bittern, white ibis, round-tailed muskrat, American alligator, Suwannee cooter, spotted turtle, alligator snapping turtle, mud sunfish and Suwannee bass (Section 2.7.2.2.1, Table 2.7-2).

2.7.3.5 Other Basins Within the Area

A number of other creek basins either are contained or originate within the project area. While in the project area, none of these creek basins has been considered as discharge alternatives, therefore they have not been studied in as great detail as those previously mentioned.

Monteocha Creek arises in a pine flatwoods-cypress dome association east of the Rocky Creek drainage and about five miles east of the Deerhaven station. Land use in this basin parallels that of the Rocky Creek basin. It flows generally northward through an area of small farms and croplands to join Little Monteocha Creek. From there it passes through a hardwood floodplain forest, and then empties into the Santa Fe River. The stream probably has little flow except in times of heavy rain.

Hatchett Creek originates in swamps about five miles east-southeast of Deerhaven. Its watershed is entirely wooded, with a high percentage of swampland. Access to Hatchett Creek is extremely limited. It drains into Newnan's Lake and eventually the St. Johns River system.

Blue's Creek arises just east of the University of Florida Agricultural Experiment Station on S-232 southwest of Deerhaven. The upper watershed is in hardwood forest, with some limited pine flatwoods. A considerable part of the upper watershed is now a large lot residential area. It flows within well-defined banks west-northwest into San Felasco Hammock, where it goes underground in Big Otter Ravine.

Burnette's Lake Branch drains a small watershed and flows into Burnette's Lake on the outskirts of Alachua, five miles northwest of Deerhaven. Hogtown Creek, Sweetwater Branch, and Little Hatchett Creek drain urbanized watersheds within the City of Gainesville and empty into Lake Kanapaha, Alachua Sink on Payne's Prairie, and Newnan's Lake, respectively.

2.8 Ambient Air

The ambient air quality at the site, as it currently exists, is defined in terms of:

* Total suspended particulate matter (TSP),
* Sulfur dioxide (SO_2),
* Nitrogen oxides (NO_x),
* Oxidants (O_x),
* Hydrocarbons (HC), and
* Carbon monoxide (CO);

the criteria pollutants defined by Chapter 17-2 of the Florida Administrative Code. In the case of NO_x, O_x, HC, and CO a qualitative description of air quality will be presented since no reliable measured air quality data nor reliable emission data exist for these pollutants. This shortcoming is offset by the fact that the emission rates of these pollutants, from the proposed source are minor, with the exception of NO_x.

Existing and baseline levels of TSP and SO_2 have been determined for the site by air quality modeling techniques. Baseline air quality is as defined in Chapter 17-2.03(4)(b)(v) of the Florida Administrative Code. It is defined as the maximum concentration of pollutants in the ambient air measured or estimates in the area of the proposed source. For sources other than fossil fuel steam generators, 1973 emission data are used. For fossil fuel steam generators, 1972 emission data are used, except that natural gas is converted to a heat equivalent of 2.5% sulfur oil for establishing baseline emission data. Actual annual emission data are used for establishing annual existing and baseline air quality. Maximum design operating conditions are used to establish short-term (twenty-four hour and three hour) existing and baseline air quality.

The meteorological data used in conjunction with the above defined emission data are from Jacksonville, Florida. For annual average modeling, the wind/stability data record for the period 1970-1974 was used. The mixing depth used was 1,000 meters; the ambient temperature, 20^{o} C (68^{o} F); and the ambient pressure, 1,000 millibars. The wind speed/wind direction/ stability data are listed in Table 2.6-5.

For short-term air quality modeling, the meteorological data were derived from 1964 Jacksonville data. These Jacksonville data were input to the CRSTER air quality model and the "worst-case" twenty-four hour and three hour conditions selected. The "worst-case" conditions were used rather than those creating the "highest second high" since only one year of meteorological data were analyzed. The twenty-four hour and three hour meteorological conditions are listed in Tables 2.8-1 and 2.8-2, respectively.

The air quality models used for simulating various conditions are:

* AQDM with the Brigg's plume rise equation and a calibration factor of 1.0 for annual TSP and SO_2

* PTMTPW with a calibration of 1.0 for three hour and twenty-four hour SO_2 and twenty-four hour TSP

2.8.1 Total Suspended Particulate Matter

Total suspended particulate matter levels in Alachua County have been measured by the Alachua County Pollution Control District for quite some time. The data are collected in accordance with the Federal Reference Method (40 CFR 50, Appendix B). It was determined that these data could be used to establish annual and twenty-four hour background TSP levels.

One site (SAROAD 10-0020-010), located approximately 1.9 miles (3 km) southeast of Deerhaven, was selected to establish TSP background levels. The AQDM predicts a current Deerhaven TSP impact at the site of zero. The site is remote from all other point and fugitive sources of par-

Table 2.8-1 24-Hour Meteorological Conditions Representative of "Worst-Case" Air Pollutant Dispersion Conditions (Day 096/1964 Jacksonville, Florida Data)

Hour of Day	Wind Dir. (DEG)	Wind Vel. (M/Sec)	Stability Class	Mix. Ht. (M)	Amb. Temp. (DEG-K)	Press (MB)
1	288.	4.10	4	589.	290.	1000.00
2	264.	5.10	4	567.	290.	1000.00
3	271.	5.10	4	544.	290.	1000.00
4	270.	5.10	4	521.	290.	1000.00
5	271.	4.10	4	499.	290.	1000.00
6	272.	5.10	4	476.	290.	1000.00
7	269.	5.10	4	454.	290.	1000.00
8	272.	3.10	4	431.	290.	1000.00
9	252.	5.10	4	409.	290.	1000.00
10	270.	6.20	4	386.	290.	1000.00
11	271.	5.10	4	364.	290.	1000.00
12	273.	5.10	4	341.	290.	1000.00
13	279.	5.10	4	319.	290.	1000.00
14	275.	7.70	4	296.	290.	1000.00
15	271.	8.20	4	296.	290.	1000.00
16	273.	7.20	4	296.	290.	1000.00
17	266.	5.10	4	296.	290.	1000.00
18	272.	5.10	4	296.	290.	1000.00
19	262.	4.10	4	320.	290.	1000.00
20	265.	5.60	4	402.	290.	1000.00
21	258.	5.10	4	484.	290.	1000.00
22	267.	4.10	4	566.	290.	1000.00
23	282.	3.60	4	648.	290.	1000.00
24	272.	2.60	4	730.	290.	1000.00

Table 2.8-2 3-Hour Meteorological Conditions Representative of "Worst-Case" Air Pollutant Dispersion Conditions (Day 096/1964 Jacksonville, Florida Data)

Hour of Day	Wind Dir. (DEG)	Wind Vel. (M/Sec.)	Stability Class	Mix. Ht. (M)	Amb. Temp. (DEG-K)	Press (MB)
1	151.	3.60	2	1100.	303.	1000.00
2	151.	2.60	1	1600.	305.	1000.00
3	154.	4.10	2	1400.	304.	1000.00

ticulate matter. The long-term (1/1976-8/1977) geometric mean TSP level of 29 μg/m³ was therefore selected as the annual TSP background level for the study.

The 95 percentile TSP level at this site was 60 μg/m³. Assuming that in 5% of the twenty-four hour periods, the station could have been influenced by particulate matter emissions from Deerhaven, the 95 percentile TSP level was selected as the twenty-four hour background level. This is not an unreasonable assumption in that the wind blows from Deerhaven toward the monitoring site approximately 6% of the time (Figure 2.6-1).

Several situations were simulated with the air quality models AQDM and PTMTPW in establishing TSP levels for various periods of time. These conditions, and the figure number in which the data are graphically presented, are listed in Table 2.8-3. The modeling data are also summarized in Table 2.8-4. The particulate matter emission inventories used are summarized in Table 2.8-5.

The baseline and 1977 TSP levels for the annual period at the Deerhaven site were at background level; 29 μg/m³. The maximum annual average TSP level predicted for the Gainesville area for both time periods, exclusive of fugitive dust, was 32 μg/m³; 3 μg/m³ above background (Figures 2.8-1 and 2.8-2).

The maximum expected twenty-four hour TSP level in the vicinity of the Deerhaven site for the baseline period was 62 μg/m^3 (Figure 2.8-1). This concentration occurred approximately 5.3 miles (8.5 km) northeast of the power plant. The maximum twenty-four hour TSP level predicted for 1977 was 61 μg/m^3. This occurs at the same location the baseline maximum occurred. Both include a twenty-four hour TSP background concentration of 60 μg/m^3 (Figure 2.8-2).

2.8.2 Sulfur Dioxide

Sulfur dioxide levels have been measured in Alachua County at a nine station monitoring network for several years. The monitoring has been conducted by the federal reference method (40 CFR 50, Appendix A), however, no steps were taken until quite recently to control the temperature on any of the samplers. Since EPA has taken the position that there is no acceptable means of making temperature corrections on historic data (Burch, EPA, 1977), baseline and existing (1977) SO_2 levels were estimated with air quality models. The background concentration of SO_2 for all averaging times was assigned a value of zero.

The conditions simulated to establish baseline and existing SO_2 levels for various time periods are tabulated in Table 2.8-6. Levels of SO_2 for the baseline and existing periods are summarized in Table 2.8-4. The SO_2 emission inventories are presented in Table 2.8-7.

Table 2.8-3 Conditions Simulated with Air Quality Models to Establish Baseline and Existing Total Suspended Particulate Matter Levels - Gainesville, Florida

Conditions	Model	Figure
Baseline - 1972 emissions from fossil fuel steam		
generators; 1973 emissions from other sources		
24-hour - Jacksonville day 096/1964		
meteorology	PTMTPW	2.8-1
Annual - Jacksonville 1970-1974	AQDM, w/	2.8-1
meteorology	Briggs	
Existing (1977) - Current emission data from all		
existing or permitted sources		
24-hour - Jacksonville day 096/1964		
meteorology	PTMTPW	2.8-2
Annual - Jacksonville 1970-1974	AQDM, w/	
meteorology	Briggs	2.8-2

Table 2.8-4 Summary of Baseline and Existing (1977) Total Suspended Particulate Matter and SO_2 Levels - Gainesville, Florida

	Annual ($\mu g/m^3$) Maximum	24-Hour ($\mu g/m^3$) Maximum	3-Hour ($\mu g/m^3$) Maximum
Particulate Matter			
1972-73	32	62	N/A
1977	31	62	N/A
Sulfur Dioxide			
1972-73	4	73	241
1977	3	63	207

Table 2.8-5 Particulate Matter Emission Inventory - Alachua County, Florida (Emission Rate in Tons Per Day)

Source Name	1972/73	1977	1981	1985	1989	Max. 24-Hour Emissions
Deerhaven No. 1	0.06	0.18	0.07	0.07	0.11	0.63
Deerhaven No. 2	---	---	1.68	1.77	2.15	2.9
Deerhaven GT 1	---	0.005	0.007	0.007	0.01	0.15
Deerhaven GT 2	---	0.005	0.006	0.008	0.01	0.15
J.R. Kelly No. 5	0.01	---	---	---	---	0.1
J.R. Kelly No. 6	0.23	0.003	---	---	---	0.1
J.R. Kelly No. 7 & 8	0.35	0.05	0.025	0.044	0.04	0.5
J.R. Kelly GT 1	0.04	0.0006	0.003	0.004	0.009	0.15
J.R. Kelly GT 2	0.04	0.0001	0.003	0.003	0.01	0.15
J.R. Kelly GT 3	0.03	0.0007	0.005	0.005	0.01	0.15
Franklin Crates	0.1	0.1	0.1	0.1	0.1	0.1
Whitehurst Construction	0.1	0.1	0.1	0.1	0.1	0.1
Maas Brothers	0.1	---	---	---	---	---
Baggett Construction	0.4	0.4	0.4	0.4	0.4	0.4
Maddox Foundry	---	0.001	0.001	0.001	0.001	0.001
U of F Boiler	---	0.22	0.22	0.22	0.22	0.22
D & H Construction	---	0.04	0.04	0.04	0.04	0.04
Thomas Concrete	---	0.05	0.05	0.05	0.05	0.05
Sunland No. 1	0.01	0.01	0.01	0.01	0.01	0.01
Sunland No. 2	0.01	0.01	0.01	0.01	0.01	0.01
Sunland No. 3	0.01	0.01	0.01	0.01	0.01	0.01
Wall Construction	0.1	---	---	---	---	---
Koppers	---	0.003	0.003	0.003	0.003	0.003

Table 2.8-6 Conditions Simulated with Air Quality Models to Establish Baseline and Existing Sulfur Dioxide Levels - Gainesville, Florida

Condition	Model	Figure
Baseline - 1972 emissions from fossil fuel steam generators; 1973 emissions from other sources		
3-hour - See Table 2.8-2 for meteorology	PTMTPW	2.8-3
24-hour - Jacksonville day 096/1964 meteorology	PTMTPW	2.8-3
Annual - Jacksonville 1970-1974 meteorology	AQDM, w/ Briggs	2.8-3
Existing (1977) - Current emission data from all existing or permitted sources		
3-hour - See Table 2.8-2 for meteorology	PTMTPW	2.8-4
24-hour - Jacksonville day 096/1964 meteorology	PTMTPW	2.8-4
Annual - Jacksonville 1970-1974 meteorology	AQDM, w/ Briggs	2.8-4

Table 2.8-7 Sulfur Dioxide Emission Inventory - Alachua County, Florida (Emission Rate in Tons Per Day)

Source Name	1972/73	1977	1981	1985	1989	Max. 24-Hour Emissions
Deerhaven No. 1	3.3	1.75	2.8	3.0	4.8	12.5 x S
Deerhaven No. 2	---	---	20.0	21.6	25.6	34.1
Deerhaven GT 1	---	0.04	0.028	0.03	0.06	0.6
Deerhaven GT 2	---	0.04	0.028	0.036	0.06	0.6
J.R. Kelly No. 5	0.5	---	---	---	---	4.7 x S
J.R. Kelly No. 6	1.8	0.27	---	---	---	2.4 x S
J.R. Kelly No. 7 & 8	16.8	3.72	1.04	2.0	1.6	10.3
J.R. Kelly GT 1	0.2	0.004	0.014	0.017	0.04	0.6
J.R. Kelly GT 2	0.2	0.004	0.015	0.015	0.04	0.6
J.R. Kelly GT 3	0.2	0.005	0.019	0.02	0.05	0.6
Whitehurst Construction	0.3	0.3	0.3	0.3	0.3	0.3
Baggett Construction	0.1	0.1	0.1	0.1	0.1	0.1
U of F Boiler	---	2.2	2.2	2.2	2.2	2.2

S = % of sulfur

The annual average SO_2 level for the baseline period near the Deerhaven site is 1 to 2 μg/m^3 and the maximum in the Gainesville area is 4 μg/m^3 (Figure 2.8-3). For the 1977 period, the annual average SO_2 levels near Deerhaven and at the point of maximum concentration are 1 to 2 μg/m^3 and 3 μg/m^3, respectively (Figure 2.8-4).

The maximum twenty-four hour SO_2 concentration for the baseline period was predicted to be 73 μg/m^3 at a point 5.3 miles (8.5 km) northwest of the Deerhaven site (Figure 2.8-3). The maximum twenty-four hour SO_2 concentration for the 1977 period is 63 μg/m^3; occurring at the same point (Figure 2.8-4).

The maximum SO_2 levels for a three hour period for the baseline and 1977 period were predicted to be 241 μg/m^3 and 207 μg/m^3, respectively. In both cases the maximum was predicted to occur 1 km northwest of the Deerhaven site.

2.8.3 Other Criteria Pollutants

The other criteria pollutants are NO_x, O_x, HC, and CO. The only one of these emitted from the existing or proposed sources in any quantity is NO_x. The annual average impact of NO_x emissions was evaluated and found to be in the order of 1 μg/m^3 at the point of maximum concentration. The only Florida air quality standard for this pollutant is 100 μg/m^3.

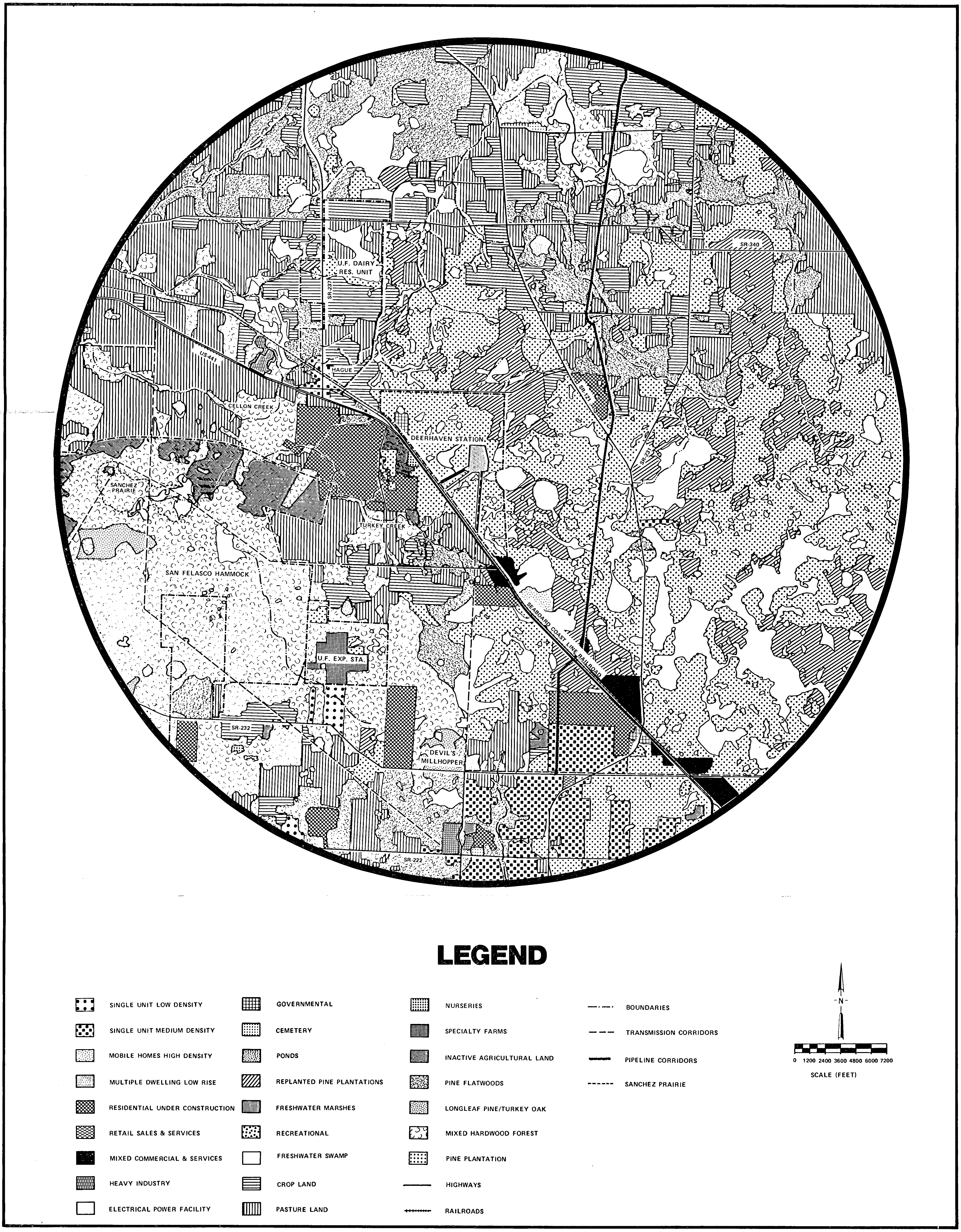


FIGURE 2.2-1 DEERHAVEN FIVE MILE RADIUS VEGETATION AND LAND USE MAP.

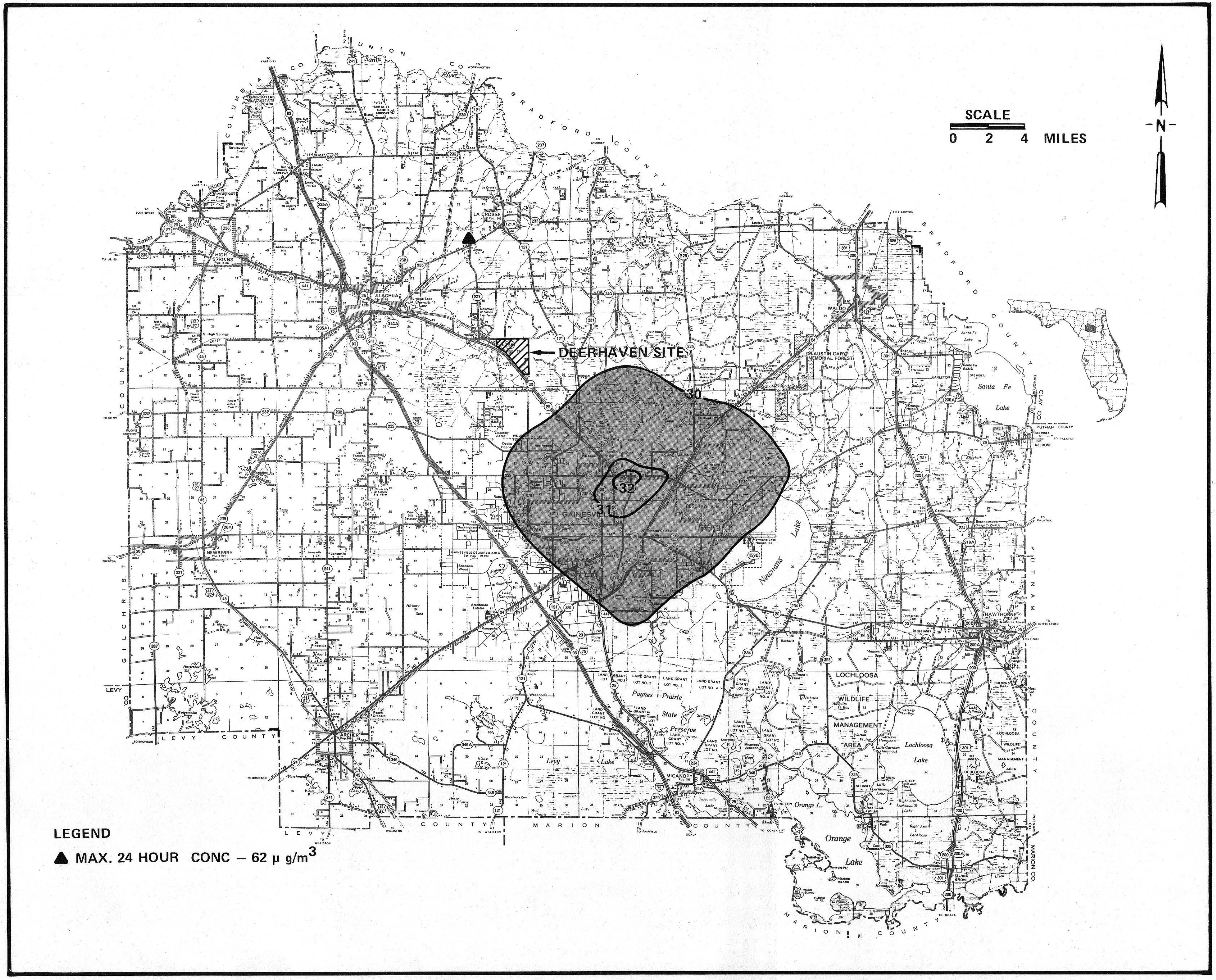


FIGURE 2.8-1 ANNUAL AVERAGE AND 24 HOUR AVERAGE BASELINE (1972/1973) TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATION, ALACHUA COUNTY, FLORIDA.

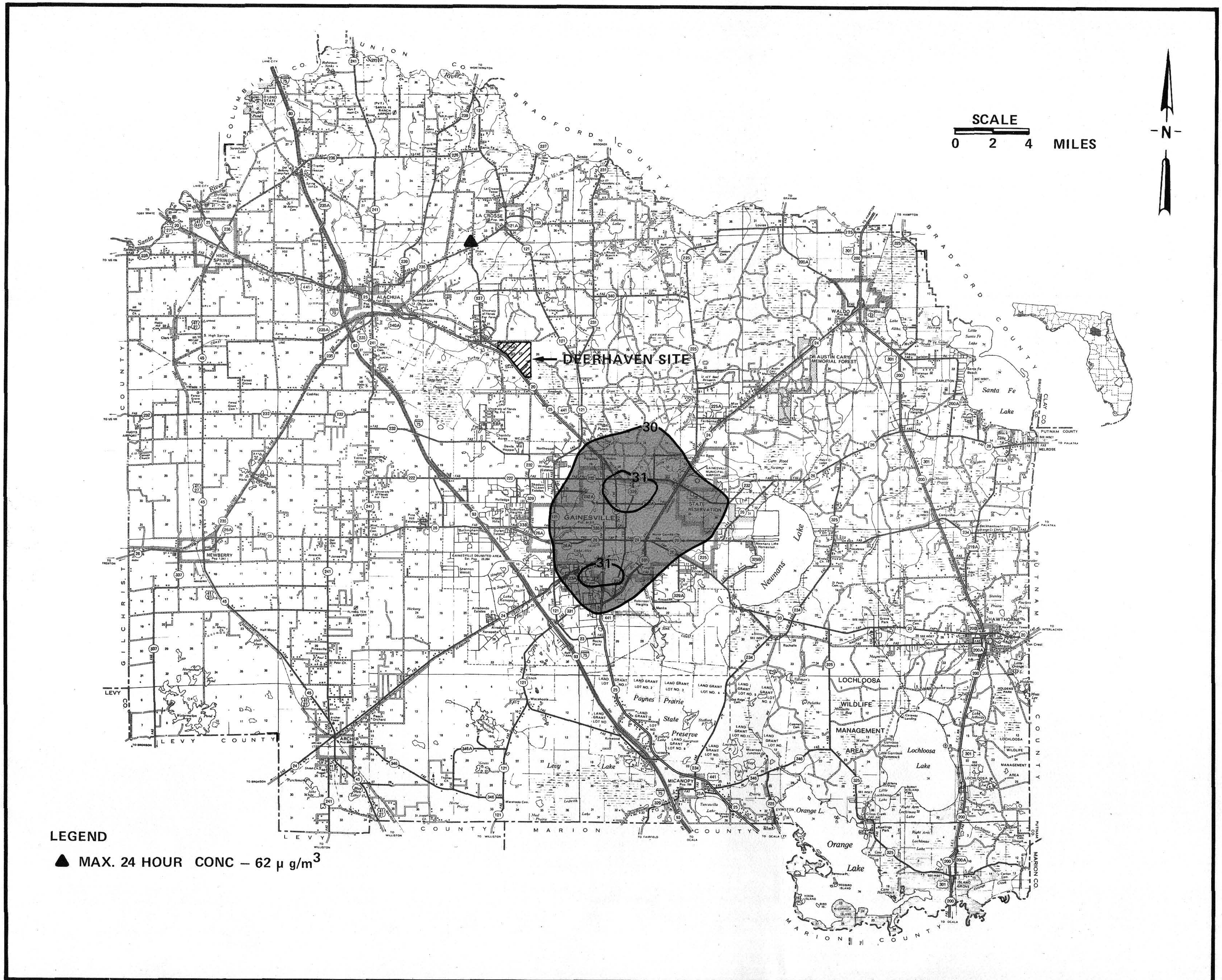


FIGURE 2.8-2 ANNUAL AVERAGE AND 24 HOUR AVERAGE 1977 TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATION, ALACHUA COUNTY, FLORIDA.

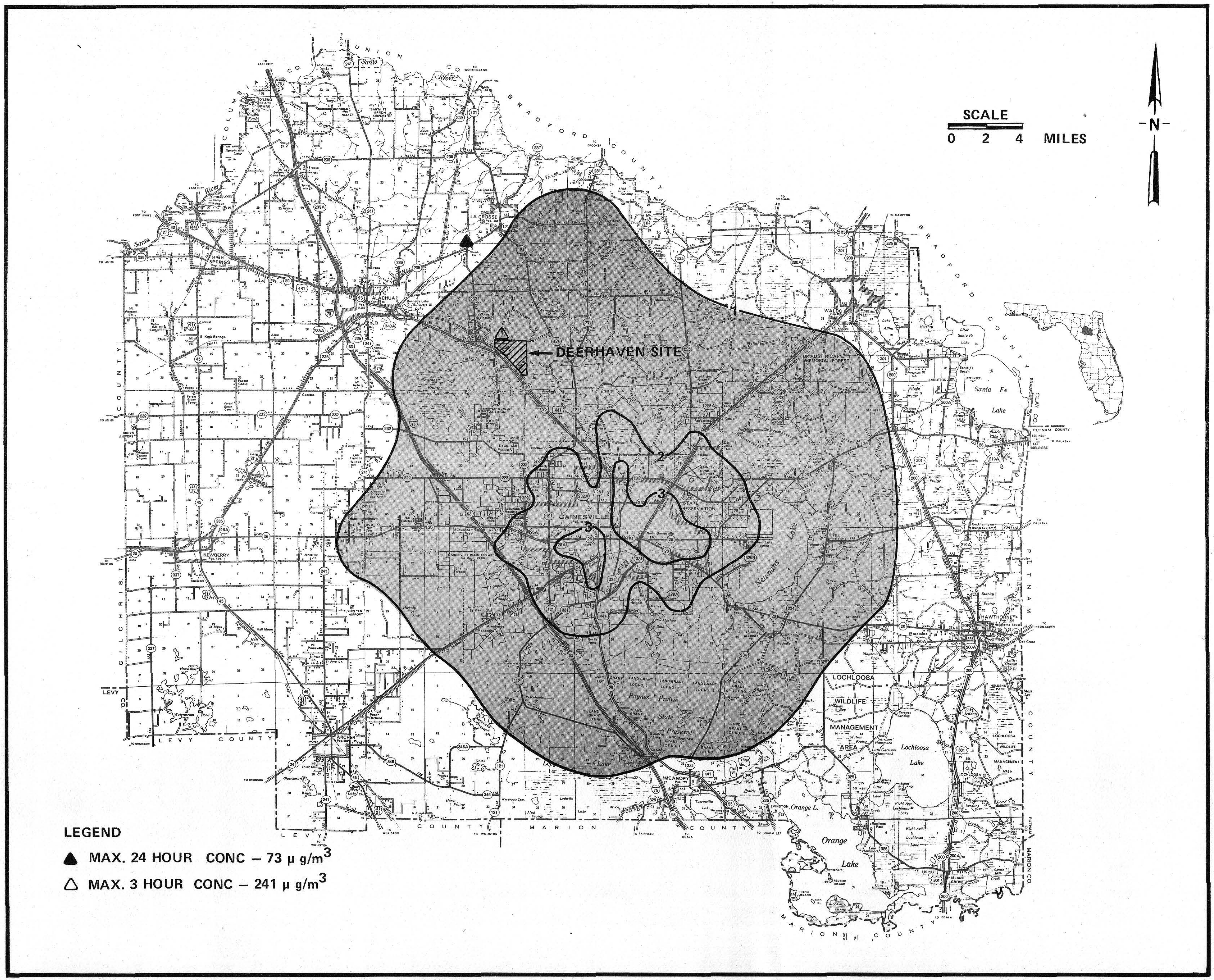


FIGURE 2.8-3 ANNUAL 24 HOUR AND 3 HOUR BASELINE (1972/1973) SULFUR DIOXIDE CONCENTRATION, ALACHUA COUNTY, FLORIDA.

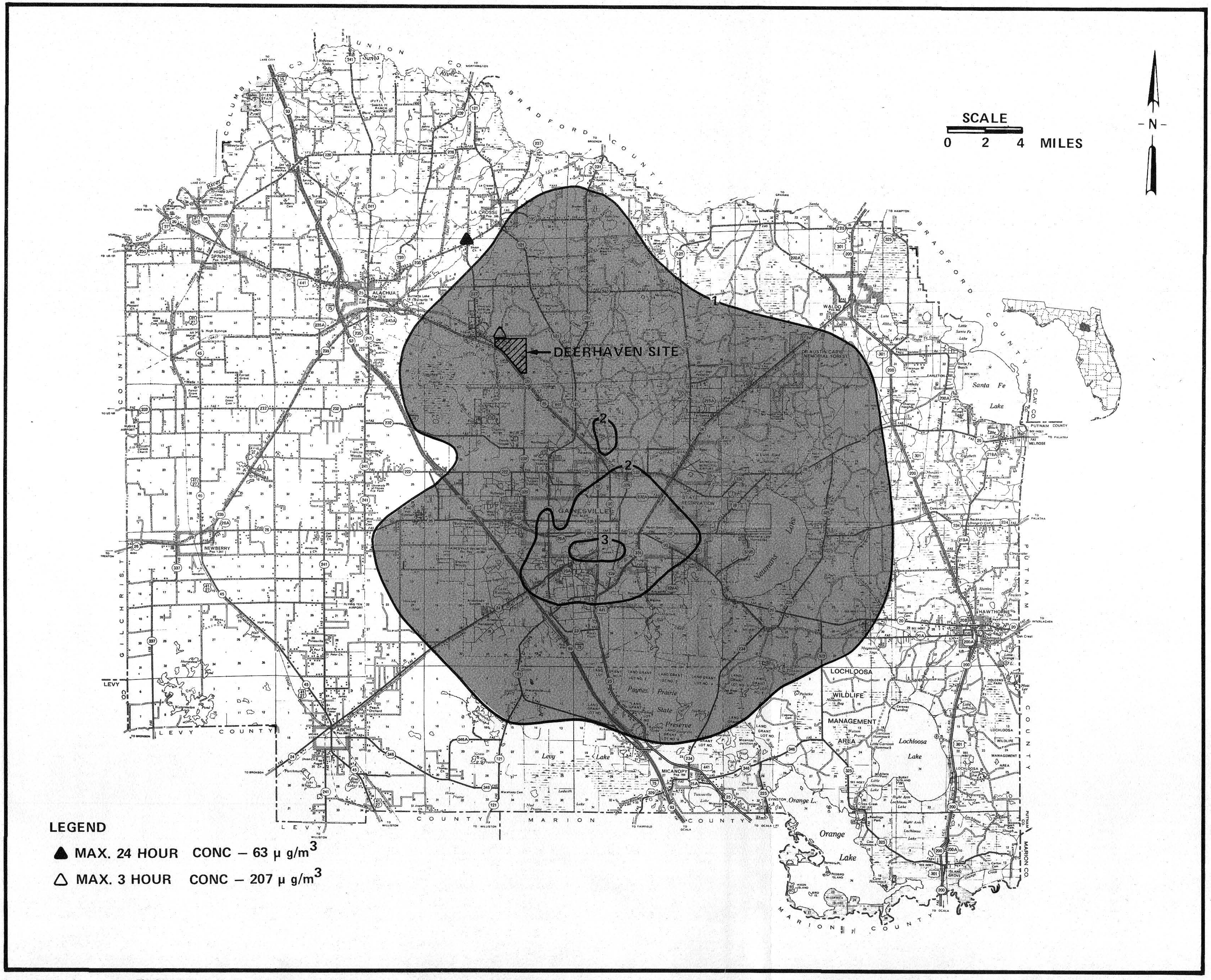


FIGURE 2.8-4 ANNUAL 24 HOUR AND 3 HOUR 1977 SULFUR DIOXIDE CONCENTRATION, ALACHUA COUNTY, FLORIDA.

CHAPTER 3

THE PLANT

The operating plant and directly associated facilities are described in this chapter. Although design has not been finalized, best estimates of plant effluents and performance of related systems have been developed.

Detailed descriptions of the major component operations which may affect the environment, such as fuel handling and storage, process water use, solid waste control and disposal, and air pollution control are provided. Process water use is described for both normal and peak plant use based upon average and peak load conditions respectively. Consumptive water use is also provided for the plant as a whole as well as each major component operating the process water balance. Estimations of the chemical and physical characteristics of certain major effluents are also discussed.

This application is based upon the use of deep well injection for the disposal of plant effluents for both Units 1 and 2. At present, a pilot program is underway to determine the feasibility of deep well injection at the Deerhaven site. Further discussion and detailed description of this program is provided in Chapter 6.

3.1 Facilities Description

3.1.1 Existing Facilities

The existing facilities consist of an 81,000 kW steam electric generating unit (Deerhaven Unit 1) and two 20,000 kW combustion turbines. The steam unit is fired both by No. 6 oil and natural gas, while the turbines are

fired with No. 2 oil and natural gas. Fuel storage facilities consist of two 55,000 barrel tanks for No. 6 oil and a 20,000 barrel storage tank for No. 2 oil along with the necessary unloading equipment.

Deerhaven Unit 1 is served by a six cell, mechanical draft wet cooling tower, a 300 foot stack and such ancillary equipment as 3 deep water supply wells and a 500,000 gallon elevated storage tank, demineralizers, electrical switch yard and 138 kV transmission line, rail spur and gas yard.

Fuel gas is supplied by the Florida Gas Transmission Company via pipeline. No. 6 oil is presently trucked to the site by the Amerada Hess Corporation from their fuel oil storage facilities at Jacksonville, Florida while No. 2 oil is trucked by the Belcher Oil from its facilities in Tampa.

3.1.2 New Facilities

The Project consists of the addition of a coal-fired, 235,000 kW, steam electric generating unit and related facilities to the 1,116 acre Deerhaven Station. The project will include a modern steam generator, an electrostatic precipitator and reheat turbine generator, a 350 foot stack, one additional deep water supply well, a multi-cell, mechanical draft wet cooling tower, ash handling, fuel storage and handling facilities, deep injection wells for effluent disposal, complete auxiliary equipment, instrumentation, controls, step-up transformers, 138 kV overhead connection to the on-site transmission substation, associated equipment and initial fuel supply inventory (Figure 3.1-1 and 3.1-2).

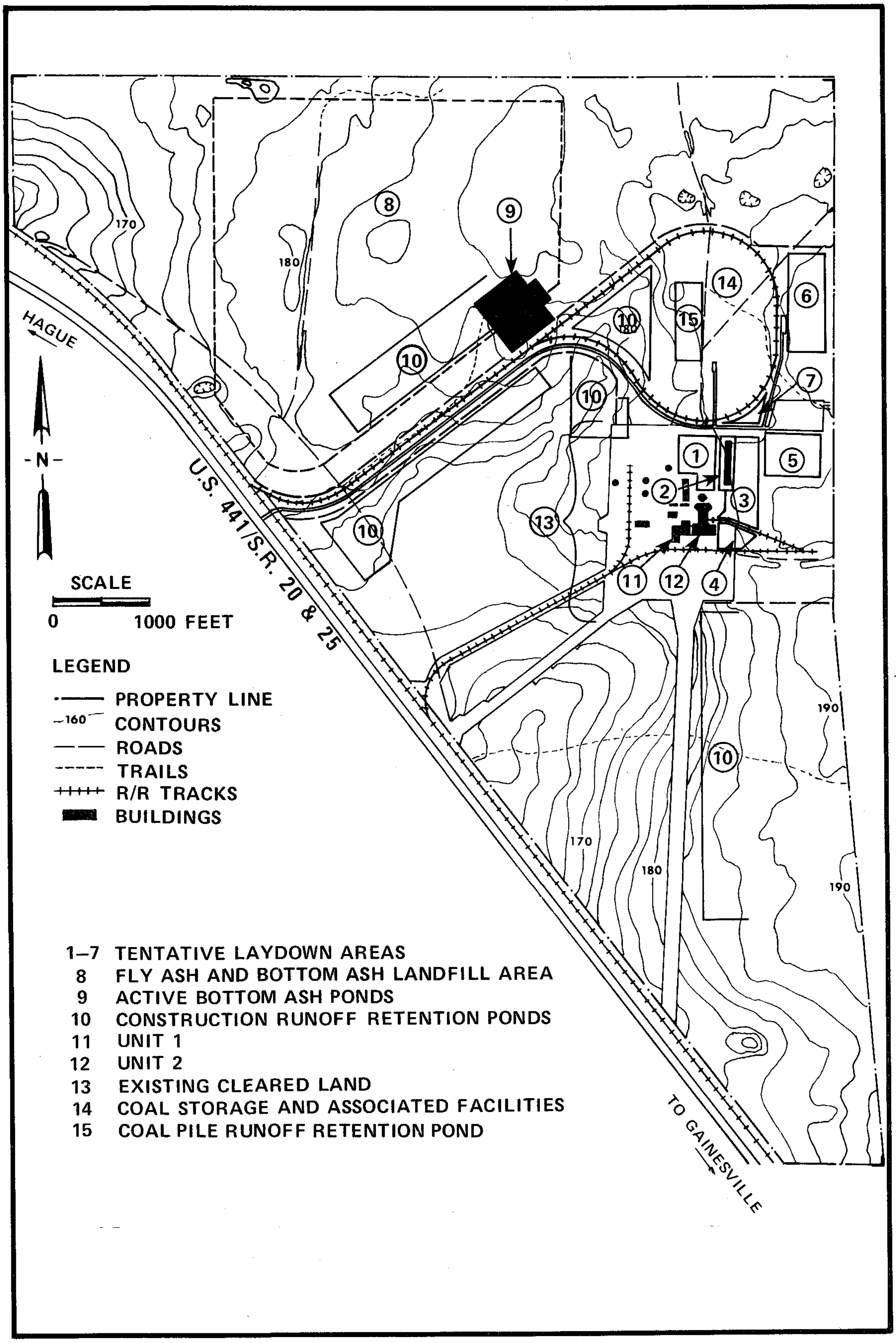


FIGURE 3.1-1 PROPOSED SITE PLAN OF THE DEERHAVEN SITE.

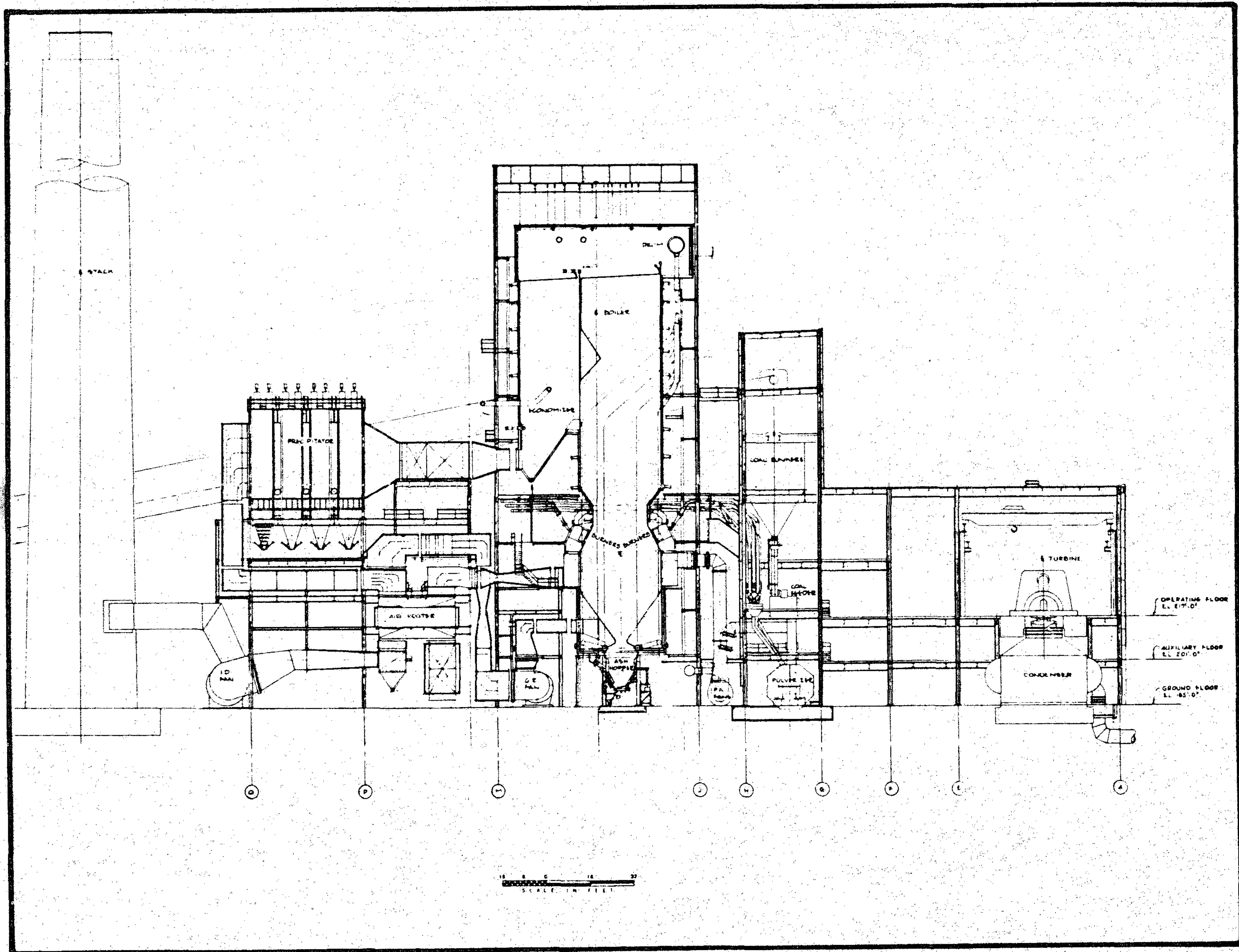


FIGURE 3.1-2 PLANT CROSS SECTION.

Steam Generator (Boiler)

The boiler will be a reheat turbo-fired furnace of balanced draft operation for semi-outdoor service. It will be fired by pulverized eastern, low sulfur coal. It will be capable of delivering 1,788,000 lbs. of steam per hour continuously at 1,980 psig and 1,005° F at the superheater outlet.

The unit will be capable of meeting all specification requirements including steam capacity, NO_x production and other environmental regulations, while burning the design coal as specified below.

Design Coal Specifications

Moisture as received, maximum	16%
Ash, dry basis, maximum	8%
Grindability, Hardgrove, minimum	50
Size 1 1/4" x 0	
Btu/lb.-dry basis, preferred minimum	12,000
Sulfur (dry basis) maximum	.72%

Electrostatic Precipitator

A hot side precipitator, with a guaranteed particulate removal efficiency of 99.5%, when generating with a gas volume of 1,346,000 acfm (actual cubic feet per minute) or less; and inlet gas temperatures 650° to 760° F will be utilized to meet U.S. EPA and Florida Department of Environmental Regulation New Source Performance Standards for particulate emissions. The maximum particulate emission from the precipitator for any load on the steam generator down to 20% of maximum rating, will not exceed 0.1 lbs./10^6 Btu heat input (during any normal operating condition, including soot blowing).

Boiler Stack

The flue gas stack will be a concrete reinforced stack with either a steel liner or an acid brick liner, all resting on a reinforced concrete foundation. The stack will be 350 feet above grade with a 17 3/4 foot inside diameter.

The flue gases exiting the stack will be 2.7 million lbs./hr. at 275^{0} F with a velocity of 50 feet per second at design load. Flue gas analysis in pounds per pound of fuel at total air for anticipated low sulfur compliance coal is:

CO_2 = 2.4

H_2O = .63

SO_2 = .01

O_2 = .5

N_2 = 8.4

Circulating Cooling Water

Circulating water for condenser cooling will be provided through the use of a mechanical draft cooling tower. The tower will be multi-celled and of the cross-flow, induced draft type.

Total dissolved solids will be controlled by blowdown. Shock chlorine addition will be used for algae growth control within the system. Sulfuric acid will be added to the system to control condenser tube scaling.

Coal Handling System

At present, a 90 day reserve supply of coal is anticipated for the Deerhaven site. This will require a maximum storage area of 11.0 acres at a maximum depth of 20 feet. It is anticipated that facilities for one ready pile over the hoppers and one pile of inactive storage will be utilized. The active pile will be conical in shape with a diameter of approximately 90 feet and a height of approximately 30 feet. Thus, the total area covered by the coal will be approximately 11.3 acres.

The interior of the on-site rail loop will be the location of both coal storage and coal handling facilities, including the coal-pile runoff retention pond (Figure 3.1-1). The enclosed loop area comprises approximately 57 acres. Within this area will be located approximately 11.3 acres of coal pile storage area and approximately 3.5 acres of coal-pile runoff retention pond area.

All runoff from the coal storage area will be captured and drained to a coal pile retention pond with a surface area of approximately 3.4 acres and with depth sufficient to retain totally the runoff from the ten year, twenty-four hour storm. Throughout a storm, a pump will transfer stormwater from the retention pond to the ash handling pond at a constant rate designed to empty the retention pond within twenty-four hours of rainfall cessation. This water will then be used for consumptive and industrial processes, and will eventually be evaporated or disposed of through deep well injection. A sump system will keep the pond drained

of coal-pile baseflow, groundwater seepage, and flows induced by the diurnal heating and cooling of the coal pile. Water pumped to the ash pond will help in neutralizing the alkaline runoff from the ash landfill disposal area. After treatment and blending, this water will be used in the ash sluicing system.

Ash Handling System

The major solid waste product of a coal-fired generating plant is ash. The quantity of ash produced depends upon the size of the plant, the generating load factor, the heat content of the coal (in Btu/lb.) and the ash content of the coal, where ash is the incombustible residue which remains after the combustion process. Ash content for the design coal is from approximately 2% to 10% of total weight of coal. Two types of ash are produced by coal-fired generating plants. Bottom ash (including boiler slag) is the residual ash and other inorganic material which remains after the coal is burned. Particle sizes range from coarse gravel to fine sand and readily settle in water. Bottom ash has low solubility and, because of its coarseness, high permeability.

Bottom ash from Unit 2 will fall from the furnace to the ash hopper and be cooled by recirculating slurry water. The cooled bottom ash will then be sluiced to the active bottom ash ponds where, because of its coarseness, it will settle. Two active bottom ash ponds, each 400 feet long by 300 feet wide by 18 feet deep (including 3 foot freeboard) are anticipated, resulting in a capacity for each pond of 39.9 acre-feet.

While sluiced bottom ash is entering one pond, the other will be emptied of ash sediment. The pH adjustment and any other necessary water treatment will be performed in these ponds. Ash sluicing make-up water will come from boiler blowdown, coal-pile runoff, ash pile runoff, and groundwater when necessary. A smaller adjacent pumping pond, 200 feet long by 100 feet wide by 18 feet deep (3 foot freeboard) will be used to hold clear decant water for pumping back into the ash sluicing system.

Fly ash will be removed from stack gases by electrostatic precipitation, and disposed of in the on-site landfill. Disposal of fly ash through commercial marketing to construction materials manufacturers for use in concrete and concrete blocks is currently being investigated. If these investigations prove to be fruitful, substantial quantities of ash may be disposed of through this method.

Both bottom ash and fly ash will be disposed of on-site in above-ground landfill cells. On-site disposal could require up to 220 acres of landfilling capability. Phasing will be developed so that only a small portion of the 220 acres would be active for landfilling at any one time. Preliminary site layouts indicate that approximately one-third of the site on the northern end will be used for ash disposal. Each cell will be from 5 to 25 feet deep and have a final side slope of not more than 25%. Each cell will be covered with soil and revegetated to within 10 feet of its working face. Each cell is expected to be filled in about 5 years, depending upon the quantity of ash produced. Rainfall

and other water running off the active landfill cell will be retained in a storage ditch and pumped back to the ash ponds for treatment. Other surface runoff will be permitted to drain naturally.

3.1.3 Visual Considerations

View of the power plant building is extremely limited because of the flat topography and the surrounding growth of tall trees on the site and throughout the area. The building can only be seen from U.S. 441 which passes about 3,000 feet southwest of the building site. The new building, like the existing power plant building, will be oriented facing toward the highway.

3.1.4 Exterior Appearance of the Power Plant Building

The new addition will be compatible with the existing power plant building. Prominent design features in the existing building, such as color, pattern of windows and siding materials, will be continued in the design of the new addition, which in general will match and line up with the existing building.

3.2 Fuel

Deerhaven Unit 2 will be fired with pulverized coal as the primary fuel. At the present time RUB is negotiating with several prospective suppliers in efforts to secure a long-term coal supply. This fuel will be a compliance coal and is anticipated to be eastern bituminous (Section 3.1.2). No. 2 oil will be used for ignition and flame stabilization purposes only.

Throughout the first 10 years of plant operation, it is projected that approximately 660,000 tons/year of coal will be burned. The coal consumption rate after the first 10 years will drop as newer and more efficient generating units are placed into service. Depending on the number of unit startups, load factor and quality of coal, it is anticipated that about 600,000 gallons per year of No. 2 oil will be consumed.

Coal will be delivered by unit train to the plant by commercial railroad, while No. 2 oil will be trucked in from area suppliers. RUB is currently evaluating the feasibility of purchasing its own cars for unit train delivery of coal. This will enhance fuel supply reliability and may result in lower cost of fuel as delivered.

Bulk storage of coal will be provided by ground level storage piles. Coal handling facilities will be constructed to unload coal from the rail cars and convey it to a ground level ready pile and reclaim hopper. Coal will then be moved by conveyor to the crusher house and the storage bunkers in the powerhouse. Additional coal preparation equipment will be located in the powerhouse to grind and transport coal fuel suitable for firing the new steam generator.

Fuel oil storage tanks and pumping equipment will comprise the additional equipment needed for ignitor fuel. Retaining walls will contain any spillage from the fuel oil storage tank.

RUB has examined the feasibility of utilizing processed municipal refuse (refuse-derived fuel) produced within Alachua County as a supplementary fuel for the project. It was determined that firing refuse-derived fuel (RDF) would not be economically feasible in the 1981 timeframe. However, based on the assumptions made in the study, RDF would prove to be economically feasible when compared with disposal by sanitary landfill by 1991. For this reason RUB has determined that it will proceed on the basis of making minimum expenditures for provisions to use RDF in the future. In other words, allowances will be made in the design and construction of the project so as not to economically preclude future RDF firing.

3.3 Plant Water Use

Figure 3.3-1 shows schematically the manner in which all plant water is to be used. The operation of the project (new and existing units combined) will result in an average withdrawal of approximately 4.67 million gallons per day (mgd) from the Floridan Aquifer via on-site wells. This water will be used for cooling tower makeup, equipment cooling and cleaning, and as a supplemental makeup source for bottom ash handling.

Boiler, demineralizer, and reverse osmosis makeup and water for domestic use will come from the RUB's water system. This average flow will be approximately 0.07 mgd.

Flyash will be removed from the precipitator and conveyed to the ash silo pneumatically. From the ash silo, it can be sold or wet with

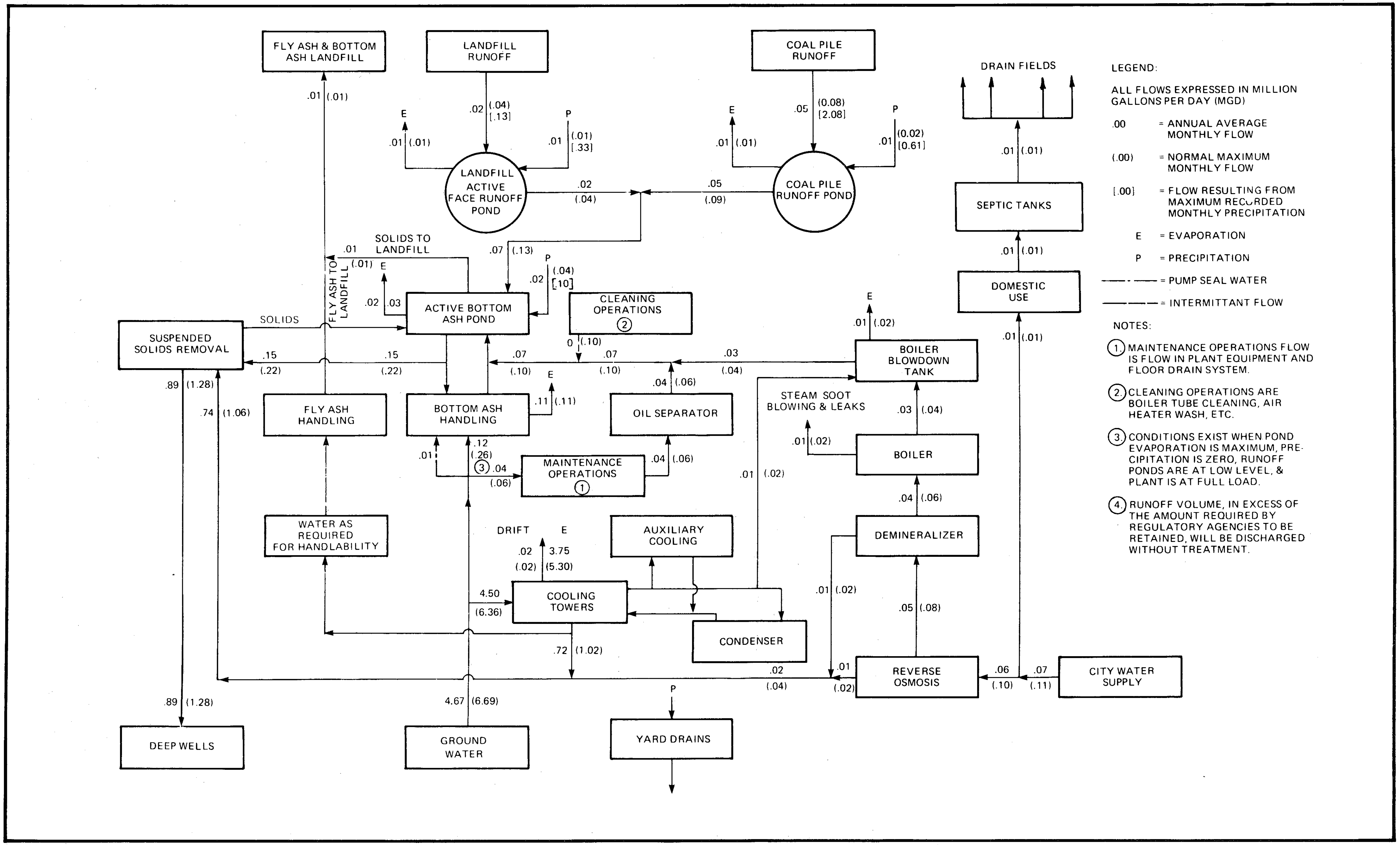


FIGURE 3.3-1 PROCESS FLOW DIAGRAM.

cooling tower blowdown and landfilled on-site. Bottom ash will be handled wet with recycling techniques to reduce the total makeup water requirements. Makeup water for the bottom ash handling system will come from coal pile runoff, ash landfill runoff, boiler blowdown, plant drains and ground water.

3.3.1 Sources of Water

Makeup water to the plant will come from ground water, precipitation, and the RUB water system.

Groundwater will be pumped from the Floridan Aquifer via on-site wells. This water will be used as makeup to the cooling water system, as pump seal water for the bottom ash sluice pumps, as makeup to the bottom ash handling system and as wash water for air heater wash and miscellaneous nonchemical cleaning operations.

Precipitation which falls directly on the coal pile and the ash landfill active face will be collected for use as makeup to the bottom ash handling system.

Water for boiler makeup and domestic use will come from the RUB water distribution system.

3.3.2 Water Withdrawal

The quantity of water withdrawn from the Floridan Aquifer via on-site wells is estimated to range from 4.67 mgd during average annual operation to 6.69 mgd during normal maximum monthly operation.

The quantity of water withdrawn from the RUB water system is estimated to range from .07 mgd during average annual operation to .11 mgd during normal maximum monthly operation.

The total ground water withdrawal from the Floridan Aquifer is therefore expected to range from 4.74 mgd to 6.80 mgd depending upon plant load and precipitation. Figure 3.3-3 describes the manner in which this water will be used.

3.3.3 Normal and Peak Load Water Use

Figure 3.3-3 represents the normal and peak plant water use based upon average and peak load conditions respectively. More cooling tower makeup will be required during periods of high ambient temperatures (increased tower evaporation) and high plant load (more cooling required because of higher heat load). Maximum cooling tower blowdown as shown on Figure 3.3-3 is indicative of high ambient temperature and high plant load occurring simultaneously, a condition which is expected to occur 1% to 2% of the time.

Boiler makeup, water to plant drains, ash handling makeup, and cooling tower blowdown used to mix with fly ash for dust suppression during landfilling will vary according to plant load.

Coal pile and landfill runoff available for ash handling makeup will vary with the rainfall. Figure 3.3-3 indicates maximum flows resulting from an average maximum month's rainfall.

The amount of ground water required for ash handling makeup will vary according to the amount of makeup available from runoff ponds, plant drains, and boiler blowdown and according to the amount of ash produced, which is a function of plant load factor. The flow of ground water for ash handling makeup, as shown in Figure 3.3-3, is indicative of no makeup water being available from runoff collection ponds and the plant operating at full load.

3.3.4 Water Use for Various Plant Conditions

During periods of maximum power production, all process water systems will be operating with their respective expected maximums of process water throughout, with exception of the cleaning operations. The expected process water flows for these systems during full plant load are as presented in Figure 3.3-3. These are per day averages which would occur if the power station were to operate at full load for approximately one month. Intermediate fluctuations will occur for certain systems (e.g. demineralizer waste, domestic use, etc.).

During periods of average power production, most of the process water systems will use proportionally less water than during extended periods of full power production. Process streams not expected to decline with plant load are domestic use and bottom ash handling evaporation. Expected process water flows for the plant during periods of average plant load are as shown in Figure 3.3-3.

3.3.5 Water Flows for Plant Systems

Figure 3.3-3 indicates the flow scheme for all water associated with plant operation and maintenance.

Cooling Water

Makeup water for the cooling towers will come directly from the Floridan Aquifer. The cooling tower makeup flow will range from 4.50 mgd to 6.36 mgd depending upon blowdown requirements and cooling tower evaporation. The cooling towers will be operated at approximately six concentrations, which is the maximum number of concentrations that ground water quality will allow without scaling or fouling problems.

Cooling tower blowdown will be injected into deep wells for disposal, with exception of the quantities used for wetting fly ash for dust suppression during landfilling and a small amount used as quench water for the boiler blowdown. Cooling tower blowdown flow will range from 0.73 mgd to 1.04 mgd depending upon plant load and operating conditions.

Reverse Osmosis Unit

The water utilized for steam generation must be of high purity to prevent scaling and fouling of the boiler, steam lines, turbine and accessories. To accomplish part of this task, drinking quality water will be passed through a reverse osmosis unit to remove a large portion of the dissolved solids. The waste stream from the reverse osmosis unit will contain a relatively high concentration of dissolved salts, and will be at a relatively neutral pH. This waste stream will be deep well injected.

The flow of product water from the reverse osmosis unit will range from 0.05 mgd to 0.08 mgd, depending upon plant load. The flow of wastewater from the unit to the deep wells will range from 0.01 mgd to 0.02 mgd, depending upon plant load.

Demineralizer

The boiler makeup water, after passing through the reverse osmosis unit, will receive final demineralization through the use of acid-base ion exchange equipment. Periodically, the exchange media will be regenerated through the use of acid and basic solutions. The waste products of regeneration are relatively high concentrations of dissolved salts of the regeneration agents. These acid-base wastes will be mixed for pH neutralization and injected into deep wells.

The flow of product water from the demineralizer will range from 0.04 mgd to 0.06 mgd depending upon plant load. The flow of demineralizer

wastewater to the deep wells will vary from 0.01 mgd to 0.02 mgd depending upon plant load.

Boiler

Although demineralized water is being used for boiler makeup, impurities still exist. To prevent a buildup of these impurities, a small percentage of water is withdrawn from the system. The flow of boiler blowdown will range from .03 mgd to .04 mgd depending upon plant load. This water, although not desirable for boiler water makeup, is still quite good, having a total dissolved solids concentration of approximately 100 mg/l and will be routed to the active bottom ash pond for use as ash handling makeup water.

High pressure steam will be used for soot blowing inside the boiler and will go up the stack with the flue gas. The amount of water used for soot blowing and loss in leakage will range from 0.01 mgd to 0.02 mgd depending upon coal ash characteristics and plant load.

Some loss of the boiler water is expected. This leakage should amount to approximately 0.2% of the steam flow rate.

Equipment Cleaning Wastes

Drains will be provided throughout the plant to collect waste waters from metal cleaning and air heater wash operations. Wastes collected by these drains will be routed to the active bottom ash pond for self-

neutralization and sedimentation prior to deep well injection. This flow will range from .01 mgd to 0.1 mgd depending upon the specific cleaning operation in progress.

Miscellaneous Equipment and Floor Drains

Drains will be provided throughout the plant to collect miscellaneous equipment drainage (e.g. packing gland leakage, etc.) and floor drainage. Water collected by this drain system will be routed through an oil separator where waste oil particles greater than 50 microns will be skimmed from the surface and burned in the boiler. The water will then be routed to the active bottom ash pond for ash handling makeup. This flow will range from 0.04 mgd to 0.06 mgd depending upon plant load and specific maintenance operations.

Bottom Ash Handling Water

Bottom ash from the boiler for Unit 2 will be hydraulically conveyed to the active bottom ash pond for settling. Approximately 85% of the water sluiced to the pond will be recirculated to the ash collecting system for reuse. The other 15% will be blowdown and deep well injected.

The active ash pond will be sealed, as described in Section 3.4, to prevent ground water contamination. Makeup to the system will be in the form of coal pile and ash landfill runoff, boiler blowdown, miscell-aneous plant drain water and groundwater.

The blowdown from the pond will vary depending upon the amount required to maintain a dissolved solids concentration in the ash sluice water which will not promote scaling or fouling in the ash handling system and as required to maintain suitable pond levels in the runoff ponds.

The blowdown rate from the ash pond will range from .15 mgd to .22 mgd depending upon plant load and pond levels.

Fly Ash Mixing Water

Fly ash from the precipitator will be pneumatically conveyed to an ash silo for storage prior to landfilling. The ash will be removed from the silo by means of a dustless unloader and moistened with cooling tower blowdown to minimize fugitive dust. The ash is then conveyed to the landfill area for ultimate disposal as described in Section 3.8.

The amount of water added to the ash at the dustless unloader is expected to be approximately 15% to 20% by weight of the dry fly ash. The flow of mix water to the dustless unloader will range from 0.01 mgd to 0.02 mgd depending upon plant load.

Coal Pile Runoff

The coal pile runoff will be that which results from rainfall directly on the coal pile. This runoff will be collected and treated as described in Section 3.7 and used for makeup to the bottom ash handling system. The flow of water from the pond will range from .05 mgd to .09 mgd depending upon plant load and pond levels.

Ash Landfill Runoff

The ash landfill runoff will be that which results from rainfall directly upon the ash landfill active face area and will be used for makeup to the bottom ash handling system and be collected and treated as described in Section 3.7.

The flow of water from the pond will range from .02 mgd to .04 mgd depending upon plant load and pond levels.

Domestic Use

Water for domestic use will come from the RUB water distribution system. The sanitary wastewater will be treated in a septic tank. Treated wastewater will be routed to a drain field for disposal. It is anticipated that sanitary sewer service will be extended to the general area of the plant site in the future. Sanitary sewers from the site will be connected to the RUB system at that time.

3.3.6 Consumptive Water Use

Total consumptive use of water by the plant will range from 4.71 mgd during extended periods of average operation to 6.40 mgd during extended periods of full plant load and high evaporation. This consumptive use will be in the form of system blowdowns (cooling tower, boiler system), ash system and cooling tower and pond evaporation and other process waters that are discussed below.

Water Retained in Ash

Water will be added to fly ash as required for dust suppression during handling. This amount of water is expected to be 15% to 20% by weight of the dry fly ash. Water will be retained in the bottom ash as the bottom ash ponds are cleaned out and the bottom ash landfilled. The amount of water retained is expected to be approximately 10% by weight of the bottom ash solids. The water retained in the fly ash and bottom ash, will be either mechanically occluded in the landfill or evaporated during landfill operations.

Reverse Osmosis Waste

As water is processed through the reverse osmosis unit, approximately 25% of the incoming water will be discharged as waste. This waste stream will have a continuous flow rate ranging from .01 mgd to .02 mgd depending upon plant load. This waste will be deep well injected.

Demineralizer Waste

Demineralizer waste will occur when the exchange media is regenerated. This regeneration is done on a batch basis, with time between batches dependent upon feed water quality and plant load. The amount of demineralizer waste expected will range from approximately .01 mgd during extended periods of average operation to .02 mgd during extended periods of full plant load. This waste will be deep well injected.

Bottom Ash Handling and Cooling Tower Blowdowns

The water blown down from the plant and deep well injected will be in the form of bottom ash handling and cooling tower blowdown and will range from 0.87 mgd during extended periods of average operation to 1.24 mgd during periods of full plant load. Water will also be blown down from the boiler, with this water used as makeup for the bottom ash handling system. Descriptions of the blowdown streams deep well injected are:

Bottom Ash Handling - The bottom ash handling system will be that of a closed loop, wet sluicing operation. Blowdown from the system will be performed as required to maintain a suitable dissolved solids concentration in the sluice water to prevent system scaling and corrosion and as required to maintain suitable pond levels. The exact amount of blowdown required is not determinable at the present time since blowdown requirements depend upon makeup water chemistry, boiler design, ash hopper evaporation rate, ash chemistry and temperature, but is expected to be approximately 15% of the sluicing rate, ranging from approximately 0.15 mgd during extended periods of average operation to 0.22 mgd during extended periods of full plant load. The water blowdown will be deep well injected.

Cooling Tower Blowdown - Water from the plant cooling system will be blown down as required to operate the cooling towers at approximately six concentrations, the maximum number of concentrations that ground

water quality will allow without scaling or fouling problems. This blowdown will be continuous, will range from 0.73 mgd during average operation to 1.04 mgd during full load, and will be injected into deep wells.

Evaporation and Losses

The total amount of water evaporated from the plant and plant site is expected to range from 3.92 mgd during extended periods of average operation to 5.50 mgd during extended periods of full plant load. The amount of evaporation will vary depending upon boiler operation, ambient temperature, ambient humidity, ground temperature, etc. Evaporation from the site and plant equipment will be in the following forms:

Material Storage Runoff and Bottom Ash Pond Evaporation - Average evaporation from the coal pile and landfill runoff ponds and the bottom ash pond will be approximately 0.04 mgd. The normal maximum monthly evaporation is expected to be approximately .05 mgd; however, data are not available from which to estimate accurately the peak or normal maximum monthly evaporation rates.

Boiler System Evaporation Losses - Water losses from the boiler will result from steam soot blowing, leaks, and evaporation from the boiler blowdown tank. Steam soot blowing is required for soot removal inside the boiler and leakage is due to valves not seating, flange gaskets leaking, etc. This flow is expected to be 0.01 mgd to 0.02 mgd depending

upon plant load. However this rate varies between different boiler manufacturers and with boiler operation and age. Steam soot blowing will result in water lost up the stack and leaks will result in water lost to the atmosphere.

Evaporation from the boiler blowdown tank is the result of quenching the boiler blowdown. This evaporation is expected to range from .01 mgd to .02 mgd depending upon boiler load and boiler operation.

Bottom Ash Handling System Evaporation - Evaporation from the bottom ash handling system will occur in the bottom ash hopper located directly below the furnace the result of water being used to cool the refractories in the bottom ash hopper and to quench the bottom ash. The rate of evaporation from the hopper cannot be accurately calculated as it depends upon boiler temperatures, furnace humidity, water temperature, etc. However, it is expected that this rate of evaporation will be in the range of .07 mgd to .14 mgd. This lost water will go up the stack.

Cooling Tower Evaporation - Evaporation of a portion of the circulating water will be necessary to provide a circulating water of suitable temperature for proper operation of the condenser and heat exchanger equipment. This evaporation will be accomplished by use of a mechanical draft cooling tower as described in Section 3.4.

The rate of evaporation from the cooling tower will be dependent upon atmospheric conditions and the amount of heat to be dissipated from the incoming circulating water, which is dependent upon plant load. The expected rate of evaporation is from 3.75 mgd during periods of average plant load to 5.30 mgd during periods of full plant load.

3.3.7 Physical and Chemical Characteristics of Towers and Ponds

Cooling Tower Blowdown

The major chemical and physical characteristics of the cooling tower blowdown are estimated to be as follows:

Specific Gravity (S.G.)	1.0
pH	7.0 pH units
Total Dissolved Solids (TDS)	3,612 mg/l
Sulfates ($SO_4^{=}$)	2,000 mg/l
Chlorides (Cl^-)	60 mg/l
Calcium (Ca^{++})	512 mg/l
Magnesium (Mg^{++})	156 mg/l
Sodium (Na^+)	121 mg/l
Silica (SiO_2^+)	185 mg/l

Ash Landfill Runoff Pond

The chemical constituents in the ash landfill runoff pond will be those which are dissolved from the active face of the ash landfill. These constituents will depend upon leachable constituents in the ash (e.g. iron, manganese, zinc, copper, etc.), lime and silica content of the ash (influences fixability of the leachates), ash pH, ash particle size, rain water pH and dissolved solids content, and volume of runoff.

The specific chemical characteristics of the runoff pond cannot be predicted as no runoff is available for testing since the coal source is not presently known, and there are no data available from any similar operation. However, published information (Chu, T. J., 1976) on existing fly ash sluicing systems shows that once-through fly ash sluice water would be acceptable for deep well injection. Since fly ash sluice water will have more particle contact time and contact more particles than will the landfill runoff, the landfill runoff will not contain dissolved constituent concentrations no higher than sluice water for the same fly ash. Since such fly ash sluice water would be acceptable for deep well injection, ash landfill runoff should likewise be acceptable.

Coal Pile Runoff Pond

The chemical constituents in the coal pile runoff pond water will be the result of erosion of fines and as result of those constituents which are dissolved from the coal particles by acids formed from further oxidation of metal oxides in the coal. The makeup of these acids is highly unpredictable without sampling and testing of the actual runoff. The chemical characteristics will vary depending upon coal source, volume of runoff, area of contact of coal with air and chemical characteristics of the rain water.

Because of this, only rough approximations of certain chemical characteristics can be made. These approximations are as follows:

pH	4-8 pH units
Acidity	0-2,000 mg/l $CaCO_3$
Total Dissolved Solids (TDS)	100-10,000 mg/l
Sulfates ($SO_4^{=}$)	0-1,000 mg/l

Bottom Ash Pond

The chemical constituents in the bottom ash pond water will be those which erode or dissolve from the bottom ash particles during collection, transport, and storage.

The bottom ash handling system will be a closed loop system as described in Section 3.3. No currently published information indicates chemical constituent concentrations for such a system. The only data available are for a once-through type of sluicing operation for specific coals. It is therefore impossible to list any specific chemical characteristics for the bottom ash pond. Even if such data were available, chemical constituent concentrations still cannot be estimated since the source of coal, ash fusion temperature, quality of ash sluice water, and performance of the settling pond all have influence of unknown impact upon the quality of the pond water. All that can be said is that the pond water should have a pH of 6 to 10 and a total dissolved solids concentration of 100-5,000 mg/l.

3.4 Heat Dissipation System

The exhaust steam from the steam turbine will be condensed by approximately 140,000 gpm of circulating water. Circulating water is then cooled by a wet mechanical draft cooling tower. Thus the circulating

water will be a closed system consuming only the amount lost to evaporation, drift, and blowdown. The system is composed of the surface condenser, cooling tower, circulating water pumps, interconnecting piping and provisions for makeup and blowdown.

Makeup water for the system will come from the system of deep water wells on the site. Makeup water will be introduced into the cooling system by pumping well water directly into the cooling tower basin. Evaporation and drift losses are expelled to the atmosphere from the cooling tower discharge plenum. Cooling tower blowdown from the discharge of the circulating water pumps will be directed to equipment designed to remove suspended solids and thence to the deep well injection system for discharge.

Design parameters for the heat dissipation system are:

Heat rejected, Btu/hour	1.329×10^9
Makeup flow, MGD	4.50
Drift and evaporation rate, MGD	3.78
Blowdown flow, MGD	.72
Maximum cold water temperature, ^oF	90
Maximum hot water temperature, ^oF	109
Cooling water flow, MGD	201.6
Travel time through condenser, seconds	4.8

Design of the heat dissipation system will include injection of a chlorine/water solution into the cooling tower basin for control of algal growths. Control of pH will be facilitated by injection of concentrated sulfuric acid into the cooling water system.

3.5 Air Pollution Control

To comply with applicable New Source Performance Standards for air emissions from new coal-fired power plants, this unit will burn low sulfur coal and utilize an electrostatic precipitator. Coal with a maximum .72% sulfur content and a heat content of 12,000 Btu/lb. will be utilized to meet the emission limitations for sulfur dioxide (Section 3.1.2). An electrostatic precipitator will be needed to clean the fly ash from the flue gas (Section 3.1.2). Oxides of nitrogen will be minimized through controlling various combustion parameters such as flame temperature and excess air. The boiler manufacturer guarantees that the average concentration of NO_x in the flue gas leaving the air-heater gas outlet shall not exceed 0.7/lbs. per million Btu heat input, measured as 525 ppm dry and adjusted to 3% O_2, at a boiler output of 1,788,000 lbs. of steam per hour. The manufacturer achieves this with a furnace which utilizes a proprietary venturi shaped cross section and directional flame burners. Air and fuel are fired downward toward the furnace bottom below the venturi throat. The directional flame burners are uniformly spaced across opposed furnace walls and develop a diffusion type flame with gradual and thorough mixing in the lower furnace. The flame propagates slowly, reversing and passing vertically to the upper furnace where combustion is completed. This swirling action results in uniform flame development across the full width of the furnace without the occurrence of excessively high temperatures. As a result NO_x, formation is of such low order that, for most fuels, neither gas recirculation nor sophisticated off-stoichiometric firing methods are required to meet EPA New Performance Standards for NO_x.

No flue gas scrubbing equipment will be utilized on this unit since low sulfur coal will be burned to control sulfur dioxide emissions. However, certain features such as space, flue gas ducts and the stack will be taken into account in the design and construction so as not to preclude the installation of flue gas desulfurization equipment at a later date should they be required.

As mentioned in Section 3.1.2 a 350 foot above grade stack will be utilized. It has been determined through various modeling techniques that this stack height will ensure that the Ambient Air Quality Standards of the U.S. EPA and Florida Department of Environmental Regulation and DER's Significant Degradation Standard will be met.

3.6 Oil Spill Prevention Plan

Drainage from Dikes and Curbed Retention Areas

The areas within the dikes which surround each of the existing fuel oil storage tanks are sloped to a low point where a drain pipe passes through the dike to the outside. This drain pipe will have a normally closed gate valve which will be opened to drain the diked area of excess precipitation. In the event of an oil spill, the spilled oil will be reused if possible. The remaining portion will be put on the coal pile.

The existing substation is encompassed by a concrete dike, approximately 6 inches in height above grade with drain outlets. The ground within the diked area is covered with gravel. In the event of an oil spill the

interior gravel will be removed and replaced with clean material. The material contaminated with oil will be disposed of in an environmentally acceptable manner.

The existing fuel oil truck unloading station is in a paved area, where the surrounding grade slopes toward the pumps, except for one side. This low side will be raised by the construction of a dike to confine the oil from a spill.

Both the existing and new step-up transformers will be surrounded by a concrete curb separate from the existing pad and the area between the pad and curb filled with crushed rock. A drainage pipe will be installed as well as an overflow and an oil separator and oil containment vessel. If spill occurs, the oil will drain to the sump and the oil contaminated limestone in the sump will be removed for disposal by an environmentally acceptable method and the sump then refilled with new material.

Drainage from Undiked Areas

Inside both the existing and new unit, plant operating personnel will monitor plant operation on a 24-hour-per-day basis by visual inspections and from the main control room. Unit 1 has floor drains which will be connected to an oil separator. Any oil leakage within the units will be contained within the powerhouse by use of the oil separator. In case of an uncontrolled spill, above the capacity of the oil separator, the oil will be routed to a surge pond or tank prior to entering the oil separator.

Oil pans used to collect leaking oil from the various equipment and machinery at the plant will be emptied into oil drums.

No oil will be stored in any area without a secondary containment structure.

The precipitator transformer areas will be surrounded by a gutter to collect any oil spills from this equipment. The downspouts from this gutter will be connected to the plant oil separator.

3.7 On-Site Drainage

Construction runoff from grading, foundation and other earth moving activities will be handled to prevent silt runoff onto the adjacent areas. To accomplish this, dikes and ditches (both natural and constructed) will be used to direct this runoff to retention ponds which will be located on the site. These ponds will be constructed to allow for the containment of the anticipated volume of runoff that can be expected from a ten year, twenty-four hour storm plus a minimum of 2 feet of freeboard. This volume will be retained in the pond, until the level of suspended solids is below that required for discharge. Any volume of runoff exceeding that which can be anticipated from the design storm will be discharged immediately to natural drainage.

Plant site runoff after construction will consist of three basic areas of concern. These areas are the coal storage area (coal yard), the plant drains (both inside and immediately outside areas adjacent to the building) and the other external plant areas.

The coal yard runoff will be retained inside the diked area created by the construction of the railroad loop embankment, which will direct this flow to a retention pond also located inside the loop. Solids (grit) will be allowed to settle out in this retention pond and the supernatant will be pumped to the active bottom ash ponds for use as makeup in the ash sluice system. Any volume of flow exceeding the referenced ten year, twenty-four hour storm will be discharged to natural drainage after passing through the pond.

The flow that can be expected from the plant floor drains and that expected in the immediate plant area will be collected in a central area and pumped to the active bottom ash pond.

Any runoff from the other external plant areas which is not contaminated will be dispersed via swales and berms to allow spreading and percolation downward.

3.8 Directly Associated Facilities

The new railroad spur will be used to deliver the coal required for the new unit. This spur will be connected to the mainline track of the Seaboard Coastline Railroad by a new switch, so positioned as to allow direct access only from the north. This spur will run from the mainline into the plant in a loop pattern. The land utilized for this facility consists of approximately 30 acres of tree covered woodland. The level of noise and fugitive dust from this facility, that will reach beyond

the project property lines, will be negligible as it will be a unit train type system where the road locomotive will handle the unit train while it moves at a constant speed over the site. The visual effect of this system will be minimal as it will be at ground level and will not be visible from off the plant site except when a train arrives, which should cause no problems as the mainline of the Seaboard is far more visible than this proposed new spur.

The proposed coal handling facility will basically consist of at least three conveyors, a below grade unloading hopper, an aboveground stacking system with storage area, an underground reclaiming unit, and an above-ground crushing system. The stacking conveyor will be equipped with a telescopic chute and dust control system (water and wetting agent spray system). Transfer points will also be provided with dust control systems and the conveyors will be enclosed through their length. The coal bunkers within the plant will be fully enclosed type, fitted with a filtered ventilation system to eliminate dust discharge. These systems will require the use of approximately 13 acres of land. The area is approximately three-quarters covered with trees and other vegetation, with the remaining part already having been cleared, grubbed and reseeded. The visual effect of this facility will be undetectable as it will be shielded from offsite view by the existing trees and other vegetation. The emission of noise from this system beyond the project property lines is expected to be minimal. Present land uses of the property adjoining the site are mainly agricultural and woodlands.

The ash disposal facility will consist of two active bottom ash ponds to be used for bottom ash dewatering with a small pond to collect this water for reuse and a landfill operation for the disposal of fly ash and bottom ash. This facility will require the use of approximately 220 acres. All of the area needed is presently tree covered. The visual effect and the anticipated noise level of this facility will be of minimal concern as a 200-foot barrier of existing trees and vegetation will be left around the area as a permanent feature. Access to this facility will be along the new railroad spur and will be entirely on the present site.

CHAP. 4-ENVIRONMENTAL
EFFECTS OF CONSTRUCTION

CHAPTER 4

ENVIRONMENTAL EFFECTS OF SITE PREPARATION, PLANT AND ASSOCIATED FACILITIES CONSTRUCTION

Presented in this chapter are the expected physical impacts of site preparation and plant construction on the environment and resources discussed in Chapter 2. Such impacts are evaluated in terms of their relative and long-term impacts. The measures for mitigating the adverse impacts are also discussed. Socio-economic impacts of construction are discussed in Chapter 7.

Also presented are those effects which represent a commitment of resources, both those irretrievably committed and those only impacted for a short-term. An estimated listing of non-recyclable building materials is presented.

4.1 Site Preparation and Plant Construction

4.1.1 Laydown Areas

The portions of the Deerhaven site which have been set aside for use as building material laydown areas during construction of the new facilities are shown in Figures 4.1-1 and 4.1-2 and summarized in Table 4.1-1. Based on preliminary site plant approximately 27 acres of land have been committed for storage of construction materials and equipment. Approximately 6 acres occur on the existing improved site and 21 acres will be cleared. Most of the latter is pine flatwoods, with approximately 3 acres in two small cypress domes. In addition, 3 acres will be cleared and used for construction parking (Figure 4.1-2).

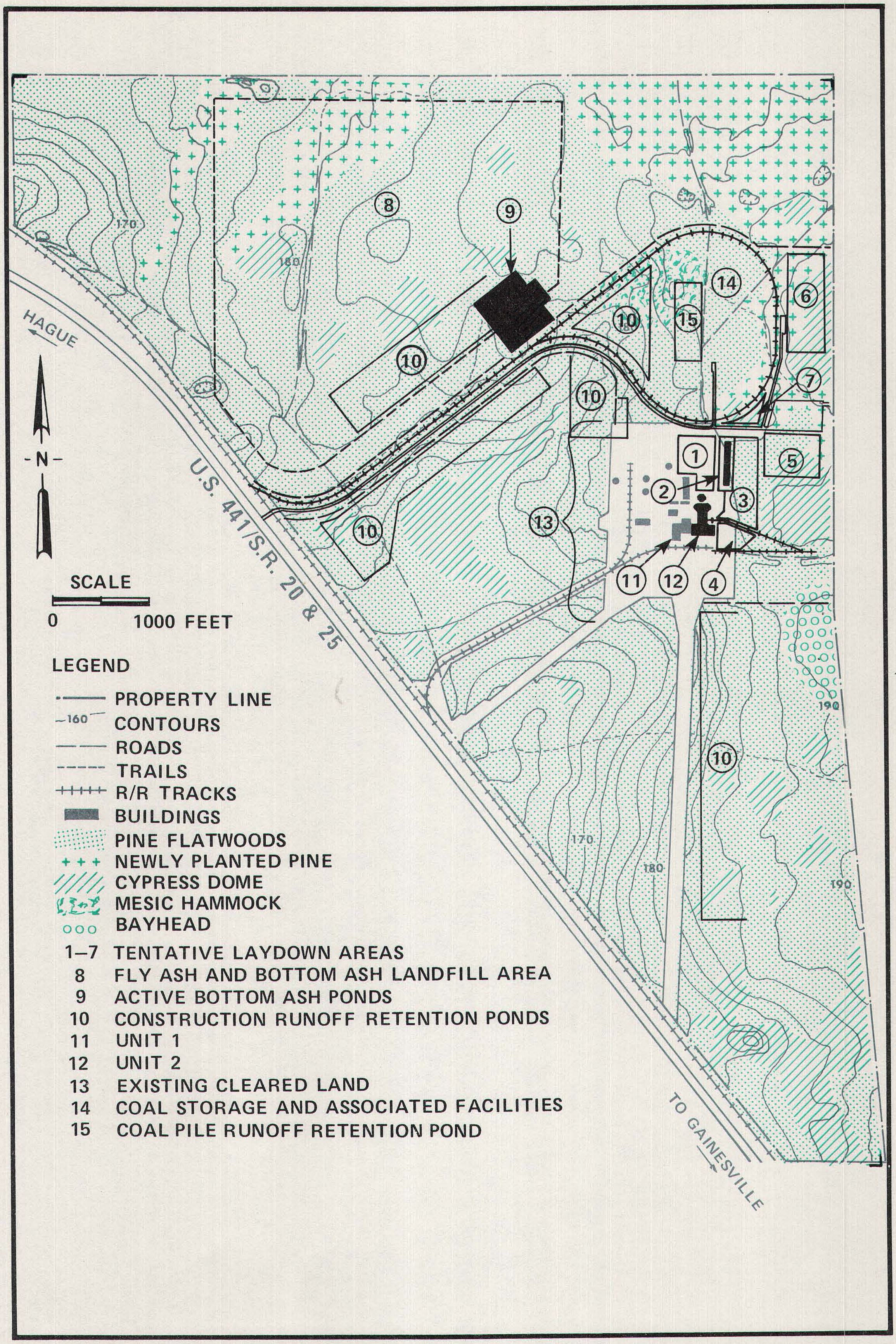


FIGURE 4.1-1 VEGETATION MAP AND PROPOSED SITE PLAN OF THE DEERHAVE SITE.

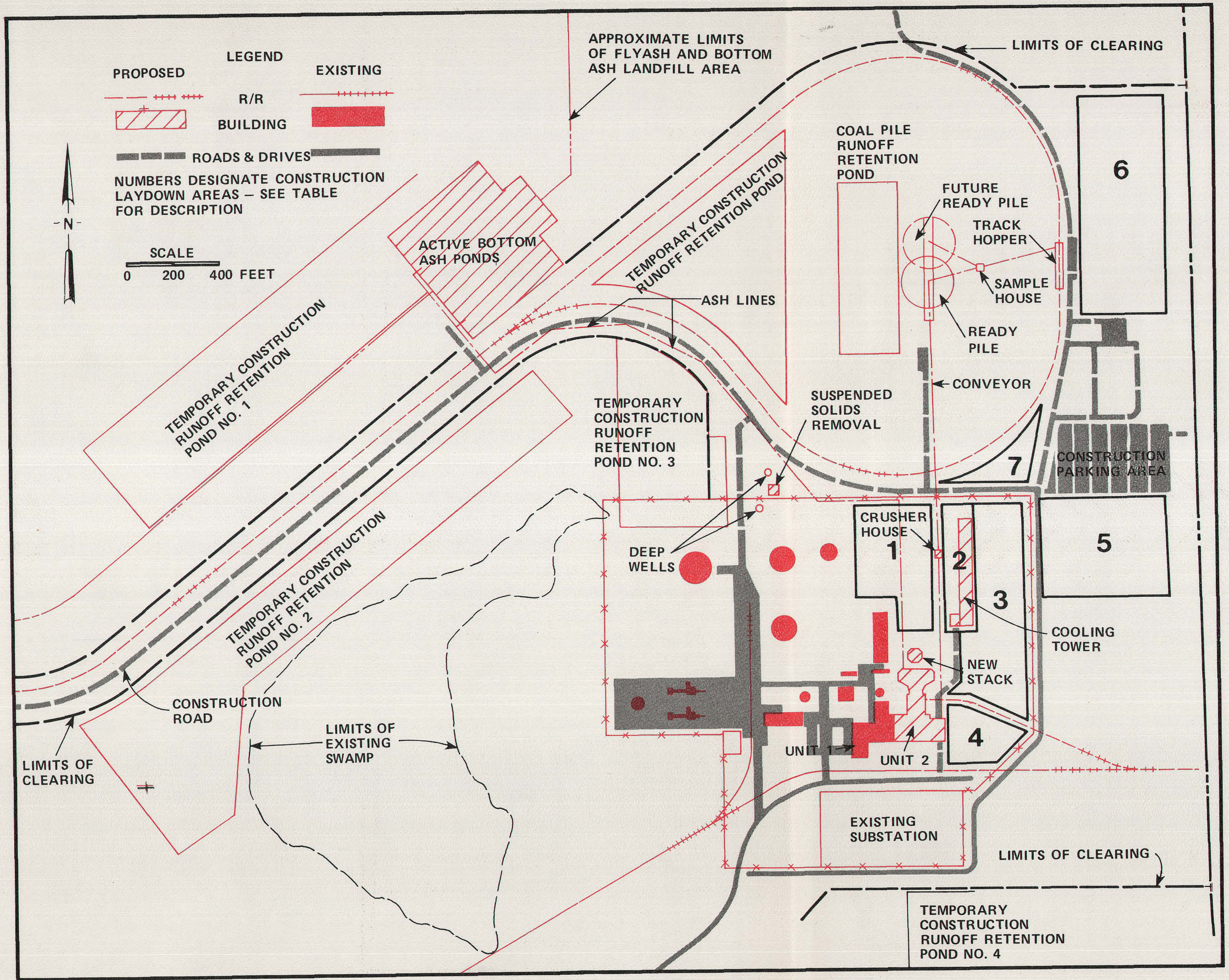


FIGURE 4.1-2 PROPOSED SITE IMPROVEMENTS AND LAYDOWN AREAS.

Table 4.1-1 Deerhaven Site Laydown Areas

Area No.	Size (acres)	Location	To Be Used By
1	3.5	North of new unit	Boiler Contractor-short term use
2	1.8	Northeast of new unit	Cooling Tower Contractor-short term use
3	5.8	Northeast of new unit	Cooling Tower, Boiler, and Other Contractors-long term use
4	1.5	East of new unit	Power House Contractor-short term use
5	7.4	Southeast of new unit	Substation Contractor
6	5.6	Northeast of new unit	All Contractors-long term use
7	1.6	Southeast of railroad loop	Coal Handling and Railroad Contractors-short term use

Laydown areas 1 and 2 are within the cleared area surrounding the present Deerhaven Unit 1 facilities. Area number 4, to the east of the proposed Unit 2, presently consists of approximately one-half cleared and grassed land with the other half consisting of planted pine flatwoods with understory vegetation. The remaining areas, numbers 3, 5, 6 and 7, consist of primarily pine flatwoods.

The above mentioned areas will remain cleared after use as laydown areas, and will become part of the permanently grassed area. It is not anticipated that any transient environmental effects during construction will result from the use of these land areas as building material laydown areas other than the removal of vegetation. A possible transient effect could have been soil erosion by stormwater runoff; however, parking and temporary roads within the laydown areas will be covered with crushed rock. Following construction, the crushed rock will be removed and all areas grassed. Erosion control during construction is discussed in a subsequent section.

4.1.2 Land Impacts

Impact Areas

Construction of access corridors, laydown areas, and new facilities for Unit 2 will require the clearing of 141 acres, or 14% of the unimproved land on the Deerhaven property (Figure 4.1-1). One hundred twenty acres are currently occupied by flatwoods, 14 acres by small cypress heads, and 7 by developing, or early successional, mesic hardwoods. These

acreages represent 14% of the pine flatwoods and 11% of the cypress heads on the Deerhaven property; assigning a percentage value to the area of developing mesic vegetation would be relatively meaningless, since it is immature and all flatwoods on the property would succeed to mesic hardwood forest or hammocks in the absence of fires for a few decades. Pine flatwoods and plantations with interspersed cypress heads are the dominant vegetation communities in the project area (Figure 2.2-1). Loss of these acreages will have negligible impact on the ecology and land use practices of the region.

With the utilization of deep injection, wells will be drilled on the existing improved plant site, requiring no additional committment of land or vegetation communities.

The fly ash and bottom ash landfill area will be cleared a portion at a time, as required, for ash disposal. With this exception, construction will require total clearing of the land areas described above.

Other areas of land impact, as shown in Figures 4.1-1 and 4.1-2 are the construction runoff retention pond, active bottom ash ponds, truck roads, and the railroad loop.

The construction runoff retention pond located within the coal storage area will be a shallow excavated earthen lagoon of total volume equal to the stormwater runoff expected from a ten year, twenty-four hour rainfall.

All other construction runoff retention areas will not be cleared but will be formed with low earthen dikes in an effort to preserve as much vegetation as possible.

The active bottom ash settling ponds will also be of excavated earthen lagoon type construction. Each lagoon will be approximately 300 feet wide, 400 feet long, and about 18 feet deep. The necessity for interior lining of these ponds will be determined from the results of a leachate travel investigation.

Cross sections of the single track railroad and adjacent roadway are shown in Figure 4.1-3. This construction will require land clearing and vegetation disposal. As with all on-site construction, cut and fill earthwork, will, if possible, be balanced to eliminate excess material or the necessity for excavating borrow pits.

Major on-site excavation will probably be confined to the areas of the coal unloading facility and the active bottom ash ponds (Figure 4.1-1). Excavated material will be used as fill for the on-site railroad embankment and other on-site fill areas and as cover material on the on-site ash landfill.

<u>Construction Solid Waste</u>

During construction, solid waste will be produced which will include vegetation removed during land clearing and grubbing, and trash and

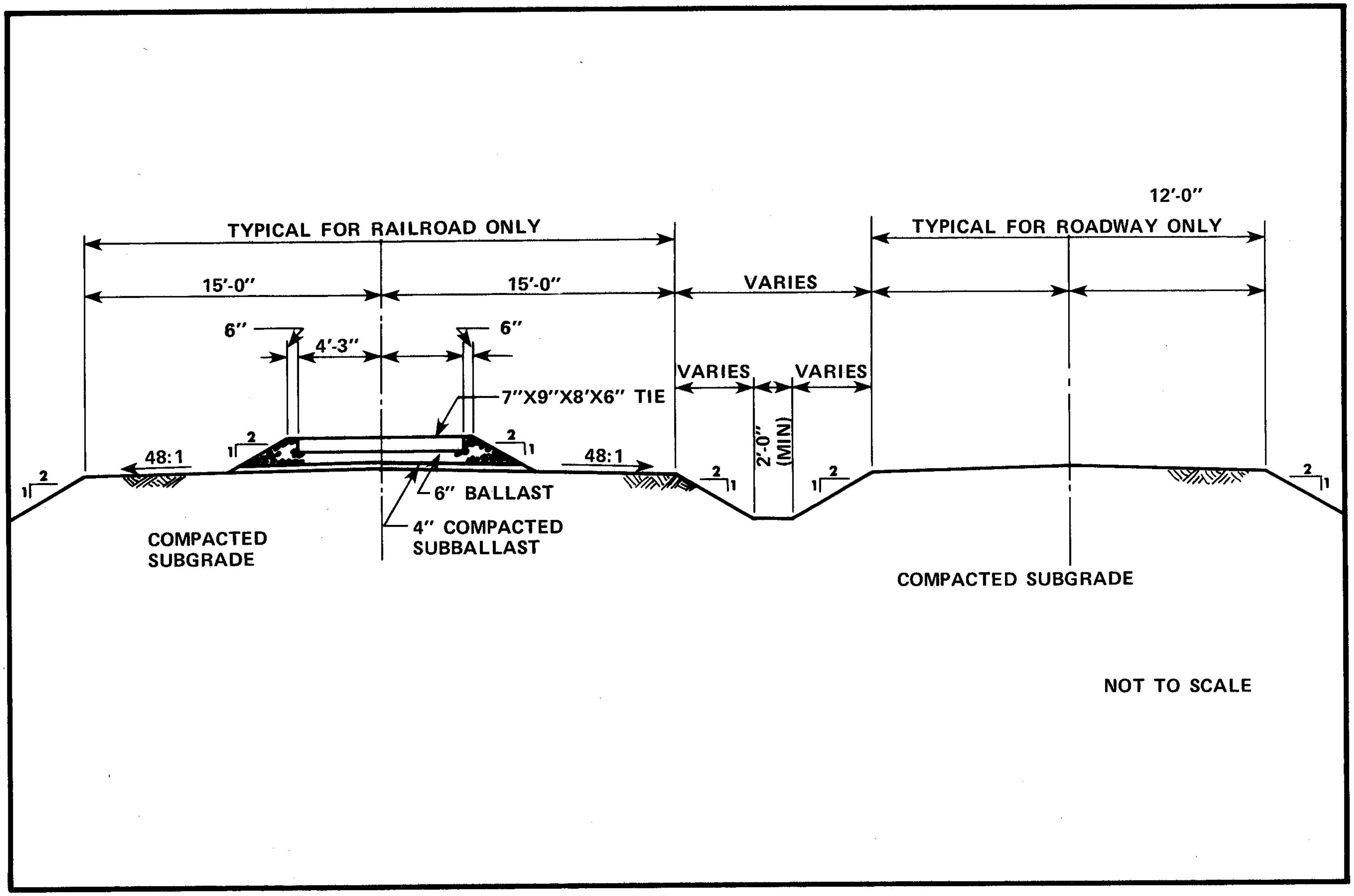


FIGURE 4.1-3 TYPICAL SECTION FOR SINGLE TRACK RAILROAD AND ROADWAY.

debris (scrap metal, scrap lumber, masonry, cardboard, paper, etc.) typical of building construction operations. It is anticipated that the combustible portion of these wastes will be burned on-site with such burning being subject to state and local laws. The contractor will be responsible for obtaining daily burning permits from the local office of the State Division of Forestry. The residue from this burning will be disposed of by the contractor either by burial on-site or by removal to the nearest landfill. The portions of the solid wastes which are not combustible will be removed from the site by the contractor for disposal at either the nearest landfill or an on-site landfill if permitted. General rubbish such as paper trash and small packing and crating materials will be incinerated in the existing on-site incinerator. This facility is permitted by the DER and can be utilized as long as its use is limited to the conditions of the permit.

It is not anticipated that hazardous chemical wastes will result from construction operations.

Construction Explosives

Present knowledge of subsurface site conditions indicates no need for the use of explosives during site earthwork or construction. In addition, the presence of the existing generating unit would discourage the use of explosives, even if such use were desirable.

Archaeological Sites

Of the 11 archaeological loci identified on the Deerhaven property, only two were assigned "site" status (Section 2.3). One of these, 8AL368, is toward the southwestern boundary of the property, well away from proposed construction, and its accessibility will not be affected by construction of Deerhaven Unit 2. The other, 8AL369, which is considered important enough to be included in the National Register, lies within the proposed construction area. However, because the Deerhaven property is entirely fenced and closed to the public, the site will remain inaccessible to unauthorized persons nor is its exact location included in the published sections of this site certification application.

Mitigating Measures

Erosion Control - As discussed in Chapter 2, the majority of the Deerhaven site is drained by channels and ditches which are tributaries to Turkey Creek. During construction of Unit 2, clearing and grubbing of the site construction area will remove protective vegetation and earthwork and construction operations will tend to loosen the ground surface. Should erosion control techniques not be implemented, such site development could result in significant transport of eroded material into Turkey Creek and possible siltation of water courses, local flooding, burying of stream biota, and increased stream turbidity.

At the present time, no specific sediment control standards exist in Florida. However, some portions of Chapter 17-3, Florida Administrative

Code, might be considered as applying to stormwater runoff containing eroded sediments. In particular, these regulations limit turbidity to 50 Jackson Turbidity Units (JTU). Table 4.1-2 presents maximum values for other water quality parameters which could be affected by eroded materials in stormwater runoffs.

Figures 4.1-1 and 4.1-2 present the portions of the existing site which will be cleared and developed during proposed construction. The construction runoff and earthwork activities in these areas will be directed, via dikes and ditches, into retention ponds at various locations on the site. These ponds will be constructed to contain the anticipated volume of runoff to be expected from a ten year, twenty-four hour storm plus a minimum two foot freeboard. This stormwater volume will be retained in the ponds until acceptable levels of suspended solids content and turbidity are reached. It is anticipated that stop logs will be used so that, upon their removal, low turbidity surface water will be first released from the retention ponds. In addition, the use of hay bales as filters and scum baffles is presently anticipated.

It is anticipated that the erosion-control techniques described above will be sufficient to prevent significant on-site erosion during construction and to contain eroded materials on-site. If needed, additional measures will be taken as necessary during the construction program.

Table 4.1-2 Water Quality Standards for Class III Waters (recreation and propagation; and management of fish and wildlife).

Item	Maximum Permissible Value
Dissolved Oxygen	5 mg/l (min 24-hr average) 4 mg/l (min value)
Turbidity	50 JTU
Total Dissolved Solids	500 mg/l (monthly average) 1,000 mg/l (max value)
Specific Conductance	not more than 100% above background level 500 μmhos/cm (max value)
Oil & Grease	no visible oil or iridescence 15 mg/l (max value)
pH	not more than 1.0 unit above or below background pH 6.0 (min value) 8.5 (max value)
Sewage, industrial wastes or other wastes	must receive approved treatment
Deleterious substances	must be free of materials attributable to municipal, industrial, agricultural or other discharges producing color, odor or other conditions in such degree as to create a nuisance

Dust Control - Figure 4.1-2 presents the proposed locations of construction access roads and parking lots. These facilities will be graveled during construction of Unit 2 both to prevent dust generation and for erosion control. Otherwise, dust generation during construction is not anticipated to be a significant problem. Should excessive dust generation occur during construction, a wetting program will be implemented. It should be noted that, because of the buffer of trees and vegetation which will remain around much of the site perimeter, the impact of dust generation upon off-site areas is not expected to be significant.

Archaeological - Disturbance of the archaeological site 8AL369 will be mitigated by professional excavation; RUB entered into a contract with the University of Florida, Department of Anthropology for test and salvage excavations. This work has been completed and a report of the findings is presently under preparation and will be submitted as soon as possible. Preliminary indications are that no material of significance was found and no further salvage work is necessary.

4.1.3 Impact on Water Bodies and Uses

Surface Streams

During the initial construction stage, runoff from the construction site will follow existing drainage patterns, percolate into the sandy soil, and enter Turkey Creek. The sandy soil, flat topography, swale areas, and vegetation should minimize any short-term impacts on Turkey Creek due to turbidity.

During the initial construction stage, 4 runoff retention areas totaling 78 acres will be constructed with the capacity to contain the runoff from a ten year, twenty-four hour storm event (Figure 4.1-1) (Burns & McDonnell, 1977). Six acres of the potentially ponded area are occupied by parts of small cypress heads and the remainder by a pine flatwoods association.

The runoff retention areas will consist of low earthen dams constructed of soil taken from the construction site. Vegetation will not be disturbed, except to allow earth-moving equipment to operate and soil to be amassed. A runoff retention capacity of four to five days is planned to reduce or eliminate turbidity prior to discharging the water to Turkey Creek.

The planned relatively short duration runoff retention periods and subsequent complete drainage of the areas should minimize vegetation stress due to flooding. Where retention areas coincide with depressions which may not drain completely and/or soils which are poorly drained, vegetation stress may occur.

The ponds will exist only for the duration of construction, after which the dams will be removed, the area seeded to reestablish a ground cover, and natural succession allowed to revegetate stressed or disturbed areas.

Figure 4.1-4 presents a typical construction runoff pond control structure. After a period of quiescent settling in the retention ponds, stop logs will be removed so that low turbidity surface water can be gradually

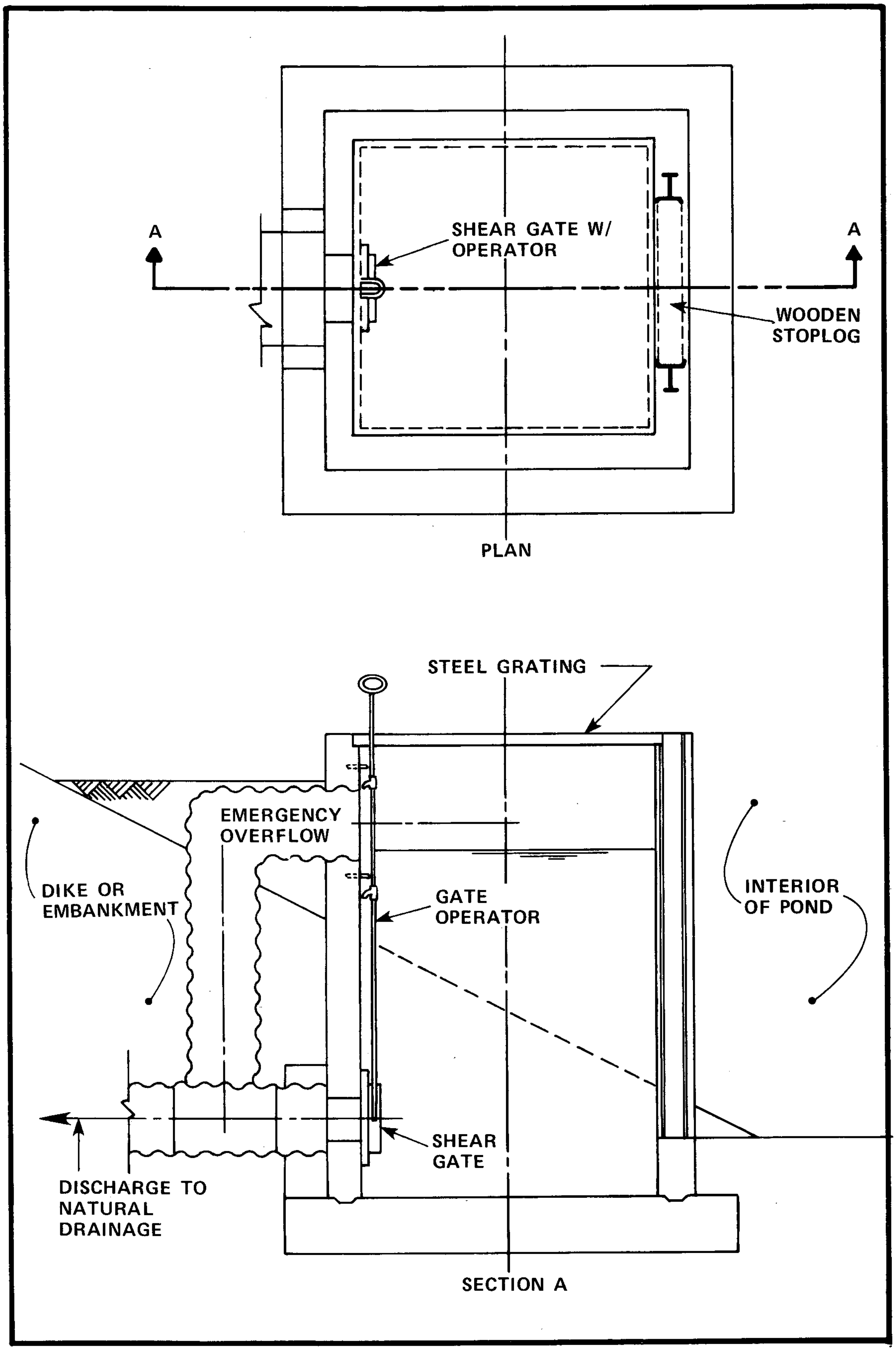


FIGURE 4.1-4 CONSTRUCTION RUNOFF POND OUTFALL STRUCTURE.

released. In addition, the use of hay bales as filters and surface scum baffles is anticipated. In addition to reducing storm water runoff turbidity, these retention ponds will prevent short duration-high rate water runoff flows from producing erosion of existing stream channels and should more than compensate for the increase in rainfall runoff rates and total runoff volume due to site development.

In addition to construction of the improvements described above, construction management of the Deerhaven site will include consideration of the following factors so as to reduce hydrological impacts:

1. Scheduling and sequencing of operations, including the scheduling of potentially harmful construction activities during periods of reduced rainfall.

2. The locating and maintaining of runoff retention ponds near potentially harmful activity areas.

3. Supervising the use and maintenance of storm water runoff retention facilities.

4. Instituting pollution abatement programs such as watering for dust control, grassing open areas during out-of-use periods, surface treating temporary roads, maintaining waste disposal areas, isolating runoff from fuel dumps and equipment service areas, etc.

5. Revegetating of construction areas upon completion of site development.

Since there are no natural open bodies of water on the Deerhaven site, there will be no constructional impacts on lakes or ponds of the project area.

Groundwater

As described in Chapter 2, it has been observed that during the rainy season the Deerhaven site groundwater approaches the ground surface at many locations, totally saturating surface soils. It is therefore anticipated that some drainage and dewatering of the site will be necessary during construction. The amount of dewatering required will depend upon construction scheduling, since the Gainesville area has seasonal rainfall variations.

At present, detailed dewatering and construction drainage plans have not been performed. However, it is possible to describe construction areas likely to require dewatering and to infer the impact of such dewatering on the site groundwater table.

The major structure likely to require dewatering will be the coal unloading facility. This facility will be constructed at the east side of the railroad loop shown in Figure 4.1-1. Excavation dimensions for this facility are estimated to be 120 feet long, 20 feet wide, and 40 feet deep. During construction, this excavation will require dewatering.

The dewatering will be terminated upon completion of the foundation system. Discharge from the construction dewatering system will go to the runoff retention pond to be constructed within the new railroad loop and, if necessary, to other nearby retention ponds.

Active bottom ash settling ponds are presently anticipated to be constructed north of the proposed railroad loop as shown in Figure 4.1-1. At present, two ash ponds, each about 400 feet long, 300 feet wide, and 18 feet deep are contemplated with a smaller pumping pond 200 feet long, by 100 feet wide, by 18 feet deep located nearby. Dewatering of this area will be required during construction but is not anticipated to be necessary following construction completion.

The major excavations described above may result in temporary lowering of the site groundwater table by approximately 40 feet. It should be noted that such dewatering would influence only the local (perched) groundwater table and would not affect the potentiometric surface in the Floridan Aquifer. Rather than removing seepage discharges from the surface drainage system, however, such dewatering will provide continuous high quality discharge from the dewatering equipment into nearby streams. Insufficient information is available to determine the rate of such discharge from dewatering equipment but is not anticipated to produce a significant impact on streams and channels. Since the total construction time for which dewatering will be necessary is not known, it is difficult to assess the effect on site groundwater hydrology of this dewatering

program. It is expected that some limited impact may result from such depressing of the shallow groundwater table.

4.1.4 Air Quality

The effects of site preparation and plant construction on air quality will be short-term reversible impacts.

As indicated earlier site preparation will involve the clearing of approximately 141 acres for the construction of Unit 2 and the additional support facilities. In addition, approximately 220 acres will be cleared at a staged rate for use as an ash disposal area.

It has been estimated that after salvage, the trash remaining on cleared land will be about 12 tons/acre, wet (Post, 1975). The estimated weight of this material after drying naturally will be 7.5 tons/acre. For the initial clearing operation, i.e., 141 acres, a total of approximately 1,058 tons of trash will be generated and probably disposed of by open burning under controlled conditions. This will generate approximately 9 tons of airborne particulate matter, 76 tons of CO and 13 tons of hydrocarbons. The clearing of the 220 acre ash disposal site will result in 14 tons of airborne particulate matter, 119 tons of CO and 20 tons of hydrocarbons (U.S. EPA, 1976). However, since the clearing for the ash landfill will be staged, the above emissions will occur intermittently over a twenty-five year period.

By limiting the burning of this refuse to 40 to 80 tons per day (material from 5 to 10 acres) the ambient concentrations of the various pollutants at the Deerhaven site boundary, under extreme conditions, can be maintained well below Florida air quality standards. For example, the twenty-four hour TSP levels will be maintained below 80 $\mu g/m^3$ (standard-150 $\mu g/m^3$); eight hour CO levels below 2 milligrams/m^3 (standard-10 milligrams/m^3); three hour hydrocarbon levels below 115 $\mu g/m^3$ (standard-160 $\mu g/m^3$).

A second source of airborne particulate matter resulting from construction activities is fugitive dust resulting from the operation of construction equipment and wind erosion of particulate matter from barren land. Estimates indicate that fugitive dust emissions from the Deerhaven site will be in the range of 3 tons per day (U.S. EPA, 1976). This number can be reduced by approximately 50% by an effective watering program conducted twice daily during the dry season. The effect of these emissions will be mitigated by the fact that most construction activities will occur more than one kilometer from the site boundary and substantial quantities of the dust will be deposited on trees and other vegetation before reaching the boundary.

4.1.5 Ambient Noise

Existing ambient noise levels are typical of rural environments except in the immediate vicinity of the operating Deerhaven Unit 1 and along the southwest boundary of the site which parallels U.S. 441. A noise survey of the site with eighteen sampling locations (Section 6.1.8)

indicated that over most of the site the average A-weighted sound level (L_{50}) is in range of 40 to 45 dBA. Readily identified sound sources were birds and wind effects from trees and shrubs. Along the perimeter adjacent to the highway, average levels are 45 to 50 dBA with motor vehicle traffic as the major noise source. Noise levels near plant operating equipment (Section 5.6.2) ranged from 60 to 75 dBA from a variety of sources.

Candidate noise sources during site preparation and construction of Deerhaven are identified as (Federal Register, Volume 40, Number 103, 1975):

* Air Compressors
* Backhoes
* Chain Saws
* Concrete Vibrators
* Cranes, Derrick and Mobile
* Dozers, Track and Wheel
* Engine Driven Industrial Equipment
* Generators
* Graders
* Loaders, Track and Wheel
* Mixers
* Pavers
* Pile Drivers
* Pneumatic and Hydraulic Tools

* Power Saws
* Pumps
* Scrapers
* Shovels

In addition, activities associated with equipment delivery by heavy truck and rail transports will impact existing ambient noise levels.

The frequency spectra of these possible noise sources will generally be broad band with acoustic energy emissions higher in the lower frequency range. The exception occurs with operation of saws which tend to emit higher frequency noise with audible tonal components. Noise emission will be partially masked by highway traffic noise during activities near the southwest boundary of the site. Similarly, for the major portion of construction adjacent to the existing station, operating noise levels will tend to mask construction noise.

Estimates of the magnitude of noise level impact on the site during construction are based on studies of construction noise for a similar an electric generating station facility (Noise Control Engineering, 1975). Construction noise levels are most appropriately represented as an A-weighted level exceeded a specific fraction of the time. For example, L_{90} represents a level exceeded 90% of the time, L_{50}, a level exceeded 50% of the time. The impact is presented as the increase in these temporal levels over existing ambient levels. The incremental increases in noise levels are estimated as an area average for "on-site"

and "off-site" receptors. Off-site receptors are defined for this study as those being approximately a one mile distance from the center of the site. The estimates are presented as follows:

CONSTRUCTION NOISE LEVEL IMPACT (dBA)

DEERHAVEN SITE, GAINESVILLE, FLORIDA

Noise Level	On-Site	Off-Site
ΔL_{90}	5	2
ΔL_{50}	10	3
ΔL_{10}	20	5

Noise level impact on humans will be almost entirely associated with construction contractor personnel. This impact will largely be mitigated by short duration of high-level exposure and by use of personal hearing protectors when appropriate. There are two permanent residences (closest proximity) located approximately one mile from the center of the site. Attenuation of noise levels with distance (noise levels will nominally decrease 6 dB for each increment of doubling the distance from the source) will result in small temporary noise level impact on permanent residents.

No definitive studies have been reported which establish the extent to which wildlife might be effected by construction noise. It is generally accepted that permanent physiological damage to wildlife will not occur from the levels of noise typical of construction activities.

4.1.6 Construction Traffic Control

As shown in Figure 4.1-2, construction access to the site will be by means of a construction traffic access road. It will enter the site from U.S. 441 approximately one-half mile northwest of the existing main entrance. Since earthwork operations will not require removal of excess material from the site or hauling in of fill material from off-site borrow pits, truck traffic will be primarily limited to delivering of construction materials and equipment, and removing construction solid waste from the site. The volume of such truck traffic is not anticipated to produce a major impact on U.S. 441. Deceleration lanes, will be provided in order to obtain a Florida Department of Transportation permit for connecting the access road to U.S. 441, which will help to minimize any hazard to through-traffic.

Representatives of the Seaboard Coastline Railroad have indicated in preliminary discussions that existing off-site railroad lines will be adequate to transport coal to the Deerhaven site and that no new lines will be necessary.

4.2 Resources Committed

4.2.1 Hydrological

As discussed in previous sections, dewatering of major on-site excavations will be performed only during construction operations and will terminate upon construction of those facilities. Thus, no long-term major depression of the shallow groundwater tables should occur.

Since the ash landfill cells are anticipated to be constructed above existing grades, the only other facility which could require long-term dewatering would be the proposed coal pile runoff retention pond. However, it is anticipated that this pond will be fairly shallow, perhaps 1.5 to 2.0 feet deep. During high groundwater periods, dewatering of the coal pile runoff retention pond by means of a sump pump will probably be necessary to keep the pond empty and ready to receive coal pile runoff flows. Therefore, the shallow groundwater table could be depressed by 1 1/2 to 2 feet in the area of the site occupied by the coal pile runoff retention pond. This seepage will be pumped to the active bottom ash ponds. It is anticipated that such minor depression of the shallow groundwater table will not have harmful effects on the ecology of hydrology of the area. In fact, such depression of the shallow groundwater table will reverse the local piezometric gradient and may help to reduce possible leachate contamination of the shallow groundwater system.

Hydrological impacts on the Floridan Aquifer are discussed in Section 5.0 of this document.

4.2.2 Archaeological

The archaeological site 8AL369 will be severely and permanently impacted by construction activities. However, as reported in Section 4.1.2 it has been excavated systematically and its artifacts will be catalogued and preserved.

4.2.3 Ecological

Total land committed for construction will be 141 acres, most of which is in pine plantation interspersed with small cypress domes. These represent a permanent and unavoidable loss of wildlife habitat.

Pine plantation is the most prevalent vegetative community in the project area; therefore, its loss on the Deerhaven property is not regarded as of serious consequence to the region. The cypress domes affected are important primarily as they provide habitat diversity for adjacent pine-lands. The developing mesic community lies with the proposed railway loop and coal storage area and becuase of its size and successional status (Section 4.1.2) is not considered important enough to warrant relocation of these features.

Construction noise, smoke, and dust may cause some animals to migrate away from sources of disturbance: smaller mobile forms will enter new areas on or off the Deerhaven property; larger ones such as white-tailed deer will be confined to the site by the perimeter fence. The resulting competition stress will be minimal and temporary and primarily confined to the property except, perhaps, near the eastern boundary, where construction activities and clearing will proceed to the perimeter fence.

As these lands are cleared, resident wildlife will move to nearby similar vegetation communities, causing temporary stress on the wildlife populations in the newly occupied areas as migrating individuals compete

with those already present. After a period of adjustment, populations will return to former levels, showing a net loss of wildlife roughly equivalent to that originally displaced when the land was cleared.

The site offers only marginal habitat for any rare or endangered species and no present utilization by an endangered species is known (Section 2.7.1) (Crider, 1973). Loss of habitat associated with plant construction will not significantly decrease the endangered species support potential of the region nor should construction cause the loss of any individuals.

4.2.4 Non-recyclable Building Material

Non-recyclable materials associated with the project are estimated to consist of the following:

Metals	Approximate Quantities	
Aluminum	50	Tons
Copper (300 miles)	300	Tons
Steel		
Structural shapes	1,700	Tons
Formed Plate	3,000	Tons
Rebar	800	Tons
Pipe	800	Tons
Tubing	1,200	Tons
Casting and forgings	600	Tons
Bituminous concrete	5,000	Tons
Cement concrete	30,000	Cu. yards
Crushed rock	30,000	Tons
Sand	2,000	Tons
Wood	350,000	Board ft.
Insulation	300	Tons

CHAP. 5-ENVIRONMENTAL
EFFECTS OF PLANT OPERATION

CHAPTER 5

ENVIRONMENTAL EFFECTS OF PLANT OPERATION

This chapter presents the details describing the interaction of the operation of the new unit and the surrounding environment, as described in Chapter 2. Both beneficial and detrimental effects or impacts arising from this interaction are identified, evaluated and described by analyzing each project operation and required resources. The evaluation and description of impacts includes a specification of their magnitude, significance and other characteristics. Impacts are distinguished in terms of their impacts on surface water bodies, groundwater, air, land, and ecology.

5.1 Effects of Heat Dissipation System

As described in Chapter 3, the new unit, as does the existing unit, will utilize a multi-cell, mechanical draft wet cooling tower for heat removal from the recirculating condenser cooling water. Cooling tower blowdown from both the existing and new units will be disposed of through deep well injection, with exception of small quantities used for fly ash wetting for dust suppression during landfilling and quench water for boiler blowdown. These small volumes will be collected in the ash land-fill.

Effects on Aquatic Life

There will be no surface water utilization as part of the heat dissipation system. Consequently, impacts to aquatic life associated with thermal discharge, impingement, entrapment, diversion and modified circulation will be non-existent.

Water Supply Well Withdrawal

As discussed in Chapter 2, all well pumping tests in the area, for which information is available, have been conducted in wells which apparently penetrate the Floridan Aquifer under artesian conditions. Tests performed originally at the Deerhaven water supply wells did not provide an estimate of the aquifer storage coefficient so that groundwater withdrawal effects could be reliably predicted. As discussed in Chapter 2 and shown in Figure 2.5-7, some authors have proposed that the Floridan Aquifer in the Deerhaven vicinity experiences groundwater table conditions. Such suggestions are based on the assumption that the Ocala group, which constitutes the top of the Floridan Aquifer in this area, performs as a hydrologic unit throughout its depth and that, since the aquifer's potentiometric surface lies below the top of the Ocala group, the aquifer therefore experiences water table (i.e. unconfined aquifer) conditions. However, field experience indicates that this formation and others which comprise the Floridan Aquifer may contain zones of both low and high permeability. The implication of this observation for the Deerhaven site is that, even though the potentiometric surface in the Floridan Aquifer is known to be 28 feet below the top of the Ocala group (in September, 1977), this is not necessarily positive proof that the Floridan Aquifer beneath the site is under water table conditions. Furthermore, if the assumption that the aquifer is under water table conditions is correct, the only data which have been available for drawdown prediction have been obtained from wells under artesian conditions, and their application to the Deerhaven water supply wells may provide invalid results.

In order to obtain site-specific data, a test of one of the existing water supply wells was performed from September 9, 1977, to September 13, 1977. As Figure 5.1-1 indicates, three water supply wells presently exist to meet the present needs of the station. These wells are aligned approximately on a north-south axis and are 150 feet apart. The three supply wells range in depth from 360 to 440 feet. An observation well, 281 feet deep, lies 485 feet south of the central water supply well.

During the week preceding the aquifer test, the central water supply well was the only well pumped for the station's needs. This well was pumped continuously to establish quasi-equilibrium in the groundwater system at a rate equal to the average withdrawal rate for the preceding months. This continuous pumping terminated at 5:00 a.m. September 9, 1977. Pre-test water levels were measured in the south water supply well and in the observation well. These were used as monitoring wells during the aquifer test and the central water supply well was used as the pumping well. It was not possible to insert water level measuring devices in the north and central water supply wells due to the small annular clearance in the well casing. Pre-test water level observations indicated that the aquifer had not fully recovered from the previous pumping; however, only a limited shut-down time could be tolerated due to water supply needs at the station. Therefore, the aquifer test was begun at 3:02 p.m. September 9, 1977, and proceeded for 94 hours, 16 minutes until 1:19 p.m. September 13, 1977. During this test period the central water supply well was pumped at a rate of 881 gallons per minute.

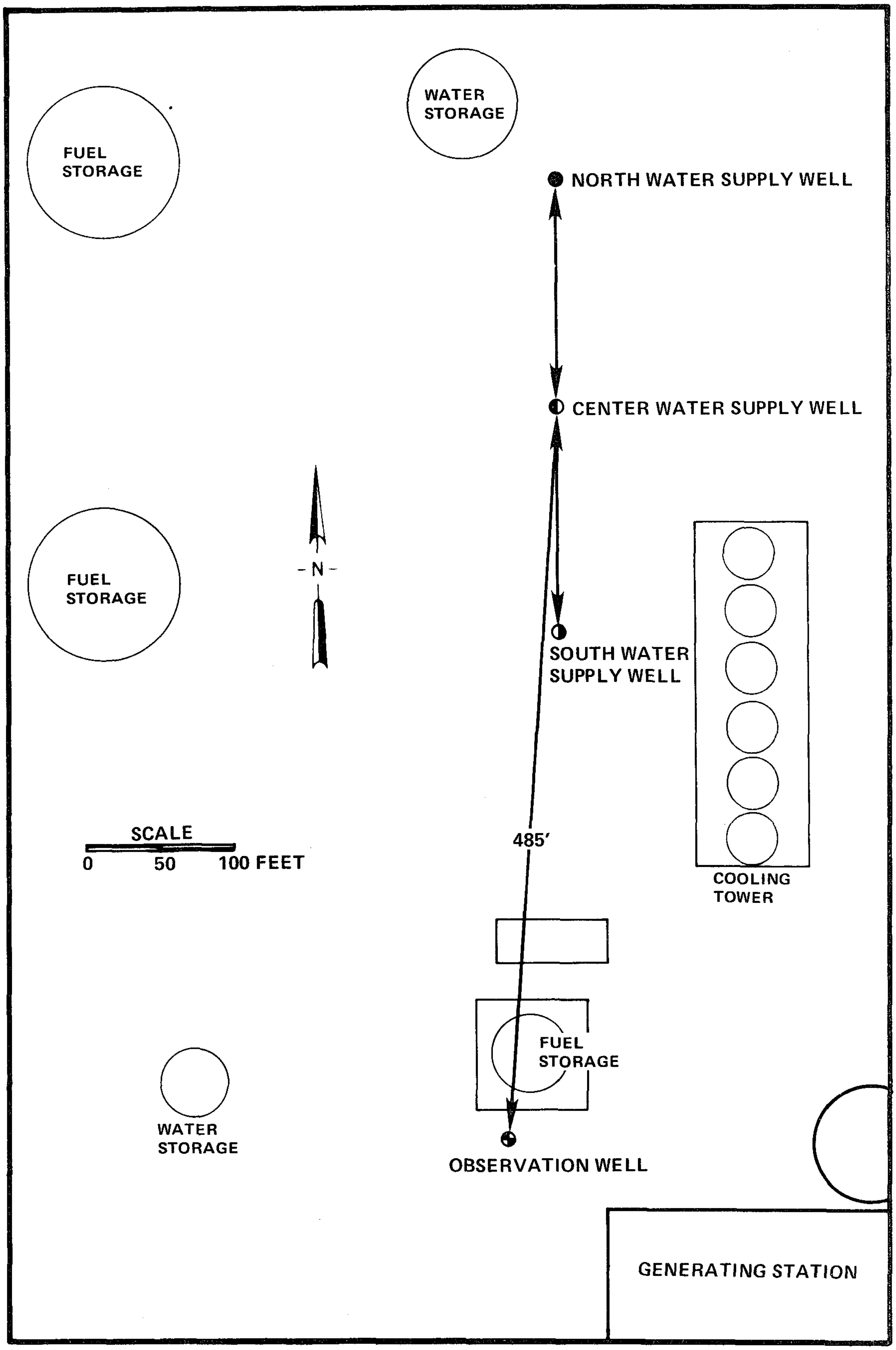


FIGURE 5.1-1 LOCATION OF EXISTING DEERHAVEN STATION WATER SUPPLY WELLS AND OBSERVATION WELL.

The collected data were analyzed using two models to determine transmissivity and storage coefficient values. These were the Hantush-Jacob model, a non-steady state, leaky artesian aquifer model which assumes fully penetrating wells, no release of water from storage in the aquitard and constant discharge conditions; and Boulton's delayed drainage model for a water table aquifer with fully penetrating wells and constant discharge conditions.

Time-drawdown response during the first few hundred minutes of the test indicated that the aquifer system may be responding as a water table aquifer. Using Boulton's technique, time-drawdown data for both monitoring wells was plotted on log-log paper and the plots were matched to the Boulton model type curves. A match for early and late times was obtained for the south water supply well and only a match for early time was obtained for the observation well. A summary of the results of this analysis is shown in Table 5.1-1.

The log-log plots of the time-drawdown data for both monitoring wells were also matched for the Hantush-Jacob leaky artesian model type curves. A summary of the results of this analysis is presented in Table 5.1-2.

As indicated, values of transmissivity determined from both methods of analysis range from a high of 300,000 gpd/ft. to a low of 250,000 gpd/ft. The values of storage coefficients range from 1.8×10^{-4} to 5.2×10^{-5}

Table 5.1-1 Aquifer Parameters Obtained Using the Delayed Drainage Model

Well	Transmissivity (gpd/ft)		Storage Coefficient (dimensionless)	
	Early	Late	Early	Late
South	250,000	250,000	1.6×10^{-4}	0.15
Observation	300,000		5.2×10^{-5}	

Table 5.1-2 Aquifer Parameters Obtained Using the Leaky Artesian Model

Well	Transmissivity (gpd/ft)	Storage Coefficient (dimensionless)
South	280,000	1.8×10^{-4}
Observation	290,000	5.2×10^{-5}

for the artesian aquifer analysis. A specific yield of 0.15 was calculated from the late-type curve match using the Boulton delayed drainage model and test data monitored at the south water supply well.

There is still a degree of uncertainty regarding the nature of the aquifer system beneath the Deerhaven site. As mentioned above, the time-drawdown response for the first few hundred minutes of the test indicated a water table system; however, the geologic condition of the site (that is, the sequence of shallow water table aquifer, clay and siltstone, and deeper limestone aquifer), could indicate a leaky artesian system, provided the confining beds are saturated. Since the purpose of the test program was to provide data to project regional water table impacts due to proposed groundwater withdrawal at the Deerhaven site, it was determined that impacts should be predicted using both models. This, it was felt, would provide both an optimistic and pessimistic prediction of such impacts. Using each aquifer model the net drawdown of the Floridan Aquifer's potentiometric surface was predicted based on an average withdrawal rate of 3,289 gpm (4.7 mgd) from on-site wells.

For the modeling assumption of a leaky artesian type system, an equilibrium type mathematical model was used. This model assumed that the Floridan Aquifer is recharged by the leakage of water through the confining layer, or aquitard, (i.e. the Hawthorn formation) from the shallow water table, and that equilibrium (i.e. no further drawdown) occurs when the cone of depression from Deerhaven water supply wells

intercepts enough leakage to offset the water supply well withdrawal. For the leaky artesian aquifer assumption, the following parameters were used: transmissivity = 290,000 gpd./ft.; storage coefficient = 5.0 x 10^{-5}; leakage = 0.197 gpd./ft.^{3}. Table 5.1-3 presents the predicted net drawdown upon reaching equilibrium. As indicated, this model predicts that detectable net drawdown will be confined almost entirely to the Deerhaven site and that no measurable offsite impacts to the shallow water table, shallow wells, lakes, or marshes would result.

For the modeling assumption of a water table type system, net drawdown was computed for several withdrawal periods. The net cone of depression predicted by Boulton's delayed drainage model for each withdrawal period was superimposed on a theoretical potentiometric surface.

It was assumed that equilibrium would be established, and no further drawdown would occur, when the annual volume of vertical infiltration into the Floridan Aquifer (i.e., recharge) intercepted by the resulting net cone of depression equaled the annual Deerhaven water supply well withdrawal. Clark et al (1964) developed an estimated value, which they described as conservative, of 1.8 inches of recharge per year for a 525 square mile area whose center is approximately 20 miles east of the site in similar terrain. Using this value, it was determined that equilibrium would be established after a cone of depression with a radius of approximately 22,000 feet had developed.

Table 5.1-3 Net Equilibrium Drawdown at 3,289 Gallons/Minute Withdrawal Assuming a Leaky Artesian Aquifer

Radius from Deerhaven Wells (ft)	Drawdown (ft)
500	2.93
1,000	1.43
2,000	0.46
3,000	0.16
5,000	0.02

The following parameters were used: transmissivity = 250,000 gpd/ft.; specific yield = 0.15; delay index = 1.11 days. This analysis predicted that equilibrium drawdown would be reached after approximately one year of withdrawal. Table 5.1-4 presents the predicted net drawdown at the end of the one-year period and Figure 5.1-2 shows net drawdown contours within 5 miles of the Deerhaven wells at the end of the one-year period as predicted by the water table aquifer model. As seen, the total drawdown due to all Deerhaven water supply well withdrawal declines from 3.1 feet one mile away from the wells to 0.2 feet four miles away from the wells. Table 2.5-9 presents the known wells within five miles of the Deerhaven site. Wells which are deep enough to penetrate into the Floridan Aquifer would be expected to be influenced by this drawdown. Because this model assumes no influence on the shallow water table by the drawdown in the Floridan Aquifer, there would be no impacts to the shallow water table or to lakes, marshes, or shallow wells.

Effects of Offstream Cooling - Fogging Potential

Offstream cooling can increase the occurrence of fog in limited areas around the plant site. It has been reported that the potential for artificially created fog occurs when moisture is discharged into air that has a deficit between the actual and saturation moisture content of less than 0.1 gram per cubic meter (GPA Report, 1972). This deficit is related to air temperature and relative humidity in Table 2.6-4.

Table 5.1-4 Net Drawdown at Equilibrium (after five years withdrawal) at 3,289 Gallons/Minute Assuming a Water Table Aquifer

Radius from Deerhaven Wells (ft)	(miles)	Drawdown (ft)
1,000	0.2	6.8
2,000	0.4	5.3
4,000	0.8	3.8
6,000	1.1	2.7
10,000	1.9	1.2
14,000	2.7	0.53
18,000	3.4	0.38
20,000	3.8	0.24
22,000	4.2	0.12

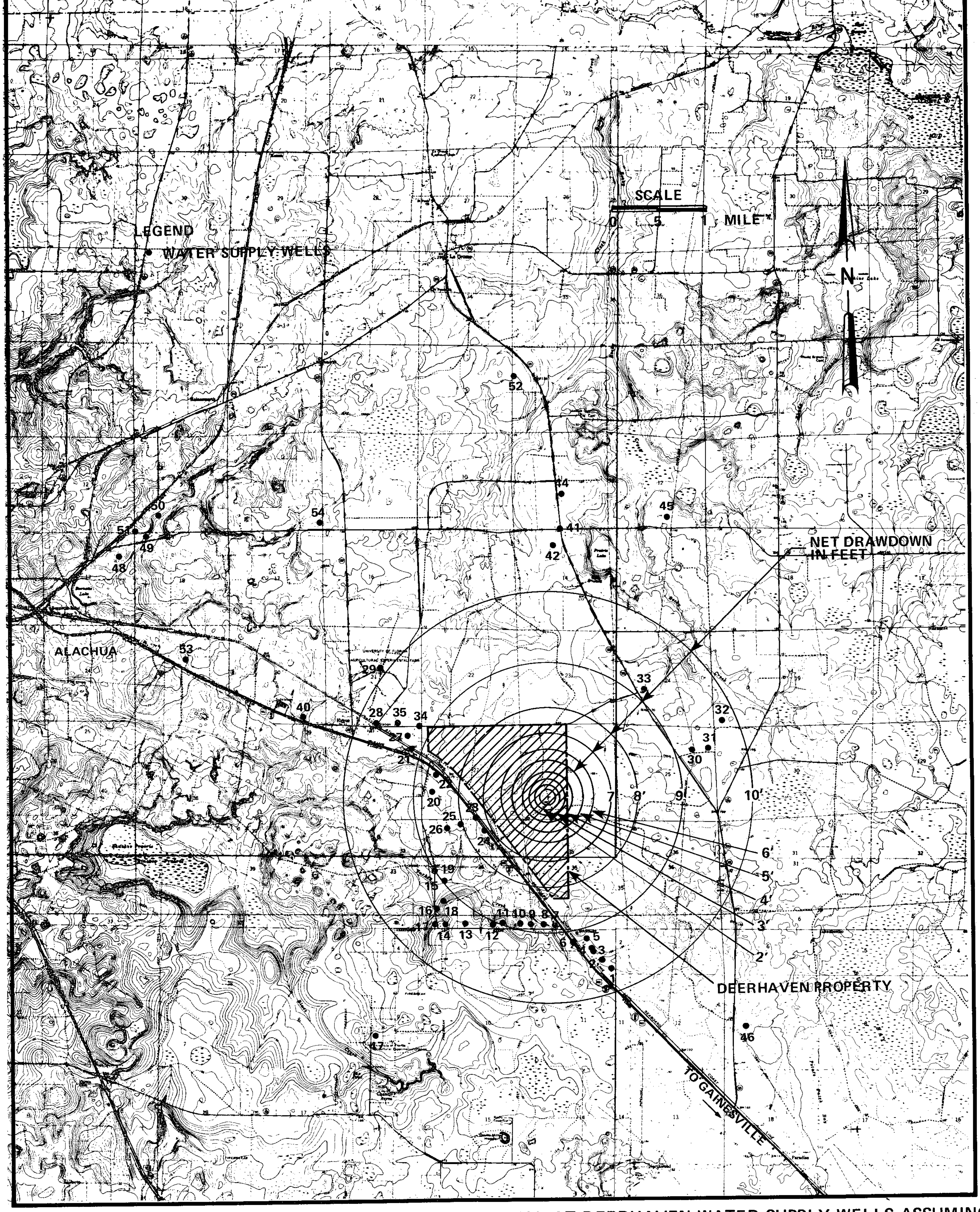


FIGURE 5.1-2 NET DRAWDOWN AFTER 5 YEARS WITHDRAWAL AT DEERHAVEN WATER SUPPLY WELLS ASSUMING WATER TABLE CONDITIONS IN FLORIDIAN AQUIFER.

A review of joint temperature and humidity conditions occuring in Gainesville in 1975 showed a deficit of 0.1 grams moisture per cubic meter of air to exist during 422 hours. Of this total, the deficit was zero (100% relative humidity) in 155 cases. Thus, the potential for fog to develop was increased by 267 hours. Several of these hours would be in conjunction with hours during which fog already occurred resulting in an extension of the period of fog.

Fog normally occurs 30 to 40 days per year in the Gainesville area, usually at night or in the early morning during the late fall and winter months and is generally dissipated by mid-morning.

The extent of the fog created by the cooling towers is expected to be limited. Of the 267 hours when artificially induced fog may occur 5% of the hours have a moisture deficit of 0.1 grams per cubic meter; 8% a deficit of ≈ 0.07 grams per cubic meter; 25% a deficit of ≈ 0.04 grams per cubic meter; and 62% a deficit approaching zero.

Since fog is normally expected to occur in the late fall and winter months and the predominant wind direction during this period is from the northwest, it is expected that the artificially created fog will generally drift southeasterly.

5.2 Effects of Chemical and Biocide Discharges

5.2.1 Effects of Surface Discharge of Industrial Type Wastes

All operational effluents from the combined Unit 1 and Unit 2 facilities will be injected into the deep well disposal system. Therefore, in this regard, no impacts on the water quality or biota of local surface streams is anticipated.

5.2.2 Cooling Tower Blowdown and Drift

Ecological Effects of Cooling Tower Blowdown

Cooling tower blowdown from both Unit 1 and the proposed Unit 2 will be injected into the deep well disposal system. Therefore, there will be no surface water quality or ecological impacts associated with this effluent.

Ecological Effects of Cooling Tower Drift

Vegetation in the area affected by cooling tower drift could potentially be impacted by increased levels of environmental salt. Injury could result either from foliar absorption of deposited salt or uptake of salt from the soils. Other potential impacts of lesser concern include possible physiological effects on animals and salt contamination of nearby surface waters.

In nature, the highest salt fallout concentrations are found in coastal areas where values normally reach 25-300 lb./acre-year, and may reach levels as high as 4,000 lb./acre-year on exposed shorelines. Natural

precipitation is usually sufficient to retard salt buildup on vegetation and in the surface soils of these areas (Bierman, et al, 1971; Edmunds, et al, 1975). In inland areas, salt deposition results primarily from rainfall with amounts ranging from about 3-25 lb./acre-year (Bierman, et al, 1971).

Information on the toxic effects of various salt concentrations on individual plant species is limited and generally qualitative in nature. From studies along salted highways, deposition rates of 1,000 lb./acre-year appear critical to roadside vegetation, even in areas of appreciable rainfall (Bierman, et al, 1971). Curtis et al (1975) report that broad leaved trees absorb greater amounts of salt than do pines, probably due to leaf shape and greater surface to volume ratio. DeVine (1975) found that deciduous trees begin to exhibit adverse effects after a few hours of exposure to salt concentrations of 100 micrograms/m^3. While no obvious injury was observed with long-term exposure to 40 micrograms/m^3, long-term exposure to concentrations of about 10 micrograms/m^3 may result in a loss of vigor for some plants and can alter the vegetational distribution pattern of affected areas (DeVine, 1975). Edmunds et al (1975) report that chloride deposition from saltwater cooling towers may produce injury in sensitive ornamental and crop vegetation. Ornamentals such as flowering dogwood, golden rain tree, red maple, trumpet creeper, Virginia creeper and black cherry, and crops such as lettuce, stone fruits and tobacco are among the more common species associated with saline toxicity. Mulchi and Armbruster (1975) produced leaf damage and reduced yields of

corn and soybeans with salt spray applications of 7.28 and 14.56 kg/ha-wk (169 and 339 lb./acre-year). A listing of plants showing varying degrees of susceptibility to saline toxicity is provided in Table 5.2.1.

No direct physiological effects of salt drift on terrestrial animals have been observed. It is thought that increased salt concentrations in soils and vegetation might attract some animals to an area resulting in competition stress, but this is at most a minor concern (Edmunds et al, 1975; DeVine, 1975). Potential contamination of surface waters is also a minor concern as illustrated by the fact that freshwater surface streams in coastal areas are not significantly higher in dissolved solids than streams further inland.

With regard to drift deposition from cooling towers per se, the major environmental problems occur when sea water is used as makeup, or when substances such as chromium are used as biocides or rust inhibitors (Hanna, 1974). Deposition and associated effects from fresh water towers are much less pronounced (Edmunds, et al, 1975). Since both the existing and planned mechanical draft towers at the Deerhaven site will use fresh water as makeup and will not depend on metallic scale or corrosion inhibitors, there is no precedent for assuming that significant environmental damage could occur.

A quantitative characterization of potential, site-specific deposition rates and resulting environmental impacts would best be made through the

Table 5.2-1 Plants Susceptible to Saline Toxicity

Alfalfa	Dogwood	Rose	Camphor weed
Oats	Red maple	Bermuda grass	Poison ivy
Clover	Blackjack oak	Trumpet creeper	Cinnamon fern
Corn	Black cherry	Geranium	Highbush blueberry
Wheat	Black gum	Virginia creeper	St. John's wort
Indian rice grass	Scrub oak		Smilax
Lettuce	Cypress		
Stone fruits	Golden rain tree		
Tobacco			
Soybeans			

Sources: Edmunds, et al, 1975
Mulchi and Armbruster, 1975

use of predictive dispersion models. However, a review of present state-of-the-art in drift modeling indicated that although a number of models presently exist (Hanna, 1974), no individual model should be accepted as providing accurate predictions of drift residue and concentration or deposition rate as validation data are unavailable (McVehil and Heikes, 1975).

In lieu of reliable predictive model for salt drift deposition, a simplistic procedure, based on empirical, literature-derived data and site-specific drift estimated, was used to provide a rough prediction of local deposition rates (Chapter 6). Stewart (1968) and Hosler, et al (1972), as quoted by EPA (1973) indicate that the majority of drift particles will fall out within 2,000 feet of the cooling tower under normal conditions. Utilizing this information, a circular deposition area within a 2,000 foot radius, was assumed. The deposition rate for total dissolved solids (TDS) is 110 tons/year. Therefore, TDS deposition within this area is calculated to be about 761 lbs./acre-year (Figure 5.2-1).

It should be emphasized that the constituent of greatest concern is chloride, which makes up approximately 2% of the calculated TDS deposition. This translates into about 13 lbs./acre-year of chloride, which assuming an addition of normal background levels, is far below levels reported to be toxic to vegetation. Sulfate salts, which represent 55% of the TDS constituents are less toxic than chlorides (Boyce, 1954).

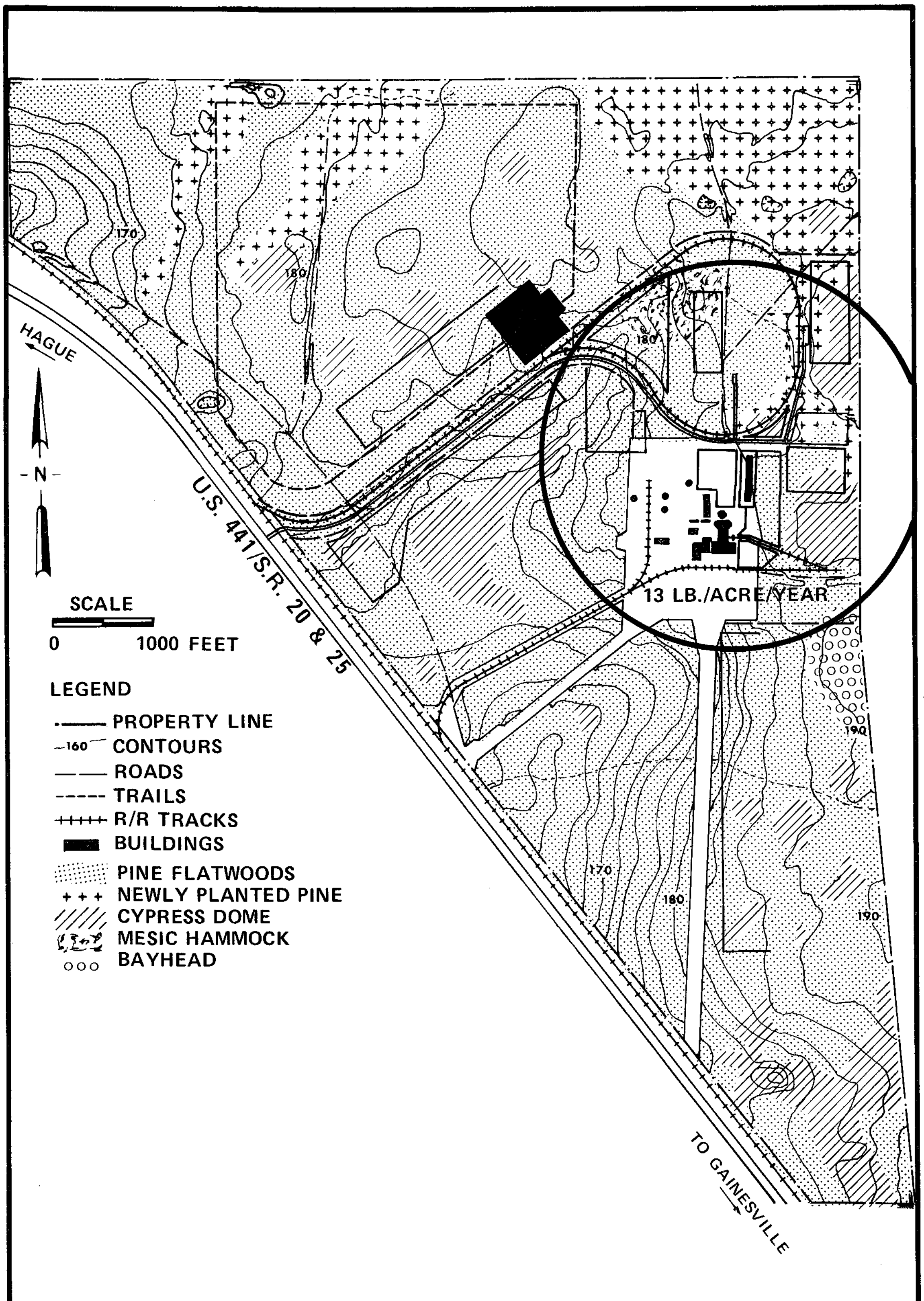


FIGURE 5.2-1 PROJECTED SALT DEPOSITION FROM COOLING TOWER DRIFT USING DEEP WELL INJECTION.

Based on this assessment and the limited existing data, no adverse impacts from cooling tower drift deposition are expected.

5.3 Sanitary Wastes

Deerhaven operating personnel report that the existing septic tank system for sanitary wastes has been operating satisfactorily since installation. This system was designed initially for a total work force of 40 people, and will be expanded to accomodate the anticipated increase to a total work force of 60 to 70 people. This expansion will be in accordance with applicable Alachua County Health Department rules for septic tank facilities.

5.4 Coal and Ash Handling Systems

Construction of Deerhaven Unit 2 will result in runoff being generated from several handling and storage systems, each with distinct chemical characteristics. The most notable of such flows are coal-pile runoff, runoff from the ash landfill, and site stormwater runoff. This section characterizes and describes the effects of runoff from these site areas.

Current U.S. Environmental Protection Agency regulations (39-Federal Register 36207, 1974) specify that runoff from coal piles and other material storage areas must have a pH between 6 and 9 and must have a maximum total suspended solid (TSS) concentration less than 50 mg/l. Recognizing that it is not economically feasible to design for all natural events, the EPA states that runoff flows exceeding those from

the ten year, twenty-four hour rainfall need not be treated. Table 5.4-1 presents estimates of the twenty-four hour total rainfall for the Gainesville area for selected recurrence intervals.

Table 5.4-2 summarizes certain portions of Chapter 17-3 of the Florida Administrative Code which might be considered applicable to runoff from the Deerhaven site.

According to Dr. G. J. Thabaraj, Department of Environmental Regulation (DER) Administrator, stormwater systems are subject to the following agency policies:

1. Storm runoff discharge requirements will be strictly based on the potential impact of the discharge in relation to the designated use of the receiving waters and the practical consideration of the cost-effectiveness of the proposed abatement measure.

2. Cost-effective solutions must consider integrative approaches utilizing pre-storm action to reduce the impact of storm flows, moderation of flow rate and possibly treatment of stormwater.

3. Detention basins should be considered as essential in residential, business, industrial and highway development. Interim drainage systems including storage should be required during all construction activity.

Table 5.4-1 Estimates of 24-hour Total Rainfall at Gainesville, Florida for Selected Recurrence Intervals

Recurrence Interval (years)	Total Rainfall (inches)
1	3.7
2	4.3
5	5.7
10	6.9
25	7.8
50	8.7
100	9.6

Source: USDA SCS Rainfall Frequency Atlas of Alabama, Florida,...

NOTE: A storm with a recurrence interval of five years occurs on the average of once every five years. There is a 20 percent chance it will occur in any year, a 4 percent chance it will occur two years in a row, etc.

Table 5.4-2 Florida Administrative Code, Chapter 17-3, Water Quality Standards for Class III Waters (recreation-propagation and management of fish and wildlife)

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1. Ninety percent organic and inorganic removal factor is required for industrial wastes.
2. The presence of any of the following constituents may be suspected of degrading water quality:
   - Sulfates
   - Sulfides
   - Nickel
   - Aluminum
   - Free mineral acids
   - Nitrates
   - Phosphates
   - Potassium
3. Chlorides should not exceed 250 mg/l in freshwater streams.
4. Turbidity should not exceed 50 JTU.
5. Dissolved solids should not exceed 500 mg/l monthly average or 1,000 mg/l at any time.
6. Specific conductance shall not exceed 100 percent above background levels or a maximum of 500 μmhos/cm.
7. Radioactive substances-gross beta activity (in the known absence of strontium-90 and alpha emitters) shall not exceed 1,000 micromicrocuries at any time.
8. There shall be no detectable cyanide or cyanates.
9. Copper shall not exceed 0.5 g/l.
10. Zinc shall not exceed 1.0 mg/l.

Table 5.4-2 Florida Administrative Code, Chapter 17-3, Water Quality Standards for Class III Waters (recreation-propagation and management of fish and wildlife) (continued)

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11. Chromium shall not exceed 0.50 mg/l hexavalent or 1.0 mg/l total chromium in effluent discharge, and should not exceed 0.05 mg/l after reasonable mixing in receiving streams.
12. Phenolic compounds shall not exceed 0.01 mg/l as phenol.
13. Lead shall not exceed 0.05 mg/l.
14. Iron shall not exceed 0.30 mg/l.
15. Arsenic shall not exceed 0.05 mg/l.
16. Oils and greases shall not produce iridescence, cause taste and odors, interfere with other beneficial uses, or exceed 15 mg/l.
17. pH of receiving waters shall not be caused to vary more than 1.0 unit above or below normal pH, the lower value shall not be less than 6.0 and the upper value shall be not above 8.5.
18. There shall be no detectable mercury.
19. Total dissolved oxygen shall not average less than 5 mg/l in a 24-hour period or 4 mg/l at any time.
20. Receiving waters shall be kept free from substances attributable to municipal, industrial, agricultural or other discharges or concentrations or combinations which are toxic or harmful to humans, animals, or aquatic life.
21. Receiving waters shall be kept free from materials attributable to municipal, industrial, agricultural or other discharges producing color, odor, or other conditions in such a degree as to create a nuisance.

The DER currently regulates stormwater discharges from stormwater management systems. Those systems discharging water that does not meet applicable water quality standards are cited by the DER and required to be brought into compliance.

The Suwannee River Water Management District is expected to assume an expanding role in regulating and permitting drainage works as a result of the Water Resources Act of 1972. A statewide water use plan is an objective of the act and is presently being prepared, principally by the Regional Water Management Districts. Stormwater systems in the site area are subject to review by the Suwannee Water Management District.

5.4.1 Leachate Movement

As part of an investigation previously performed to evaluate the potential for cooling tower blowdown disposal on-site by means of percolation ponds or spray irrigation systems, limited groundwater and soils data were obtained from on-site auger borings. This information is presented in Chapter 2 of this document. Based on this information mathematical and computer models indicated that the lateral groundwater seepage rate on-site is too low to permit cooling tower blowdown disposal through groundwater seepage. These conclusions indicate that leachate movement from unlined or partially lined on-site waste storage and disposal facilities may be sufficiently low such that full lining of all such facilities will not be required.

An investigation is currently underway to evaluate potential leachate movement from unlined on-site solid waste storage and disposal facilities. Should this investigation predict that leachate contamination to groundwaters may occur, additional evaluations will be performed to determine the locations for and types of permeable barriers to help prevent such contamination.

No long-term data exist to show the behavior of the perched on-site groundwater table. Water levels were recorded on auger borings performed during September, 1976. These boring logs are presented in Chapter 2. Selected cross-sections, showing assumed soil stratification and groundwater elevations, are also presented in Chapter 2. It should be noted that all groundwater table observations were made following three successive rain-free days. The greatest depth to water table was found to be approximately 2 to 3 feet, and, in the southern part of the site, only 1 foot below ground surface. Permeability tests performed on various sands within the upper 5 feet indicated an average permeability of 0.43 ft./day. Order-of-magnitude mathematical and computer models performed using inferred stratification, results of permeability testing, and simplifying assumptions as to slope and groundwater depth indicated little possibility for reliable on-site cooling tower blowdown disposal by percolation. Such models also infer low lateral groundwater velocity. These conclusions correlate well with the observations of plant operating personnel that surficial soils are completely saturated during some parts of the year and that most rainfall leaves the site through surface runoff during those periods.

Groundwater information will be obtained during the study to evaluate potential leachate movement from unlined on-site storage and disposal facilities. During this program a network of on-site and off-site soil borings will be obtained; the potentiometric surface will be monitored in a network of observation wells; groundwater observations will be continuously recorded at key observation wells; permeability testing will be performed on undisturbed soil samples and by means of pumping tests of surficial sands; and, if possible, modeling will be performed to predict the potential for leachate movement.

5.4.2 Coal Pile Runoff and Leachate

A substantial on-site supply of coal will be necessary to fuel the boiler in Unit 2. This coal will be stored in an open pile exposed to the weather as shown in Figure 4.1-2.

Chemical reactions between rainwater and minerals in coal typically form a solution called coal pile leachate (CPL) which can have characteristics such as high acidity, high dissolved mineral content, and heavy metals content. CPL is generated by variable rainfall flushing through the coal pile. Exposed slopes of finely crushed coal can be a significant source of sediment. Unless otherwise retained, this sediment may be deposited in natural stream channels, thus affecting channel stability and harming aquatic life. Such loss of coal is also an unnecessary fuel loss.

Coal pile leachate which leaves the pile by surface runoff is termed coal-pile runoff (CPR). Although CPR is usually acidic, some alkaline values have been reported. Anderson and Youngstrom (1976) in a single set of observations, observed that CPR pH does not seem to decrease with storm duration as do many other characteristics of the runoff, thus inferring that detention and treatment may be necessary to meet applicable pH standards for some coals. The EPA (1974) reported total suspended solids values for selected coal-pile runoff effluents varying from 22 mg/l to 3,302 mg/l, with an average value of 828 mg/l. This implies that applicable total suspended solids regulations can be met without treatment for some coal, but usually must be met by utilizing retention and/or clarification.

Rainfall runoff from the coal storage and handling area (approximately 11.3 acres) will be captured and drained to a retention pond (approximately 3.4 acres) which will contain runoff from storm events up to and including a ten year, twenty-four hour rainfall. Thus, in this area, 15 acres of land area will be removed from contributing to the runoff/infiltration hydrological systems. Figure 5.4-1 presents schematically the coal-pile runoff retention system and presents hypothetical hydrographs at various points for the system. The cross-hatched portions of the hydrographs represent excess discharges to be overflowed to Turkey Creek. No coal-pile runoff will enter the surface waters unless the design storm is exceeded. Any amount of runoff in excess of that produced by the design rainfall will be allowed to overflow to the

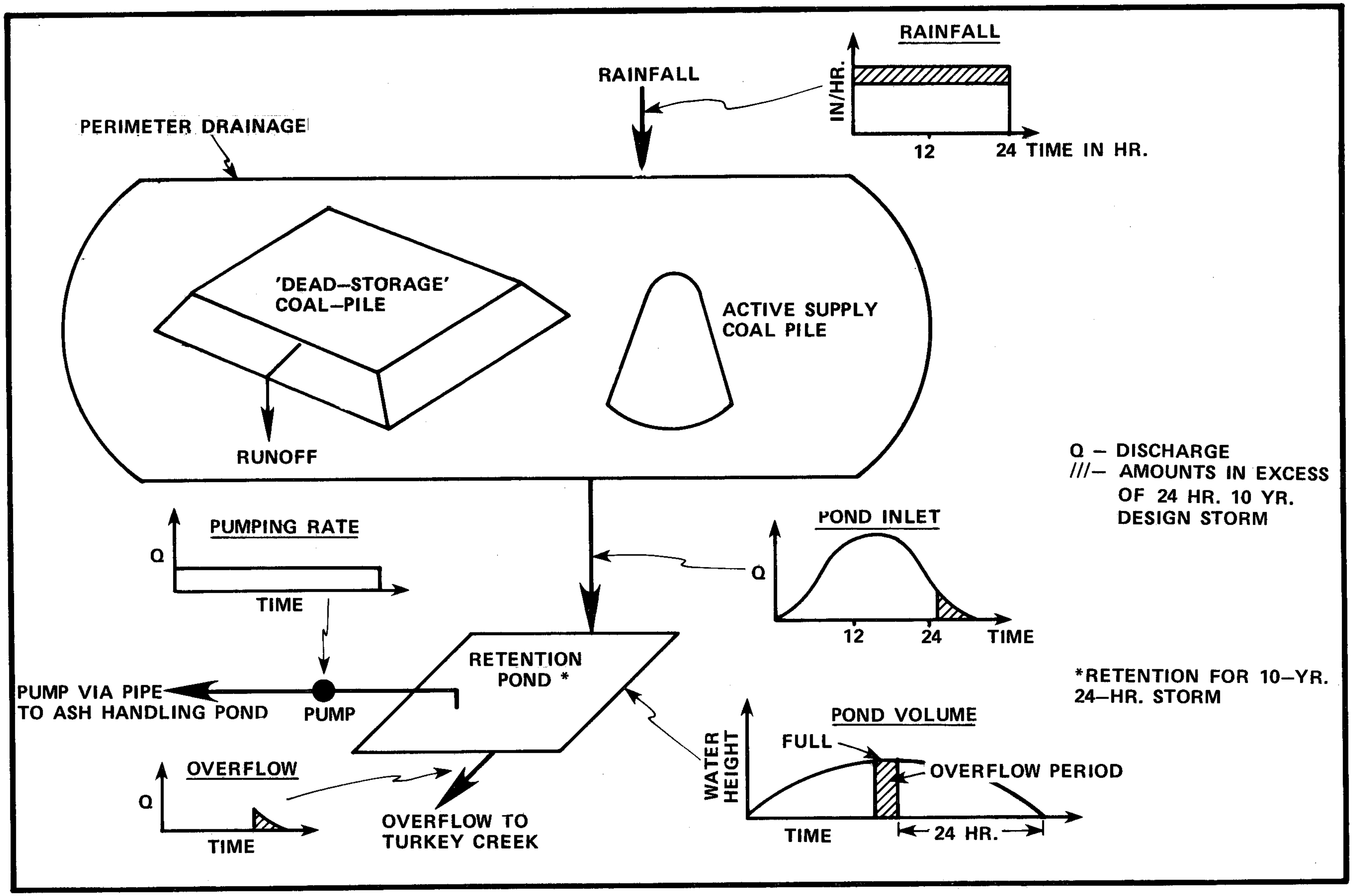

FIGURE 5.4-1 COAL PILE RUNOFF RETENTION SYSTEM.

southern tributary of Turkey Creek. No detectable seepage to the shallow aquifer from the coal pile area or retention pond will be permitted. Should the results of the Deerhaven site leachate movement evaluation indicate that lining of this area is necessary to prevent groundwater contamination, such lining shall be provided.

5.4.3 Ash Runoff and Leachate

Except for boiler blowdown water used to moisten fly ash prior to burial, and residual water in ash pond sediment, all water entering the ash sluicing and ash pond systems will either be evaporated or will be disposed of by deep well injection. None will go to surface drainage systems.

Active Bottom Ash Ponds - The active bottom ash ponds will occupy an area of approximately 6.5 acres (Figure 4.1-2). At present, it is anticipated that these ponds may receive either an internal lining or some other impermeable barrier to prevent infiltration of ash pond water into surrounding groundwaters. However, it is likely that direct rainfall on these ponds usually will be part of the recirculating ash sluicing water system, thus removing 6.5 acres of land area from contributing to the stormwater runoff/infiltration hydrological systems.

Ash Landfill - The 220 acre landfill area shown in Figure 4.1-2 will be utilized over approximately a 30-year period for ash disposal. It is anticipated that rectangular cells, each providing a five year ash

storage volume, will be gradually cleared, stripped of topsoil, stockpiled with ash above ground, covered with previously stripped topsoil, and revegetated. Thus, approximately 37 acres will be stripped per five year period. Surface runoff from the active face of the landfill will be retained and introduced into use as process water via the ash pond system. Surface runoff from the remaining covered landfill area will be permitted to run to the on-site natural drainage system. Fortunately, the landfill site lies on the drainage divide between the north branch and south branch of Turkey Creek and along the drainage divide between Rocky Creek Basin and Turkey Creek Basin (Figure 2.5-1). Therefore, it is anticipated that landfill cell construction would have no appreciable effect on surficial groundwater movement.

5.4.4 Ecological Effects of Ash and Coal Handling System Runoff and Leachate

The ash landfill runoff pond, the active bottom ash pond and the coal pile runoff pond are all designed to contain the stormwater associated with a ten year, twenty-four hour event. Runoff in excess of the design storm will be allowed to overflow into the surface drainage. Surface waters could also potentially be contaminated from subsurface movement of leachate from the coal pile and ash disposal landfill areas. Impacts on the biota of Turkey Creek, the principal site drainage pathway, will depend on the type and concentration of chemical constituents reaching the aquatic habitats and the toxic response characteristics of potentially affected species.

5.4.4.1 Chemical Characteristics and Toxicity of Ash Pond Effluent and Coal Pile Runoff

A precise chemical characterization of the ash and coal pile runoff cannot be made since the source of coal has not yet been determined. In lieu of a site-specific analysis, data from the literature were assembled and are reported in Tables 5.4-3, 5.4-4 and 5.4-5. Table 5.4-5 also shows best estimates for Unit 2.

Studies on the biotic effects of ash and coal pile effluents offer no consistent conclusions. Gualke and Crawford (1976), who studied fly ash pond effluent levels of arsenic, cadmium, chromium, iron, lead, mercury, nickel, selenium, copper and zinc both individually and combined, reported no adverse effects on fish and benthic communities. Conversely, Guthrie, et al (1974) and Cherry and Guthrie (1975) reported a reduction in diversity of biotic communities associated with effluents from a coal ash basin. Most notably affected were primary and secondary consumers; with only a few species of aquatic insects and one fish species present in the portion of the stream receiving effluent. Current studies by Guthrie and Cherry (1976) and Cherry, et al, (1976) on this same basin report biological magnification of bromide, iodide, sodium, calcium, cadmium, selenium, tin, zinc, chromium, iron, copper, mercury, cobalt, and arsenic. However, they found the most active ash removal mechanism to be abiotic since 35 of the 40 analyzed elements accumulated in the sediments. A study by Cairns, et al, (1970) reported that highly caustic water (pH 12) was the primary toxic agent associated with fly ash pond spills into the Clinch River, Virginia.

Table 5.4-3 Chemical Waste Characterization of Coal Pile Drainage

Parameter*	$\bar{x}$	Range
Alkalinity	20	0 - 82
BOD	3	0 - 10
COD	830	85 - 1,099
TS	11,200	1,330 - 45,000
TDS	12,600	247 - 44,050
TSS	828	22 - 3,302
NH_4N	0.69	0 - 1.77
NO_3N	1.31	0.3 - 2.25
P	0.72	0.23 - 1.2
Turbidity (JTU)	205	2.7 - 505
Acidity	9,907	8.7 - 27,810
Total Hardness	804	130 - 1,850
SO_4	6,880	525 - 21,920
Cl	130	3.6 - 481
Al	1,012	825 - 1,200
Cr	2.7	0 - 15.7
Cu	2.1	1.6 - 3.4
Fe	11,000	0.06 - 93,000
Mg	130	89 - 174
Zn	5.9	0.006 - 23
Na	890	160 - 1,260
pH	4.4	2.1 - 7.8

*All units in mg/l unless otherwise noted.

Source: U.S. EPA 1974 Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Steam Electric Power Generating Point Source Category. EPA 440/1-74.029-a.

Table 5.4-4 Ash Pond Effluent Characterization

Parameter	EPA, 1974 Net Discharge		EPRI		Guthrie & Cherry	Gaulke and Crawford '76		Rice & Strauss '77		Bottom Ash	
	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)
Na	-4.7	-1609 to 982	---		7.7	---		---		---	
K	---		---		6.1	---		---		---	
Rb	---		---		0.4	---		---		---	
Cs	---		---		<0.01	---		---		---	
Be	---		0.003	0.001 to 0.004	---	---		0.001	<0.01 to 0.02	<0.01	All <0.01
Mg	15.3	-11 to 156	---		4.1	---		13.99	9.4 to 20.0	5.85	0.3 to 9.3
Ca	---		---		9.2	---		136	94 to 180	40.12	23 to 67
Sr	---		---		0.3	---		---	---	---	
Ba	---		<0.3	<0.3 (all)	0.7	---		0.25	0.2 to 0.4	0.15	<0.10 to 0.30
La	---		---		<0.01	---		---		---	
Ti	---		---		0.9	---		---		---	
V	---		<0.18	<0.1 to <0.2	0.04	---		---		---	
Cr	0.01	-0.113 to 0.139	<0.0001	<0.0002 to 0.004	0.2	0.0096	0.0008 to 0.025	0.067	0.012 to 0.17	0.009	<0.005 to 0.023

Table 5.4-4 Ash Pond Effluent Characterization (continued)

	EPA, 1974 Net Discharge		EPRI		Guthrie & Cherry	Gaulke and Crawford '76		Rice & Strauss '77		Bottom Ash	
Parameter	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)	$\bar{x}$ (mg/l)	Range (mg/l)
I	---		---		0.1	---		---		---	
Ce	---		---		0.2	---		---		---	
Th	---		---		0.03	---		---		---	
U	---		---		0.01	---		---		---	
CN	---		---			---		<0.01	all < 0.01	<0.01	all < 0.01
Total Alk. (as $CaCO_3$)	---		---			---		---		85	30 to 160
Conductivity mhos/cm	---		---			---		810	615 to 1125	322	210 to 910
Total Hardness as($CaCO_3$)	---		---			---		260.5	185 to 520	141.5	76 to 394
pH	---		---			---		4.4	3.6 to 6.3	7.2	4.1 to 7.9
Dissolved Solids	---		---			---		508	141 to 820	167	69 to 404
Suspended Solids	---		---			---		62.5	2 to 256	60	5 to 657

Table 5.4-4 Ash Pond Effluent Characterization (continued)

Parameter	EPA, 1974 Net Discharge x̄ (mg/l)	EPA, 1974 Net Discharge Range (mg/l)	EPRI x̄ (mg/l)	EPRI Range (mg/l)	Guthrie & Cherry x̄ (mg/l)	Gaulke and Crawford '76 x̄ (mg/l)	Gaulke and Crawford '76 Range (mg/l)	Rice & Strauss '77 x̄ (mg/l)	Rice & Strauss '77 Range (mg/l)	Bottom Ash x̄ (mg/l)	Bottom Ash Range (mg/l)
Ge	---		0.05	0.02 to <0.1	---	---		---		---	
Sn	---		---		0.1	---		---		---	
Pb	---		0.019	0.008 to 0.03	---	0.0076	0.0021 to 0.011	0.058	<0.01 to 0.2	0.016	0.01 to 0.031
NH_4(N)	-0.49	-5.0 to 3.4	---		---	---		0.43	0.02 to 1.4	0.12	0.04 to 0.34
NO_3(N)	0.79	-1.35 to 6.1	---		---	---		---		---	
P	-0.15	-1.19 to 0.41	---		---	---		0.021	<0.01 to 0.06	0.081	0.01 to 0.23
As	---		0.008	0.003 to 0.02	0.06	0.061	0.0 to 0.183	0.010	<0.005 to 0.023	0.006	0.002 to 0.015
Sb	---		0.01	0.003 to 0.03	0.07	---		---		---	
SO_4	06.4	-006 to 527	---		---	---		357.5	240 to 440	48.75	41 to 80
Se	---		0.008	0.0044 to 0.015	0.1	0.069	0.0 to 0.254	0.0019	<0.001 to 0.004	0.002	<0.001 to 0.004
F	---		2.9	0.35 to 10.4	---	---		---		---	
Cl	158	-140 to 1700	---		3.8	---		7.12	5 to 14	8.38	5 to 15
Br	---		---		0.1	---		---		---	

Table 5.4-4 Ash Pond Effluent Characterization (continued)

	EPA, 1974 Net Discharge		EPRI		Guthrie & Cherry	Gaulke and Crawford '76		Rice & Strauss '77		Bottom Ash	
Parameter	x̄ (mg/l)	Range (mg/l)	x̄ (mg/l)	Range (mg/l)	x̄ (mg/l)	x̄ (mg/l)	Range (mg/l)	x̄ (mg/l)	Range (mg/l)	x̄ (mg/l)	Range (mg/l)
Mo	---		0.04	0.004 to 0.10	---	---		---		---	
Mn	0.04	-0.02 to 0.102	0.31	0.004 to 1.1	0.07	---		0.48	0.29 to 0.63	0.16	0.07 to 0.26
Fe	0.02	-4.6 to 2.89	---		16.9	0.0620	0.020 to 0.310	1.44	0.33 to 6.6	5.29	1.7 to 11
Co	---		---		0.1	---					
Ni	-0.002	-0.054 to 0.015	<0.05	<0.01 to 0.11	---	0.024	0.0095 to 0.070	1.1	0.06 to 0.13	<0.059	0.05 to 0.12
Cu	0.01	-0.037 to 0.02	0.03	<0.004 to 0.09	---	0.025	0.0029 to 0.090	0.31	0.16 to 0.45	0.065	<0.01 to 0.14
Ag	---		---		---	---		<0.01	all <0.01	<0.01	all <0.01
Zn	0.03	-0.02 to 0.162	0.67	0.12 to 2.5	0.4	0.023	0.0003 to 0.075	1.51	1.1 to 2.7	0.09	0.02 to 0.16
Cd	---		0.01	0.0001 to 0.04	0.1	0.0017	0.00037 to 0.0029	0.037	0.023 to 0.052	0.0011	<0.001 to 0.002
Hg	0.0009	-0.002 to 0.002	0.001	<0.001 to 0.0022	0.03	0.001	0.00003 to 0.0095	0.0003	<0.0002 to 0.0006	0.007	<0.0002 to 0.0026
B	---		0.54	0.233 to 0.47	---	---		---		---	
Al	0.96	-0.22 to 530	---		13.0	---		7.19	3.6 to 8.8	3.49	0.5 to 8.0
Si	---		---		---	---		12.57	10 to 15	7.4	6.1 to 8.6

Table 5.4-5 Representative Ranges of Values for Chemical Constituents of Coal Ash

Constituent	Bern[1] Range (%)	Bern[1] Average (%)	Rice & Strauss[2] Fly Ash (% by wt.)	Rice & Strauss[2] Bottom Ash (% by wt.)	Deerhaven Unit 2 Estimate[3]
Phosphorus Pentoxide, P_2O_5	N.R.[4]	N.R.	0.01-0.50	0.01-0.04	0.35-0.75
Silica, SiO_2	20-60	48	20.1-46.0	19.4-48.9	46.00-57.00
Aluminum Oxide, Al_2O_3	10-35	26	17.4-40.7	18.9-36.2	27.00-35.00
Titanium Oxide TiO_2	0.5-2.5	1	1.3-2.0	1.3-1.8	0.55-1.50
Magnesium Oxide, MgO	0.25-4	2	0.4-1.2	0.5-0.9	N.R.
Calcium Oxide, CaO	1.20	5	0.1-6.1	0.01-4.2	1.00-2.20
Magnesia	N.R.	N.R.	N.R.	N.R.	0.75-0.90
Sodium Oxide, Na_2O	0.4-1.5	1	0.3-0.8	0.2-0.8	0.25-0.75
Potassium Oxide, K_2O	1-4	2	1.2-2.4	1.7-2.8	0.85-2.00
Sulfur Trioxide SO_3	0.1-12	2	0.01-4.50	0.01-1.0	0.55-1.20
Carbon, C	0.1-20	4	N.R.	N.R.	N.R.
Boron, B	0.01-0.6	trace	<0.01	<0.01-0.3	N.R.
Phosphorus, P	0.01-0.3	trace	N.R.	N.R.	N.R.
Manganese, Mn	0.01-0.3	trace	110-150 ppm	150-200 ppm	N.R.
Molybdenum, Mo	0.01-0.1	trace	N.R.	N.R.	N.R.
Zinc, Zn	0.01-0.2	trace	N.R.	N.R.	N.R.
Copper, Cu	0.01-0.1	trace	90-150 ppm	0.01-300 ppm	N.R.
Mercury, Hg	0.00-0.02	trace	0.7-0.15 ppm	1-2 ppm	N.R.
Uranium, U & Thorium, Th	0.0-0.1	trace	N.R.	N.R.	N.R.
Arsenic, As	N.R.	N.R.	8-120 ppm	2-250 ppm	N.R.
Cadmium, Cd	N.R.	N.R.	0.01-8 ppm	0.01-15 ppm	N.R.
Cesium, Ce	N.R.	N.R.	100-8000 ppm	15-800 ppm	N.R.
Cobalt, Co	N.R.	N.R.	7-90 ppm	20-80 ppm	N.R.
Chromium, Cr	N.R.	N.R.	90-120 ppm	80-150 ppm	N.R.
Magnesium, Mg	N.R.	N.R.	0.0012-0.05	0.01-0.03	N.R.
Sodium, Na	N.R.	N.R.	0.0012-0.012	0.002-0.008	N.R.
Nickel, Ni	N.R.	N.R.	110-150 ppm	150-250 ppm	N.R.
Lead, Pb	N.R.	N.R.	110-150 ppm	150-250 ppm	N.R.
Tin, Sb	N.R.	N.R.	0.01-15 ppm	2-15 ppm	N.R.
Selenium, Se	N.R.	N.R.	25-75 ppm	3-10 ppm	N.R.
Titanium, Ti	N.R.	N.R.	0.009-0.02	0.005-0.015	N.R.
Vanadium, V	N.R.	N.R.	115-150 ppm	100-300 ppm	N.R.

[1]Reference: Bern (1976), p. 232, quoting Duvall (1975).
[2]Reference: Rice & Strauss (1977), values are representatives of Pensylvania coals.
[3]Reference: Correspondence from J.C. Hoffman, P.E., of Burns & McDonnell, Inc.
[4]N.R. = not reported.

Toxicity response data were assembled from a variety of sources (EPA, 1976; McKee and Wolf, 1963; Gualke and Crawford, 1976; and AEC, 1973) and reflect sensitivity, life stage, exposure time, and various abiotic conditions (McKee and Wolf, 1963). These data were compared to the chemical characteristics reported in Tables 5.4-3 and 5.4-4 in order to assess potential biotic effects and to identify chemical constituents of potential concern. Parameters which exceeded either the toxic response levels and/or Federal and state water quality standards (EPA, 1976; DER 17-3) are presented in Table 5.4-6. For copper, zinc, nickel, and selenium, the 96 hour LC50 (lethal concentration for 50% of the exposed population) of the most sensitive freshwater species was multiplied by an application factor to obtain a consistent criterion for comparison (EPA, 1976).

Information on the toxic response of freshwater aquatic life for certain parameters are listed in the following paragraphs.

Calcium

The toxicity of many compounds to fish and other aquatic fauna are reduced by calcium (McKee and Wolf, 1963). Concentrations of 50 mg/l calcium have been shown to cancel the toxic effect of 2 mg/l zinc; and 10 mg/l lead (Jones, 1938). In general, fish and other aquatic life can survive 1 to 3 days in water containing 2,500 to 4,000 mg/l $CaCl_2$ (Doudoroff and Ktaz, 1953) while various independent investigators have reported concentrations of between 300 and 1,000 mg/l of calcium in soft or distilled water as toxic to fish (McKee and Wolf, 1963).

Table 5.4-6 Summary of Parameters of Biological Concern Associated with Ash Pond Effluent-Coal Pile Runoff

Parameter	Aquatic Life Toxicity Response mg/l	Freshwater Life Criteria EPA, 1976 mg/l	Drinking Water Criteria EPA, 1976 mg/l	DER FAC Chapter 17-3 mg/l	Coal Pile Runoff	Ash Pond Effluent
Sodium	6.0 to 8250	---	---	---	A	A
Chromium	0.16 to 389	0.01	0.05	0.5	A,B,C,D	A,B,C,D
Iron	0.9 to 36.8	1.0	0.3	0.3	A,B,C,D	A,B,C,D
Copper	0.18 to 122	0.1 x 96hr LC_{50}	1.0	0.5	A,B,C,D	A,B
Zinc	0.2 to 40.9	0.01 x 96hr LC_{50}	5.0	1.0	A,B,C,D	A,B,D
Cadmium	7×10^{-4} to 5.0	4×10^{-4}	0.001	---	---	A,B,C
Mercury	2.3×10^{-4} to 0.31	5×10^{-5}	2×10^{-3}	None Detectable	---	A,B,C,D
Aluminum	0.7 to 50	---	---	---	A	A
Ammonium	0.2 to 2.0	0.02	---	---	A,B	A,B
Arsenic	3.0 to 20	0.05	0.05	---	---	B,C,D
Sulfate	---	2×10^{-3}	---	---	A*,B*,C*	A*,B*
Selenium	>0.003 to 183	0.01 x 96hr LC_{50}	0.01	---	---	A,B,C
Fluoride	1.5 to 1700	---	---	10**	---	A,D
Chloride	3.4×10^{-3} to 0.5	0.002	---	250	A	A,D
Cesium	0.15 to 30,000	---	---	---	---	A
Nickel	0.13 to 43	0.01 x 96hr LC_{50}	---	---	---	B
Manganese	1.5 to 1000	---	0.05	---	---	C
pH	<5, >9	6.5 to 9.0	5 to 9	±1	B,C,D	A,B,C,D
Dissolved Solids	---	---	250	1000	D	---
Turbidity	---	---	---	50	D	---

* = Possible problem as H_2S in swamps.
** = 1.4 for drinking water, 10 for other uses.
A = Exceeds toxicity response.
B = Exceeds freshwater life criteria.
C = Exceeds drinking water criteria.
D = Exceeds FAX 17-3 effluent criteria.

Manganese

Since tolerance values for freshwater aquatic life reported for manganese range from 1.5 to over 1,000 mg/l, manganese is generally not considered a problem in freshwaters (EPA, 1976). Conversely, permanganates are extremely toxic to fish and other aquatic life (2.2 to 4.1 mg/l can be lethal to fish) (EPA, 1976); however permanganates are not persistent and are rapidly reduced to a non-toxic form. A concentration of 1.0 mg/l manganese should not be deleterious to fish and aquatic life (McKee and Wolf, 1963).

Germanium

Elemental germanium, the oxide, and the sulfide are relatively and pharmacologically inert (Rothstein, 1953). Germanium has not been reported to accumulate in animal systems (McKee and Wolf, 1963).

Cesium

Cesium behaves like potassium in animal metabolism and, as such, has a low toxicity potential (McKee and Wolf, 1963). However, aquatic organisms have been found to bioaccumulate cesium (as Cs-137) dissolved in water 50-10,000 times (Pendleton, 1958). Human consumption of aquatic organisms high in cesium-137 is considered potentially hazardous.

Barium

The physical and chemical properties of barium generally preclude the existence of the toxic soluble form. Studies have shown that soluble

barium would have to exceed 50 mg/l before toxicity to aquatic life is expected. As such, EPA (1976) concluded a restrictive criterion for aquatic life which appears unwarranted. A limit of 1.0 mg/l is recommended for domestic water supplies (EPA, 1976).

Phosphate

Phosphates seldom exhibit toxic effects upon fish and other aquatic life (McKee and Wolf, 1963); however, phosphates may result in an overabundant growth of algae with concomitant odors and detriment to fish. "To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, total phosphates should not exceed 50 mg/l in any stream at the point where it enters any lake or reservoir, nor 25 mg/l within the lake or reservoir" (EPA, 1976). In streams and other flowing waters not discharging directly to lakes or impoundments, 100 mg/l is considered acceptable (Mackenthun, 1973).

Suspended and Settleable Solids and Turbidity

Suspended solids possibly affect fish and food populations "(1) by acting directly on the fish swimming in water in which solids are suspended, and either killing them or reducing their growth rate, resistance to disease, etc.; (2) by preventing the successful development of fish eggs and larvae; (3) by modifying natural movements and migrations of fish; and (4) by reducing the abundance of food available to the fish" (EIFAC, 1965). For example, suspended solids from a rock quarry (80 mg/l) have been associated with a 60% decline in macroin-

vertebrate density; a similar decline was noted in areas of sediment accumulation (Gammon, 1970). Similarly, burial of bottom organisms and decreased organism density have been associated with increased turbidity (25 ppm upstream versus 390 ppm downstream) from intensive logging (Tebo, 1955). Suspended materials may also reduce light penetration into the water, thereby reducing the photic zone depth, which in turn may reduce primary production. The EPA (1976) criterion for freshwater fish and other aquatic life is as follows: "settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life.

Dissolved Solids

All species of fish and other aquatic life must tolerate a range of dissolved solids concentrations under natural conditions. Rawson and Moore (1944) concluded that lakes with dissolved solids in excess of 15,000 mg/l were unsuitable for most species of freshwater fish. The NTAC Report (1968) also recommended osmotic pressure less than that caused by 15,000 mg/l NaCl or by 15,000 mg/l dissolved solids for most species of freshwater fish.

Hardness

The effects of hardness on freshwater fish and other aquatic life appear to be related to the ions causing the hardness rather than to hardness itself. Hardness is caused by the polyvalent metallic ions dissolved in

water, principally calcium and magnesium. Iron, strontium, and manganese may also contribute to hardness.

Biochemical Oxygen Demand

The effects of Biochemical Oxygen Demand (BOD) of an effluent on fish and freshwater aquatic life is directly related to the reaeration characteristic of the receiving stream. As little as 5 mg/l of 5 day BOD may cause deoxygenation in a slow moving stream; whereas, as much as 50 mg/l may be handled without appreciable depletion of dissolved oxygen in a swift flowing mountain stream (McKee and Wolf, 1963).

5.4.4.2 Impact on Turkey Creek

Since a site-specific chemical characterization of coal and ash handling system overflow and leachate has not been made, resulting impacts on the biota of Turkey Creek can not be precisely defined. However, structural or environmental features which will minimize potential surface water contamination have either been incorporated into the facility design or are under analysis. In light of these mitigating measures, a qualitative assessment of potential impacts can be made.

It should be emphasized that retention pond overflows from the coal and ash handling systems will be a rare event associated with only the most severe storm occurring less than once in ten years (e.g. a twenty-five year storm). Furthermore, it is anticipated that mixing and subsequent dilution of the chemical constituents with runoff from surrounding areas

will mitigate biotic impacts to some degree. Given the severity of the causative storm and the total runoff volume it could generate, dilutory reduction of contaminant concentrations should be substantial.

Vertical stratification of the pond waters during the storm will also serve to reduce the concentration of suspended solids in overflow.

In consideration of these mitigating features, it is doubtful that adverse impacts associated with pond overflow will be either extensive or extreme. In any event, the runoff quality characteristics will be monitored in order to determine if overflows would be problematic or in violation of state standards. If so, appropriate measures will be taken in accordance with Florida DER regulations and rules.

5.5 Stormwater Runoff

The existing Deerhaven site has an area of approximately 1,116 acres. Of this area, approximately 80 acres were cleared as part of the construction of the existing Unit 1 facility. The remaining site area is presently in an undeveloped, natural condition consisting primarily of pine and palmetto flatwoods. The thick, vegetative understory, combined with the relative flatness of upper site areas, tends to retard surface runoff with the result that soils throughout the site area remain saturated at or near ground surface for extended periods. At present, cooling tower blowdown from the Unit 1 cooling tower is discharged to Turkey Creek by means of drainage ditches which convey this flow through

on-site swampy areas; blowdown leaves the site via box culverts located beneath U.S. 441 at the west site boundary. This flow averages approximately 0.8 cfs (500,000 gpd).

Design of Unit 2 site and drainage system improvements has not been finalized to the point where precise calculations are possible to predict hydrological changes which may occur either on-site or to off-site receiving streams due to site development. However, qualitative hydrological changes may be discussed as follows:

a. Rail Spur and Roadway - Figure 4.1-2 illustrates the location of the proposed on-site rail spur and adjacent roadway. Figure 4.1-3 presents a cross-section of roadbed construction. Both roadbeds will be constructed on raised embankments using fill materials excavated on-site. A raised embankment, 200 feet in width, will be required for the rail spur and roadway between the west site boundary and the west end of the on-site railroad loop. Surface drainage from areas to the north of this corridor will be intercepted and concentrated in stormwater culverts directing flows to the 28 acre on-site swamp. Such interception and concentration of flows may result in increased effective peak surface runoff rates for the flow coming from that portion of the site. In addition, the swales should act to depress the surface groundwater table in the area of the corridor during times of high groundwater level.

b. Roofing and Paving - As Figure 4.1-1 indicates, impermeable surfaces such as driveways, road paving and building roofs, will increase with the construction of Unit 2. The increased runoff volume and peak runoff rate should be expected to increase slightly from the presently cleared portion of the site due to such construction.

c. Unit 1 Cooling Tower Blowdown - It is anticipated that such removal of this blowdown (500,000 gpd) will result in Turkey Creek having no continuous base flow during low rainfall seasons. The removal of such flow from the Turkey Creek system may result in decreased stream erosion, and decreased total annual bedload transport.

The cumulative effect of the above mentioned modifications to the site area cannot be precisely quantified. However, examination of each of the modifications presented above seems to imply that the only major hydrological impact resulting from the operation will be the removal of continuous cooling tower blowdown baseflow from the Turkey Creek system.

5.5.1 Ecological Effects of Stormwater Runoff

Stormwater runoff from external plant areas will be dispersed into the natural site drainage through the use of swales and berms to allow spreading and downward percolation (Section 3.7). This, in conjunction with the flat topography of the site, should minimize potential contamination of Turkey Creek by accumulated surface materials. No significant impact to aquatic systems either on or off site is anticipated.

5.6 Effects of Air Pollutant Emissions

The impact of emitted particulate matter, SO_2 and fugitive dust from coal handling and storage from Unit 2 were evaluated by air quality modeling. The AQDM was used for the long-term impact evaluation and the PTMTPW for the short-term evaluation. These models and the criteria for their use have been discussed in Section 2.8.

Emissions from all existing and proposed sources were projected to the years 1981, 1985, and 1989 and the impacts evaluated.

5.6.1 Total Suspended Particulate Matter

The annual average twenty-four hour average TSP impact of Deerhaven Unit 2 and of existing sources in the Gainesville area were determined for the years 1981, 1985 and 1989. Figure 5.6-1 lists the figures in which these impacts are geographically summarized. The impact data are summarized in Table 5.6-2. Figures 5.6-4 and 5.6-5 present these impacts as they relate to the ambient standards.

To summarize, the annual TSP levels in the Gainesville area will decrease slightly from those existing during the baseline period and the twenty-four hour levels will increase slightly. During the baseline period the maximum annual average TSP level in the Gainesville area was 32 $\mu g/m^3$. During the years 1981, 1985 and 1989 this level will drop to 31 $\mu g/m^3$, excluding fugitive dust. The maximum impact of Deerhaven Unit 2 on annual TSP levels is less than 1 $\mu g/m^3$.

Table 5.6-1 Conditions Simulated with Air Quality Models to Establish Impact of Deerhaven Unit 2 and Existing Sources on TSP Levels Gainesville, Florida

Conditions	Model	Figure
1981 - Projected 1981 emissions from all proposed and existing sources		
24-hour	PTMTPW	5.6-1
Annual	AQDM, w/Briggs	5.6-1
1985 - Projected 1985 emissions from all proposed and existing sources		
24-hour	PTMTPW	5.6-2
Annual	AQDM, w/Briggs	5.6-2
1989 - Projected 1989 emissions from all proposed and existing sources		
24-hour	PTMTPW	5.6-3
Annual	AQDM, w/Briggs	5.6-3

24-hour meteorological data - day 096/1964 Jacksonville, Florida

Annual meteorological data - 1970-74 summary Jacksonville, Florida

Table 5.6-2 Summary of TSP Impact Evaluation for 1981, 1985 and 1989 - Gainesville, Florida

	Annual*($\mu g/m^3$)				24-Hour ($\mu g/m^3$)**			
Period	Maximum	Baseline (1972/73)	Maximum Incremental Impact	Maximum Deerhaven Unit 2 Impact	Maximum	Baseline (1972/73)	Maximum Incremental Impact	Maximum Deerhaven Unit 2 Impact
1981	31	32	-1	1	64	62	2	2
1985	31	32	-1	1	64	62	2	2
1989	31	32	-1	1	63	62	2	2
Standard								
Air Quality	60	60			150	150		
PSD*** Increments			19	19			37	37

*Includes background of 29 $\mu g/m^3$
**Includes background of 60 $\mu g/m^3$; 24-hour impact reported for Deerhaven site area
***Prevention of Significant Deterioration increments permitted by the 1977 Clean Air Act amendments for Class II area

The maximum twenty-four hour TSP level for the baseline and other periods was predicted for an area 8.5 km (5.3 miles) northwest of the Deerhaven site. This occurs with the wind blowing from Gainesville toward Deerhaven, with the point of maximum concentration occurring downwind of the Deerhaven site. The maximum concentration occurring during the baseline period was 62 $\mu g/m^3$ (including 60 $\mu g/m^3$ background).

The maximum concentration occurring during the year 1981, 1985 and 1989 will be 64 $\mu g/m^3$. The impact of Deerhaven Unit 2 is 2 $\mu g/m^3$. For both time periods the incremental impacts are much less than permitted by the 1977 Clean Air Act Amendments.

Another source of particulate matter resulting from the operation of Unit 2 is the coal handling and storage. This will be a fugitive source, resulting from handling approximately 10,500 tons per week of coal. By using EPA emission factors (U.S. EPA, 1976) and assuming adequate control measures on site (such as watering and paving) a particulate matter emission rate of 700 pounds per week or about 4 pounds per hour has been determined.

Because of the diffuse area of this source (approximately 2 acres), the distance to the site boundary (approximately 1 kilometer) and the magnitude of the emission rate, the twenty-four hour and annual average impact on TSP levels at the site boundary will be less than 1 $\mu g/m^3$.

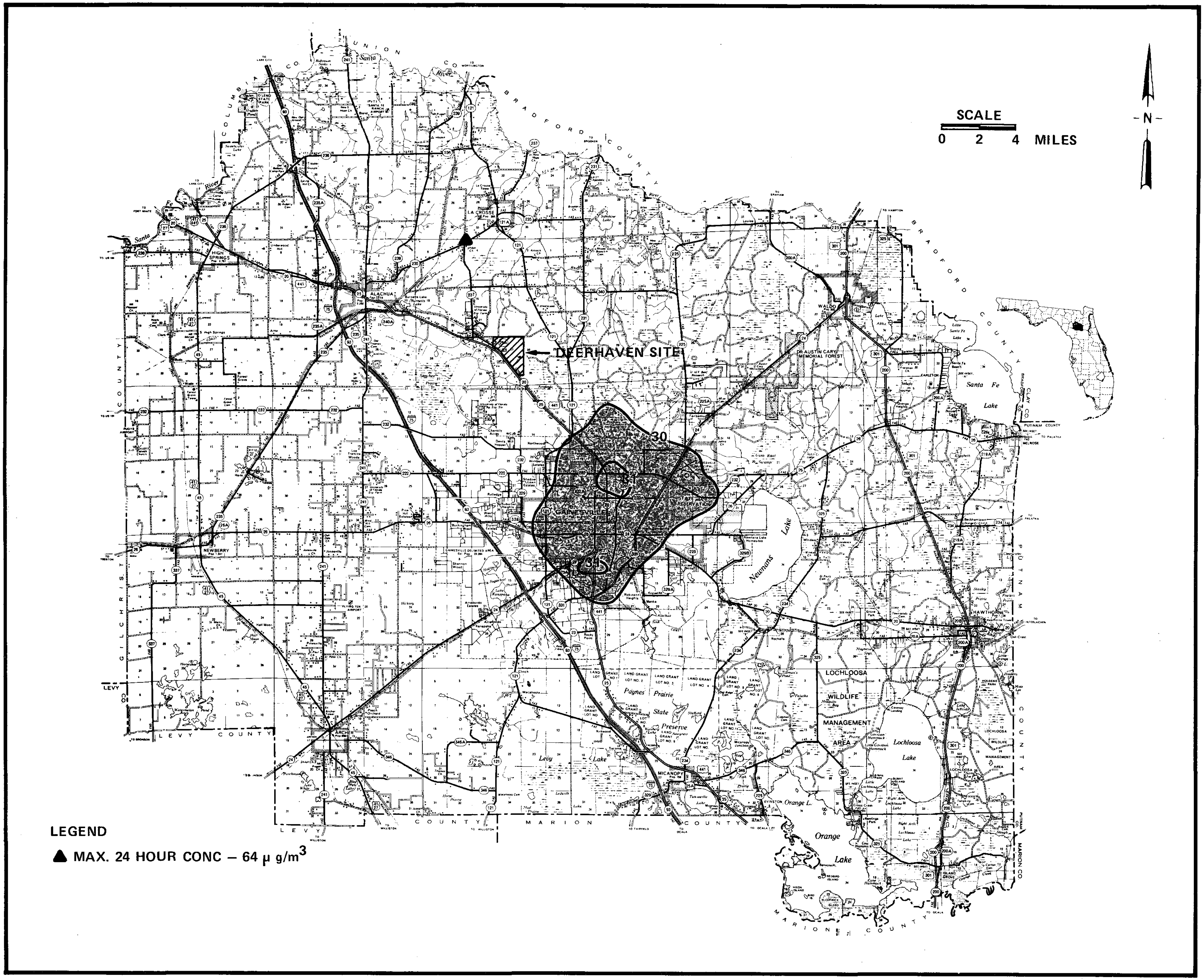

FIGURE 5.6-1 ANNUAL AVERAGE AND 24 HOUR AVERAGE 1981 TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATION, ALACHUA COUNTY, FLORIDA.

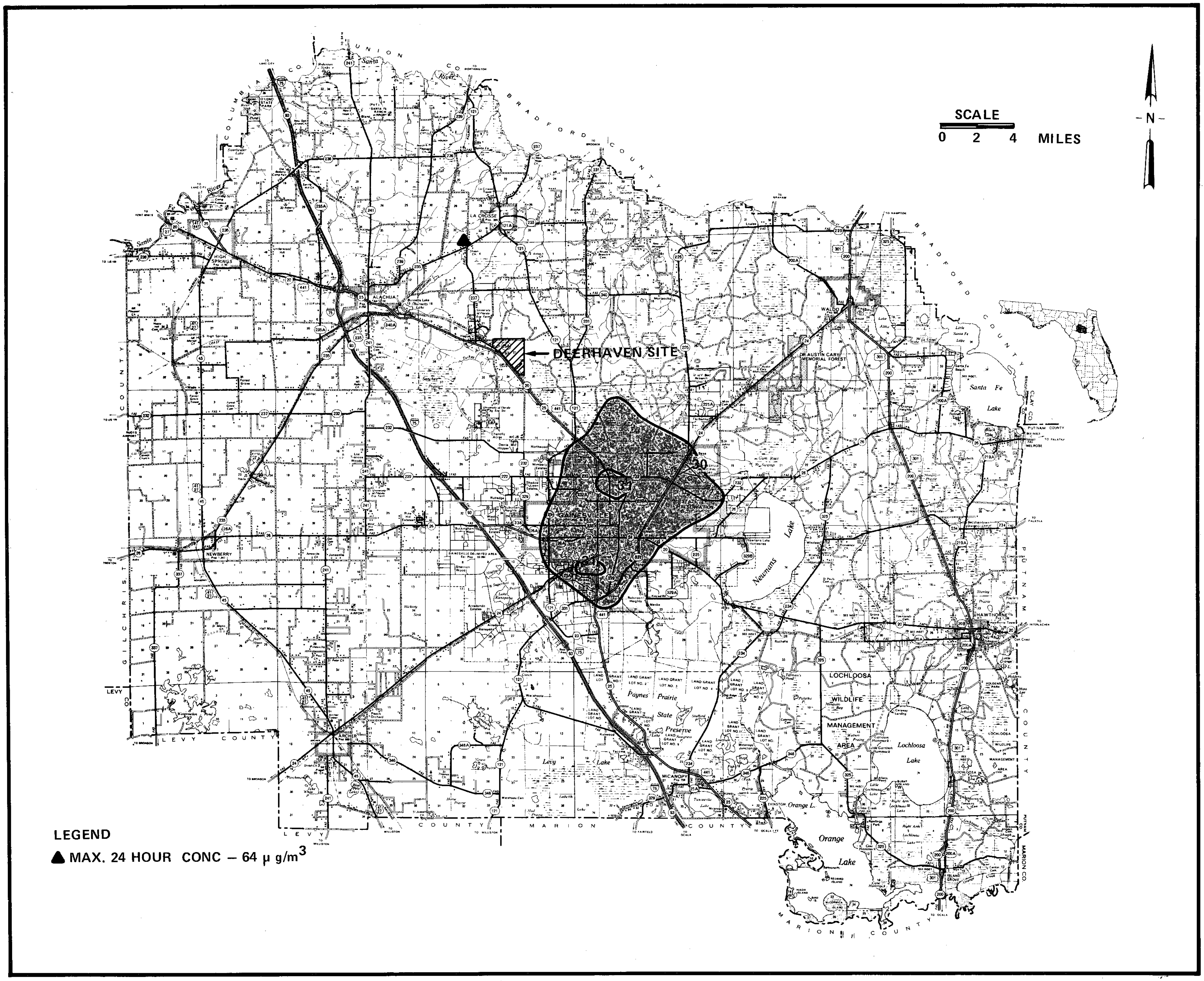

FIGURE 5.6-2 ANNUAL AVERAGE AND 24 HOUR AVERAGE 1985 TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATION, ALACHUA COUNTY, FLORIDA.

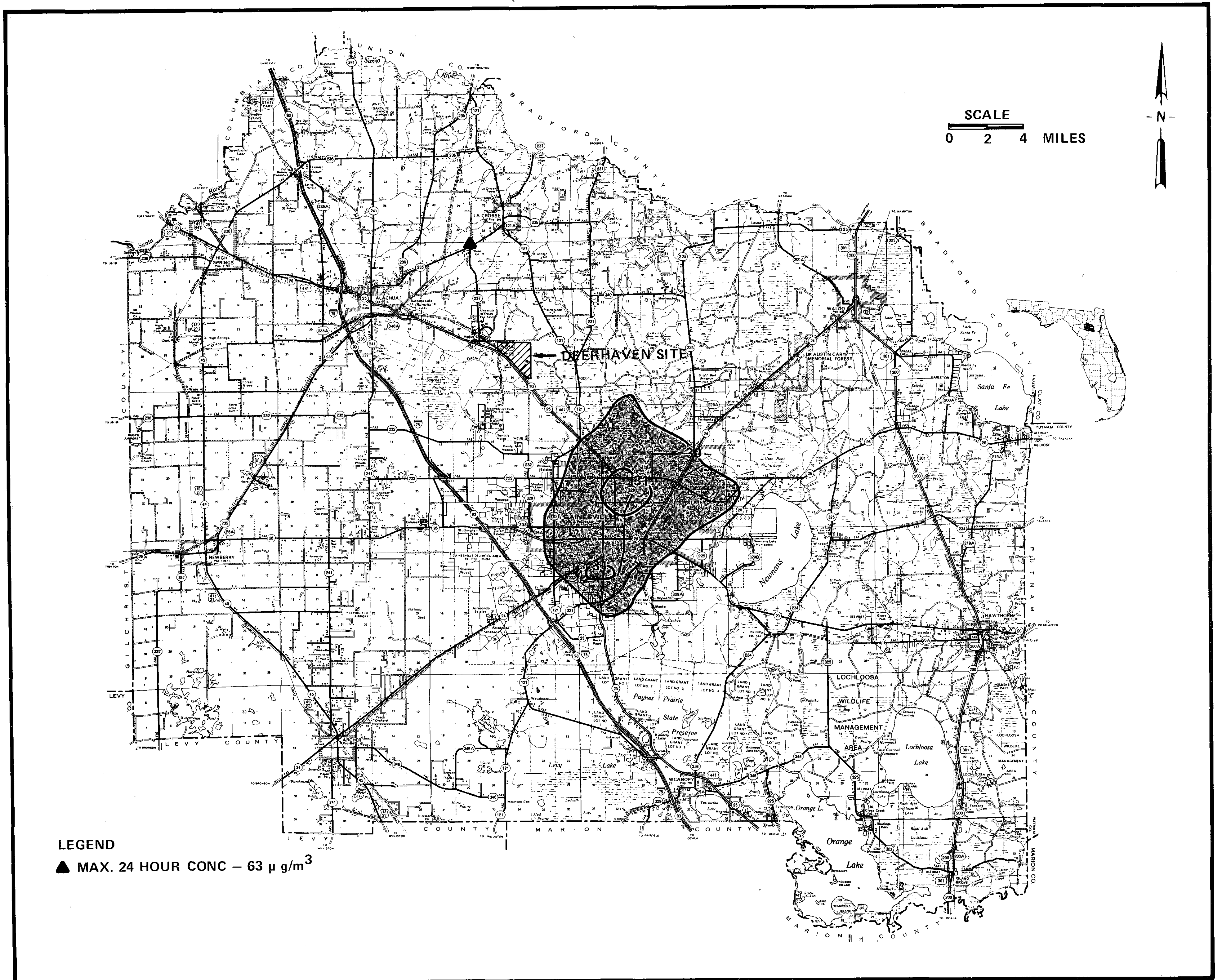

FIGURE 5.6-3 ANNUAL AVERAGE AND 24 HOUR AVERAGE 1989 TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATION, ALACHUA COUNTY, FLORIDA.

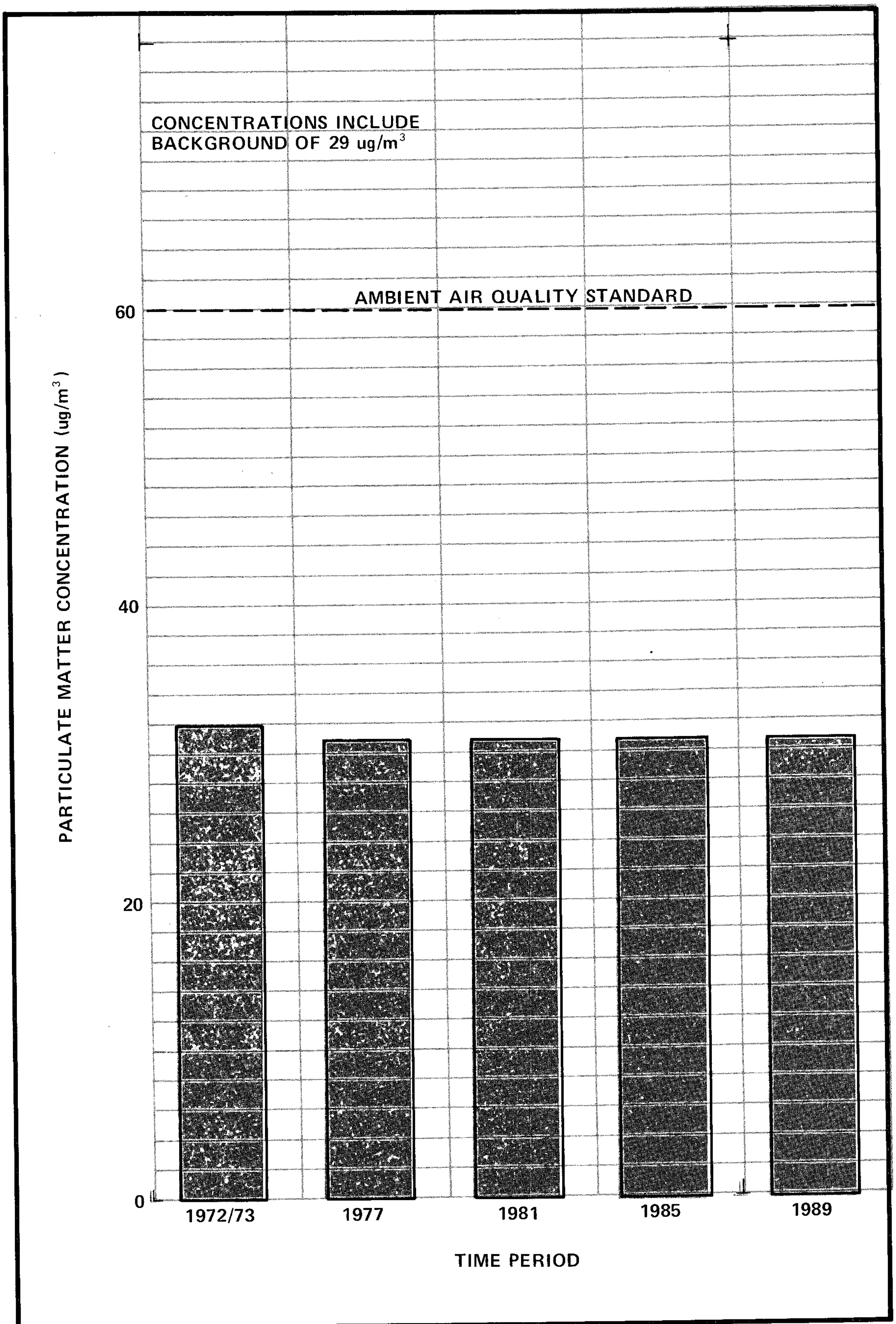

FIGURE 5.6-4 MAXIMUM ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATION, 1972/73 TO 1989, ALACHUA COUNTY, FLORIDA.

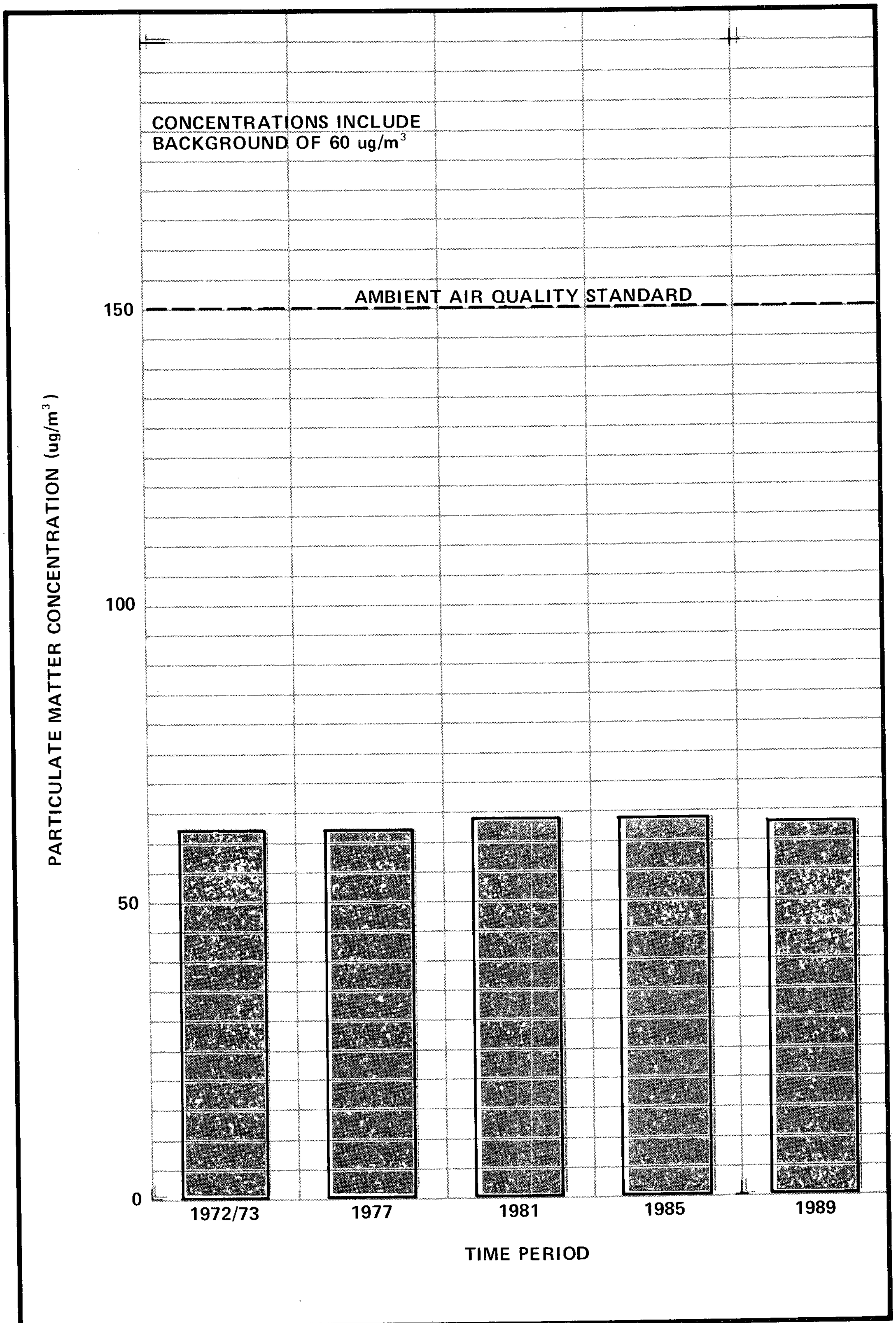

FIGURE 5.6-5 MAXIMUM 24 HOUR TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATION, 1972/73 TO 1989, ALACHUA COUNTY, FLORIDA.

5.6.2 Sulfur Dioxide

The annual average, twenty-four hour average, and three hour average SO_2 levels were determined for the years 1981, 1985 and 1989. These data are presented geographically in Figures 5.6-4 to 5.6-6 (as described in Table 5.6-3) and summarized in Table 5.6-4.

During the baseline period the maximum annual average SO_2 concentration in the Gainesville area was 4 $\mu g/m^3$. During the periods 1981, 1985 and 1989, this level will drop to 2 $\mu g/m^3$. Annual average SO_2 levels increase from zero to 1 $\mu g/m^3$ northwest of Gainesville and the Deerhaven site.

The maximum twenty-four hour SO_2 level for the baseline period was 73 $\mu g/m^3$ at a point 8.5 kilometers (5.3 miles) northwest of the Deerhaven site. In 1981 and 1985 this level will increase to 82 $\mu g/m^3$ and then drop to 76 $\mu g/m^3$ in 1989. The maximum incremental impact is 9 $\mu g/m^3$, compared with an allowable incremental increase of 91 $\mu g/m^3$ (U.S. EPA, 1976). The maximum twenty-four hour impact of Deerhaven Unit 2 is 19 $\mu g/m^3$.

The maximum three hour SO_2 level for the baseline period was 241 $\mu g/m^3$ at a point 1.1 kilometers (.6 mile) northwest of the Deerhaven site. For the periods 1981, 1985 and 1989, the maximum three hour SO_2 levels are 265, 265 and 241 $\mu g/m^3$, respectively. The maximum incremental impact is 24 $\mu g/m^3$ compared with an allowable incremental increase of 512 $\mu g/m^3$ (U.S. EPA, 1976). The maximum three hour incremental impact of Deerhaven Unit 2 is 89 $\mu g/m^3$.

Table 5.6-3 Conditions Simulated with Air Quality Models to Establish Impact of Deerhaven Unit 2 and Existing Sources on SO_2 Levels - Gainesville, Florida

Conditions	Model	Figure
1981 - Projected 1981 SO_2 emissions from all proposed and existing sources		
3-hour	PTMTPW	5.5-4
24-hour	PTMTPW	5.6-4
Annual	AQDM, w/Briggs	5.6-4
1985 - Projected 1985 SO_2 emissions from all proposed and existing sources		
3-hour	PTMTPW	5.6-5
24-hour	PTMTPW	5.6-5
Annual	AQDM, w/Briggs	5.6-5
1989 - Projected 1989 SO_2 emissions from all proposed and existing sources		
3-hour	PTMTPW	5.6-6
24-hour	PTMTPW	5.6-6
Annual	AQDM, w/Briggs	5.6-6

24-hour meteorological data - day 096/1964 — Jacksonville, Florida

Annual meteorological data - 1970-74 summary — Jacksonville, Florida

Table 5.6-4 Summary of SO_2 Impact Evaluation for 1981, 1985, and 1989 - Gainesville, Florida

	Annual (μg/m³)				24-Hour (μg/m³)				3-Hour (μg/m³)			
Period	Maximum	Baseline (1972/73)	Maximum Incremental Impact	Maximum Deerhaven Unit 2 Impact	Maximum	Baseline (1972/73)	Maximum Incremental Impact	Maximum Deerhaven Unit 2 Impact	Maximum	Baseline (1972/73)	Maximum Incremental Impact	Maximum Deerhaven Unit 2 Impact
1981	2	4	1	1	82	73	9	19	265	241	24	89
1985	2	4	1	1	82	73	9	19	265	241	24	89
1989	2	4	1	1	76	73	3	19	262	241	21	89
Standard												
Air Quality	60	60			260	260			1300	1300		
PSD* Increments			20	20			91	91			512	512

*Prevention of Significant Deterioration Increments Permitted by the 1977 Clean Air Act Amendments for Class II Area

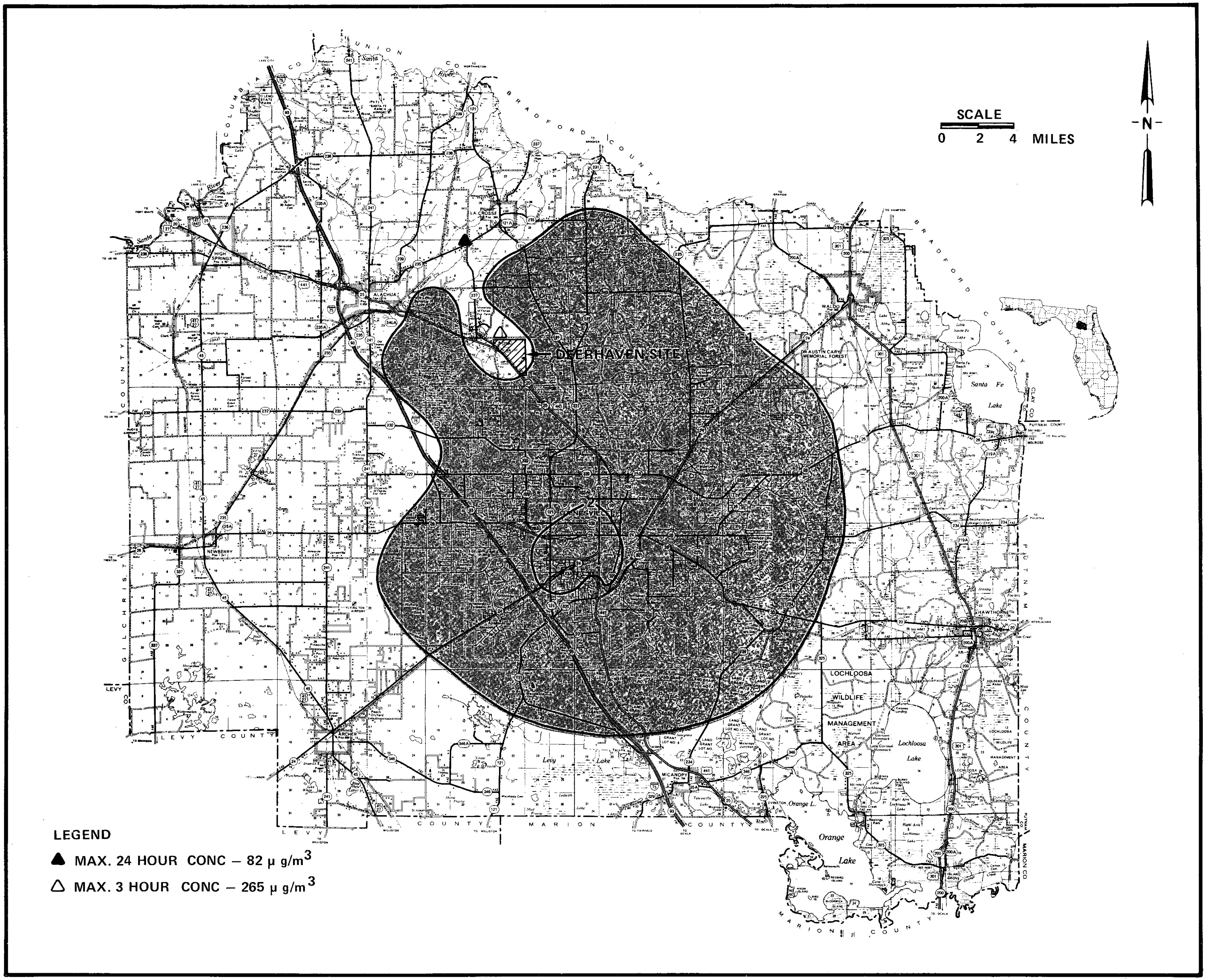

FIGURE 5.6-6 ANNUAL 24 HOUR AND 3 HOUR 1981 SULFUR DIOXIDE CONCENTRATION, ALACHUA COUNTY, FLORIDA.

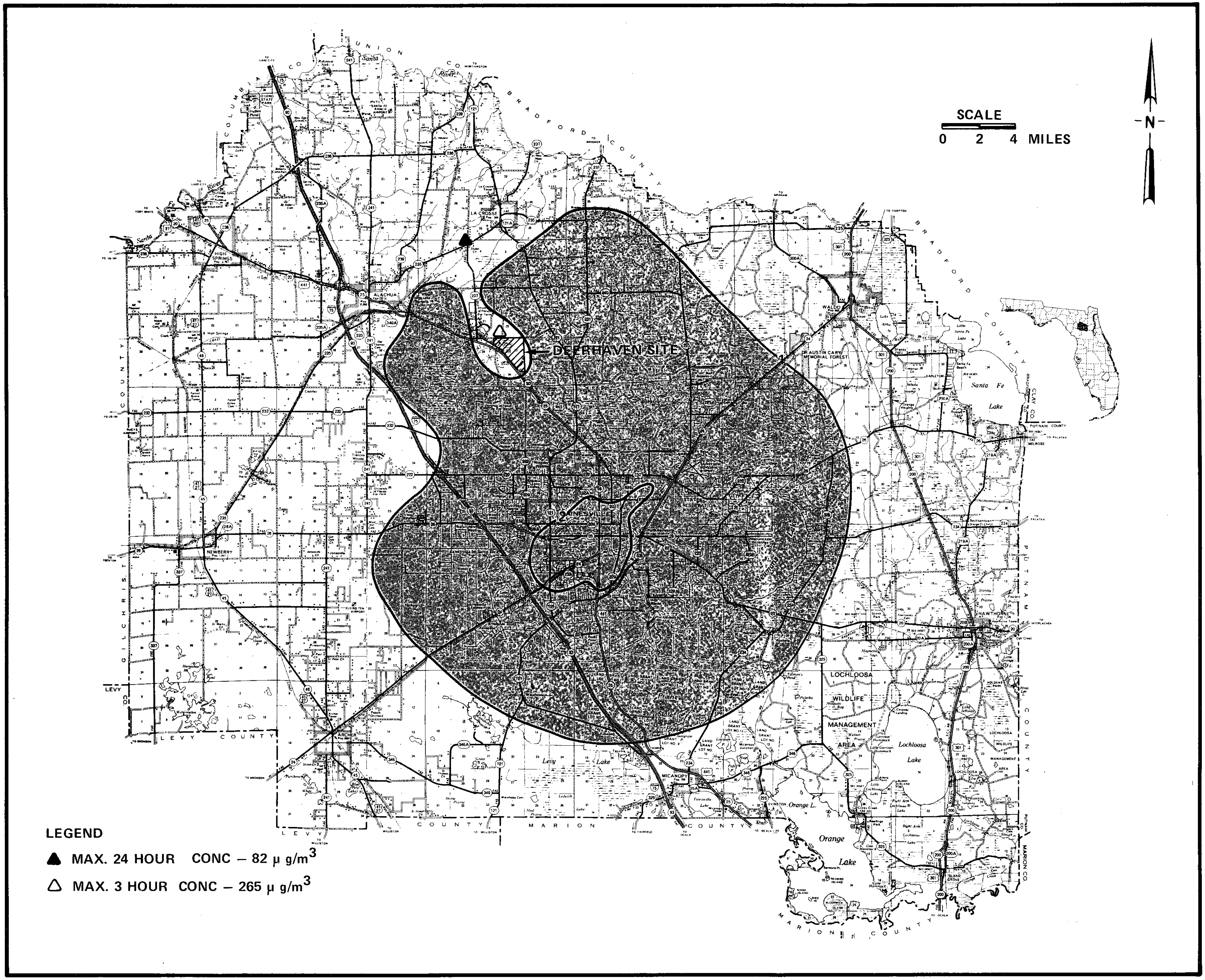

FIGURE 5.6-7 ANNUAL 24 HOUR AND 3 HOUR 1985 SULFUR DIOXIDE CONCENTRATION, ALACHUA COUNTY, FLORIDA.

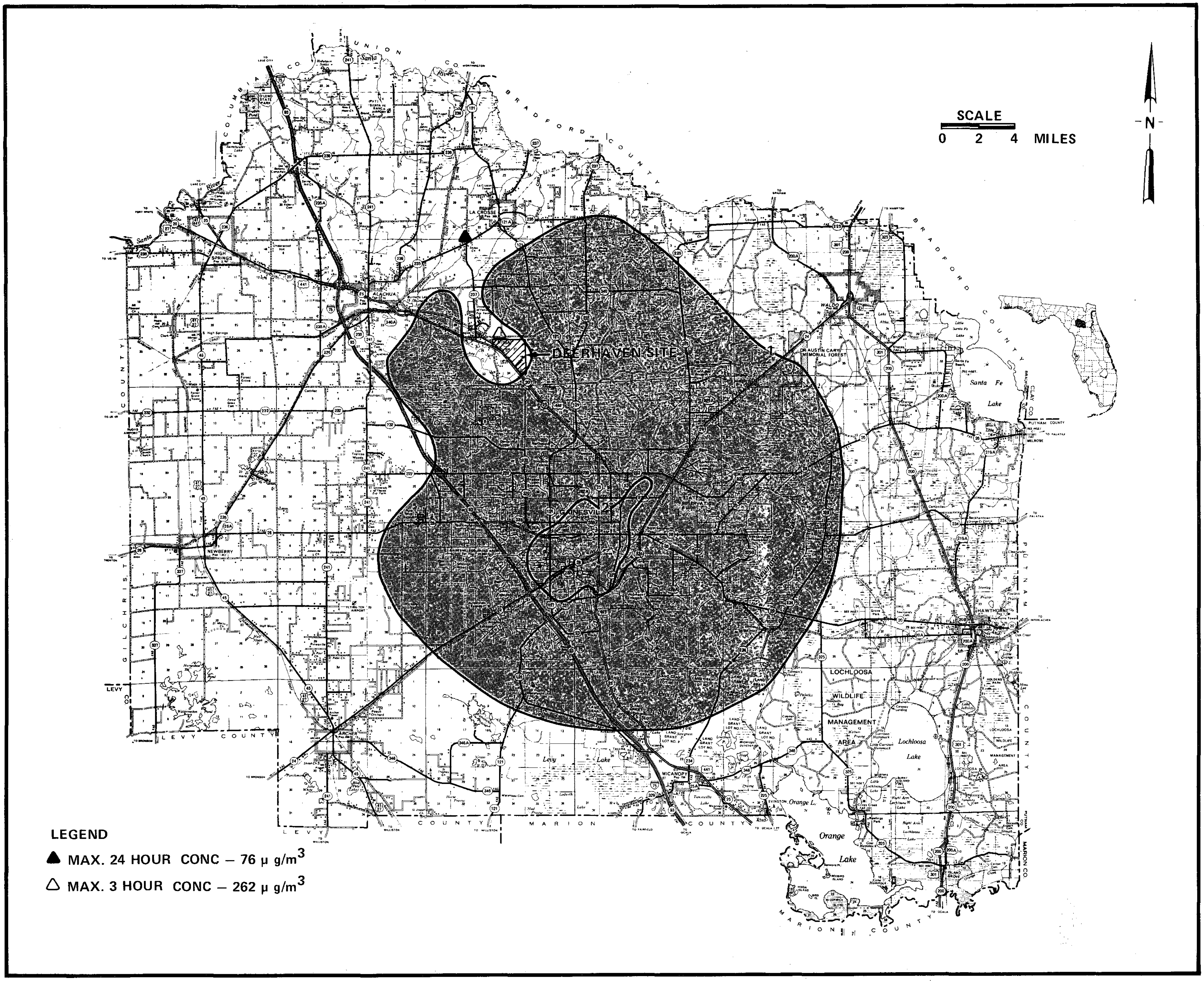

FIGURE 5.6-8 ANNUAL, 24 HOUR AND 3 HOUR 1989 SULFUR DIOXIDE CONCENTRATION, ALACHUA COUNTY, FLORIDA.

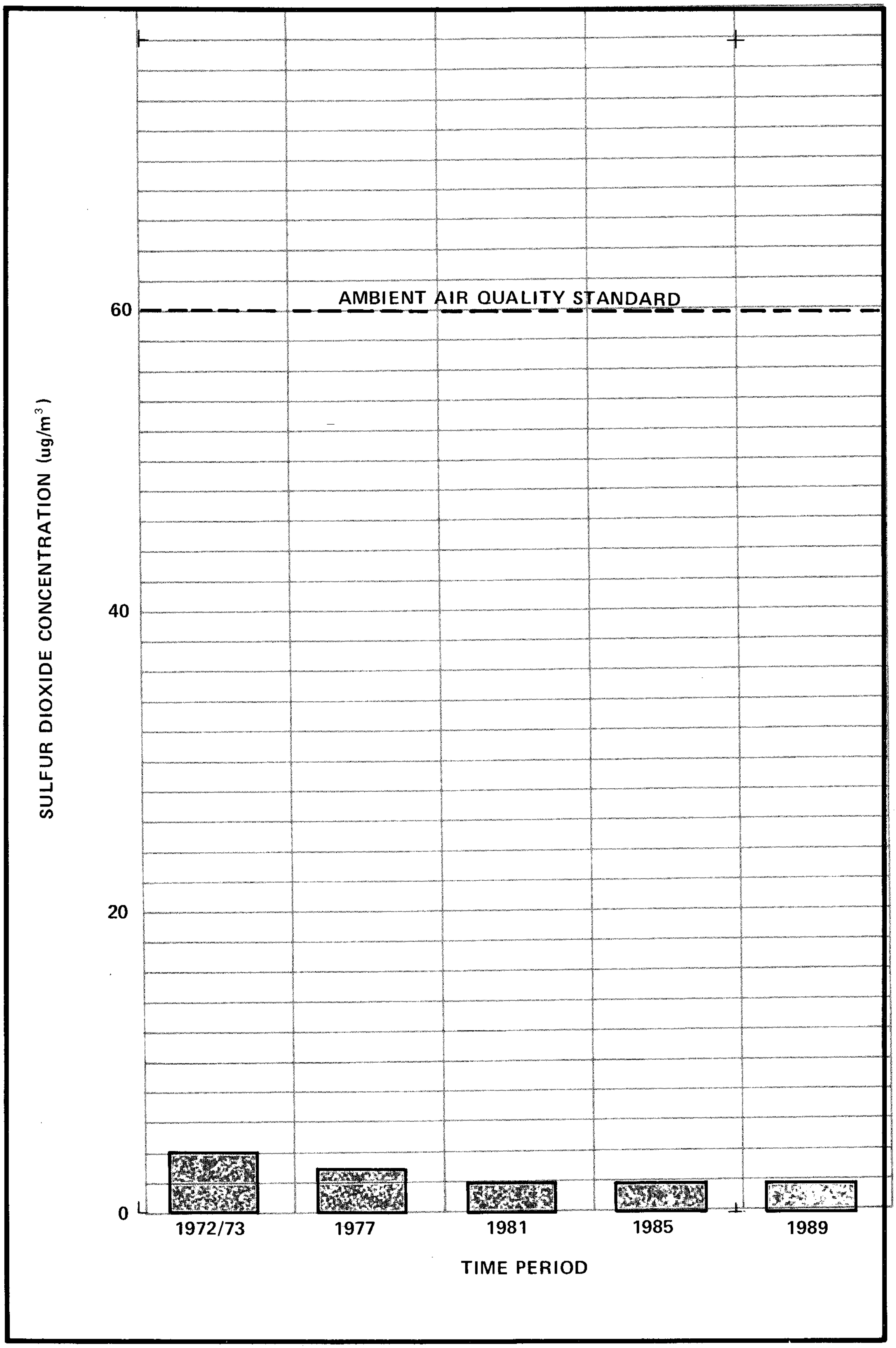

FIGURE 5.6-9 MAXIMUM ANNUAL AVERAGE SULFUR DIOXIDE CONCENTRATION, 1972/73 TO 1989, ALACHUA COUNTY, FLORIDA.

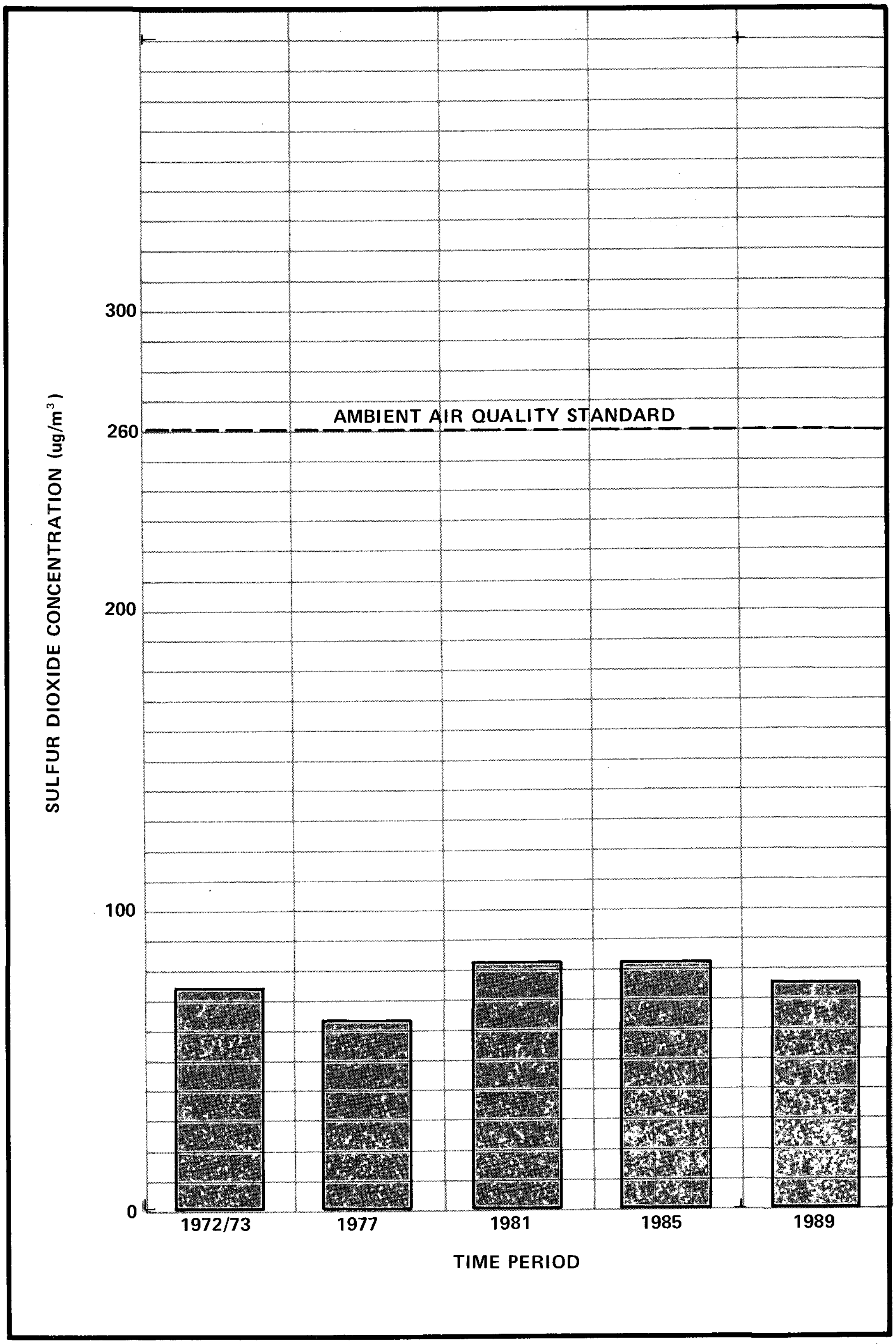

FIGURE 5.6-10 MAXIMUM 24 HOUR SULFUR DIOXIDE CONCENTRATION, 1972/73 TO 1989, ALACHUA COUNTY, FLORIDA.

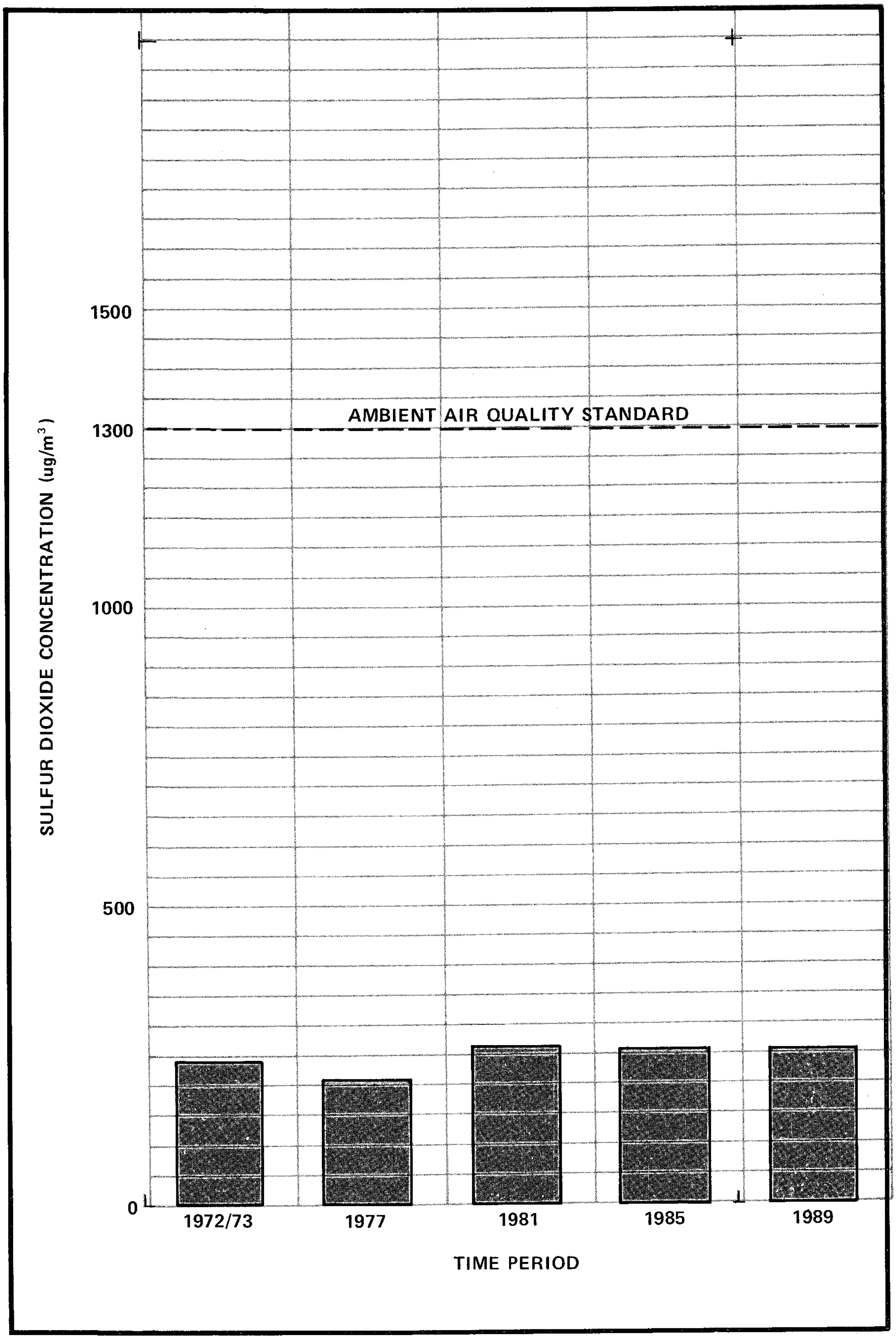

FIGURE 5.6-11 MAXIMUM 3 HOUR SULFUR DIOXIDE CONCENTRATION, 1972/73 TO 1989, ALACHUA COUNTY, FLORIDA.

5.6.3 Other Criteria Pollutant

The only other criteria pollutant that will be emitted from the proposed Deerhaven Unit 2 in significant quantities is NO_x. NO_x will be emitted at an annual average rate of 12.6 tons per day and a maximum rate of 20.2 tons per day. This will result in an annual average impact of less than 1 $\mu g/m^3$ and a maximum twenty-four hour impact of 12 $\mu g/m^3$.

5.6.4 Ecological Effects of Air Emissions

The only substance in the air emission inventory of potential concern to the surronding biota is sulfur dioxide. Vegetation injury from sulfur dioxide is dependent on the sensitivity and physiological condition of the plant and the duration and concentration of the exposure. Thresholds for acute injury are approximately 0.25-0.30 ppm and for chronic injury about 0.05 ppm on a seasonal or yearly average (Mukammal, 1976). Linzon (1973) concludes that there is a risk of sulfur dioxide damage to forests and lichen when the following concentrations persist: 0.02 ppm averaged over a year, 0.35 ppm averaged over four hours, and 0.55 ppm averaged over two hours.

Predicted ground level sulfur dioxide concentrations for the site and surrounding vicinity are provided in Section 5.6.2. Since the predicted maxima are below the Federal and state standards and the injury thresholds mentioned above and elsewhere in the literature, no impact to surrounding biotic environments is expected.

5.7 Effects of Directly Associated Facilities

Directly associated facilities include the new railroad spur and the coal handling and ash disposal facilities (Figure 3.1-2). Potential impacts associated with their operation on the surrounding areas include possible leachate contamination and wind-blown ash, and disturbance of wildlife due to operational noise.

A buildup of ash in the environment could affect local vegetation either through direct deposition on exposed foliage or through alteration of soil characteristics. Such effects are not anticipated, however, since the ash will be moistened prior to transport to the disposal site and the landfill cells will be covered with soil as soon as possible following disposal.

The sources, spectra and levels of noise emission for electric power generating facilities are well established (Noise Control Engineering, 1976). The relative size of the Deerhaven Unit 2 (235 mW) will increase operating noise levels very little above present Unit 1 levels. Delivery, unloading and handling of coal is expected to be the only significant source of permanent noise level increase on or near the site. It is anticipated that coal delivery will be made by a 70 car unit-train every 5 days. The unloading facility is to be located within approximately 1,000 feet of the east boundary of the site. Coal handling facilities are to be located more distant from the site boundary. Because of noise level attenuation with distance from the source plus additional attenuation with existing ground cover, noise abatement procedures will not be necessary.

The addition of Unit 2 could possibly increase average noise levels on the east boundary of the site by 3 to 5 dBA. Property adjacent to this boundary of the site is presently in agricultural use. Although residential development of this property is highly unlikely, the area would not be unsuitable for residences on the basis of noise considerations.

High levels of operational noise can affect local wildlife by causing a relocation of sensitive species into areas further removed from the source. Competition stress in the newly settled areas could result in net animal losses unless acclimation to the level of noise allows an eventual resettlement of the affected area. Based on the operational noise levels outlined previously, wildlife acclimation to the local noise levels should occur. No permanent displacement or loss of animals from adjacent habitats is expected.

5.8 Resources Committed

5.8.1 Ecological Resources

Ecological resources irreversibly committed to the operation of the proposed facility include:

a. 198 acres of flatwoods (in various stages of succession) and 22 acres of cypress swamp habitats committed to the ash landfill disposal site. The most obvious impact resulting from landfill ash disposal will be the ultimate loss of 220 acres of wildlife habitat. The regional significance of this loss will be minor since the affected

habitats are quite common (Section 2.7) and since no endangered species are known to utilize the site. Existing habitats will be replaced by soil-covered 20 to 25 foot mounds which will be maintained in grasses.

b. Since Unit 1 began operation in 1972, cooling tower blowdown has been discharged into Turkey Creek. During this time, the stream biota and associated wetlands have undergone adjustments to the imposed hydro-period. This is particularly evident in the on-site cypress swamp which initially receives the discharge and has sustained some tree losses and other plant adjustments. As the new unit becomes operational, Unit 1 blowdown will no longer be routed into Turkey Creek, but will be deep well injected along with the Unit 2 operational effluents. As a result, Turkey Creek will no longer have a perennial flow, but will revert to its former intermittent hydro-period. Some biotic adjustments will ensue which, because of the reduced base flow, should include a net reduction of aquatic animal life. Vegetation in affected areas of the on-site swamp will begin a gradual transformation to its original composition.

As discussed in their corresponding sections, these impacts will be permanent, though of relatively minor significance to the region. This

assessment assumes that the final design will effectively eliminate potentially adverse effects associated with leachate contamination of surface water.

5.9 Deep Well Injection

As described in Chapter 3 cooling tower blowdown from both Unit 1 and Unit 2 will be disposed of by means of on-site deep injection wells. At the time of writing this document, a test well program verifying the technical feasibility of this disposal technique is nearing completion. Should injection zone permeabilities be found to be too low to accept all anticipated disposal flows without pumping the flows at unacceptably high pressure, it is anticipated that cooling tower blowdown may be disposed of by any one of the active alternative techniques presented in Chapter 9.

Florida Geologic Survey Bulletin 33, which describes the geology of Citrus and Levy counties, discusses several fault features in the shallower bedrock units, but does not indicate how deeply these faults may extend nor does it directly answer the question of faulting in the region of the RUB site. About all that can be said is that there undoubtedly is faulting and fracturing in the area, as is the case generally in other parts of Florida. However, there is little or no evidence that the faulting and fracturing have provided direct hydraulic interconnections between deeper and shallower beds.

In previous injection well projects in Florida, the significance of faulting and fracturing was addressed by installing a monitoring tube in the shallow fresh water zone above the confining beds, which has been done on the pilot well. All such prior experience indicates that the confining beds have proven to be fully effective in isolating shallow fresh waters from deeper saline waters, and the presumption is that this will also be the case at the Deerhaven site. However, to provide direct proof of whether or not the confining beds are breached, RUB will monitor the zone immediately above the confining beds in the test injection well, by measuring water level changes continuously during the testing. If a permanent facility is installed, similar monitoring will be conducted periodically in the monitor well. This approach should provide a specific answer on whether or not there is hydraulic continuity across the confining beds due to faulting or fracturing.

Although vertical solution channels exist in Florida in some sinkholes, these rarely extend to depths of more than a few hundred feet below the land surface. There are no known instances of vertical solution channels extending to very great depths, except perhaps in the case of some large natural springs in the state.

There is much more evidence of lateral or horizontal solutional activity in the region of the site, reflected by the presence of shallow sinkholes and by openings in the rock formations that have been penetrated during drilling operations. Again, it appears that such solutional openings

are prevalent mostly in the uppermost few hundred feet of materials, and are unlikely to be present in the deeper beds that are being considered as the potential injection zone. The deepest solutional activity may be in the upper Oldsmar Limestone and perhaps in the overlying Lake City, Avon Park, and Ocala formations.

Geologic conditions in the region of the site are believed to be somewhat complex, owing to disturbances associated with the Ocala Uplift. Some old faults mapped for this area are considered to be inactive, and it is believed that they are not conduits of water but instead are hairline cracks that probably contain gouge or relatively impermeable materials created by the shearing action along the walls of the faults. Natural fracturing is also believed to be present and will be identified to the degree possible on geophysical logs to be taken in the test well.

Based upon favorable results from the pilot well program, RUB proposes to inject cooling tower blowdown, reverse osmosis waste, demineralizer regeneration waste, and blowdown from the active bottom ash ponds which consists of ash sluicing water, landfill active-face runoff and coal-pile runoff. Table 5.9-1 presents the estimated flows and chemical constituents for each of these streams. The chemical constituents of cooling tower blowdown are based on laboratory analyses of cooling tower blowdown from the existing cooling tower and on the anticipated number of cooling tower concentrations of groundwater makeup for Unit 1 and Unit 2 facilities. Chemical concentrations of the ash handling wastes

Table 5.9-1 Estimated Chemical Characteristics of Injected Effluents

	Cooling Water[1]	Ash Handling Waste[2]	Reverse Osmosis Waste[3]	Demineralizer Waste
Flow (mgd)[4]	0.72 (1.92)	0.15 (0.22)	0.01 (.02)	0.01 (.02)
pH	7.0	5 - 10	6.5 - 7.0	6 - 9
Temperature	---	Ambient	Ambient	Ambient
TDS (mg/l)	3,612	3,000 - 5,000		20,000 mg/l
SO_4 (mg/l)	2,000	1,500 - 2,500		
$NaSO_4$ (mg/l)	---	---	---	15,000 mg/l
K (mg/l)	6	100 - 200		
Cl (mg/l)	60	5 - 50		
SO_4 (mg/l)	2,000	1,500 - 2,500		
Si (mg/l)	185	4 - 60		
B		4 - 20		
As		.01 - 2		
Zn		.01 - 1.5		
Ba		0.3 - 1.4		
Al		0 - 0.6		
Cr		0 - .12		
Ni		.10 - .50		
Fe		.05 - .25		
Cu		.05 - .10		
Se		.03 - .10		
Mn		.01 - .50		

[1]Heavy metal concentrations will be six times greater than concentrations of the local groundwater.

[2]Values of concentration are approximations based on information as supplied by MR. T.Y.J. Chu of TVA. The information as supplied is data from fly ash sluicing trench tests. The concentrations of chemical constituents for bottom ash sluicing should be less than those tabulated. No published information is available to substantiate any other values; the chemical composition of the water in the proposed system is not precisely known because the character of the coal and its products in the system are not known.

[3]Chemical constituent concentrations will be approximately eight to nine times the concentrations in the City of Gainesville's treated water supply.

[4]Flows presented are monthly averages. Flows in parentheses are anticipated monthly maximum.

are estimates only. At present the source of coal, ash fusion temperature, quality of ash sluice water, and performance of the ash settling pond are unknown. Reverse osmosis waste and demineralizer waste concentrations are based on known performance of existing units.

Figure 5.9-1 presents a schematic diagram of the test/monitoring well presently being drilled at the site. As indicated, the casings are pressure cemented to a depth of 2,000 feet to isolate the test injection fluid from upper geological zones. It is anticipated that two permanent injection wells will be installed at the site, cased through fresh water and into the deep injection zone. Preliminary indications are that this zone contains saline water with total dissolved solids concentration in excess of 17,000 mg/l. The on-site locations of these wells have not yet been identified.

The potential injection zone is presently anticipated to occur at depths from 2,500 to 3,300 feet below land surface, and thus is approximately 800 feet thick. In all likelihood, only some of the layers within this depth interval will prove to have an acceptable permeability, so that the true thickness of the receiving zone will not be known until the drilling and testing has been concluded. However, as mentioned above preliminary information from the pilot program indicates that the confining layers overlying the injection zone will be approximately 800 feet thick.

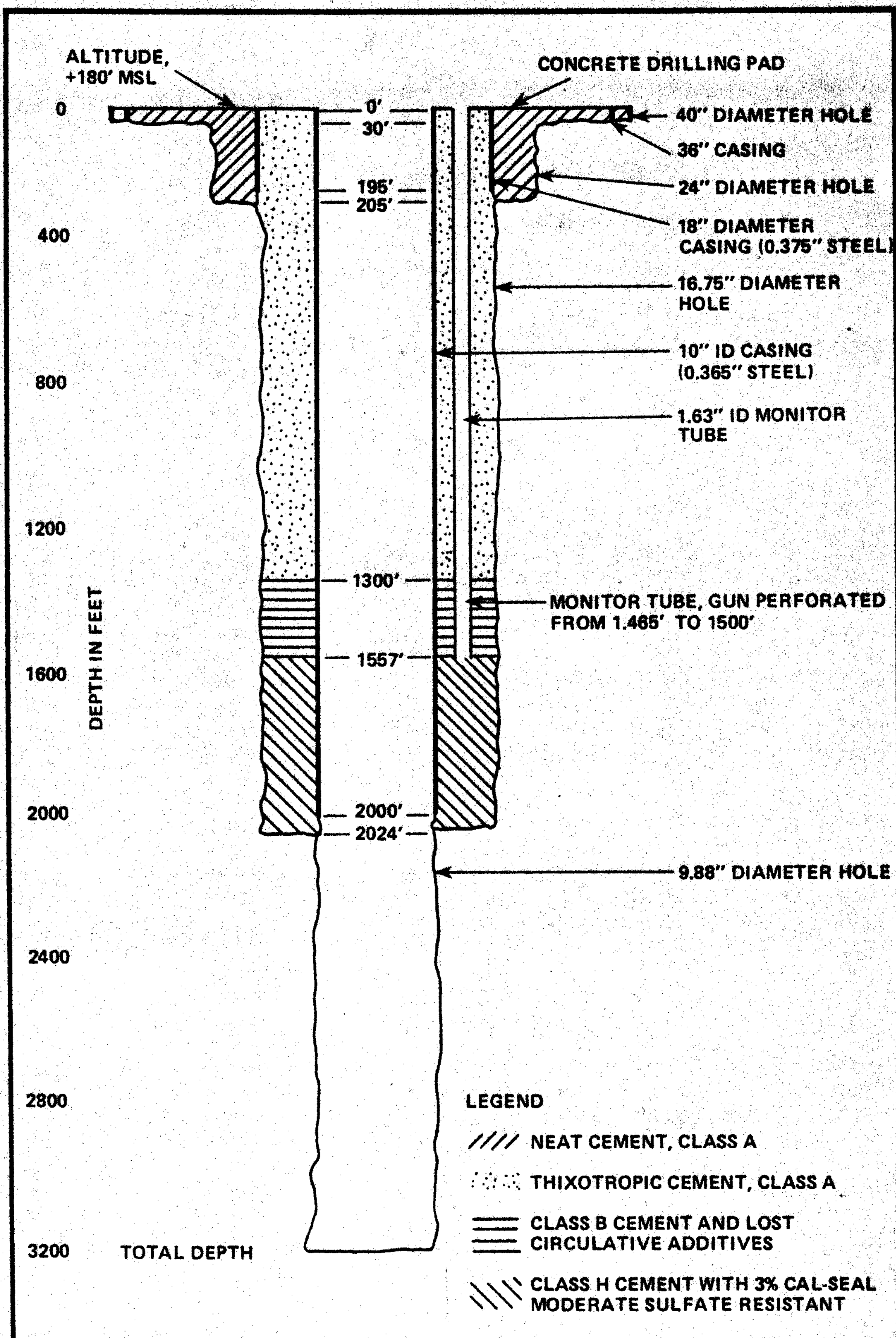

FIGURE 5.9-1 CONSTRUCTION DIAGRAM OF TEST – INJECTION WELL.

To date, the results of the water quality analysis indicates that the base of potable water is approximately 1,000 feet below ground surface. Although the water below this depth is not potable, it appears to remain fresh (less than 1,000 mg/l total dissolved solids), to approximately 1,520 feet. At 1,520 feet, sulfate concentrations are significantly higher, which correlates closely with the appearance of sulfate minerals in the cuttings at 1,540 feet. Sulfate concentrations in water samples collected to a depth of 2,024 feet are high and increase significantly wherever evaporite (gypsum and anhydrite) beds were penetrated.

A preliminary evaluation of the drill cutting samples and geophysical borehole logs indicate that potential confining units occur from 1,550 feet to approximately 2,500 feet in the Cedar Keys formation, Lawson Limestone, and Taylor Beds.

RUB is considering several alternative rates of injection for a final injection well facility, depending on what is learned during the test program with regard to the permeability or injection potential of the deep zones. If the overall permeability proves to be comparatively low, than the long-term injection rate may be as low as 0.2 mgd. However, if the potential for injection is much more favorable, RUB anticipates injecting as much as 1.3 mgd. Over the life expectancy of the plant, which has been set at 35 years, the total volume of injected fluid would be in the range of from 2.6 to 14 billions of gallons, depending on the injection rate. Assuming that the injection zone were to be 1,000 feet

thick and were to have an overall effective porosity of 0.1, and also assuming that the waste fluid were to move radially outward equally in all directions from the injection well, then the theoretical radius of the cylinder of earth materials containing the injected fluid would be from about 1,000 feet to 2,500 feet at the end of the 35 year period, again depending on the injection rate. In actuality, these distances might be different if there is any natural flow pattern in the deep salt water zone or if the permeabilities are not uniform in the immediate area of the well.

The allowable maximum injection pressure in the injection well is 0.5 psi (pounds per square inch) per foot of overburden material, which has been established in order to protect overlying formations against fracturing. The RUB injection well would never be operated at such high pressures, and detailed records of pressures would be maintained at all times, both in the injection well and in the nearby monitoring well, to insure that the pressure limitations are never exceeded.

Prior experience in Florida indicates that no problems of any significance have arisen in injecting essentially water into water, despite the fact that the mineral concentrations in the injected and receiving waters may differ somewhat. The subject of compatibility of fluids is of much concern where radical differences in chemistry exist between the injected fluid and the native fluid. The principal such difference in the case of the RUB project is with respect to acidity, because the injected

water has a pH of about 6.8. This pH level probably would cause some small degree of solutional activity in the zone penetrated by the injected waste water, but it is not believed that this would be of major consequence. In several other locations in Florida, for example, wastes of a very acidic nature are being successfully placed into injection wells without any apparent adverse consequences. Some of the reported problems in connection with wells injecting acid materials have been entirely due to the constructional characteristics of the wells themselves, rather than to the movement of the acidic fluid into the earth.

Some temperature anomalies have been encountered in the drilling and testing of injection wells in southeastern Florida, where the so-called "Boulder Zone" is used as the injection interval. There, the deeper waters are somewhat colder than would have been anticipated from an evaluation of normal geothermal gradients. At the Deerhaven site, it is likely that the temperature of the water in the injection zone will be on the order of 100° F, which more or less reflects the geothermal gradient measured at an injection well site in Orlando, where very detailed information was obtained during testing. At that site, the temperature of the native groundwater at a depth of 6,000 feet was roughly 130° F.

If any osmotic change were to take place during long-term injection, it most likely would be a very small migration of dissolved minerals from the native salty water or brine into the advancing front of the injected

process water. Such minor effects, which could really only be estimated through laboratory experiments, have no real bearing on the feasibility of injection of the particular fluid to be discharged at the site. Osmotic determinations are of greater importance in cases where the injected fluid is radically different in composition from the native water, for example, where oils, other hydrocarbons, or highly concentrated waste chemicals are the waste materials entering a water-filled environment.

There are no known mineral resources of value at the site of the proposed injection facility. Moreover, even if some value were to be assigned to the surficial sands or limestone rock deposits, the injection well project would in no way diminish the availability of those resources.

No cumulative long-term negative effects of drilling and/or operating the well on the immediate surficial environment, either with respect to water resources or to any other part of the environment are anticipated. A body of injected fluid will eventually accumulate in the deep injection zone around the open part of the injection well, but this is normal for any injection well facility and will only affect non-potable waters that are hydraulically isolated from the physical and biologic environments at the land surface. More detailed evaluation of impacts will be thoroughly addressed upon the completion of the on-going pilot program. The results and findings will be provided as an addendum.

As part of implementation of Public Law 93-523, the Safe Drinking Water Act, EPA has formulated proposed rules for underground injection of wastes. These rules are presently being reviewed and rewritten by EPA. Proposed regulations issued in August, 1976, included the following major stipulations:

1. All underground drinking water sources of 3,000 mg/l total dissolved solids or less must be protected by a casing cemented to the land surface.

2. Cementing and installation of an injection tube with packers must be performed to insure that no migration of injected fluid above or below the injection zone occurs.

3. Injection pressures must be limited to preclude the possibility of fracturing the confining strata.

4. A comprehensive monitoring program must be instituted to assure that no contamination to underground drinking water sources, or failure of the injection system is occurring.

Injection into receiving zones with dissolved solids concentrations less than 10,000 mg/l will be prohibited if these proposed rules are adopted. The Deerhaven injection wells will comply with the proposed regulations.

CHAP. 6-ENVIRONMENTAL
MEASUREMENTS AND MONITORING

CHAPTER 6

ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

Presented in this chapter are the programs and methods by which baseline data in previous chapters were collected and the projected impacts determined and evaluated. Sample techniques are described as to station location, frequency, methodology, and instrumentation for both collection and analysis. Details on instrument accuracy, sensitivity, and reliability are also provided. For those computer programs utilized details on their source, assumptions, and applicability are provided. Sources of literature used and previous reports prepared are also discussed.

The final section of this chapter provides a detail explanation of the pilot program being undertaken for deep-well injection at the site. Details include a physical description of the well being drilled, drilling techniques and all logging performed during the program.

6.1 Pre-Application Monitoring

6.1.1 Surface Waters

Hydrological

This section summarizes pre-application surface water hydrological monitoring and evaluation programs. These programs and their results are presented in detail in "An Evaluation of Alternatives to the Present Releasing of Deerhaven Generating Station Blowdown to Turkey Creek" (Breedlove and Associates and Jones, Edmunds and Associates, 1977).

Computer Modeling - The hydrological and hydraulic analyses of Cellon Creek, Rocky Creek, and Mulatto Pen Branch were performed using computer models. Computer programs used to implement these analyses were developed by the U.S.D.A. Soil Conservation Service. These programs are used extensively by these agencies because of the high quality, rapidity and overall cost-effectiveness of this method of analysis.

The water surface profile program, entitled WSP-II, calculates water surface elevations for a given waterway under several flow conditions. Output data consist of stage-discharge curves for each cross-section or structure, hydraulic parameters for cross-sections and structures, and water surface elevations corresponding to given discharges.

Modeling of basin hydrology involved a second computer program, TR-20, which generates runoff from a natural or synthesized rainfall using hydrologic characteristics of in situ soils, land use, overland flow times, and natural storage capacities in the system. This program has a distinct advantage in that infiltration is computed and deducted from incident rainfall to give surface runoff. The procedures for developing input parameters are outlined in the National Engineering Handbook as prepared by the U.S.D.A. Soil Conservation Service.

Soil classifications and hydrologic groupings were taken from the U.S.D.A. Soil Map for Alachua County, Florida, and from the U.S.D.A. Soil Conservation Service Special Soil Survey Report, Maps and Interpretations -

Alachua County, Florida. Land uses were taken from available recent aerial photos provided by Alachua County government and the local office of the Soil Conservation Service. Times of concentration, storage, and other relief-dependent factors were developed from actual field survey information and from standard quadrangle maps published by the U.S. Geological Survey.

Flow Measurement - A program of daily flow measurements was conducted during September and October, 1976, in order to supplement base flow data, to provide comparative values for computer data, and to verify assumed channel roughness values.

Flow measurements for Rocky Creek and Cellon Creek were taken at Cross-Sections R003, R006, C003, C004, C008, C009 and at the box culverts where Cellon Creek crosses beneath U.S. 441. Additional flow measurements were attempted in Rocky Creek, however, flow velocities were too low to measure.

Each cross-section was transversely stationed with hubs evenly spaced on 1.0 to 4.0-foot centers, depending on the width of the channel. A staff gage was installed at each section. Stream bed profile elevations and staff gage elevations were precisely leveled to a temporary bench mark for future reference.

Water velocities were measured by means of an Ott propeller meter. The Ott meter is accurate to plus or minus 1% for flows above 0.17 feet/second and is operated so as to provide time-mean-velocity readings over a period of several minutes. A velocity profile was obtained at each traverse station by measuring time-mean-velocities at three depths at each station. Flows between stations were then manually integrated across the stream measurement section to obtain total flow.

Field Investigations and Surveys - For computer modeling purposes, Rocky Creek was divided into 28 channel reaches by a combination of 23 channel cross-sections and five roadway structures (Figure 2.5-5). In addition, several tributaries to Rocky Creek were considered to have sufficient influence upon the analysis that they required limited modeling. Three of these tributaries were broken down into nine channel reaches by six cross-sections and three roadway structures. Profiles for sections R001, R003, R006, R007, R008, R009, R010, R011, R012, R212, R013, R115, R016, and R017 were obtained through field surveys.

The cypress swamps to the north and south of the County road NW18C bridge were considered to be areas where substantial environmental impact could occur and, therefore, received detailed scrutiny. A level traverse was run from a Florida D.O.T. bench mark on SR-121 to the bridge on County Road NW18C to establish a temporary bench mark for this work.

For computer modeling purposes, Cellon Creek was divided into 19 representative reaches containing 16 cross-sections C001, C003, C004, C007, C208, C008, C010, and C012 were established by precise leveling and these profiles were tied to physical features that were identifiable on the Alachua County U.S.G.S. topographical maps. All precisely leveled profiles were calculated to an accuracy of 0.1 feet. Hydraulic structure data for the two farm roads crossing Cellon Creek, which included profiles of the roadway and both the upstream and downstream inverts of all culverts, were also obtained by precise leveling. All information pertaining to the structures located at the Cellon Creek crossing of U.S. 441 was taken from Florida Department of Transportation construction maps. Meander distances, roughness coefficients, and transition stations for section segments were estimated for each channel reach during the profiling of cross-sections.

A level traverse was run from a U.S.G.S. bench mark (Alachua BA 10) near U.S. 441 to Lee Sink in order to tie in 2 stage recorders and Cross-Sections C012, C010, C009 and C208, which were considered of special importance to the analysis. Bench marks for the remaining surveyed cross-sections were established from U.S.G.S. topographical maps. Profiles for Cross-Sections C002, C005, C006, C071, C108, C308 and C011 were developed from a combination of U.S.G.S. topographical maps and adjacent cross-section profiles.

Field investigation along Mulatto Pen Branch involved extensive on-site investigation and verification of control points in the channel. Field measurements and surveys covered 6 significant bridges and culverts, and 30 cross-sections (Figure 2.5-4). Level traverses were performed along Rocky Creek to establish sea level datum at all cross-sections near the confluence with Mulatto Pen Branch. Further, pooling along the middle reaches indicated a flat hydraulic gradient and probable points of constriction in the channel. These conditions were field verified through precise leveling and comparison of predicted water surface elevations with field observations.

Available technical literature on the Santa Fe River was reviewed and summarized for inclusion in this document. Hydraulic and hydrologic characteristics were verified through field observations made at several times during the study period. Close examination of the river channel between Rocky Creek and the bridge at U.S. 27 confirmed the extremely complex nature of the interchange of surface and groundwater flows and the relative impact of flows from the New River and from Olustee Creek. Both recent and long term statistical records collected and evaluated by the Suwannee River Water Management District and the U.S. Geological Survey were reviewed.

Instrumentation and Special Investigations - Instrumentation in the Rocky Creek basin consisted of installation and monitoring of a Richardson-type water level recorder at a gaging station established at cross-

section R115. In addition, a non-recording rain gauge was installed near the center of the basin. This work was started in mid-October, 1976, and was unsuccessful in that no significant rainfall was received during the short monitoring period. Efforts were terminated when the water level recorder was vandalized and made inoperative.

Cellon Creek instrumentation consisted of a tipping bucket rain gauge with a battery powered recorder and two Stevens water level recorders. The rain gauge was installed and maintained in the area of the effluent treatment ponds on the General Electric battery plant site. One water level recorder was installed at Cross-Section C009 and the second was placed in the pool at Lee Sink. Daily flow measurements using the Ott meter were made and base flow data were successfully recorded.

In order to determine discharge into the ground at Lee Sink, it was necessary to perform a detailed topographic survey of the sink and the flooded upstream channel and to develop a storage-elevation curve. In this way, changes in storage in the pool at Lee Sink with respect to time could be determined from the record of water level at Lee Sink and the storage-elevation curve. Similarily, flow into the pool at Lee Sink was continuously recorded by means of the water level recorder at Cross-Section C009 and a water level-versus-discharge curve which was developed for this cross-section.

Flow into the ground at Lee Sink was computed for short time increments by subtracting incremental changes in pool storage from cumulative inflow. This flow into the ground was plotted as a function of Lee Sink pool surface elevation in order to develop curves for the hydraulic capacity of Lee Sink.

This instrumentation and these techniques were helpful in evaluating basin hydrology. The highest rainfall during the monitoring period fell on October 8, 1976, and amounted to 1.97 inches in 15 hours. Total runoff from this event amounted to 1.07% of incident rainfall. This amount was found to be in agreement with predicted runoff based on parameters used in the computer model, TR-20. Peak outflow from Lee Sink into the ground was slightly greater than 4 cfs, but considerably less than the anticipated base flow of 7 cfs. Further testing was deemed necessary to confirm stage-discharge values for Lee Sink.

Flooding of the large borrow pit and the adjacent low-lying area upstream of Lee Sink was accomplished by temporarily blocking a 48-inch CMP culvert beneath the haul road between the borrow pit and the channel to the sinkhole. A topographic survey of the borrow pit was made and a storage-elevation curve was calculated. Approximately nine acre-feet of water were impounded in this area. Blocking of the culvert was performed by using 2-inch by 12-inch stop-planks sealed with plastic sheeting. Wire cables, attached to each plank, permitted rapid release of stored water. Discharge into the ground at Lee Sink was again determined by

subtracting changes in storage per unit time from inflow into the pool area. The initial effort generated a peak discharge into the ground of slightly more than 5.8 cfs. A second test was conducted with results closely paralleling those of the first test. It should be noted that the high water levels predicted for Lee Sink were developed by extrapolation of the data to discharges much higher than any observed during this study period. Experience indicates that a sinkhole may not achieve maximum hydraulic capacity until it has been flushed a number of times during the rainy season.

Erosion and Deposition Analyses - Potential bedload transport was used to predict changes in erosion and deposition patterns for the open channels being evaluated. The analysis of sediment transport was performed using Einstein's Bedload Function (Einstein, 1950), DuBoys' empirical equation (DuBoys, 1879) and the results of TR-20 and WSP-II computer modeling. These techniques of calculation were employed to establish potential transport rates for the existing condition and for increased, sustained discharges from Deerhaven station.

Field investigation consisted of sampling both bed and bank materials at several representative cross-sections in each creek. A standard sieve analysis was performed on all bed samples and, due to the similarities in size distribution, a composite grain size distribution curve was developed for each creek. Control cross-sections, selected and monitored in each creek, established physical evidence of scour and depo-

sition. Finally, direct observations of various channel reaches confirmed existing areas of scour, deposition, and quasi-equilibrium.

Summary calculations were performed using Straub's values (Straub, 1935) in DuBoys' equation. Preliminary calculations were performed for cross-section C003 (see Figure 2.5-3) using both Einstein's and DuBoys' methods. Results by both techniques were of the same order of magnitude. It should be noted that DuBoys' approach primarily addresses the shear stress relationship between flowing water and soil particles while Einstein's approach includes statistical considerations of flow-induced lift forces. DuBoys' equation was employed in all subsequent bedload transport calculations. These calculations were performed for flows at selected cross-sections located throughout Rocky Creek and Cellon Creek. In all cases, determination of the average shear stress required calculation of an adjusted hydraulic radius reflecting both effective grain size and prevalent bed form. Potential bedload transport rates were then used as a basis of comparison and as an indicator of channel scour and deposition.

Water Quality

Representative sample stations were located upstream of roads, culverts, or other man-made features and marked with numbered aluminum tags.

Separately labelled collection containers were used for major groups of parameters (e.g. nutrients, heavy metals, pesticides, oil and grease,

etc.). All containers were pre-cleaned in the laboratory and rinsed twice with the ambient water prior to sample collection. Grab samples were collected in mid-channel at mid-depth. Those collected from swamps or marshes were taken from the approximate center.

Hydrogen sulfide was collected in 4 mid-stream subsamples with a 35 cc syringe. Each subsample was injected below the surface of 2 ml of zinc acetate in a 4 oz. nalgene bottle, with care taken not to aerate the sample. Preservation/fixation was completed by adding 2 ml of sodium hydroxide (APHA, 1975).

Samples collected for metals analysis were acidified in the field with concentrated nitric acid. Upon return to the laboratory, all samples were stored at 4° C until analyzed.

In situ analyses of dissolved oxygen (DO) were performed with a YSI Model 57 dissolved oxygen meter equipped with a YSI 5739 probe and a YSI 5791A submersible stirer. Temperature and conductivity analyses were made with a YSI Model 33 S-C-T meter equipped with a YSI 3300 conductivity/temperature probe.

The analytical methods employed for all of the above water quality parameters are listed in Table 6.1-1.

Table 6.1-1 Water Quality and Sediment Characteristics Measured, Methods of Analysis, Detection Limits and References

Characteristics	Method of Analysis	Detection Limit	Detection Units	Reference
Aluminum	Atomic Absorption	0.1	mg/l	EPA Storet 01105
Arsenic	Silver Diethyldithiocarbamate	0.03	mg/l	Std. Methods 404 A
Cadmium	Atomic Absorption	0.0005	mg/l	EPA Storet 01027
Cyanide	Distillation, pyridine-pyrazalone	0.02	mg/l	EPA Storet 00720
Chromium	Atomic Absorption	0.01	mg/l	EPA Storet 01034
Hexavalent Chromium	Colorimetric	0.01	mg/l	Std. Methods .211(11) D 1971
Copper	Atomic Absorption	0.001	mg/l	EPA Storet 0.1042
Iron	Atomic Absorption	0.01	mg/l	EPA Storet 01045
Lead	Atomic Absorption	0.01	mg/l	EPA Storet 01051
Manganese	Atomic Absorption	0.01	mg/l	EPA Storet 01055
Mercury	Flameless Atomic Absorption	0.0002	mg/l	EPA Storet 71900
Molybdenum	Atomic Absorption	0.1	mg/l	EPA Storet 01062
Nickel	Atomic Absorption	0.01	mg/l	EPA Storet 01067
Zinc	Atomic Absorption	0.005	mg/l	EPA Storet 01092
Ammonia	Automated Phenolate	0.01	mg/l	EPA Storet 00610
Kjeldahl Nitrogen	Automated Digestion, Phenolate	0.05	mg/l	EPA Storet 00625
Nitrate	Automated Cadmium Reduction	0.01	mg/l	EPA Storet 00630
Total Phosphorus	Manual Digestion, Automated Single Reagent	0.01	mg/l	Std. Methods 425 C (1975) and EPA Storet 70597
Sulfates	Gravimetric	0.1	mg/l	Std. Methods 427 A (1975)
Sulfides	Titrimetric - Iodine	0.1	mg/l	Std. Methods 428 D (1975)
Free Mineral Acidity	Electrometric Titration pH 3.7	0.1	mg/l	Std. Methods 201 (1971)
Total Organic Carbon	Combustion - Infra Fed	1	mg/l	EPA Storet 00680
Magnesium	Atomic Absorption	0.0005	mg/l	EPA Storet 00927
Calcium	Atomic Absorption	0.003	mg/l	EPA Storet 00916
Alkalinity	Potentiometric titration	0.2	mg/l	Std. Methods 403 (1975)
Hardness	EDTA Titrimetric	0.1	mg/l	Std. Methods 309 B (1975)
Total Dissolved Solids	Total Filtrable Residue @ 103/105°C	1	mg/l	Std. Methods 208 C (1975)
Color	Platinum, Cobalt Visual	1 Unit		Std. Methods 204 A
Turbidity	Hach 2100 A Turbidimeter	0.02	NTU	Std. Methods 214 A
Sulfate in Sediment	HCl Digestion, Gravimetric	0.1	mg/l	Private Communication, EPA Region IV
Sulfide in Sediment	HCl HNO_3 Digestion, Atomic Absorption			
Heavy Metals in Sediment:				
Chloride	Argentometric	0.1	mg/l	Std. Methods 4084 (1975)
Fluoride	Distillation - Electrode	0.01	mg/l	Std. Methods 414 A & B (1975)
Sodium	Atomic Absorption	0.002	mg/l	EPA Storet 00929
Potassium	Atomic Absorption	0.005	mg/l	EPA Storet 00937
Conductivity	Texas Instruments Conductivity Bridge	0.1	µmhos/cm	Std. Methods 215 (1975)
pH	Electronic Glass Electrode	0.01 Unit		Std. Methods 424 (1975)
Total Dissolved Oxygen	Membrane Electrode (TI)	0.1	mg/l	Std. Methods 422 F (1975)
Biological Oxygen Demand	5 day incubation @ 20°C TI/DO Analyzer	0.1	mg/l	Std. Methods 507 (1975)
Chemical Oxygen Demand	Dichromate Oxidation Titration	0.1	mg/l	Std. Methods 508 (1975)
Oil & Grease	Partition Gravimetric	0.1	mg/l	Std. Methods 502 A (1975)
Phenols	Distillation-Extraction Colorimetric	0.001		Std. Methods 510 A & B (1975)
Detergents	Methylene Blue Colorimetric	0.002	mg/l	Std. Methods 512 A (1975)

Table 6.1-1 Water Quality and Sediment Characteristics Measured, Methods of Analysis, Detection Limits and References (continued)

Characteristics	Method of Analysis	Detection Limit	Detection Units	Reference
Aldrin	Extraction-Florisil Cleanup Gas Chromatography - EC Detector	0.001	mg/l	Std. Methods 509 A
Chlordane		0.003	mg/l	
DDT		0.005	mg/l	
DDE		0.005	mg/l	
Dieldrin		0.001	mg/l	
Endrin		0.0002	mg/l	
Heptachlor		0.0001	mg/l	
Heptachlor Epoxide		0.0001	mg/l	
Lindane		0.004	mg/l	
Methoxychlor		0.1	mg/l	
Toxaphene		0.005	mg/l	
2,4 D (Acid)	Extraction-Ethylation, Gas Chromatography W/EC Detector	0.01	mg/l	Std. Methods 509 B
2,3,5 TP (Silvex)		0.01	mg/l	Std. Methods 509 B
Chloroform Other Chlorinated Hydrocarbons	Gas Phase Stripping, Gas Chromatography W/EC Detector	0.01		EPA 670/4-74-009 Bellar & Lichtenberg

Pesticides in sediments extracted and analyzed in accordance with EPA "Manual of Analytical Methods for the Analysis of Pesticide Residues in Human and Environmental Samples" Section 11, B (ff)

Sediments - Sediment samples were collected primarily at water sampling locales. Initially, a hand-operated linear type core sampler was used; however, problems in pushing the sampler through fibrous root mats, removing the core, and carrying the sampler to remote areas necessitated direct collection by hand. Samples taken by hand were approximately the upper 5 cm of sediment. Sediments were placed in labeled double Ziploc bags for heavy metal, pesticide and herbicide analyses. Samples intended for sulfate and sulfide analysis were collected under water in labeled wide-mouth glass bottles to which zinc acetate was then added to prevent the loss of hydrogen sulfide. All samples were stored in the laboratory at 4° C until analysis was begun.

Data Interpretation - Any abnormalities in water quality and sediment data were examined and the corrected data keypunched for computer analysis. The raw data printout was checked for input processing and corrected. SAS-76 was used for data management and statistical analysis.

Duncan's multiple range test with Kramer's adjustment for unequal cell frequencies was employed to determine which variables were significantly different. In order to use Duncan's procedure, the data were grouped to represent stream segments. From Duncan's procedure and visual inspection of the data, the parameters were categorized as: (1) those which showed no significant difference between streams and segments of streams; (2) those that were significantly higher in the segment of Cellon Creek below the battery plant outfall; (3) those that were significantly

higher in the present Deerhaven discharge ditch and associated on-site swamp; and (4) those that were significantly higher in portions of streams receiving only agricultural runoff or inputs.

A Hewlett-Packard Model 25 desk-top calculator was programmed to test the significance between mean concentrations of sediment parameters. The t-statistic for two means which has the t distribution with $n_1 + n_2 - 2^o$ of freedom was used to test the null hypothesis at the 5% probability level.

Existing water quality was compared to water quality standards (State of Florida FAC Chapter 17-3; EPA, 1976). STORET, Alachua County Department of Pollution Control, and USGS data were used to further characterize the regional and local area water quality, including that of Turkey, Cellon, and Rocky Creeks.

Water Flow - Current was measured with a Marsh-McBirney Model 201 portable water current meter. Prior to use, the meter was checked against a previously calibrated meter and later rechecked for accuracy in the flow tank at the University of Florida Hydrology Research Laboratory. Accuracy was ±4% (average) which is in agreement with the manufacturer's specifications. At each sampling station current was recorded at 0.2 and 0.8 of the depth from the creek bottom where the water was 0.5 to 1.5 feet deep. In places where the water was too shallow to take 2 readings, 1 reading at mid-depth was taken, while in

places where depth was greater than 1.5 feet, all measurements were taken 0.6 of the depth from the bottom. Velocity was measured at 5 to 10 points equally spaced across the stream. Width and depth were measured with a tape measure and used to calculate cross-section areas (ft^2).

6.1.2 Groundwater

6.1.2.1 On-Site Shallow Groundwater Table

At present, no long-term data exist which show the behavior of the perched on-site groundwater table. Water levels were recorded in some auger borings performed during September, 1976. These boring logs are presented in Section 2.4 along with selected cross-sections showing assumed soil stratification and groundwater elevations. Groundwater table observations were made following three successive rain-free days. The greatest depth of the water table was found to be approximately 6 feet. However, in most borings the depth was found to be 2 to 3 feet and in the southern part of the site, the depth was found to be only 1 foot below ground surface. Simplified mathematical and computer models indicated little possibility for reliable on-site cooling tower blowdown disposal by percolation. Such models also inferred low lateral groundwater seepage. These conclusions correlate well with observations of plant operating personnel that surficial soils are completely saturated during some parts of the year and that most rainfall leaves the site as surface runoff during those periods.

Leachate Program

The leachate program consists of a network of on-site soil borings, a network of observation wells monitoring the potentiometric surface and continuous recording of groundwater elevation at key observation wells. Permeability testing will be performed on undisturbed soil samples and by means of pumping tests of surficial sands. Modeling will be performed to predict the potential leachate movement.

6.1.2.2 Floridan Aquifer

The condition of the Floridan Aquifer in the study area has been obtained from information published by the Suwannee River Water Management District, the United States Geological Survey, the Department of Natural Resources, and logs and tests of area water supply wells.

6.1.3 Geology

Geological information presented in this document has been obtained from publications of the U.S. Geological Survey, the Florida Geological Survey, the U.S. Department of Agriculture Soil Conservation Service, and from well logs, drilling logs, and geological reconnaissance of the area. It should be noted that the site has been "proof loaded" by the existing generating plant and associated structures for approximately 5 years with no evidence of soils or geological instability.

6.1.4 Ecological

Macroinvertebrates

Benthic macroinvertebrates were initially collected with standard Ekman grabs (232.2 cm^2), which are light and well-suited to soft, finely-divided substrates (EPA, 1973), such as are found in streams of the project area.

Grabs were taken in representative portions of streams away from roads, bridges, culverts, or other man-made structures. Proceeding upstream at each station, grabs were taken from near the left bank, at the center, and near the right bank in sequence. Four replicates of 4 grabs each were taken for each station, sieved through U.S. standard 30 mesh screen, transferred to labelled double Ziploc bags, and kept separate as basic analysis units (Southwood, 1974; Atomic Industrial Forum, 1974). In addition, a 5 minute sweep sample was taken at each station; the sweep net was moved upstream as sediment was agitated ahead of it.

In order to sample other habitats and to supplement the organism lists, stream width samples were taken with a 4 x 15 foot x 0.25 inch mesh minnow seine in a known area of stream.

Invertebrates were picked within 72 hours, or preserved in ethanol and stored at 4° C. After picking, all organisms were put into labeled vials with 70% ethanol.

Organisms were identified to the lowest possible taxon (Ward and Whipple, 1959), and checked against a reference collection.

After identification, the benthic communities of each station were evaluated according to the Biotic Index (Beck, 1955), Shannon-Weaver diversity (EPA, 1973), equitability (MacArthur, 1957; EPA, 1973), and population density (number/m^2). These indices, based primarily on Ekman samples, were then used to estimate overall stream sensitivity and quality.

Fish

Fish were collected with minnow seines and trot lines. The seines were 0.25-inch mesh lined with mosquito netting. At each collecting station a block net was placed upstream of the seine, which was then moved to the block net. Care was taken to probe under overhanging banks, to pass closely over and around obstructions, and to keep the lead line in contact with the block net until the seine was lifted clear of the water; 1 team member watched to see that no fish escaped under or over the seine or block net.

Standing crop was determined from the surface area and volume of each stream segment seined.

The trot lines carried No. 6, 7, and 4-0 hooks baited with liver or cut fish and were checked once a day for 5 days.

Specimens were put into labelled double Ziploc bags with 10% formalin. Later, they were sorted and transferred to labeled glass jars and preserved (Knudsen, 1972).

Fish were identified to the lowest possible taxon using accepted keys (Blair, et al, 1968; Eddy, 1969; Carr, 1937).

Small specimens were weighed on a Mettler analytical balance, larger ones on an Ohaus triple beam balance or a spring type fish scale. Length (cm) was determined on a fish board. Numbers and weight (g) of each catch were used to extrapolate and estimate standing crop for each species and for all fish at the station, subsystem, and the system level (Ricker, 1971).

Reptiles and Amphibians

Herptile surveys and collections were made using dip nets, turning over debris with a potato rake, excavating and screening sediments, and walking shorelines. Additional specimens were captured on trotlines intended for fish or observed during other field studies. Uniformity was attempted by spending equal time at each station.

Specimens were identified to the lowest possible taxon using accepted keys (Altig, 1970; Carr and Goin, 1955; Conant, 1975), then checked against expected species lists for the habitat types afforded by each stream.

Terrestrial Vegetation

Determination of the composition and extent of vegetation communities and land use types for the respective creek basins was accomplished using belt transects, existing ASCS aerial photographs, new aerial color infrared photographs, planimetric readings, vehicular and on-foot ground truthing, and individual plant specimen identification.

Thirty-two belt transects were established along the perimeters of the Rocky Creek swamps (Figure 6.1-1). The beginning of each transect was marked with a numbered tag affixed to a tree or plastic stake. Dominant plant species were recorded at 10 to 50 foot intervals along each transect, depending on homogeneity. Changes in elevation were recorded with a Leitz MS-27 stereoscope. A Leitz 28253 planimeter was used on photographs to determine acreages. Areas of interest were planimetered at least three times for accuracy. Plant specimens were identified using accepted keys (Kurz and Godfrey, 1962; Radford, et al, 1968).

Salt Drift Deposition Calculations

In lieu of a predictive model for salt drift deposition, (Section 5.2.2) empirical observations on the extent of drift were derived from the literature and used to identify a probable deposition zone. Using the projected drift rate of 20,000 gallons/day for Units 1 and 2 combined (Burns & McDonnell, 1977) and the expected solids concentrations of the recirculating cooling system waters (Section 3.3.7). An estimate of total salt drift was made which was assumed to be evenly dispersed

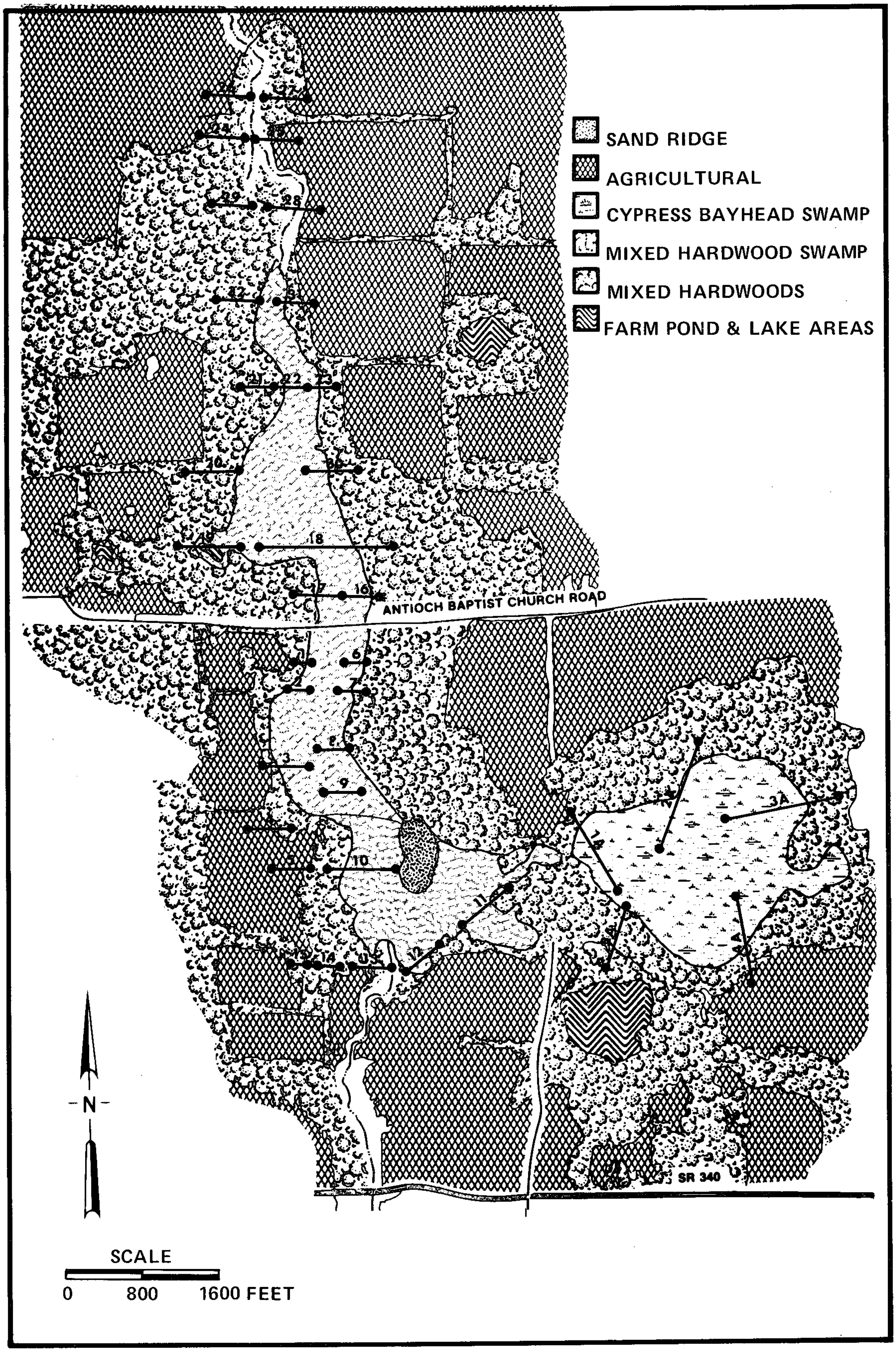

FIGURE 6.1-1 LOCATION OF ROCKY CREEK SWAMPS VEGETATION TRANSECTS.

throughout the deposition zone. While the underlying assumptions from this type of analysis are highly simplistic and the results therefore are of only marginal predictive value, it should serve to adequately identify whether cooling tower drift from the planned facility is potentially detrimental to the environment.

6.1.5 Archaeological and Historical Survey and Assessment Methods

An archaeological and historical study was performed. A total of 23 man-days was spent on the project, 5 in documentary research and interpretation, 9 in field work, and 9 in materials analysis and report preparation.

Methods used in the study may conveniently be divided after the example of Mueller (1974) in the categories of objectives, strategies, tactics, and tasks. Objectives designated before beginning the project included: (1) identify properties listed in or under consideration for nomination to the National Register of Historic Places; (2) conduct a literature and documentary search to determine known site locations and to permit the prediction of areas with high site potential; (3) conduct an intensive survey of the impact area to locate prehistoric, historic, and architectural properties; (4) evaluate all sites in terms of National Register criteria and potential impact; (5) propose a program of mitigation including research design, public and scientific value, and cost; and (6) prepare a detailed report of investigations.

A strategy may be considered a general plan for achieving the objectives of a project, while tactics are minor plans useful for organizing work in specific areas. Strategies were developed both before and during the study, and, for the most part, were determined by standard or current archaeological and historical research procedures. For example, collection of site location data from areas surrounding the survey area was useful in predicting potential archaeological site distribution on the property. Aerial photography from 1938 to 1974 was studied to gain knowledge of past land use, disturbance, and historic site distribution. Also, documentary research by a historian was carried out using historical sources at state libraries, deed and survey records at the Florida Bureau of Public Lands, and Alachua County deeds and tax rolls.

Tactics used during the archaeological survey were chosen to suit the nature of various areas of the tract with respect to natural features, accessibility, degree of disturbance, and potential for site location. Since ground cover was dense over most of the tract, and because much of the habitable, dry ground had been disturbed during cultivation for planted pines, some areas were not tested except where access and surface exposure was provided by trails, fire lanes, dirt roads, or similar disturbances. A tactic heavily relied upon was interpretation of aerial photographs. Stereo pairs of various scales, flown in 1938, 1949, 1961, and 1974, were examined to gain an understanding of environments and landscape features. Blue line prints of 1974 coverage, with a scale of 1 inch = 400 feet, were used during field work to plan survey routes, plot site locations, and identify vegetation types.

The survey was accomplished by one archaeologist on foot. Vehicle reconnaissance was precluded by lack of good roads and poor surface exposure. Approximately 31 miles were walked, about two-thirds of this on the Deerhaven tract. All such soil exposures as dirt roads, ditches, trails, fire lanes, railroad embankment, cleared ground, fence lines, and power line cuts were searched for surface material. Subsurface testing was done in areas where artifacts were found on the surface.

A list of tasks accomplished:

1. Check Florida Master Site File at Florida Division of Archives, History and Records Management,
2. Consult National Register and staff of State Historic Preservation Officer for sites in process of nomination,
3. Check site records and survey data at Florida State Museum,
4. Interview archaeologists at Florida State Museum,
5. Conduct literature search,
6. Plot known site distribution,
7. Predict potential site locations and functions as allowed by data,
8. Search surveyor's field notes and plat sheets from mid-nineteenth century at Bureau of State Lands,
9. Search map collection at P. K. Yonge Library of Florida History,
10. Interview RUB personnel at Deerhaven about artifact finds,
11. Plot artifact locations,
12. Walk all available soil exposures,
13. Walk and test creeks, pond margins, and suspected site locations,

14. Interview local residents,

15. Search historical sources at R. M. Strozier Library and P. K. Yonge Library,

16. Search Alachua County deed books and tax rolls,

17 Search State of Florida deed books,

18. Interview Historic Gainesville, Inc. for results of Alachua County historic building survey,

19. Evaluate results of documentary study,

20. Walk pipeline corridors,

21. Assemble site data,

22. Determine National Register eligibility in consultation with staff of State Historic Preservation Officer,

23. Analyze occupation and environmental data, and

24. Prepare report.

6.1.6 Identification of Alternative Siting Areas

Alachua County was surveyed to identify areas potentially compatible with the siting of the proposed power generating facility. Alternatives were identified using a modified McHarg overlay approach (McHarg, 1969) for cumulatively excluding areas from consideration on the basis of land use or environmental incompatibilities. Excluded areas were delineated by shaded screens on a transparent overlay of the county base map (Figures 8.1-1 through 8.1-3). All overlays were then composited onto a single map to identify alternative siting areas as those not superimposed by a shaded screen (Figure 8.1-4). Final analysis of alternative areas for the purpose of identifying the best siting location was made on the basis of facility support features and economic considerations (Section 8.1).

6.1.7 Noise Survey Method

A noise survey of the site was completed on October 4, 1977. Measurements were made during afternoon hours with a clear sky, a moderate wind from a northerly direction and ambient temperatures near 75° F. The instruments used included a B & K type 2202 Precision Sound Level Meter, a B & K type 4230 Acoustic Calibrator and a B & K type UA 0207 Windscreen. The windscreen was attached to the sound level meter during all measurements and a calibration check was performed both before and after the period of measurements (on the same day).

Eighteen sampling locations were selected of which four were on the site near (within 15 meters) major noise sources from Unit No. 1. The remaining locations were around the perimeter of the site. Figure 6.1-2 shows the noise level sampling locations.

6.1.8 Air Quality

<u>Ambient Air Quality Monitoring Program</u>

A ambient air monitoring network, that has grown to nine stations, has been operated in Alachua County by the Alachua County Pollution Control District since 1973. Total suspended particulate matter (TSP), sulfur dioxide (SO_2), and/or nitrogen oxides (NO_x) have been monitored at these sites. The original monitoring site in the Alachua County area, as required by the State Implementation Plan (SIP), was established by the Florida Department of Environmental Regulation (FDER) in September 1972. This site, designated as B in Figure 6.1-3, was operated initially by FDER and later by the Alachua County Pollution Control District.

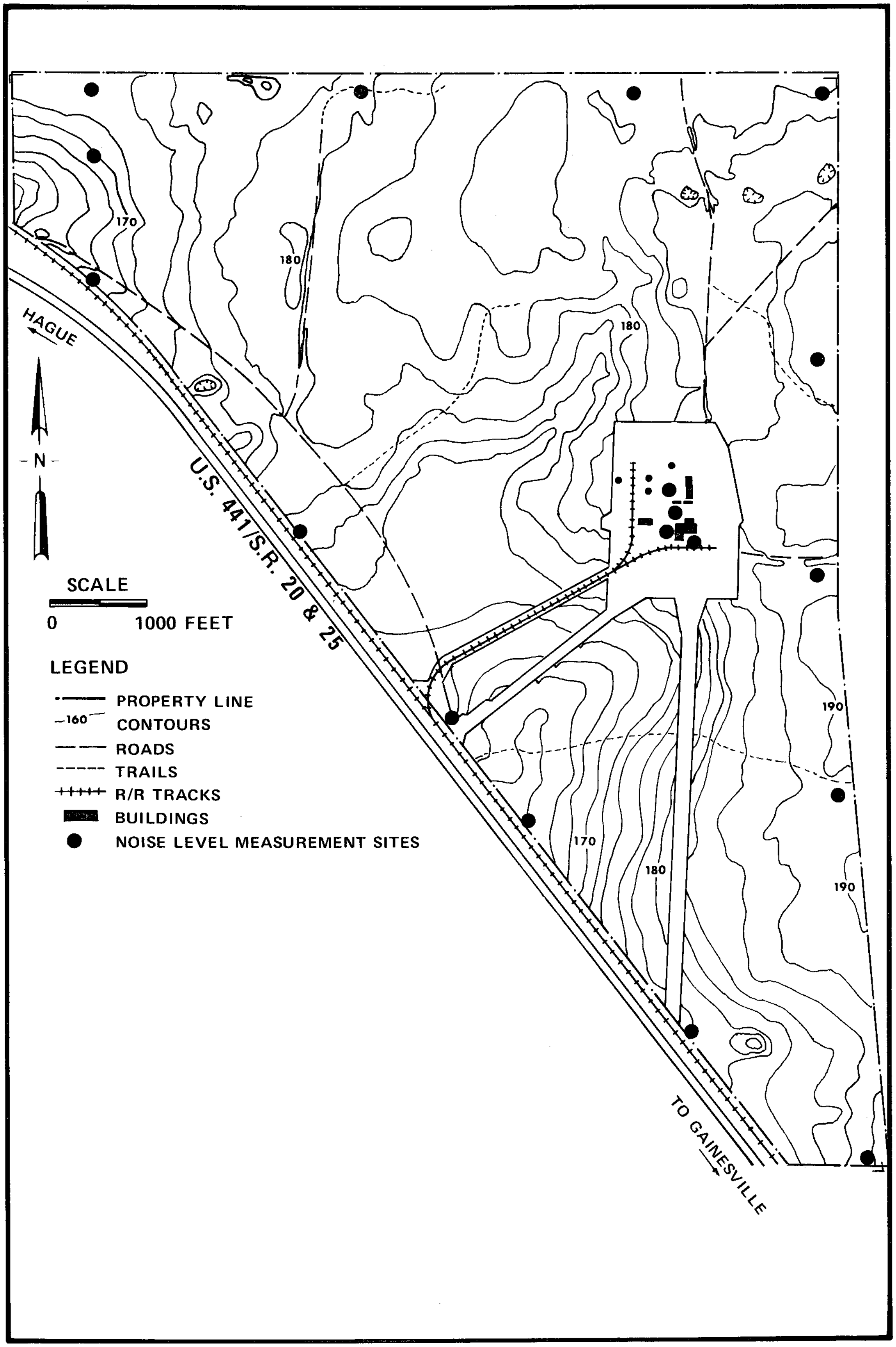

FIGURE 6.1-2 NOISE LEVEL SURVEY MONITORING SITES DEERHAVEN SITE, GAINESVILLE, FLORIDA.

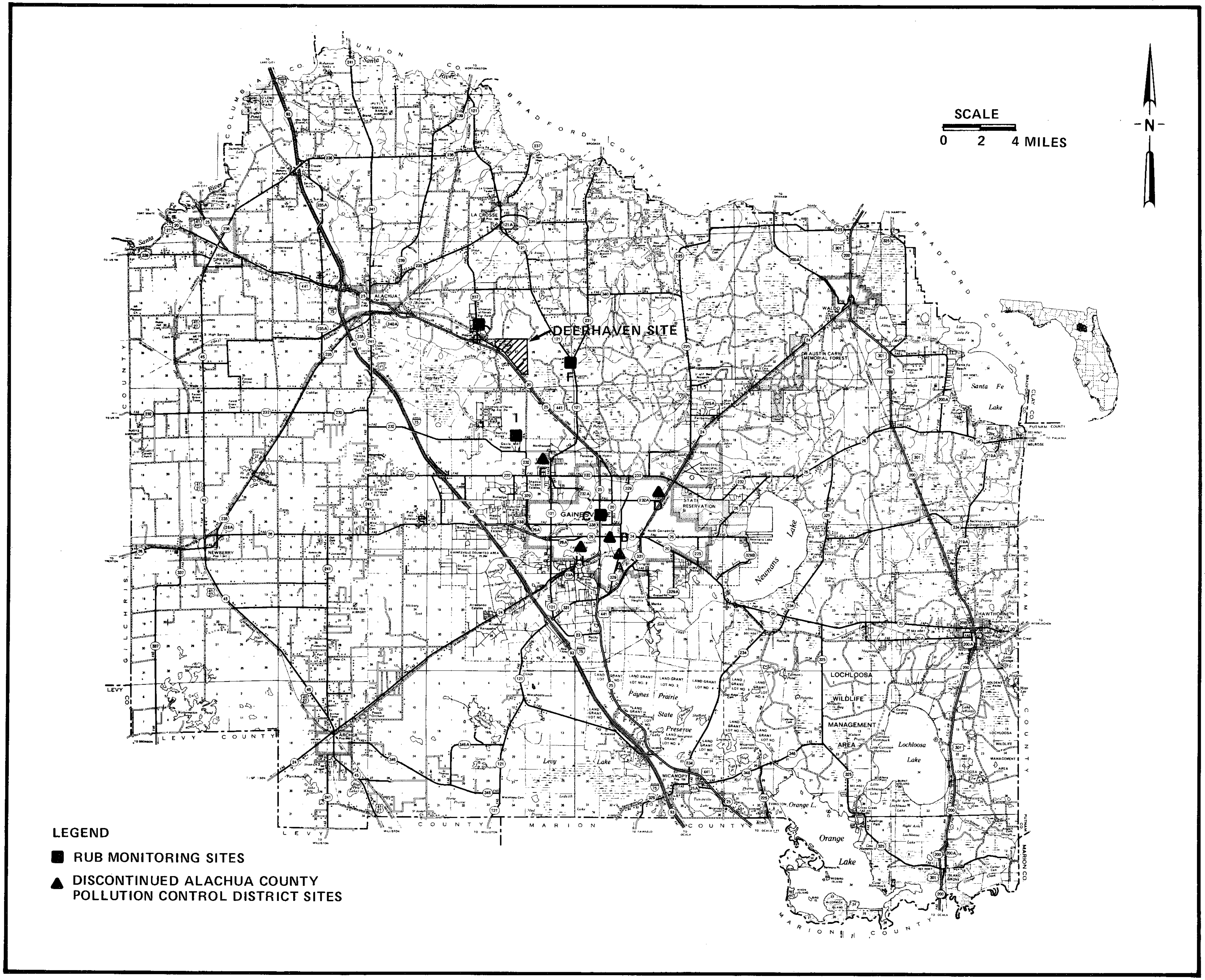

FIGURE 6.1-3 AIR QUALITY MONITORING SITES.

In November and December of 1974, six additional monitoring sites, identified as A, C, D, E, F, G and H in Figure 6.1-3 were established. Sites A, D, E and H were county sites and sites C, F, and G were RUB sites operated by the county.

An additional monitoring site was established (site I, Figure 6.1-3) and site G moved to its present location in February 1977 by RUB. These monitors are also operated by the county. The pollutants monitored at each of these sites are listed in Table 6.1-2.

The monitors at each site were operated on a six-day schedule corresponding to the schedule adopted by the U.S. Environmental Protection Agency (EPA) and the FDER. The monitoring methods employed were reference methods adopted by EPA and published in Title 40, Part 50, Code of Federal Regulations at the time of program implementations. EPA later discovered deficiencies in the SO_2 and NO_x monitoring methods. The deficiencies in the NO_x monitoring method were announced by EPA in June 1972 while the deficiencies in the SO_2 monitoring method were announced in December 1974. Although criticism has been directed toward the TSP monitoring method, no serious deficiencies have been announced.

In December 1976 RUB purchased temperature controllers for the four samplers in the monitoring network supported by that agency. The temperature controlled samplers were installed to overcome the deficiency of the SO_2 monitoring method. In June 1973 EPA published a

Table 6.1-2 Air Quality Monitoring Sites and Pollutants Monitored Alachua County, Florida

Identification[1]	Site Activated	Site Discontinued	Responsible Agency	Pollutants Monitored TSP	SO_2	NO_x
A	9/1972	10/77	County[2]	x	x	x
B	11-12/1974	10/77	County	x		
C	11-12/1974	-	RUB[3]	x	x	x
D	11-12/1974	10/77	County	x	x	x
E	11-12/1974	10/77	County	x		
F	11-12/1974	-	RUB	x	x	x
G	10/1976	-	RUB	x	x	x
H	11-12/1974	10/77	County	x		
I	2/1974	10/77	RUB	x	x	x

(1) See Figure 6.1-3.
(2) County - Alachua County Pollution Control District
(3) RUB - Gainesville-Alachua County Regional Electric, Water & Sewer Utilities Board; these sites operated by the County prior to 10/1977 and by private contractor subsequent to 10/1977.

candidate monitoring method for NO_x which was adopted by the county in December 1976. The official reference method later specified was the gas phase chemiluminescenct method (U.S. EPA, 1976). When specifying the new reference method, EPA also stated that the sodium arsenite manual method, the method adopted by the county in 1973, was evaluated and found to have good performance. However, the method has not yet been specified as an equivalent method.

In summary the SO_2 data collected in the Alachua County area except those samples collected at the four RUB sites prior to January 20, 1977 are suspect because of the temperature instability of the monitoring method. Likewise, all NO_x monitoring data collected in the Alachua County area prior to June 1973 are also suspect since the reference method is not utilized. TSP monitoring data collected in the Alachua County area appears to be valid.

On October 1, 1977 the operation and maintenance of monitoring sites C, F, G and I (those owned by RUB) were taken over by a private contractor. The five remaining sites in the county were continued to be operated by the ACPCD. The monitoring methods used in the RUB network are:

TSP: The high-volume air sampler method specified by the U.S. Environmental Protection Agency in 40 CFR 50, Appendix B.

SO_2: The paraosaniline method specified by the U.S. Environmental Protection Agency in 40 CFR 50, Appendix A, with the temperature controlled to less than 68^o F (20^o C).

NO_x: The monitoring method for nitrogen oxide is the sodium arsenite method as published in the Federal Register, volume 38, number 110, page 15174, June 8, 1973.

Modeling

While the above ambient monitoring network has been in operation for several years, air quality models were used exclusively for establishing pre-certification as well as post-operational ambient levels of SO_2 and NO_x. This is due to the discoveries that the SO_2 monitoring method was temperature sensitive above temperatures of 68° F (20° C) and that deficiencies less well defined, but equally serious, existed with the NO_x sampling method.

The monitoring method used for TSP, is the high-volume sampling method adopted by EPA (40 CFR 50, Appendix B). No major discrepancies have been discovered with this sampling method. Data collected by the Alachua County Pollution Control District using this method were evaluated during the establishment of pre-certification air quality. It was determined that the TSP monitoring data could best be used to establish background TSP concentrations and that air quality models could best be used to establish the spacial distribution of TSP and to establish the highest TSP levels to be expected in the County for the pre-certification and post-operational time periods.

TSP levels measured at Alachua County Pollution Control District monitoring site 10-0020-101 (site F, Figure 6.1-3), located approximately 1.9 miles

(3 kilometers) southeast of the Deerhaven site, was selected to establish TSP background levels. The methodology used in establishing annual and twenty-four hour background levels is described in Section 2.8.

Background levels of SO_2 and NO_x were assigned values of zero. This is to say that all SO_2 and NO_x discharged into the ambient air in the Alachua County area is from anthropogenic sources.

Ambient levels of TSP, SO_2 and NO_x above background levels was determined by air quality modeling and procedures promulgated by the U.S. EPA and adopted by the FDER. These techniques require that air quality modeling be conducted to establish annual average TSP, SO_2 and NO_x levels; that short-term modeling be conducted to establish twenty-four hour levels of TSP and SO_2; and that short-term modeling be conducted to establish three hour ambient SO_2 levels. The air quality models used for these tasks were the AQDM with the Briggs plume rise equation, and the PTMTPW. The AQDM was used for annual average modeling and the PTMTPW was used for twenty-four hour and three hour air quality modeling.

Description of AQDM

The Air Quality Display Model (AQDM) is a computer program designed to estimate the spacial distribution of pollutants over a long-term averaging time. The computer code for the AQDM was developed in 1968 and has been modified since to accomodate changes in the state-of-the-art of air quality modeling. The version used for the Deerhaven site studies is defined as the AQDM with the Briggs plume rise equation.

The model is based on the Gaussian-diffusion equation which describes the horizontal and vertical spread of a plume as it is transported downwind from a continuously emitting point or area source. The model is utilized to compute annual arithmetic average ground-level pollutant concentrations resulting from specified point and area sources. The model calculates the impact of each source on each receptor for observed combinations of wind direction, wind speed, and atmospheric stability. The relative frequency of occurrence for each combination is stored as a factor, and the resulting factors are summed for each receptor over all combinations of meteorological conditions and all sources.

The plume is assumed to be normally distributed about its center line (i.e., a Gaussian distribution) in the vertical direction and distributed as a linear function of crosswind distance in the crosswind direction. The pollutant distribution in the vertical direction is controlled by the magnitude of the vertical standard deviation of pollutant concentration. The program uses the vertical standard deviation values given by Pasquill (1961) and Gifford (1961). These values are functions of the source-receptor downwind distance and atmospheric stability category. The stability categories (1 through 5, in order of increasing stability) are defined on the basis of the objective criteria specified by Turner (1964). These categories are used to define both the standard deviation of the plume concentration distribution and the mixing depth of the atmosphere.

Input data to the AQDM includes the following:

A. Receptor Data - Up to 225 receptor locations corresponding to the intersections in a grid pattern having equidistant vertical and horizontal spacing may be specified, together with a maximum of twelve individually located receptors.

B. Source Data - Both area and point sources may be specified. For each point source the location, average annual emission rate and stack parameters must be specified. The stack parameters (physical stack height, stack exit diameter, effluent exit velocity, and effluent temperature) are used to obtain the effective height of release for use in the diffusion calculations. For each area source (assumed square in shape) the area, centroid location, average annual emission rate, and effective height of release must be input.

C. Meteorological Data - These data give the relative frequency of occurrence for each wind direction, wind speed class, and stability category combination as observed for the region and time period of interest. The data represent sixteen wind directions, six wind speed categories and five atmospheric stability categories. In addition to these data an annual average mixing depth and ambient temperature must be specified.

PTMTPW Description

The PTMTPW (point/multiple point) air quality model was developed by EPA to predict hourly concentrations of pollutants at several pre-selected receptor locations resulting from emissions from several point sources. The location of the receptors and the location of the point source are pre-defined by a rectangular grid system.

The model is based on the Gaussian-diffusion equation which describes the spread of a plume as it is transported downwind from an elevated continuous emitting point source. The plume spread in the horizontal and vertical directions is defined by the Pasquill-Gifford dispersion coefficients. Plume spread in a downwind distance is defined by wind speed. The plume rise is calculated according to the Briggs (1969) plume rise model (Briggs, G.A., 1969).

For each source receptor pair the downwind and crosswind distances are calculated. If the downwind distance is closer than the distance required for the plume to attain its final height the plume rise for the distance is calculated. The concentration from the source at the receptor is then determined by the Gaussian model using the calculated downwind, crosswind and plume height distances. This procedure is repeated to determine the contribution of each source to each receptor for each hour of meteorological data input.

The number of hours of meteorological data can vary from one to twenty-four. If multiple hours of meteorological data are input the model will average the hourly pollutant concentrations at each receptor over the number of hours of meteorological data input. For example, if twenty-four hours of meteorological data are input the resulting model output will be a twenty-four hour average pollutant concentration at each receptor.

The input data to the model includes:

A. Receptor Location - The location of each receptor is defined by its location in a rectangular grid system. The elevation of the receptor, if different from the elevation of the air pollution source base, can also be defined.

B. Source Data - Emission data from up to 25 point sources can be input to the model. For each source the location, as defined by a rectangular grid system, must be specified. In addition the pollutant emission rate, stack height, stack gas temperature, stack gas velocity, and stack diameter must be defined.

C. Meteorological Data - Hourly values for wind direction, wind speed, atmospheric stability, mixing height, ambient temperature, and ambient pressure must be specified. For determining the maximum expected twenty-four hour and three

hour pollutant concentrations. The meteorological data used with the PTMTPW for the Deerhaven site is described in Section 2.8.

6.1.9 Socio-economics

Socio-economic data and information used to assess social and economic impacts were collected in a variety of ways. Initially, published secondary information such as planning reports, labor publications, newspapers and periodicals were collected and reviewed. In addition, intensive interviewing of key community individuals was conducted in order to gain a better understanding of community socio-economic characteristics and attitudes.

6.2 Pilot Injection Well Program

The program is designed to test the feasibility of injecting process water into very deep saline water zones that are totally isolated from the surficial environment and fresh groundwater resources. The principal purpose of the program is to explore the feasibility of deep injection as the best alternative for effluent disposal in terms of protecting public health and the natural environment. RUB has intensively investigated a number of other alternatives for the disposal, and has reached the conclusion that the highest degree of protection to public health and the environment would be achieved if the process water were to be stored at great depth where it could in no way impact the environment.

Currently, a test well is being constructed to a depth of approximately 3,300 feet, with the final casing string installed to a depth of 2,000 feet to isolate the well from geologic formations that are known to contain fresh water. The remainder of the hole is being drilled with a highly controlled fresh water mud, after which geophysical logs will be run to define water quality and to indicate potential injection zones. Upon completion of this work, injection tests will be conducted, using fresh water, to define the hydraulic characteristics of the deep beds and to provide information needed for the design of a permanent injection well. Depending on the permeability characteristics, RUB may design the permanent well to inject only a very small quantity of process water or, if the situation proves to be extremely favorable, to inject somewhat larger quantities.

A key element to be investigated in the testing of the injection well will be the pressures required for injecting fluid at different rates. Careful testing will be conducted and the test results will be evaluated by different quantitative methods to show patterns of pressure change with time, with distance from the injection facility, and at different assumed rates of injection. Because the ultimate objective is to make certain that injection pressures in the injection well do not exceed the 0.5-psi requirement, a series of predicted responses will be developed so that DER will have the best advance information on how the injection facility will function. In any event, if the program proceeds into an operational stage, detailed measurements will be made continuously of

pressure changes in the injection well and in the monitoring well to verify the initial findings, and if at any time these pressures were to approach the stipulated maximum, the injection rate would be reduced or other corrective changes would be made in the operation of the system. The key fact to be determined, of course, is the maximum pressure in the system, which will be that recorded in the injection well itself. All other pressure changes at various distances from the well will be less than the one recorded in the well itself.

Based on an analysis of the oil test well data and other geologic information for this part of Florida, it is anticipated that some degree of permeability will be found in the potential injection zone. What is unknown at this time is whether this permeability will be high enough to support injection at the desired rate, and acquiring this information is, of course, the primary purpose for installing the test well. No other injection wells have been drilled into the deep saline zone within distances of many miles from the RUB site, and it is probably unwise to extrapolate findings from these more distant wells. At the closest such well, however, which was installed roughly twelve miles northeast of the RUB site, there apparently were good indications of an injection potential at the depths to be penetrated by the RUB well. Unfortunately, this nearest well was never completed successfully and was abandoned as a result of sanding problems that occurred in the deeper layers. The sanding problem appears to have been caused by acidizing the injection zone to improve its permeability.

Throughout the entire investigation, the highest level of field supervision and scientific control is being exercised, in order to provide a very detailed analysis of the hydrogeologic sequence from land surface to bedrock. Experienced geologists are present at all times during the drilling to collect geologic information, water quality information, data on water levels and head changes, and information on the respective permeabilities of the different layers that will be penetrated. Water samples will be collected to compare the characteristics of the injected water with those of the native groundwater in the injection zone. It is anticipated that the chemical quality of the native groundwater in the injection zone will be at least equal to that of sea water and perhaps even may be several times more concentrated than sea water. All regulatory requirements with regard to design of the well, operating procedures, pressure requirements during injection, and other similar elements will be strictly adhered to during the test program.

Drilling Program

Two drilling methods are being used to construct the well: conventional mud-rotary and air-reverse rotary. The test hole has a diameter of 9 5/8 inches and will have an approximate ultimate depth of 3,300 feet. During the drilling of the upper part of the hole, which was first by the mud-rotary method and later by the air-reverse method after losing circulation, open mud pits were used because the water was still fresh. While drilling below a depth of 1,270 feet, the drilling fluids are being contained in leak proof concrete tanks rather than open mud pits.

An organic based mud "Dristac" is being used for drilling from 2,400 feet to the final depth. After drilling through the Cedar Keys formation to a depth of about 2,000 feet, a blow-out preventer was installed on the 10-inch diameter casing, which was set to a depth of 2,000 feet.

Well Construction

Figure 5.9-1 shows schematically the construction details of the proposed test well. Note that a monitor tube has been installed to a depth of 1,537 feet and that water levels will be collected during the testing phase to provide direct evidence on whether or not the deep injection affects groundwater levels in the shallower beds. The 18-inch diameter surface casing has been installed to a depth of about 195 feet while the 10-inch diameter long-string casing has been installed to a depth of about 2,000 feet. The wall thickness of the surface casing is 0.375 inches and for the long-string casing, 0.365 inches. Both are block steel pipe, with welded joints, conforming to AWWA standard A100-66, with weights of 70.6 lbs./ft. for the surface casing and 40.5 lbs./ft. for the long-string casing. The long-string casing was fitted with half-moon, strap-type centralizers, welded every 20 feet along the lower 100 feet of the casing and every 100 feet along the rest of the casing.

Neat cement was used for the surface casing while the long-string casing was pressure cemented in place, with a moderate sulfate-resistant type concrete used through the deeper zones containing brackish to salty water having a high sulfate content. Pressure cementing in a single

stage was used for the surface casing and for the lower part of the long-string. Successive stages of cementing for the long-string casing was by tremie pipe. The potential injection zone is anticipated to occur at the depth interval from 2,500 feet to 3,300 feet, in the deeper sediments of Cretaceous age, which consist of interbedded limestone, dolomite, sandstone, and shale containing salt water or brine. The porosity and permeability are unknown, but will be determined by the injection tests and the evaluation of geologic and geophysical logs.

Data Collection Program

Drill cutting are collected at each 10 foot interval and at all significant changes in lithology. Duplicate samples are sent to the state geologist in Tallahassee for description of lithology and formation contacts. Side wall cases will be taken in potential confining beds and deeper zones to determine vertical permeabilities and to provide information that will be useful in correlating well bore geophysical logs. The geophysical logs include a selected suite of electrical logs, temperature log, caliper log, natural gamma log, borehole-compensated sonic log or equivalent, and cement-bond log. These logs will be used to help define water quality changes, formation contacts, primary and secondary porosity, fracturing, and numeral identification. In addition the program included the collection of water samples for chemical analysis at intervals of approximately 100 feet to a depth of about 2,000 feet. Other samples will be collected after the hole has been cleaned out for testing purposes. The samples are analyzed by a certified laboratory for standard water quality parameters.

Monitoring to detect any head changes in the formations overlying the confining beds above the injection zone will take place during the testing at a depth of 1,500 feet (Figure 5.9-1). During the injection test, pressures in the test injection well will be monitored by a pressure gage at the well head. If the project proceeds into a long-term injection program, a complete monitoring system will be developed, in coordination with the Suwanee River Water Management District, to provide specific data on pressure changes, temperatures, injection rates, and other factors.

If the testing operations prove successful, RUB proposes to install two permanent injection wells at the site, cased through fresh water and into the deep saline zone. One of the wells will be an operating injection well, with the other left as a stand-by well in the event that a temporary failure of some kind takes place in the operating injection well. The stand-by well also will serve as a monitoring well during long-term injection, so that careful records can be compiled of changes in the potentiometric levels. The stand-by well also will serve to detect the time of arrival of the injected fluid.

If the well is abandoned, it will be plugged and sealed in conformance with regulatory requirements. There are no access roads that would have to be restored, and only a minor amount of regrading would be needed on the small tract that would have been disturbed. All such restoration would take place within a few days after completion of the project.

The principal test will be the injection of fresh water, at rates of up to 500 gpm (gallons per minute), for a minimum of 48 hours. During this test, pressure changes will be monitored by a pressure gage installed at the well head. Drill-stem are not planned tests because it is not critical to know the precise chemical composition of the native water in each specific bed in the potential injection zone. Also, detailed knowledge of formation pressures is not essential because the injection test itself will demonstrate conclusively the rates at which injection can be carried on without exceeding pressure build-up limitations. With regard to fluid compatibility, the blowdown water will be essentially water of the calcium-sulfate type, with a pH of about 6.8. It is not anticipated that precipitation of solids would occur under these conditions, and that in fact the injected fluid may slightly increase the natural permeability of the geologic layers.

Status of Pilot Injection Well Program

A preliminary evaluation of the drill cutting samples and geophysical borehole logs indicate that potential confining units occur from 1,550 feet to approximately 2,500 feet in the Cedar Keys formation, Lawson Limestone, and Taylor Beds.

Throughout the drilling of the test injection well, water quality is being monitored in the field and water samples are being collected for laboratory analysis to aid in identifying zones of fresh, brackish, and salty water. To date, the results of the water quality analysis indicates

that the base of potable water is approximately 1,000 feet below ground surface. Although the water below this depth is not potable, it appears to remain fresh (less than 1,000 mg/l total dissolved solids), to approximately 1,520 feet. At 1,520 feet, sulfate concentrations are significantly higher, which correlates closely with the appearance of sulfate minerals in the cuttings at 1,540 feet. Sulfate concentrations in water samples collected to a depth of 2,024 feet are high and increase significantly wherever evaporite (gypsum and anhydrite) beds were penetrated.

The formation water grades from brackish to salty (greater than 10,000 mg/l total dissolved solids) between the depths of 1,520 and 2,020 feet. At a depth of 2,020 feet a drill-stem water sample was collected which showed a dissolved solids concentration of 17,244 mg/l.

Throughout the drilling of the test injection well, water levels are measured in the borehole to determine the nature of the head gradients with depth.

At present, the proposed program is to collect water samples in the interval from 2,024 feet to the bottom of the well after the mud drilling fluid has been removed. Two techniques will be used for sampling: (1) a thief sampler; and (2) a "repeat information tester" which collects an "in situ" sample of the formational fluid. After completion of drilling, additional tests will be conducted to obtain more quantitative information about the potential confining units, and the hydrologic properties of the potential injection zone.

CHAPTER 7

ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND OPERATION

A large-scale development such as a power plant represents not only a large capital investment, but also a multitude of environmental and socio-economic ramifications associated with the nature of the project activities. Such a project can produce changes in the existing character of the socio-economic structure of the area in which it is to be located. The extent and magnitude of these changes vary; they can be defined as long-term/short-term, local/regional, and primary/secondary. Also, the nature of a significant change, or "impact", can be described as beneficial or adverse. While some impacts associated with a project may stress various segments of the community, other impacts can provide short-term and long-term stability. The generation of new jobs and monies can provide a base for expanded social services, business, and trade, but in other sectors, it can stress community facilities, such as schools, water supply or housing.

The purpose of this chapter is to assess the economic and social effects related to the construction and operation of the proposed Deerhaven Unit 2 generating facility. Existing or baseline conditions are described in Section 7.1. The baseline study specifically addresses four broad subject areas: (1) population characteristics; (2) economic trends such as employment and income; (3) housing; and (4) infrastructure. Section 7.2 discusses the potential social and economic impacts likely to occur as a result of Deerhaven Unit 2. Specific emphasis is placed upon analyzing the internal project costs and benefits, population, employment, wages and income, housing, infrastructure, and attitudes.

7.1 Study Area Profile

Defining an appropriate study area is an important step in the socio-economic impact assessment process. The particular geographical areas chosen must reflect consideration of the locations in which impacts are likely to occur. Ordinarily, these impacts result from construction worker and permanent employee in-migration, and are a function of the supply (capacity) and demand characteristics of an area's public services.

For example, a power plant built within a highly metropolitan area usually has the advantage of a readily available labor force. This tends to reduce the number of workers and their families that must relocate and, consequently, decreases the need for new community infrastructure. Furthermore, those persons who do migrate represent a relatively small incremental increase in demand on the wide range of services which exist in urban areas. Conversely, the more rural an area, the more likely it is that it will experience impact from a project of any given size.

As Figure 7.1-1 shows, the proposed Deerhaven Unit 2 plant site is located on U.S. Highway 441 between Alachua and Gainesville. With a 1976 population of 70,228, the City of Gainesville represents by far the largest close urban center (University of Florida, 1976a). Gainesville was therefore considered to be the area likely to receive the most concentrated socio-economic impacts. For this reason, it was chosen as the primary impact study area. Based upon a number of factors, including

typical commuting characteristics of construction workers (Environmental Research and Technology, 1976; Tennessee Valley Authority, 1976; Woodward-Clyde Consultants, 1975), the secondary study area was chosen to be Alachua County, and includes Alachua, Archer, Hawthorne, High Springs, LaCrosse, Micanopy, Newberry, and Waldo.

7.1.1 Population

Alachua County has grown substantially since 1950. Population rose by 30% from 1950-1960, 41% from 1960-1970, and 26% from 1970-1976 (North Central Florida Regional Planning Council, 1976c; University of Florida, 1976a). Of this increase (1970-1976), totaling over 26,000, approximately 79% resulted from in-migration (North Central Florida Regional Planning Council, 1976c, Table R13). During the period 1970-1976, Florida's population increased by approximately 26% per year (University of Florida, 1976b; Smith, 1977). Gainesville's population grew by 8.9% from 1970-1976 (Table 7.1-1), however, its share of county population shrank from 62% in 1970 to 53% in 1976, in part because of the accelerating growth of unincorporated suburban areas. During the same period, unincorporated areas grew by over 60%, reflecting the outward expansion of the City. Table 7.1-1 illustrates the contributions to growth made by incorporated cities and towns.

The population density of Alachua County in 1975 was 142.8 people per square mile, as compared with a statewide figure of 156.9 people per square mile, and a national average of 60.3 people per square mile

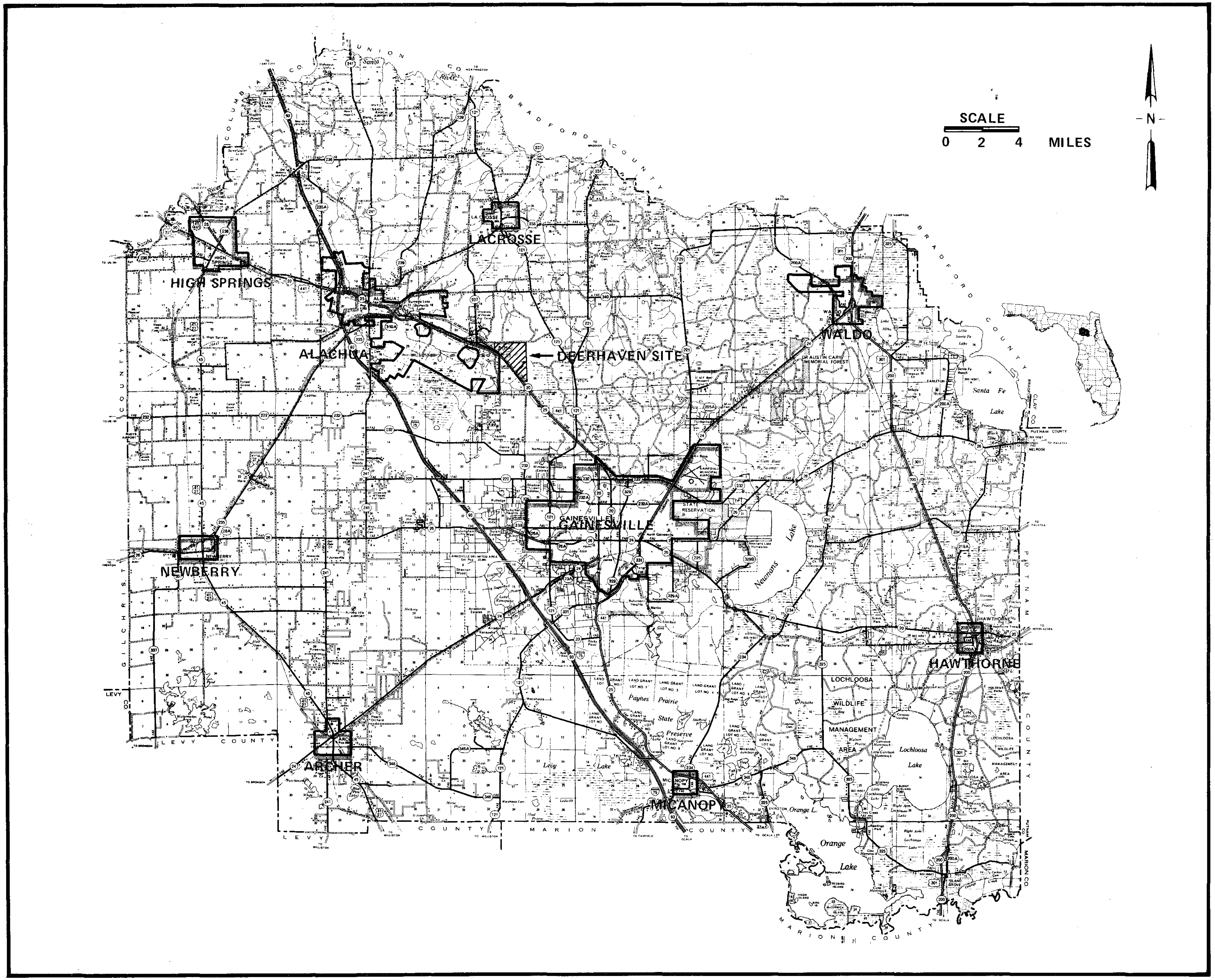

FIGURE 7.1-1 STUDY AREA.

Table 7.1-1 Alachua County Population

	April 1970	July 1976	Percent Change
Alachua County	104,764	131,552	26
Alachua	2,252	3,169	41
Archer	898	1,028	14
Gainesville	64,510	70,228	9
Hawthorne	1,126	1,328	18
High Springs	2,787	3,000	8
LaCrosse	365	360	(1)
Micanopy	759	837	10
Newberry	1,247	1,569	26
Waldo	800	944	18
Unincorporated	30,020	49,089	64

Source: University of Florida, 1976a.

( ) = negative value

(North Central Florida Regional Planning Council, 1976c). This county level is somewhat high, particularly since the statewide density (only slightly higher than Alachua County) includes the heavily populated coastal regions.

The age group distribution in Alachua County shows that, from 1970-1975, the number of individuals in the 15-24 age group increased, most rapidly, by approximately 37% (Table 7.1-2). Over the same period, growth in the number of residents in the 25-54 age group was approximately 34% (North Central Florida Regional Planning Council, 1976c). Although the Alachua County-Gainesville area is becoming increasingly desirable as a retirement area, it is noted that the number of residents over 65 years of age increased by only 27% during the 1970-1975 period.

A number of different population projections for Alachua County have been developed by various agencies and research groups. These include the North Central Florida Regional Planning Council, the Bureau of Economic Research, the City of Gainesville's Department of Community Development, the Alachua County Comprehensive Plan, and the Bureau of the Census. In general, such estimates differ in terms of assumptions, modeling techniques utilized, and conclusions reached. This generates a range of possible or expected outcomes. As events capable of influencing future economic conditions develop, the projections may vary accordingly.

Table 7.1-2 Age Group Distribution Alachua County, 1950-1975

Age Groups	1950	1960	1970	1975
0-14	15,197	22,531	27,646	28,228
15-24	13,648	17,396	30,298	41,416
25-54	21,421	24,795	33,333	44,577
55-64	3,290	4,673	6,903	8,246
65+	3,470	4,679	6,584	8,371
Total	57,026	74,074	104,764	130,838

Source: North Central Florida Regional Planning Council, 1976c.

Population projections developed by the University of Florida's Bureau of Economic and Business Research were selected for analysis in this study, essentially because this set of estimates expresses the average of most other available population studies, and offers a high-medium-low range for each year shown (Table 7.1-3). Alachua County's population may reach 188,200 by 1990 (high estimate), which represents an annual average growth rate of about 2.7%. The low growth projection, also through 1990, would reflect a yearly growth rate of slightly more than 1%.

7.1.2 Economy

Employment

Because agricultural activity represents a small portion of overall Standard Metropolitan Statistical Area (SMSA) employment, the following discussion generally relates to industrial or nonagricultural jobs. However, in terms of total employment, it is noted that in March 1977, total SMSA employment was 61,700 (Gainesville SMSA Labor Market Trends). Also in 1977, it is estimated that there are approximately 1,000 agricultural jobs, comprising 1.6% of total SMSA civilian employment (personal communication with Dennis Harmon, Labor Market Analyst, State of Florida Department of Commerce).

Historically, the period 1960 through 1970 was characterized by strong, steady growth in the number of nonfarm jobs in the Gainesville SMSA. During this interval, an average of 1,500 jobs per year were generated. Over 40% of this annual average increment was attributable to activity

Table 7.1-3 Population Growth Estimates, Alachua County

	Estimate July 1, 1976	1978	1980	1985	1990	1995	2000
Alachua County	131,552						
Low		133,500	135,500	141,800	152,900	162,100	170,900
Medium		135,100	141,400	153,400	170,600	183,900	197,500
High		139,600	147,700	165,000	188,200	208,900	228,900

Source: Smith, 1977.

within the government sector (Gainesville SMSA Labor Market Trends). The period 1970 through 1974 produced even stronger growth, with nonfarm employment increasing by an average of 4,200 jobs per year (Gainesville SMSA Labor Market Trends, 1977).

Between 1974 and 1976, Alachua County experienced an economic recession, with manufacturing and contract construction each losing approximately 1,000 total jobs. By 1976, government activity began to reflect the effects of the recession, and growth in government jobs leveled off.

Among Gainesville SMSA nonagricultural employees, 48.5% were employed by government in 1976. By contrast, government employment in the entire State of Florida accounted for only 19.8% of nonagricultural workers. Nationwide, the percentage of government workers among nonagricultural employees was 19.1% (Florida State Employment Service, no date). Table 7.1-4 summarizes the 1976 industrial composition of total nonagricultural workers for the Gainesville SMSA, the State of Florida, and the Nation.

From 1976 through March 1977, the local economy began to recover, and total SMSA employment among nonagricultural establishments increased by 1,800 jobs, 1,200 of which were in the government sector. No other single industrial group showed such a significant employment increase. For the purposes of this study, it is therefore assumed that the data presented in Table 7.1-4 generally reflect current employment levels.

Table 7.1-4 1976 Industrial Composition of Nonagricultural Employment: Gainesville SMSA, Florida, and Nation

	Gainesville SMSA Average Number of Employed	Gainesville SMSA Percent of Total	Statewide Percent of Total	Nationwide Percent of Total
Total	53,000	100.0	100.0	100.0
Contract Construction	2,500	4.7	6.6	4.3
Manufacturing	3,900	7.4	12.3	24.0
Durable Goods	2,600	4.9	6.2	13.9
Nondurable Goods	1,300	2.5	6.1	10.1
Transportation, Communication, Electric, Gas & Sanitary Services	1,500	2.8	6.5	5.7
Trade	10,600	20.0	26.1	22.1
Wholesale	1,700	3.2	5.6	5.4
Retail	8,900	16.8	20.5	16.7
Finance, Insurance & Real Estate	2,300	4.3	6.8	5.5
Services, Mining & Miscellaneous	6,500	12.3	22.5	19.3
Government	25,700	48.5	19.8	19.1

Sources: Estimates by Labor Market Analyst, Florida Department of Commerce; Current Employment Statistics Program, Office of Research and Statistics, Division of Employment Security; Employment and Earnings, Bureau of Labor Statistics, as quoted in ANNUAL PLANNING REPORT, Gainesville SMSA, Florida State Employment Service. (unpublished report).

In general, Table 7.1-4 shows that percentage components of industrial employment within the Gainesville SMSA were significantly less than State and nationwide percentages. For example, manufacturing accounted for only 60% of statewide levels, and only 31% of the nationwide figure. Proportionate employment within the services sector was less than 50% of state composition.

Table 7.1-5 summarizes employment by general occupational class for 1970 and 1974, and presents employment estimates for 1977 and 1978, and a projection for 1985. Data are reported for two general job areas: "Crafts and Kindred Workers" and "Operatives". These categories were focused upon since they describe the bulk of the expected Deerhaven Unit 2 construction force. A more complete breakdown, showing employment by occupational title, may be found in Appendix Table A7-1, which contains roughly 140 additional specific job categories.

It is anticipated that medical, health, and educational services will show relatively large employment increases through 1985. On the other hand, categories such as trade contractors, general contractors (heavy), and general building contractors are not expected to increase substantially. Table 7.1-6 illustrates this trend and lists the 20 Gainesville SMSA industries expected to show the largest employment increases through 1985. Through 1978, however, contract construction may realize rapid short-term growth in employment. Several projects within the SMSA have received funding through the Public Works Employment Act, and could

Table 7.1-5 Employment By Crafts and Operatives, Gainesville SMSA

	1970	1974	Est. 1977	Est. 1978	Projected 1985
Crafts and Kindred	3,742	5,780	6,710	7,040	9,180
Construction Crafts	1,665	2,690	3,120	3,260	4,310
Blue Collar	316	440	520	540	710
Metalworking Craft	117	140	180	180	250
Mechanics, Repairers, Installers	893	1,360	1,550	1,620	2,070
Printing Trade Crafts	68	80	90	100	130
Transportation Public Utility Craft	322	560	650	670	880
Other Crafts, Kindred	361	510	600	620	830
Operatives (Excludes Transportation)	2,897	3,540	4,200	4,410	5,960
Semiskilled Metal Working	91	160	180	190	240
Semiskilled Textile	--	--	--	--	--
Semiskilled Packing and Inspecting	276	310	360	380	520
Other Operatives	1,455	1,650	1,960	2,060	2,770
Transportation Equipment Operatives	1,075	1,420	1,700	1,780	2,430

Source: Unpublished data compiled by Office of Research and Statistics, Florida Department of Commerce.

Table 7.1-6 Twenty Gainesville SMSA Industries Expected to Show Largest Employment Increases: 1974-1985

	Rank According to Additional Jobs Provided	Projected Employment Increase 1974-1985	Ave. Ann. Employment Increase 1974-1985	Percent Increase in Employment 1974-1985
Medical & Other Health Services	1	5,903	537	97
Education Services	2	4,968	452	49
Eating & Drinking Places	3	1,992	181	85
Local Public Administration	4	1,757	160	109
Elect. Machinery Manufacture	5	1,281	116	54
Misc. Business Services	6	1,012	92	127
Retail Food & Dairy Stores	7	813	74	50
Utilities & Sanitary Services	8	788	72	93
Auto Dealers, Gas Stations	9	783	71	58
Misc. Retail Stores	10	772	70	55
Retail Gen. Merchandise Stores	11	762	69	49
Spec. Trade Contractors	12	677	62	29
Gen. Contractors (heavy)	13	655	60	61
Hotels & Lodging Places	14	650	59	60
Gen. Building Contractors	15	619	56	40
Insurance	16	611	56	75
Non-profit Organizations	17	569	52	92
Professional Services (Other than Business, Legal, Medical)	18	448	41	47
Communications	19	431	39	45
Banking	20	390	35	75

Source: Florida State Employment Service (unpublished report), no date.

generate approximately 700 short-term jobs (Harmon, 1977). Should this occur, it would signify an average annual employment increase of 14% through 1978. This number is based upon the contract construction work force of 2,500 (Table 7.1-4). If employment increased to 3,200 over a 2 year period, it would average to about 14% per year.

In March of 1976, the unemployment rate within Alachua County was 6.3%. By March of 1977, however, this rate had dropped by nearly one-third to 4.4%, reflecting the strong 1976-1977 economic recovery (Gainesville SMSA Labor Market Trends). It is estimated that by 1978, the SMSA unemployment rate could rise to 5% among all persons 16 and over, and to 8.4% among workers of ages 20-24 (Table 7.1-7) (Harmon, 1977).

Statewide, the unemployment average in March of 1976 was 11%, down only 0.8% from the previous year. The national unemployment rate in January 1976 was 8.3%, or nearly twice the Gainesville SMSA rate (unemployment figures are seasonally adjusted).

As may be expected, the most extreme surplus of job seekers is currently among unskilled or marginally skilled individuals, while the greatest undersupply occurs among highly skilled applicants. Thus, while general construction labor is often in great supply, craftsmen such as skilled carpenters or sheet metal workers are sometimes difficult to locate (Harmon, 1977).

Table 7.1-7 Projected 1978 Unemployment Rates for Selected Segments of SMSA Labor Force

	Projected Share of Labor Force (%)	Projected Share of Unemployed (%)	Projected Number of Unemployed	Projected Unemployment Rate (%)
Total (Persons 16+)	100.0	100.0	3,300	5.0
Whites	83.7	82.5	2,721	4.9
Nonwhites	16.3	17.5	579	5.3
Males	54.0	47.1	1,554	4.3
Females	46.0	52.9	1,746	5.7
White Males	45.8	41.3	1,364	4.5
Nonwhite Males	8.2	5.8	190	3.5
White Females	37.9	41.1	1,357	5.4
Nonwhite Females	8.1	11.8	389	7.2
Ages: 16-19 yrs	9.6	23.7	781	12.2
20-24 yrs	23.3	39.5	1,305	8.4
25-34 yrs	26.1	16.2	533	3.1
35-44 yrs	15.3	7.6	251	2.5
45-64 yrs	22.9	10.8	358	2.4
65+ yrs	2.8	2.2	72	3.9

Sources: Projected by Labor Market Analyst, Florida Department of Commerce; Current Employment Statistics Program, Office of Research and Statistics, Division of Employment Security; Employment and Earnings, Bureau of Labor Statistics, as quoted in Annual Planning Report, Gainesville SMSA, Florida State Employment Service (unpublished report).

Income

Personal income is defined as the total income received from all sources by residents of an area before the deduction of income taxes and other personal taxes, but after the deduction of personal contributions to social security and other social insurance programs. Personal income is a useful economic indicator in that it provides an understanding of relative consumer access to goods and services.

Personal income within the Gainesville SMSA increased by 134% from 1950-1960, 165% from 1960-1970, and 102% from 1970-1975 (State of Florida, Department of Commerce, Bureau of Economic Analysis). Table 7.1-8 shows personal income by major sources for the period 1970 through 1975, as well as per capita income for the Gainesville SMSA. It is estimated that total SMSA personal income will reach $543 million (1967 dollars) in 1980, and $859 million (1967 dollars) by 1990 (University of Florida, 1976b).

The SMSA percentage distribution of personal income for 1974 is presented below, and it is noted that the overwhelming share of personal income (47%) is derived from government activity (University of Florida, 1976b).

Table 7.1-8 Gainesville SMSA Personal Income, 1970-1975 (Thousands of Dollars)

	1970	1971	1972	1973	1974	1975
By Type						
Wage and Salary Disbursements	250,918	281,974	343,191	410,586	456,322	488,415
Other Labor Income	7,826	9,269	12,166	14,569	17,465	19,265
Proprietors Income	20,954	23,529	25,081	33,061	30,258	32,613
Farm	3,551	5,024	4,327	7,234	6,662	7,018
Nonfarm	17,403	18,505	20,754	25,827	23,596	25,595
By Industry						
Farm	6,073	7,327	6,801	9,954	9,676	10,088
Nonfarm	273,625	307,445	373,637	448,262	494,369	530,205
Private	138,162	154,096	185,376	229,372	253,728	260,339
Manufacturing	24,870	24,262	28,435	35,171	41,200	39,793
Mining	(A)	313	427	545	625	538
Contract Construction	17,771	21,652	31,288	38,600	35,758	29,056
Wholesale and Retail Trade	39,961	45,082	52,306	62,066	68,808	76,234
Finance, Insurance, and Real Estate	11,246	13,382	16,786	20,094	23,376	24,518
Transp., Comm. & Public Util.	11,311	12,524	13,843	16,854	19,507	19,485
Services	31,409	35,585	40,545	53,009	61,657	68,133
Other Industries	(A)	1,296	1,745	3,033	2,797	2,582
Government	135,463	153,349	188,262	218,890	240,641	269,368
Federal, Civilian	16,207	19,249	22,762	24,085	25,610	28,670
Federal, Military	2,503	2,681	3,090	3,295	3,550	3,887
State and Local	116,753	131,419	162,410	191,510	211,481	236,309
Personal Income by Place of Residence	308,303	351,600	422,808	509,706	567,677	623,604
Per Capita Income	2,917	3,302	3,654	4,214	4,545	4,813
Total Population (Thousands)	105.7	106.5	115.7	121.0	124.9	129.6

Source: State of Florida, Bureau of Economic Analysis, Regional Economics Information System.

(A) Information not disclosed.

Farm Total	2.71
Nonfarm Total	97.29
Manufacturing	8.09
Services	12.43
Contract Construction	7.06
Wholesale, Retail Trade	13.55
Finance, Insurance, Real Estate	4.73
Government	47
Other	4.43

Between 1970 and 1975, as population in the Gainesville SMSA increased by around 23%, per capita income increased by 65%. This represented an average increase of 13% per year. In 1973 and 1974, per capita income was 84% of the national average. During this same period, Florida per capita income was 99% of the national figure (University of Florida, 1976b).

Figure 7.1-2 shows the rise in the Gainesville SMSA per capita income for 1950 through 1975. This trend is derived from information presented in Table 7.1-8, and in the 1976 Florida Statistical Abstract, and points out the accelerating rate of growth. For example, between 1950 and 1965, personal income grew at a compound rate of 5.3% per year. Between 1965 and 1975, however, compound growth was 10.3%.

Local Government

Within Alachua County there are ten local governments, the county government and nine incorporated municipalities. Municipalities range in population size from about 360 in LaCrosse to over 70,000 in the City of Gainesville, the county seat (Table 7.1-1). Alachua County has a number of elected constitutional officers, including county and circuit

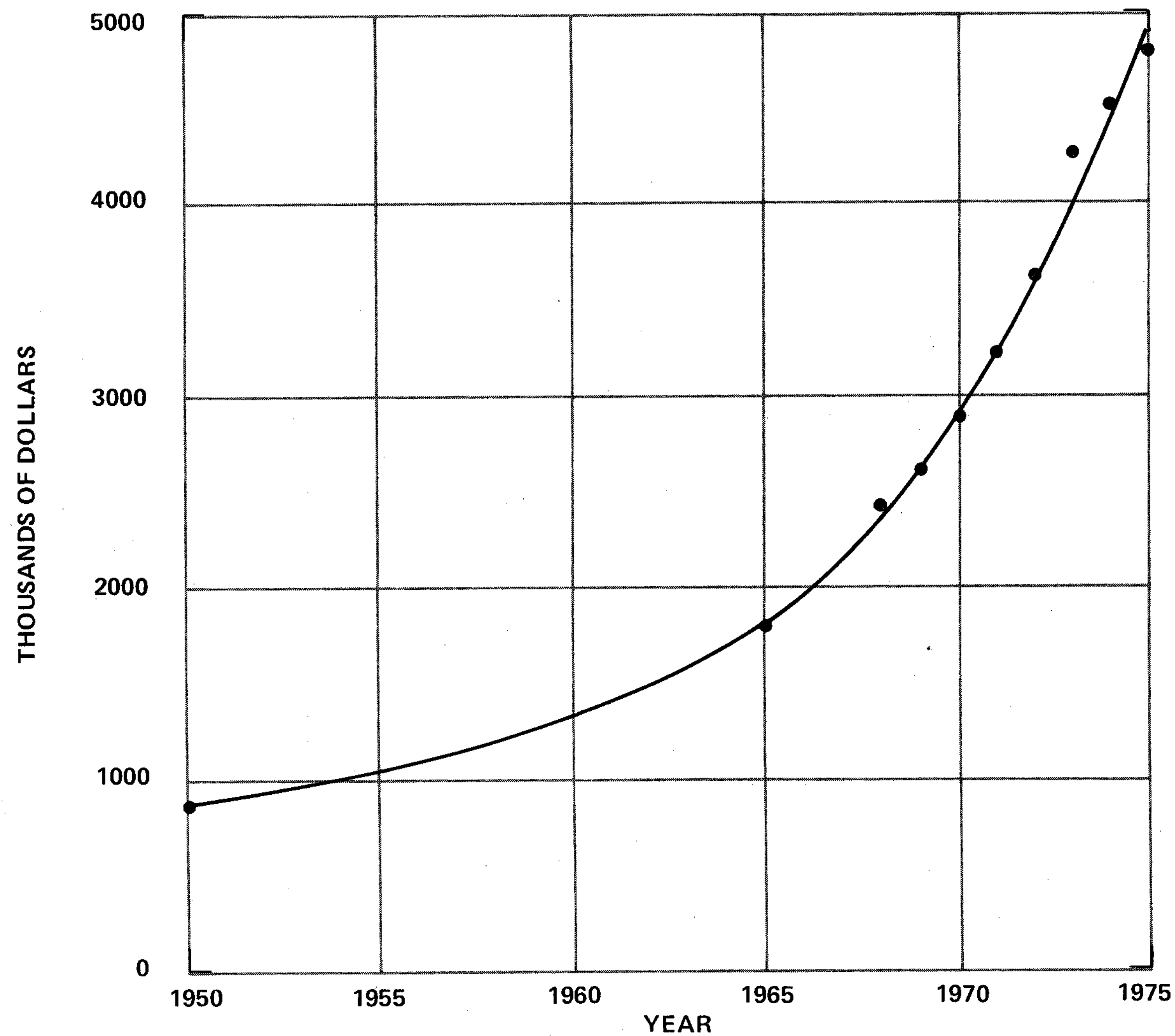

FIGURE 7.1-2 GAINESVILLE SMSA PER CAPITA INCOME, 1950-1975.

judges, clerk of the circuit court, sheriff, tax assessor, tax collector, and the supervisor of elections.

The City of Gainesville operates under a council-manager plan. The governing body is a five member commission, elected at-large for staggered three-year terms. The commissioners elect a mayor among themselves to serve a one-year term. The City Manager is appointed by the Gainesville City Commission and oversees the government operations.

In 1972, the City of Gainesville and Alachua County entered into an Interlocal Agreement establishing RUB for utilities services within the county. RUB is composed of the five Gainesville City Commissioners and the five Alachua County Commissioners. Under this interlocal agreement, RUB assumed responsibility for providing electric, water, and sanitary sewer services on a regional basis where needed in the city and throughout the unincorporated areas of the county.

7.1.3 Housing

The basic types of housing in Alachua County can be classified as single-family, multifamily, and mobile homes. The following discussion presents housing characteristics of the county in terms of these types.

Single-family homes are the predominant dwelling unit in Alachua County, although since 1960 they have declined as a percentage of all housing units. For example, single-family residences accounted for 76% of all

units in 1950, 82% in 1960, 69% in 1970 and about 59% in 1975 (North Central Florida Regional Planning Council, 1976a). Consistent with their decline as a percentage of all housing units, the growth rate for single-family units has been below that of multifamily units and mobile homes since 1960. The increase in single-family units was 29% from 1960-1970 and 20% from 1970-1975 (North Central Florida Regional Planning Council, 1976a).

Multifamily units have increased substantially in Alachua County, from 21% of all housing units in 1950 to 29% in 1975. From 1960-1970, the growth rate for multifamily units was 147%, greatly exceeding the 29% growth rate for single-family units. This trend has continued in the 1970's (North Central Florida Regional Planning Council, 1976a).

Mobile homes have recently experienced the county's highest growth rate, increasing by 88% from 1950-1960, 206% from 1960-1970, and 186% from 1970-1975. However, as a proportion of total housing units, there are still fewer mobile homes than multifamily and single-family units. Within the urban area of Alachua County, mobile homes are fast becoming the most economical alternative to single-family homes. This is reflected in a county-wide increase in mobile homes of 186% from 1970-1975. The majority of these are found in mobile home parks in the urban area, with scattered-site units in the rural portion of the county (City of Gainesville, Department of Community Development, 1976).

Table 7.1-9 summarizes the housing statistics for Alachua County. The rapid growth of multifamily and mobile homes in Alachua County since 1960 can be largely attributed to increased enrollments at the University of Florida and Santa Fe Community College. In 1975, the University of Florida adopted a new enrollment policy limiting all education programs to a combined base enrollment of 27,000 students. Once that limit has been reached, student body increases will be allowed at a rate of 2% annually. The effect of this policy is to slow down multifamily construction unless an impetus is provided by another source. It should be noted that the number of construction permits issued in the early 1970's for the Gainesville urban area indicates that housing activity has fluctuated, with peaks in 1971 and 1972. Most of this fluctuation was due to variations in multifamily unit construction.

A U.S. Postal Survey conducted in the Gainesville area on November 17, 1976 indicates the vacancy rates of residences and apartments. The survey is based on reports of individual mail carriers covering a total of 38,812 possible deliveries, and shows Gainesville area vacancy rates for 1975 vary from 1.8% (residences) to 3.5% (apartments). For 1976 vacancy rates range from 2.8% (residences) to 4.5% (apartments). The vacancy rate considered ideal to allow for market flexibility ranges from 5% to 6% (U.S. Postal Service, 1977).

In the past four years, new single-family home building has been strongest outside Gainesville's city limits. Recently, construction has begun to

Table 7.1-9 Housing Statistics--Alachua County

Housing Characteristics	1950 Number	1950 Percent	1960 Number	1960 Percent	1970 Number	1970 Percent	July 1975 Number	July 1975 Percent
Total Population	57,026		74,074		104,764			
Total Housing Units	15,988	100.0	21,978	100.0	33,538	100.0	47,312	100.0
Total Occupied Units	14,811	92.6	19,888	90.5	31,115	92.8	44,189	93.4
Vacant	1,145	7.2	2,045	9.3	2,405	7.2	3,123	6.6
Other*	32	.2	45	.2	18	**	--	--
Housing Types								
Single Family	12,251	76.6	17,987	81.8	23,271	69.4	27,833	58.8
Multifamily	3,379	21.1	3,319	15.1	8,203	24.5	13,627	28.8
Mobile Homes	358	2.3	672	3.1	2,046	6.1	5,852	12.4
Public Housing Units	0		0		785	2.3	785	1.7

Sources: North Central Florida Regional Planning Council, 1976a, personal communications with Gail Monahan, Executive Director, Gainesville Housing Authority and Scott Koons, North Central Florida Regional Planning Countil, September 23, 1977.

*Includes seasonal and migratory housing units.

**Trace

NOTE: "Housing Types" for 1970 does not add up to "Total Housing Units" because of apparent differences in data reporting methodology.

move beyond the urban area into the rural county. The new multifamily apartments are clustered in the southwest quadrant, near the University of Florida, and in the northern section of the city.

Prices for homes in the urban area have accelerated rapidly. The median sales price of a new home in 1976 reached $38,500, and the average resale home cost was $36,000. Over 40% of the homes listed for sale in 1976 were over the $45,000 range, as compared to about 17.5% nationally (City of Gainesville, Department of Community Development, 1976).

Rents are higher in the Gainesville area than in other north Florida cities. The University of Florida Off-Campus Housing Office reports that average rents range from $167 per month for an unfurnished one-bedroom apartment to $355 per month for unfurnished four-bedroom apartments. Most of the rental units surveyed by the University of Florida (over 90%) were in large apartment complexes located within the Gainesville city limits. Apartment units in older duplexes, triplexes and converted single-family homes rent for somewhat less.

An important source of rental units in the Gainesville urban area is the single-family home. Older housing, along East University Avenue and east of the campus of the University of Florida, draws the lowest rents. Homes in the southeast quadrant and the area north of the center of the city rent for $150 to $250 per month, middle income range. Rentals in the northwest and southwest, with newer units closer to the University

campus, command higher rents (City of Gainesville, Department of Community Development, 1976). The 1970 census revealed that 42% of the rental units in Alachua County were single-family homes. In the City of Gainesville, 34% were single-family homes.

The cost of mobile homes in the Gainesville urban area is below the national average. Costs range from $10.42 to $11.4 per square feet as compared to the national average of $12.50 per square feet.

Future housing requirements for the Gainesville urban area are projected in Table 7.1-10. Table 7.1-11 indicates the number of building permits authorized in the Gainesville urban area between 1970 and 1975. The historical trend has been that about 90% of the permits granted are actually translated into construction starts. Assuming the projections made on Table 7.1-10 are accurate, more housing starts than the number shown on Table 7.1-11 must be commenced in the future to meet the demand of the next ten years.

7.1.4 Infrastructure

Education

All public school facilities providing instruction for grade levels K-in Alachua County are under the direction of an elected Board of Public Instruction. Existing facilities consist of 20 elementary (K-5), 6 middle (6-8) and 6 secondary (9-12), of which 3 of the preceding 32 facilities are special education schools (Table A7-2) (North Central

Table 7.1-10 Gainesville Urban Area Housing Requirement Projections

	1975-80	1980-85
1. Population growth during the projection period:	15,841 - 19,876	19,000 - 30,028
2. Estimated number of new household formations during projection period:	4,982 - 6,408	8,541 - 12,653
3. Estimated total number of housing units required during projection period:	5,425 - 6,903	9,104 - 13,362
Annually:	1,085 - 1,380	1,821 - 2,672
Annually: (1975-85)[1]	1,453 - 2,026	
4. Total annual effective demand for new sales units:[2]	660 - 931	
$30,000 - 40,000	106 - 149	
40,000 - 50,000	132 - 186	
50,000 - 60,000	125 - 177	
60,000 - 70,000	118 - 168	
70,000 - 80,000	79 - 112	
80,000+	100 - 139	
5. Total annual effective demand for rental units:	793 - 1,095	
$150 - 179	31 - 43	
180 - 209	207 - 286	
210 - 239	265 - 366	
240 - 269	159 - 221	
270 - 299	74 - 100	
300+	57 - 79	

[1] Annual demand for 10 year period, 1976-1985. Figures are an average of the low and high projections for 1975-80 and 1980-85.

[2] The new sales:rental ratio is 45%:55% (average over 10 years). In 1975, the City had an owner:renter ratio of 49%:51%. It is assumed that tenure shift will lean towards rentals, particularly in the 1975-80 period, based upon the growing gap between real income and the high cost of new housing. Home ownership may represent a higher percentage from 1980 to 1985.

Table 7.1-11 Units Authorized by Building Permits
Gainesville Urban Area

	Number of Permits			
	Single-Family Units		Multifamily Units	
Year	GUA	City	GUA	City
1970	494	220	105	85
1971	660	230	2,765	1,350
1972	794	206	1,636	678
1973	668	111	445	144
1974	602	118	} 487	109
1975	575	92		78

Source: City of Gainesville, Department of Community Development, 1976.

Florida Regional Planning Council, 1976a). Overall enrollment numbers are approximately 14% below capacity. Elementary school enrollment represents 45% of the total public school enrollment, with the middle and secondary schools representing 23% and 32%, respectively.

Historical and projected school system enrollments for Alachua County are shown on Table 7.1-12. As can be seen, enrollments increased between 1950 and 1970, and stabilized after 1970 (actually, a slight decrease was realized). In addition, the percentage of elementary age students has been decreasing since 1950.

The two main higher educational institutions in Alachua County are the University of Florida, with an enrollment of 28,514 (1975 estimate), and Santa Fe Community College, with an enrollment of 6,171 (1975 estimate) (North Central Florida Regional Planning Council, 1976a).

For 1974-1975, the expense per full-time student (grades K-12) was $1,270 (University of Florida, 1976b). The estimated ration of instructional staff to pupils for 1974 was 1:19 (University of Florida, 1976b). For 1977, this ration is estimated to be 1:20, and includes all instructional staff except aids. Also for 1977, the expense per full-time student (grades K-12) has risen to $1,355 (Personal Communication with Mr. Lanny Alcorn, Director of Personnel, Board of Education).

Table 7.1-12 Historical and Projected School System Enrollments, Alachua County

Year	Total Enrollment (K-12)	Percent Change
1950	10,182	--
1955	12,439	+22
1960	15,676	+26
1965	19,971	+27
1970	22,481	+13
1975-76	22,040	-2
1976-77	21,922	-0.5
1977-78	21,723	-1
1978-79	21,321	-2
1979-80	20,991	-2

Source: North Central Florida Regional Planning Council, 1976a; University of Florida, 1976b.

Law Enforcement

Law enforcement services in Alachua County are provided by several city police departments and the Alachua County Sheriff's Office. The cities of Gainesville, Waldo, LaCrosse, High Springs, and Alachua maintain individual police departments while the sheriff's office is responsible for the balance of the remaining cities and all of the unincorporated areas of the county. In 1975 there were a total of 286 sworn officers in Alachua County, representing a ratio of 2.19 officers per 1,000 individuals. This is approximately the same as the number recommended by the Federal Bureau of Investigation of 2.1 officers per 1,000 individuals (North Central Florida Regional Planning Council, 1976a; Personal communication with City of Alachua Sheriff's Office, 10-5-77).

Fire Protection

The unincorporated areas of Alachua County are provided fire protection service through contractual agreements with the City of Gainesville and volunteer fire departments in each of the smaller municipalities. A total of ten fire and rescue service districts are now established by the Alachua County Department of Public Safety to provide fire protection. The Gainesville urban area comprises one district and is serviced by five fire stations located in and operated by the City of Gainesville. The remaining nine districts are served by a single volunteer fire station each. There are 325 fire fighters in the county (North Central Florida Regional Planning Council, 1976a).

Health Care

Table 7.1-13 presents statistics regarding the medical services of Alachua County. As can be seen, the ratios of various medical services to population for Alachua County exceed those of the State of Florida.

An important part of the health care provided by a community relative to construction projects is its emergency rescue and medical services. The Alachua County Department of Public Safety and the Alachua Ambulance Service, Inc. provide emergency ambulance service throughout the county. A total of six ambulances and one emergency transport vehicle are owned by the county and leased to the Alachua Ambulance Service. In addition to the ambulance service, the county has established a "Rapid Response" service which operates an emergency vehicle in each of the ten fire and rescue districts. The units are manned and operated by volunteer or regular fire department personnel from the district which they serve. These units are not equipped to transport victims to the hospitals (North Central Florida Regional Planning Council, 1976a).

Transportation

Alachua County is served by Interstate 75, which has seven active points of access; four other major U.S. highways (U.S. 441, U.S. 301, U.S. 41, U.S. 27); nineteen state roads; and many local service roads.

Two factors which may be indicative of major traffic problems are the presence and location of congestion. There are at least five locations

Table 7.1-13 Alachua County Medical Statistics

Number of Physicians per 1000 population (1975)	4.30 (1.49)*
Number of Dentists per 1000 population (1975)	0.55 (0.46)
Number of Registered Nurses per 1000 population (1975)	9.65 (5.25)
Number of Licensed Practical Nurses per 1000 population (1975)	3.39 (2.52)
Number of General Hospitals (1974)**	3
Number of Long-Term Care Facilities (1974)	3
Number of Beds at General Hospitals (1975)	1,061
Number of Beds at Long-Term Care Facilities (1974)	332

*Denotes State of Florida Averages.

**In addition to the three general hospitals shown above, there is a Veterans Administration Hospital in Gainesville which has approximately 480 beds.

Sources: University of Florida, 1976b; the Gainesville Chamber of Commerce, 1977.

in Alachua County where traffic congestion is a serious problem (North Central Florida Regional Planning Council, 1976a). These areas are (1) the central business district of Gainesville, where high volumes of traffic are characteristic; and (2) northwest and southwest 13th Street, where high volumes of vehicular traffic are in conflict with pedestrian bicycle movement, as well as the high-volume curb cuts created by strip commercial developments; (3) West University Avenue at NW 34th Street, where both roads experience high traffic volumes; (4) Archer Road, where high volumes of traffic are generated by high density residential and commercial development; and (5) Hawthorne Road, where average daily traffic volumes exceed design capacity. Work is underway to widen Archer Road and Hawthorne Road to four lanes and to provide left turn facilities. When completed, these areas will be able to more safely handle large volumes of traffic.

Present locations noted for high incidence of accidents (25 or more annually) are: (1) Archer Road near its intersection with West 34th Street; (2) U.S. 441 at its intersection with I-75 west of the City of Alachua; and (3) within the City of Gainesville along University Avenue and along SW 34th Street.

Traffic accidents in the county numbered 3,817 in 1974, with 2,603 of these occurring in the City of Gainesville. From January through August 1975, 3,874 accidents occurred in the county, of which 2,246 were in the City of Gainesville. These figures reflect a county increase of 1.5%

over the 1974 rate and a decrease in the City of 14% (North Central Florida Regional Planning Council, 1976a).

The largest generators of traffic in Alachua County are the educational institutions (the University of Florida and Santa Fe Community College), the Veterans Administration Hospital, the central business district of Gainesville, and the major shopping areas such as the Gainesville Mall. Specific points outside the urban area that are considered to be traffic generators are the General Electric plant near Hague and the small incorporated cities (North Central Florida Regional Planning Council, 1976a).

Most traffic in Alachua County is generated by trips originating within the county, and most of these trips terminate within the Gainesville urban area. The vast majority of internal-external trips (trips with one terminus inside the county) will be carried mainly on five principal routes: U.S. 441 north and south, SR 24 north, SR 20 east, and SR 26 west. The vast majority of external-external trips (trips having both of their termini outside the county) will be in a nort-south direction (North Central Florida Regional Planning Council, 1976a).

7.2 Impact Assessment

7.2.1 Project Parameters

A major determinant of the extent of the impact that construction and operation of a power plant will have on an area is obviously the absolute

size of the project. Other important considerations are the size and composition of the labor force required, the number of workers that may be added to the local populace, and the project schedule. The purpose of this section is to identify these types of key parameters to serve as the foundation for the following impact assessment. It is important to emphasize that conservative estimates will be utilized throughout, in an attempt to avoid any overestimation of the benefits while at the same time accounting for the "worst-case" impact potential.

Schedule

Timing of construction for the proposed unit influences not only the degree of impact, but also the duration of increased demands upon community facilities. Figure 7.2-1 illustrates that construction is projected to begin during the summer of 1978 and end in the early part of 1981. This figure also estimates the annual construction work force requirements for the construction period.

Direct Employment

Peak construction employment is expected to reach approximately 350 workers. The composition of the construction work force is shown in Table 7.2-1 as a percentage of the total estimated man-hours required for construction, and does not necessarily express worker composition by specific year.

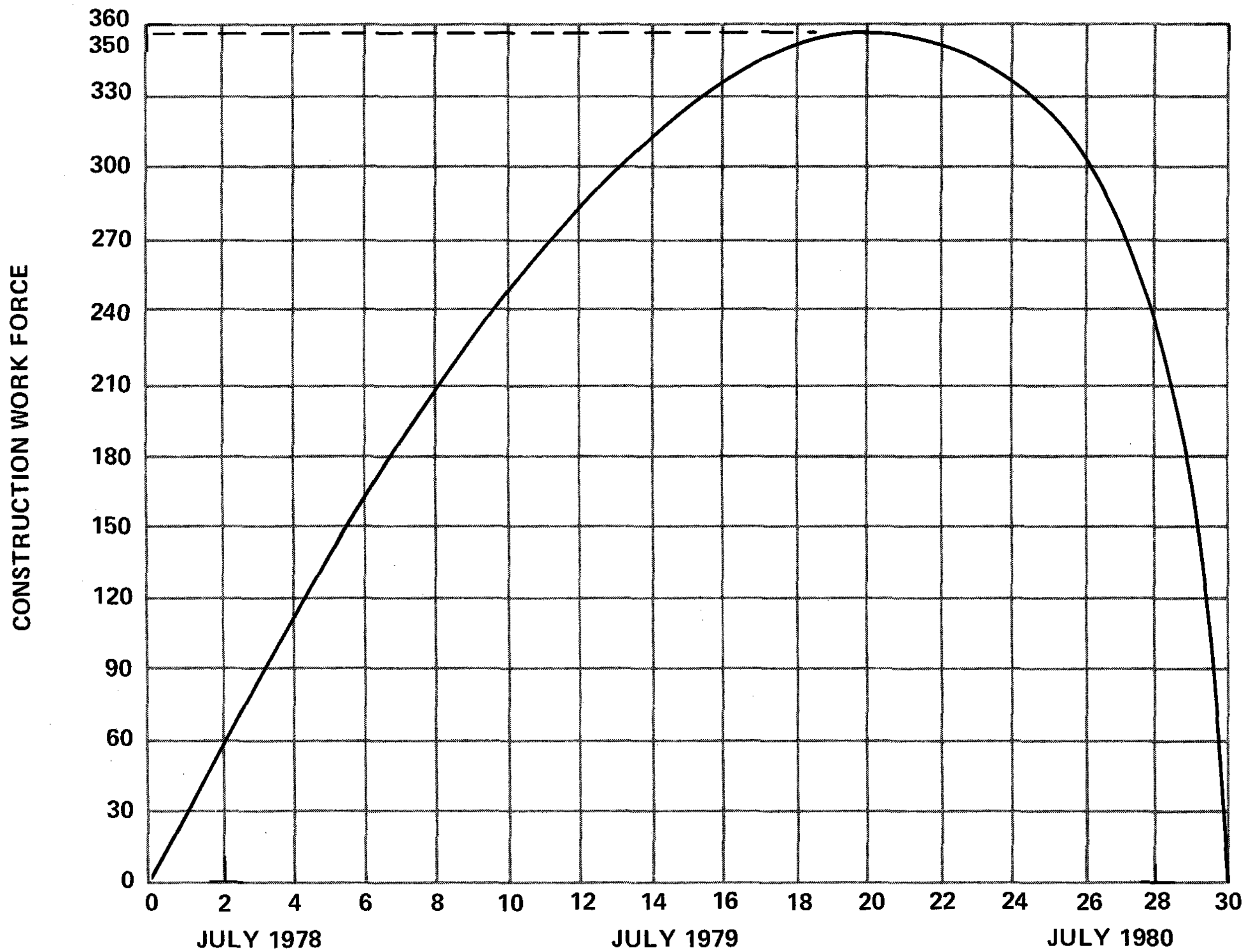

FIGURE 7.2-1 CONSTRUCTION EMPLOYMENT.

Table 7.2-1 Composition of Workforce

Skill	Estimated Percent of Total Labor By Skill
Asbestos Workers	2
Boilermakers	13
Bricklayers	1
Carpenters	7
Cement Masons	1
Electricians	12
Iron Workers	14
Laborers	10
Millwrights	2
Operating Engineers	6
Painters	2
Pipefitters	20
Sheetmetal Workers	2
Teamsters	1
Other	3
Field Non-Manual	4

NOTE: Total estimated labor required is 1.2×10^6 man-hours.

It is estimated that 25% to 50% of all Deerhaven Unit 2 construction workers will be hired locally, especially electricians, carpenters, and general laborers. Of the remaining 50% to 75%, to be hired from outside the Gainesville area, it is estimated that approximately 20% will temporarily move into the area. Using the 75% estimate for non-local workers to represent a worst-case situation, it is projected that approximately 15% of the total work force will move to the Gainesville area. The following shows the annual peak construction work force based on the above assumptions.

Annual Peak Construction Work Force

Year	Total Work Force	Total Influx of Workers
1978	165	25
1970	345	52
1980	350	53

The previous estimates for work force influx were based on the following:

1. Experience with the construction of Deerhaven Unit 1. Although exact employment records are not available, key individuals involved with the project were contacted to obtain employment information relevant to this Unit. The worker influx patterns were found to be similar to the ones predicted above. The majority of the workers were from the Jacksonville area and commuted daily to the site.

2. The proximity of Jacksonville, a major union labor center located 65 miles from Gainesville via Interstate 10 and

U.S. 301. It appears unlikely that in-migration in excess of 15% would occur. This conclusion is based in part upon the demonstrated willingness of workers to commute such distances on a daily basis, over good roads (Tennessee Valley Authority, 1976).

3. The relatively short construction time frame of 30 months, which would tend to encourage commuting rather than relocation.

It is estimated that approximately 36 individuals will be required for operation of Deerhaven Unit 2. Although some individuals having experience with coal-fired power plants will probably move into the area, it is not anticipated that significant numbers of operating personnel will in-migrate.

7.2.2 Internal Project Costs and Benefits

The purpose of this section is to present the economic impact of the proposed coal-fired electric generation project in terms of quantifiable economic benefits and costs. Also presented for comparative purposes are the economic impacts of power supply alternatives to the proposed coal-fired Deerhaven Unit 2. These economic benefits and costs are shown in the form of gross revenue requirements. Such gross revenue requirements are financial models of the electric utility operations for the various power supply alternatives studied and are presented herein on a comprehensive system-wide basis. Additionally, certain significant financial elements such as capital investment and fuel costs related exclusively to the various alternatives are presented on an incremental basis.

Baseline data used for this section were obtained from the "Report on the Status of Deerhaven Unit II" dated November 1976, which was compiled to assess alternatives to constructing a low-sulfur oil electric generating facility.

Alternatives Considered

Alternatives available to a utility for power supply lie within a limited framework of how best to meet the requirements of customers while maintaining the necessary reserve allowances for both scheduled and forced outages of generating equipment. Accordingly, the scheduling of new construction is dependent upon the demands of customers for increases in services. Given the service demands discussed in Chapter 1, the primary criteria used to select one of the following project alternatives are continuous electric service and minimization of charges to customers for such service.

In its action of October 1976, RUB initiated an evaluation of the then-possible alternatives to the project. The following three alternatives to the oil-fired unit were concluded to be the most viable, and were further evaluated:

1. Convert the project to accommodate the use of low-sulfur coal from either contract or leased coal supply.

2. Convert the project to accommodate the use of high-sulfur coal.

3. Cancel all contracts, sell any equipment possible, purchase power and jointly participate in future generating projects to supply the system's requirements.

Tables A7-3, A7-4, and A7-5 summarize costs associated with these alternatives in terms of system gross revenue requirements for the 1977-1987 period. Also shown on these tables are projected average electric rates per kWh for the 1977-1987 period and a present-worth representation of the average rates, entitled "Levelized", for each alternative. The components of these gross revenue requirements are discussed in the following subsections.

RUB, as all utilities, continually reviews and refines its plans and projections and, therefore, data in this section as taken from the status report may be superseded by refinements or improvements from time to time.

Costs

Minimum Net Revenue Requirements - The minimum net revenue requirement provides funds for transfers to the system's Utility Plant Improvement Fund (renewal and replacements) and the General Fund of the city and is therefore vital to the design of the gross revenue requirements. These revenue requirements must be designed to ensure not only sufficient cash availability, but they must also meet all of the city's covenants with its bond holders. The city has covenanted with the holders of bonds that, so long as any bonds are outstanding and unpaid, or until there is

set apart a sum sufficient to pay the principal and interest on the bonds when due, that: The city will fix the rates and will collect charges which will provide revenues in each year equal to 125% of principal and interest on bonds maturing in such year, plus 100% of all other required annual payments or any other obligations payable from the revenues.

Additional Parity Bonds - Additional bonds, payable on a parity with outstanding bonds may be issued if:

1. Average annual net revenues, during the immediately preceding 24 calendar months, are at least 125% of the maximum principal and interest becoming due in any fiscal year thereafter on all outstanding bonds and the bonds proposed to be issued.

2. Estimated average annual net revenues, increased by one-fifth of the additional net revenues to be derived from additions, extensions or improvements, or which will be derived from any then foreseeable additional services during the first five fiscal years following completion and placing in operation of such additions, extensions and improvements, is at least 150% of the amount of debt service described above.

Capital Costs - The construction costs of Deerhaven Unit 2 and alternatives as developed in 1976 include costs of construction of the generating facility and related requirements such as the initial fuel inventory and

a unit train. The capital costs for construction of a low-sulfur oil project and both low and high sulfur coal projects are developed on Table A7-6. The project-related capital budget is summarized on Table A7-7. Comparison of estimated construction costs on a per kilowatt basis for the proposed alternatives (235 mW) is as follows:

Fuel Type Alternatives	Generation Investment per Kilowatt	% Increase over Oil
Low-sulfur oil	$308	--
Low-sulfur coal	$496	61
High-sulfur coal	$582	89

Financing the capital requirements for the above fuel types assumes a 6 3/4% interest rate. The oil alternative financing assumes that one year's interest and bond reserves are both financed by the bond issues. The coal alternatives assume these interest and reserve requirements are fully met with current earnings of the utility. The coal alternatives also assume a somewhat longer average maturity of bonds in order to hold down the magnitude of additional electric rate increases.

The project-cancellation alternative includes charges which will be incurred in order to cancel equipment contracts that have already been let. Such costs are estimated to be about $20,000,000. The coal-fired generation alternatives include equipment contract cancellation charges of about $11,000,000.

Operation and Maintenance Costs Excluding Fuel - A summary of operating and maintenance (O&M) expenses for the entire system incorporating the

Deerhaven Unit 2 project alternatives are shown below. "Production O&M Expense" is related to the operation of existing and proposed generating facilities. "Other O&M Expenses" include transmission, distribution, engineering, and administrative and general expenses which are common to all project alternatives. Production O&M expense assumes 70% of total production labor is a fixed cost.

Projected Operation and Maintenance Expenses

Year	Production O&M Expense (Excluding Fuel Costs): Low-Sulfur Oil	Low-Sulfur Coal	High-Sulfur Coal	Total All Other O&M Expense
1977	1,746	1,746	1,746	3,887
1978	1,955	1,955	1,955	4,353
1979	2,190	2,190	2,190	4,875
1980	2,449	2,449	2,449	5,452
1981	2,709	3,305	4,839	6,031
1982	2,997	3,680	5,442	6,671
1983	3,314	4,015	5,826	7,377
1984	3,668	4,496	6,643	8,163
1985	4,054	4,986	7,369	9,021
1986	4,483	5,438	7,905	9,975
1987	4,959	6,067	8,905	11,031
Average Compound Annual % Increase	11.0%	13.3%	17.7%	11.0%

Fuel Costs - The assumptions used for projecting the fuel costs of each generation alternative are itemized as follows based on 1976 costs:

	$/Btu x 10^6	$/Purchase Unit
Low-Sulfur Oil	$1.95	$12.00/bbl
Low-Sulfur Coal:		
Contract coal	$1.39	$33.37/ton
Leased coal	$1.13	$27.14/ton
High-Sulfur coal	$1.29	$28.38/ton

Purchase Power and Participation Costs - To evaluate the cancellation alternatives, it was necessary to make several assumptions concerning the method by which the system would meet its future energy requirements. It was assumed that the system would be able to purchase its energy requirements for the period 1981 through 1985 through firm interchanges with other utilities in the State of Florida. This would be an incremental sale of capacity and energy and therefore would not reflect the fully allocated costs of providing this capacity. It was assumed that in 1986 the system would jointly participate with a 210 mW share of an 800 mW low-sulfur coal-fired electric generation project.

Gross Revenue Requirements

Summation of the projected operation and maintenance expense, projected fuel expense, projected minimum net revenue requirements (Section 7.2.2), and projected debt service provides gross electric revenues required for each project alternative. Tables A7-3, A7-4, and A7-5 show total revenue requirements for the project alternatives from 1977 to 1987. Projections of gross revenue requirements are based on trends of 8% annual load growth to 1981 and 7% from 1981 to 1987 for the various fuel alternatives on Table A7-3. To provide a critical reference for the gross revenue requirements at the above mentioned 8% and 7% growth rates, revenue requirements were projected based upon 5% annual load growth on Table A7-4. Table A7-5 shows the gross revenue requirements for the project cancellation alternative. Financial models for high-sulfur coal were not completed and are not included in the gross revenue requirements

analysis because the economic results of the high-sulfur coal alternative were significantly poorer based on projected electric rate increases.

The estimated system-wide electric rate increases (including fuel cost adjustments) needed to meet the projected revenue requirements are as follows:

Assumed Percentage Electric Rate Revenue Increases Including Fuel Adjustment Clause Increases

	April 1977	April 1978	April 1979	Combined Total Percentage Increase Over 1976 Average Electric Sales Revenues
Low-Sulfur Oil	9.6	3.2	-	13.11
Low-Sulfur Coal	6.4	3.3	3.1	13.32
Cancellation (with Bond Defeasement)	19.8	-	-	19.8
Cancellation (without Bond Defeasement)	6.2	-	-	6.2

Based on data in Tables A7-3, A7-4, and A7-5 the average annual residential customer savings in electric costs over the 1977-1987 period are:

Alternative	Average Monthly Residential Customer Savings Compared to Oil-Fired Project (assumes 1,000 kWh sales)
Low-Sulfur Coal (contract)	$ 46
Low-Sulfur Coal (leased)	$ 86
Cancellation with Bond Defeasement	$(69)
Cancellation without Bond Defeasement	$(32)

NOTE: () represents cost rather than savings

Based on the above data, the leased-coal project appears most economically beneficial to the electric customers, while the contract-coal project would provide the second preferred alternative.

Benefits

The projected generation capability of Deerhaven Unit 2 is an integral part of an overall, continuing plan of generation expansion to assure an adequate and reliable supply of electricity. The need for an incremental addition of base load generation capability of this size was demonstrated in Chapter 1 of this report. Fulfilling this need will contribute to the improved health, safety, well-being, and productivity of the consumers in the region. This then is the primary benefit of this project.

As mentioned, the benefit of electricity produced is more than can be measured by the dollar value of the electric revenues collected. However, as a conservative (underestimated) forecast, the benefits that can be expressed quantitatively are: (1) transfers to the City of Gainesville General Fund; (2) surplus power sales; (3) diversification of fuel sources; and (4) capacity additions that ensure the system reliability and stability.

General Fund Transfers - Annual transfers are made to the City of Gainesville's General Fund. Future projections of transfers are based upon an amount equal to the historical return on system equity. Payments of this kind are often made by municipal utilities to the general funds of cities and such transfers can be considered a benefit to the city.

Surplus Power Sales - The construction alternatives include projected sales of surplus power and energy in 1981, 1982, and 1983 (Tables A7-3 and A7-4). These surplus sales for the coal-fired alternatives represent about $12 million of revenues and result in lower projected rate increases to electric consumers. These surplus sales are about 8% of total revenue requirements for the above mentioned years for the coal-fired alternatives, and about 3% for the oil alternative. Of course, such sales are not available to the cancellation alternative.

Energy Sources - Adoption of the coal-fired alternative provides diversification of fuel sources for generation and thus insulates the system to some degree from price, supply, and political considerations, particularly in the short term. Additional information concerning energy sources is given in Section 8.2.

Reliability of Service - The ability of RUB to meet system load and energy requirements is dependent upon having adequate capacity on its system, either by firm purchase or from its own units. Peninsular Florida utilities, through interconnection agreements and operating criteria, share reserves and provide back-up services (Section 1.1.2). Should RUB contract with another system to provide firm capacity for its system requirements rather than add Deerhaven Unit 2, the adequacy and reliability of electric service would be dependent upon the terms of purchased power, wheeling arrangements, and internal system generation. Assuming the contracted commitments were firm, the reliability of service

would not be diminished by such arrangements. However, in order to assess the actual increase or decrease in reliability with or without Deerhaven Unit 2, one must examine the peninsular Florida capacity situation.

The addition of Deerhaven Unit 2 in 1981 would add to the overall reliability of peninsular Florida interconnected systems, particularly in light of the low reserve margins presently predicted by Florida's two largest utilities in the 1981-1986 period (Table 1.6-1). Although these projections are not expected to change significantly, it is anticipated that more recent information will be provided, for agency review, as soon as the required information is made available from other state utilities.

Without the planned addition, excess capacity would have to be purchased from other systems in the 1981-1986 period and it is likely that RUB would plan jointly or alone to add additional capacity in the late 1980's. This would, however, result in a continuing dependence on oil for generation requirements through most of the 1980's. A new addition in the late 1980's would reflect the increased costs of new capacity at that time. RUB would be required to amortize the funds currently expended for Deerhaven Unit 2. Additionally, potential economy energy sales from coal-fired generation would not be available to other interconnected systems.

7.2.3 Population

The population increase due to the 53 workers expected to move to the project site area during peak construction is estimated to be 118 individuals. This is based on 65% of the work force being married and an average of 2.89 individuals per household. These ratios are 1970 State of Florida averages (Florida Department of Commerce, 1977), since the workers will be drawn from parts of the state outside Alachua County. The projected population for Alachua County in 1980 is 135,500, which represents a 4,000 increase over the 1976 population. The population associated with the worker influx of 118 individuals is about 3% of the projected population increase from 1976 to 1980. The increase will be a non-discernible fraction of the 1980 projected Alachua County population of 135,500. The above estimates are conservative because it is conceivable that a certain portion of the worker influx may commute to the site on a weekly basis (Monday through Friday) and therefore will not move to the site area with their families.

7.2.4 Economy

Indirect Employment

Direct employment (Section 7.2.1) will generate a certain number of indirect jobs, mostly in the service sector, that will be needed to support the direct employment. However, no worker influx is anticipated to fill these jobs.

Employment multipliers provided by the Florida Department of Commerce indicate that, on the average, new power plant construction in the State of Florida generates 0.478 additional jobs for each single construction job. That is, each such "basic" job will, on the average, support an additional 0.478 "nonbasic" local jobs. During peak construction activity, therefore, the potential for 517 total jobs (350 direct and 167 indirect) will exist. Because most workers are expected to commute to the project, it is anticipated that few indirect jobs will be created locally. The employment multiplier for "operation of an electric utility" is 2.15, meaning that for each single operating employee an additional 1.15 local jobs could potentially be supported (State of Florida, Department of Commerce, 1976). Based upon the operating work force of 36 individuals (Section 7.2.1), total direct and indirect operating employment could eventually generate 77 local jobs.

It should be noted, however, that these multipliers describe the general relationship between "basic" and "nonbasic" employment. Several factors may influence this relationship, including possible time lags before the multiplier takes effect, excess capacity within the regional economy, or variances among intraregional linkages.

Income

Based upon union wage rates for the expected Deerhaven Unit 2 workers, and assuming the worker composition breakdown described in Section 7.2.1, it is estimated that total direct worker income will be over $10

million (1977 dollars). This estimate is further based upon the assumption that the total man-hours required for construction will be 1.2×10^6. Table 7.2-2 shows this breakdown by worker skill, estimated percentage of job jours involved, and total estimated wage income by skill.

The direct construction income will itself generate a certain amount of indirect income, in part because of increased local demand for goods and services. It is apparent that with a large number of workers commuting from Jacksonville, much of this direct $10.7 million income will be exported, or re-spent elsewhere. By applying the Florida Department of Commerce income multiplier of 2.23, it is calculated that the potential for an additional indirect income of 13.2 million is created (Florida Department of Commerce, 1976). This would total approximately $23.9 million in direct and indirect income resulting from the project. Thus, for each dollar of Deerhaven Unit 2 construction worker income, the potential for an additional 1.23 dollars of regional income develops. This does not necessarily mean that the entire amount will actually be generated, but simply points out that the potential for such an additional income increase will be created.

Assuming the operational work force of thirty-six workers described in Section 7.2.1, and by applying an average operating employee gross salary of $15,000 per year, it is estimated that direct operating worker income would reach $540,000 per year. With an economic multiplier of 1.9 (Florida Department of Commerce, 1976), this would total $1,026,000

Table 7.2-2 Deerhaven Unit 2 Worker Income By Job Skill

Skill	Estimated % of Total Man-Hours	Estimated Total Hours	Hourly Wage	Total Job Wages
Asbestos Workers	2	24,000	$ 9.00[a]	216,000
Boilermakers	13	156,000	9.50[b]	1,482,000
Bricklayers	1	12,000	9.25[d]	111,000
Carpenters	7	84,000	8.92[c]	749,280
Cement Masons	1	12,000	8.92[c]	107,040
Electricians	12	144,000	9.25[c]	1,332,000
Iron Workers	14	168,000	8.85[c]	1,486,800
Labor	10	120,000	5.32[c]	638,400
Millwrights	2	24,000	9.23[c]	221,520
Operating Engineers	6	72,000	8.90[d]	640,800
Painters	2	24,000	8.17[c]	196,080
Pipefitters	20	240,000	9.10[d]	2,184,000
Sheetmetal	2	24,000	9.08[c]	217,920
Teamsters	1	12,000	8.16[d]	97,920
Other	3	36,000	8.50[a]	306,000
Field, Non-Manual	4	48,000	15.22[d]	730,560
TOTAL:		1,200,000		10,717,000 (rounded)

Sources:
[a]Estimate based upon comparative wage levels.
[b]Business Manager of Jacksonville Boilermakers, Jacksonville, Florida.
[c]Gerald Clements, Labor Market Analyst, Jacksonville, Florida. State Employment Service.
[d]Estimates from Merom Station Units 1 and 2, Hoosier Energy Division. Letter of April 27, 1976.

per year. That is, the multiplier for the operation of an electric generating facility states that, for each dollar of operating income, the potential for an additional $0.90 of local income would be created. Since it has previously been assumed that operating personnel will be furnished locally, it is concluded that the majority of related income would be re-spent within the Gainesville area.

In addition to generated wage incomes, it is estimated that $1 million in supplies and materials will be purchased locally. These purchases will create further economic benefits to the local area.

7.2.5 Impacts on Housing

Based on the estimated percentage of the construction work force that will move into the Gainesville area as a result of the proposed project, no significant adverse housing impacts are anticipated. The worker influx will range from approximately 25 workers in 1978 to approximately 53 workers in 1980. The peak construction period will occur during the last part of 1979 and early to mid 1980. It is expected that nearly all the operating personnel will be from the Gainesville area, and thus will create little demand for housing.

Assuming a conservative ratio of one worker per housing unit, a maximum of 53 housing units will be needed at peak. These housing units will be distributed among single-family, multifamily, and mobile home rentals. From estimates presented in Section 7.1.4, Table 7.1-10, this project-

related need for housing represents less than 4% of the projected annual household formations during the 1979-1980 time frame in the Gainesville urban area.

According to Mr. Carl Opp, Director of Off-Campus Housing, University of Florida, present housing and apartment starts will flood the market with about 3,000 more units in 1978. This will probably have the effect of stabilizing rents, perhaps even lowering rents in some cases. This excess in apartment rental units corresponds to the beginning of the project period.

The October 1975 U.S. Postal Survey vacancy rates in Alachua County averaged 3.5% for apartments and 1.8% for single-family residences. With a sub-standard housing percentage of 4% (North Central Florida Regional Planning Council, 1976b), about 455 apartments and 480 single-family residences were vacant in Alachua County. Although these are 1975 estimates, they show that, in general, the housing demands anticipated as a result of the project are a small fraction of the vacancies occurring in Alachua County.

The projected increase in apartment rental units, the normal vacancy rates occurring in the Gainesville area, and the urban setting of the proposed project will combine to minimize the housing effects in the area. It should also be noted that the above estimates of housing needs are potentially high because: (1) some of the workers who will move

into the area may own mobile homes and would therefore locate in mobile home parks in the vicinity of the project site; (2) some of the single workers may choose to share housing units; and (3) some of the projected influx of workers may commute from outside Alachua County on a weekly basis (Monday through Friday). This group may tend to find housing accommodations in hotels/motels and/or rooming houses in the area.

7.2.6 Infrastructure

Overall adverse impacts on the infrastructure of Alachua County due to construction and operation of Deerhaven Unit 2 will be minimal. The impact areas judged to require further discussion are: (1) education, due to the fact that most families have direct contact with the educational system and are therefore more interested in education than in other social services; and (2) transportation, because transportation impacts are potentially more significant than other impacts. These two impact areas are discussed below.

Due to the urban setting of the project, other areas such as law enforcement, fire protection, and health care (Section 7.1.5), are not discernible enough to warrant further discussion.

Education

Data presented in Section 7.1.5 indicates that there is a 14% excess capacity in public school facilities for grade levels K-12. This overall percentage is composed of a 13% excess for elementary schools,

a 16% excess for middle schools, and a 15% excess for secondary schools. Enrollments projected for 1979-1980 are approximately the same as present levels (actually, a 2% drop is projected).

The projected increase of school age children, as a result of the worker influx at the peak construction period, is 24 pupils. This is based on a peak influx of approximately 53 workers, approximately 65% of whom will be married; a household size of 2.89 individuals; and 0.701 school age children (K-12) per household (Florida Department of Commerce, 1977).

This influx of 24 pupils represents less than 0.6% of the excess capacity for grades K-12 in 1979-1980 and is therefore not expected to have any significant impact on the public school facilities of Alachua County.

Again, this estimate is conservative due to the fact that a certain number of the workers will commute weekly to the site without their families. Moreover, some of the children will probably not be of school age.

Transportation

Since a majority of the construction workers will commute daily to the plant site from areas outside Alachua County, a certain degree of adverse traffic impact is expected. This impact will occur mainly during the morning work reporting hours and after termination of work in the

evenings. As noted earlier, Jacksonville is expected to be the main source of the construction work force. The expected route taken by most Jacksonville commuters would be impacted to a certain degree by the increased traffic.

7.2.7 Environmental Enhancement

There are no direct on-going benefits from environmental enhancement in support of the propagation of wildlife and the improvement of wildlife habitats. However, the removal of Deerhaven Unit 1 blowdown from Turkey Creek should restore the creek to pre-Deerhaven conditions. In addition, RUB previously contacted the Florida Game and Freshwater Fish Commission concerning the utilization of undeveloped land surrounding Deerhaven Unit 1 for research and/or tagging and trapping projects. The Commission expressed no interest in this proposal.

Ecological studies performed in the Turkey Creek, Cellon Creek, and Rocky Creek watersheds have increased our knowledge of water quality and invertebrate and fish population characteristics of small brown water streams in Central Florida. Comparisons have been made between naturally intermittent streams with no industrial influences (e.g. Rocky Creek) and intermittent streams which have modified water quality and water quantity characteristics as a result of industrial discharges.

7.2.8 Attitudes

Based upon field interviews conducted between August 1 and August 9, 1977, it was learned that both support of and opposition to the Deerhaven Unit 2 project exist among the residents of Alachua County. Both proponents and opponents of the project were contacted to obtain an insight into the basis of their support or opposition. These interviews were not intended to yield statistically relevant data. Therefore, since the number of informants contacted was limited and not statistically representative of the local population, views obtained cannot be clearly judged to represent the opinions of major segments of the population.

In general, among those contacted, commonly expressed opinions were that sufficient power at some (reasonable) environmental cost was the most practical option available. Those individuals favoring community growth most strongly endorsed this belief, stating that industry might be attracted to the Gainesville area if ample power supply were available. It was argued that this would stimulate the economy and could provide a number of local jobs. As has been previously noted, it is estimated that Deerhaven Unit 2 would generate 594 direct and indirect local jobs (517 construction jobs and 77 operating jobs). In addition, nearly $25 million in construction/operation income would be created. Also, approximately $1 million would be spent locally for supplies and materials, which in turn would stimulate the local economy.

Among those expressing some concern regarding environmental effects of the Deerhaven Unit 2 project were organized groups such as the Florida Defenders of the Environment, the Gainesville Group of the Sierra Club, and the Alachua Audubon Society. These organizations feel that at least three main issues warrant additional consideration: (1) the need for power; (2) potential air quality problems; and (3) potential water quality impacts, particularly as they may affect the San Felasco Hammock area.

CHAP. 8-ALTERNATIVE
ENERGY SOURCES AND SITES

CHAPTER 8

ALTERNATE ENERGY SOURCES AND SITES

The basis for RUB's selection of coal as a fuel source and the Deerhaven site as the geographical location for the proposed 235 mW, low-sulfur, coal-fired, generating unit follows. In section 8.1 environmentally compatable siting areas within the RUB service area are identified and analyzed and in section 8.2 the economic criteria which must be considered if an alternate site were to be developed are presented. In sections 8.3 and 8.4, together, the rationale for the construction of a coal-fired generating unit is considered in light of the availability of other fuel sources and capacity alternatives. Section 8.5 is a summary of the overall analysis designed to present a clear demonstration that the proposed choice of site and fuel best serves the interests of the public.

8.1 Alternative Siting Areas

A variety of environmental criteria are reported in relevant literature which might be considered in siting a power generating facility. Many general siting criteria apply, however, to areas of broad geographic, hydrologic, atmospheric and ecological variability, and are, thus, inappropriate in the present application because of RUB's relatively small service area (Alachua County).

Areas of Alachua County having land use or environmental features incompatible with the siting of the proposed facility were excluded from consideration (Section 6.1.6). Exclusion criteria used in this survey

were: (1) ecologically sensitive or recreationally important areas; (2) existing or planned residential, commercial, or institutional land uses; and (3) areas of existing or potentially high agricultural productivity.

8.1.1 Ecologically Sensitive or Recreationally Important Exclusion Areas

Eleven areas were excluded from consideration on the basis of ecological sensitivity or recreational importance (Table 8.1-1 and Figure 8.1-1). The areas include: all of the major lakes, wetlands, wildlife management areas and sanctuaries, publicly-owned parks and recreational resources in the county.

8.1.2 Residential, Commercial and Institutional Exclusion Areas

Areas of Alachua County which are presently, or are planned to be, used for residential, commercial, or institutional areas were eliminated from consideration as potential plant sites. More than 25 such areas were identified, including: all of the major cities, communities, and residential developments, and the commercial areas and institutionally owned facilities (e.g. the University of Florida and its extensions) in the county (Figure 8.1-2 and Table 8.1-1). Exclusion area boundaries around towns and cities include any outlying residential areas and planned growth limits as indicated by the Alachua County Land Use Plan (1976).

Table 8.1-1 Descriptions of areas excluded from consideration as a power plant site.

Figure	Exclusion Area Number	Description
Figure 8.1-1 (Ecologically Sensitive Areas)	1	Relatively undeveloped areas adjacent to the Santa Fe River.
	2	O'Leno State Park.
	3	Major wetland and recreational area containing Lakes Santa Fe, Little Santa Fe, Altho, Hickory, Bonnet, Black and Elizabeth.
	4	San Felasco Hammock.
	5	Devil's Millhopper.
	6	Major wetland and recreational area containing Newnan's Lake, Gum Root Swamp and lower Hatchet Creek basin.
	7	Wetland area containing Watermelon and Horseshoe ponds.
	8	Wetland and recreational area containing Lake Kanapaha and Hogtown and Sugarfoot Prairies, and the Biven's Arm, Lake Alice and Colclough Pond Audobon Sanctuaries
	9	Paynes Prairie.
	10	Major wetland and recreational area containing Orange, Lochloosa, Tuscawilla, Jeffords, Little Orange and Little Lochloosa Lakes, a variety of Ponds; Levy, Kanapaha, Grass, Horse and Fish Prairies; Magnesia Springs; Cross Creek, River Styx, a variety of swamps and marshes, the Lochloosa Wildlife Management Area and the Orange Lake and Micanopy Cypress Audubon Sanctuaries.
	11	Major swamp and marsh area containing Buck Bay swamps and Potato Patch Bay.
Figure 8.1-2 (Residential, Commercial and Institutional Land-Use)	1	High Springs Area*
	2	La Crosse
	3	Waldo Area*
	4	Alachua Area*
	5	University of Florida Experimental Farm
	6	University of Florida Agricultural Experiment Station
	7	University of Florida Beef Research Unit

Table 8.1-1 Descriptions of areas excluded from consideration as a power plant site (continued)

Figure	Exclusion Area Number	Description
Figure 8.1-2 (continued)	8	Austin Cary Memorial Forest
	9	Santa Fe Beach
	10	Orange Heights
	11	Newberry Area*
	12	University of Florida Experimental Farm
	13	Gainesville Area*
	14	Windsor Area*
	15	Campville
	16	Archer Area*
	17	Micanopy Area*
	18	Evinston Area*
	19	Rochelle
	20	Grove Park and Magnesia Springs
	21	Hawthorne Area*
	22	Cross Creek Area*
	23	Island Grove
	24	Lochloosa
	N/A	Unnamed Residential Areas
Figure 8.1-3 (Productive Agricultural Land)	N/A	Approximate distribution of the most productive soils in the county. Those include the undulating and rolling phases of Gainesville loamy fine sand, Gainesville-Arredondo loamy fine sands, Arredondo-Fellowship loamy fine sands, Arredondo loamy fine sand - fine sand, Fort Meade loamy fine sand and Alachua loamy fine sand, which are considered the best general farming land in the county; and Hernando-Jonesville fine sands, Jonesville-Hernando fine sands, Archer-Jonesville fine sands and Chiefland fine sands which are considered the best in the county for bright tobacco and peanuts and also well suited to watermelon, sugarcane and truck crops (Alac. Co. Soil Survey, 1954).

*Areas contain existing and projected city limits and surrounding residential development. (Alachua County Land Use Plan, 1976).

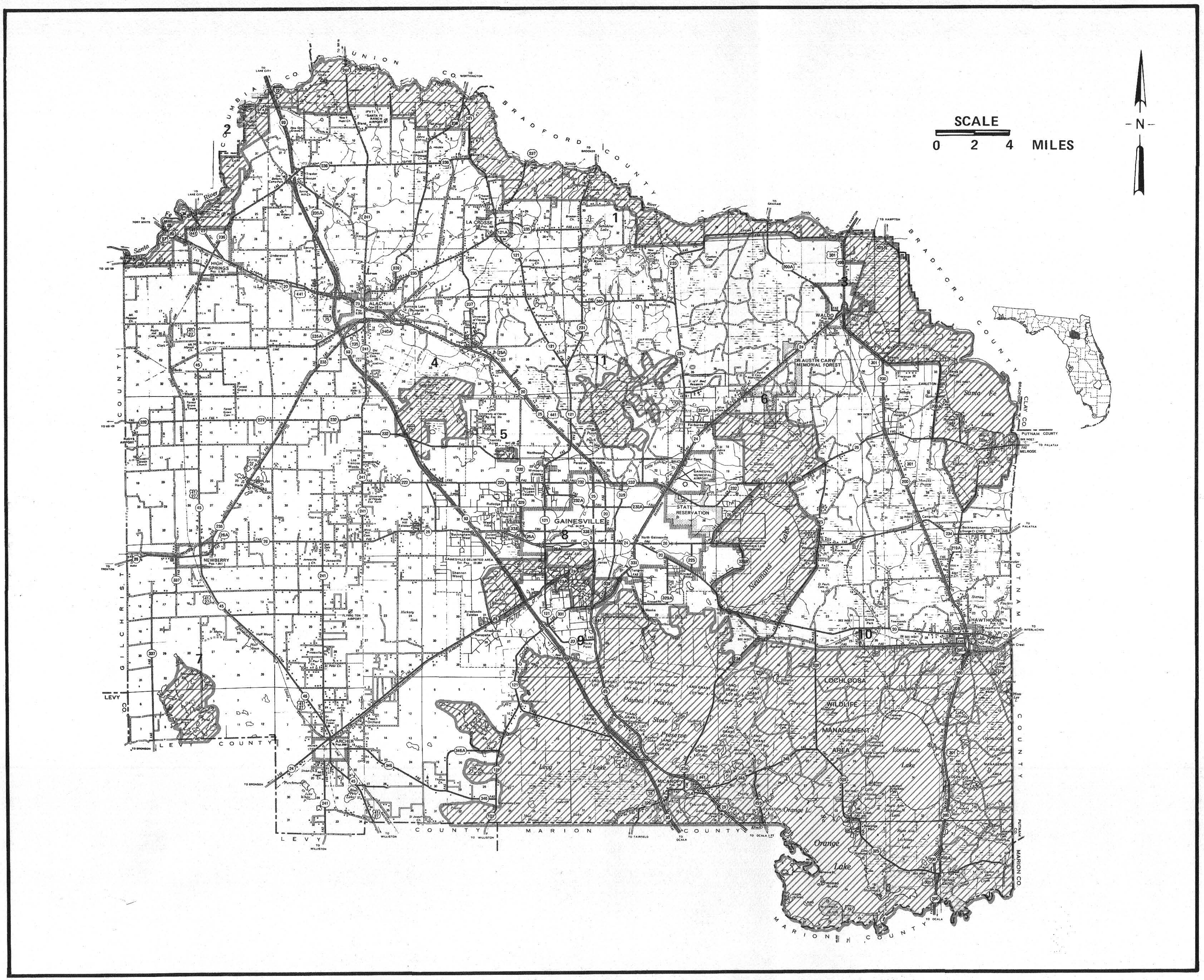

FIGURE 8.1-1 ECOLOGICALLY SENSITIVE OR RECREATIONALLY IMPORTANT EXCLUSION AREAS.

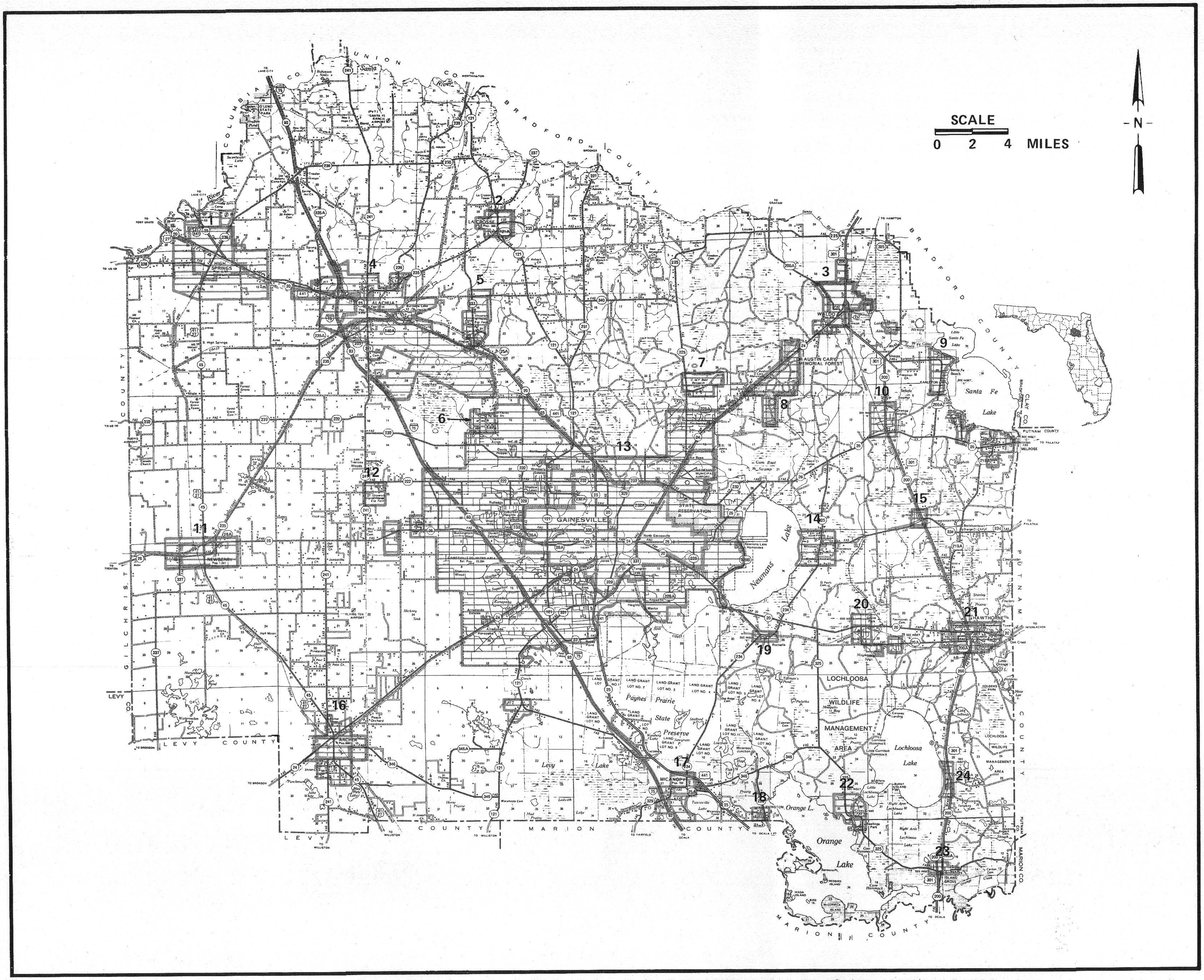

FIGURE 8.1-2 RESIDENTIAL, COMMERCIAL, AND INSTITUTIONAL EXCLUSION AREAS.

8.1.3 Agricultural Exclusion Areas

Areas of existing or potentially high agricultural productivity were eliminated from consideration as potential sites. Existing production areas were identified from recent aerial photos while potentially productive areas were identified from the only complete, county-wide soil survey (SCS, 1954), as the most versatile and productive soil types (Figure 8.1-3 and Table 8.1-1).

8.1.4 Identification and Analysis of Alternative Areas

The exclusion area overlays and the existing RUB transmission network, were composited to identify alternative siting areas on Figure 8.1-4, with the exception of several areas which were too small or too isolated for further consideration. The above technique identified one broad alternative area starting to the north and ending to the east of Gainesville. This area extends from northeast of Alachua to just west of Waldo, then curves southeasterly to include the area east of Newnan's Lake and north of Hawthorne.

8.2 Economic Feasibility of Alternative Sites

An analysis of this area, to identify suitable site locations, was made using facility support features and economic feasibility as major selection criteria. Necessary support features are dictated by the input and output needs of the facility and include accessibility to highway and rail lines and availability of a suitable water supply and discharge routes.

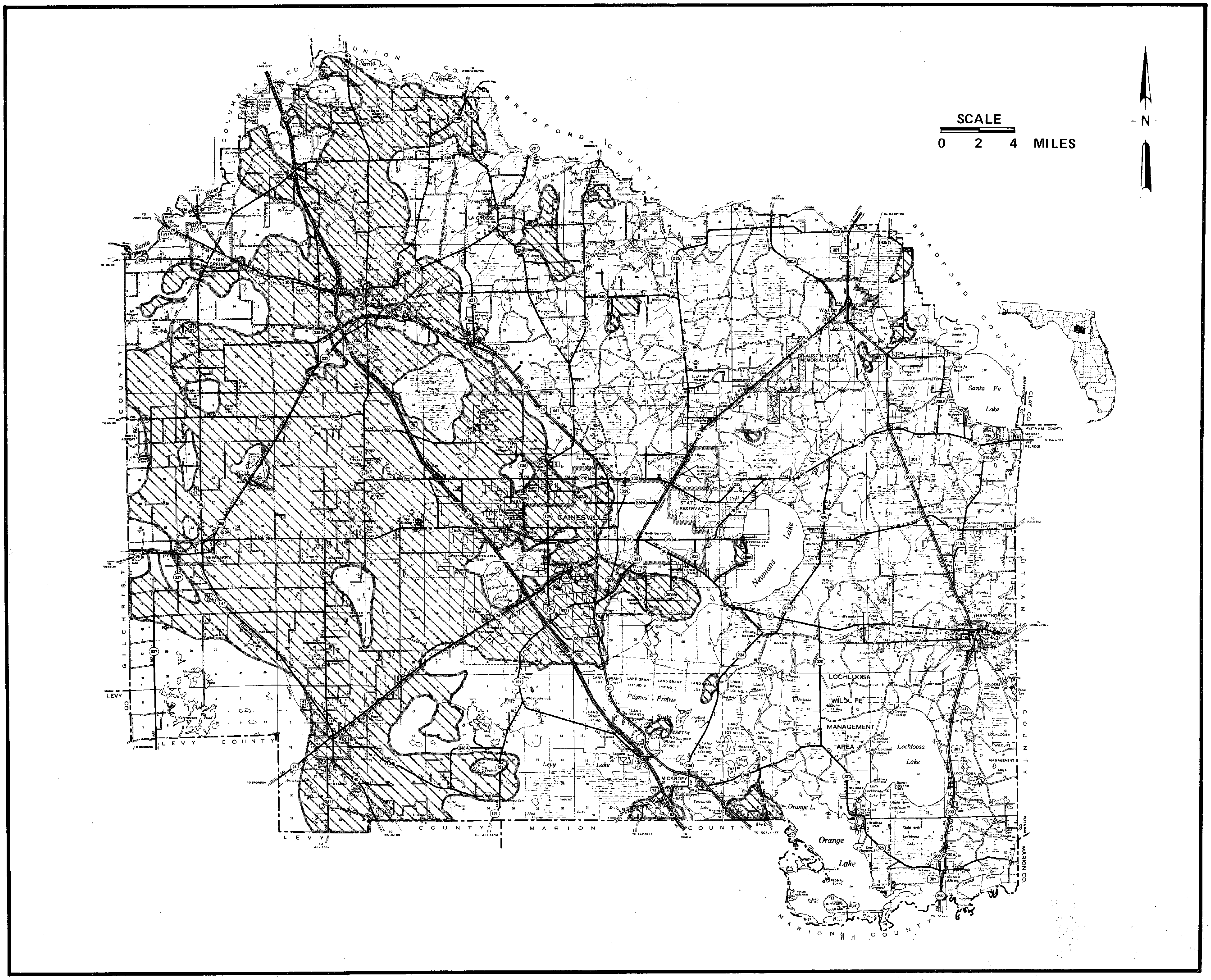

FIGURE 8.1-3 AGRICULTURAL EXCLUSION AREAS.

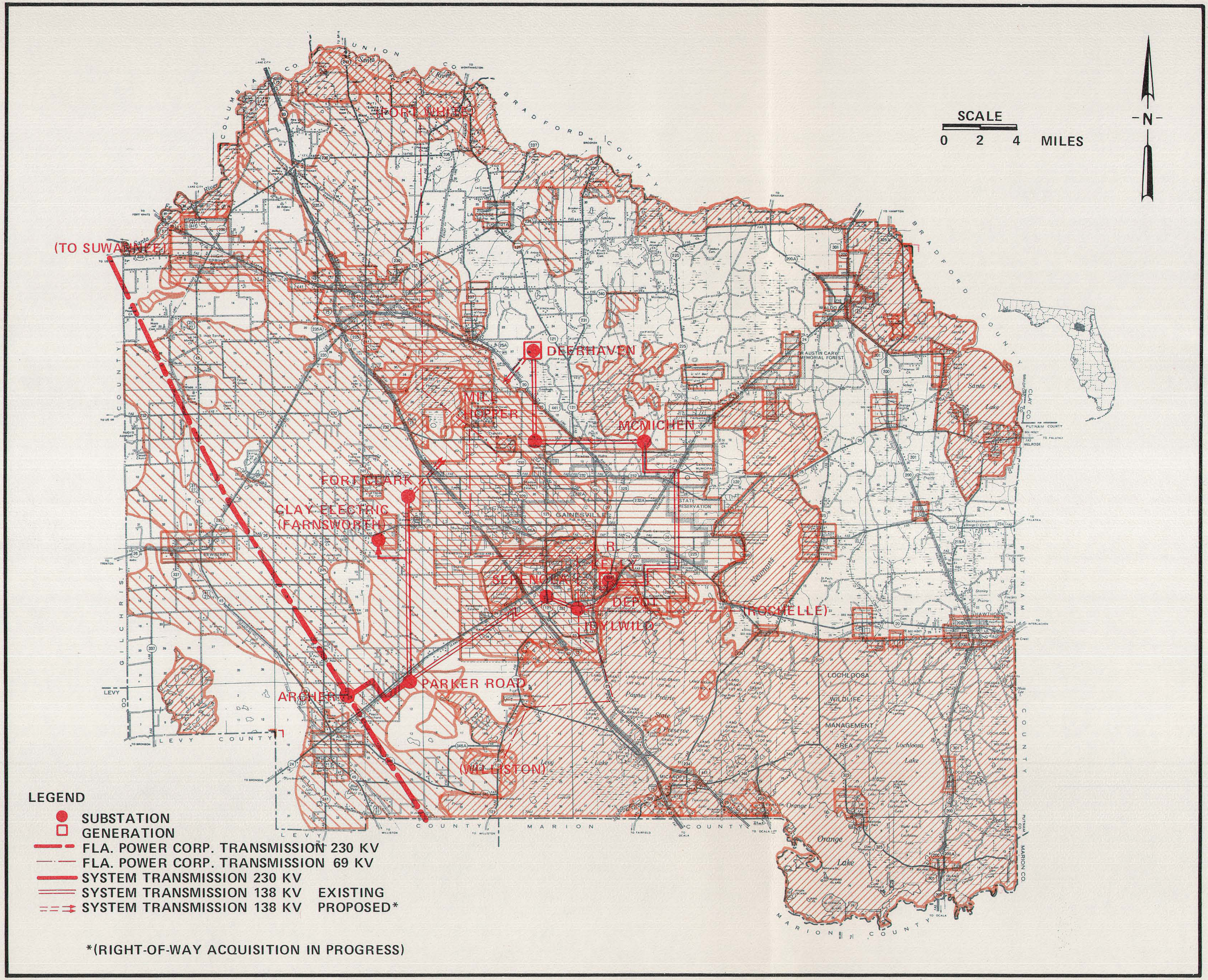

FIGURE 8.1-4 COMPOSITE OF ALL EXCLUSION AREAS WITH EXISTING TRANSMISSION FACILITIES.

8.2.1 Accessibility

Areas serviced by a suitable highway and rail lines lie along either U.S. 301, between Hawthorne and Waldo, U.S. 441, between Gainesville and Alachua, or SR-24, between Gainesville and Waldo.

Upon a review of Seaboard Coast Line/Louisville & Nashville (SCL/L&N) system maps, it was determined that other tracks within the alternative area are not main lines and would therefore result in additional switching charges. Assuming conservative estimates of 300 railroad-car shipments during the construction period and a minimum of one 70-car train shipment of coal to the site every five days for the life of the plant, the additional transportation charges would be significant.

8.2.2 Additional Construction Costs

Table 8.2-1 summarizes the minimum estimated, additional costs associated with constructing the proposed unit at a presently undeveloped alternate site. As noted on the table, the additional cost is in excess of $11 million, and does not include the costs of additional transmission lines and associated right-of-way. From the available alternative area boundaries, as shown on Figure 8.1-4, it appears unlikely that an alternate site could be developed any closer than 5 miles from the existing transmission facilities or any farther than 20 miles. Utilizing these distances to develop cost estimates for transmission construction and right-of-way procurement, a range from $650,000 to $2,000,000 is derived.

Table 8.2-1 Estimate of Additional Costs to Construct the Proposed Unit at an Undeveloped Alternate Site

Required Facilities	Estimated Costs
Site Procurement (1,000 acres)	$ 1,000,000
Site Planning, Surveying and Environmental Monitoring	350,000
Site Investigation and Monitoring Well	500,000
Site Development	1,250,000
Substation Facilities	2,500,000
Site Paving and Landscaping	800,000
Railroad Spurs	750,000
Fire Main, Hydrants and Elevated Storage Tank	300,000
Sanitary Disposal Facilities	10,000
Miscellaneous Yard Structures	200,000
Street and Yard Lighting and Start-up Transformers	500,000
Miscellaneous Electrical Yard Piping	100,000
General Construction Facilities	250,000
Machine Shop Facilities	500,000
Fencing	250,000
Office Facility Structures	100,000
Emergency Power Facilities	250,000
Turbine Room Crane	100,000
Cathodic Protection	50,000
Water Supply Wells, Storage Tank and Back-up Compressors	600,000
Yard Supply Piping	210,000
Dispatching Facilities	50,000
Fire Alarm System	50,000
Construction Site Security	200,000
General Plant Equipment	250,000
On-Site Equipment and Materials Transfered	750,000
TOTAL ADDITIONAL COSTS:	11,370,000
Transmission Line Facilities	125,000/mile
Right-of-Way Procurement	15,800/mile

Consumable water, for any alternate site, would be drawn only from wells and it is assumed for the purposes of this evaluation that plant effluents would be deep-well injected. Since the transmissivity of the Floridan Aquifer would not be expected to vary significantly from location to location within the service area, an evaluation of geohydrological factors would not benefit the alternative site selection process. Therefore, the estimated costs in Table 8.2-1 do not reflect costs for any geohydrological analysis.

8.2.3 Additional Personnel Requirements

It is anticipated that the proposed unit constructed at the Deerhaven site will require 36 personnel in addition to those now utilized for the operation of Deerhaven Unit 1 (Section 7.2.1). The construction of the proposed unit at an alternate site would necessitate an increase in manpower requirements.

Manpower estimates developed for such a unit would anticipate at least 57 operating, maintenance and administrative personnel broken down as follows:

Alternate Site Personnel Requirements

Functional Description	Required Personnel
Operators (5 shifts/5 per shift)	25
Maintenance	5
Technicians	7
Coal and ash handling	10
Janitorial	4
Administrative and Supervisory	3
Clerical	3
TOTAL	57

8.3 Alternative Energy Sources

Base load generating capacity on the order of 235 mW may be developed utilizing any of several different generation technologies powered by various energy sources. This section presents the rationale for the selection of coal as the fuel source for the proposed power plant.

Hydroelectric

Developed conventional hydroelectric power within the State of Florida yields a total of 30,168 kW and 232,900 mWh per year, of which 30,000 kW and 232,400 mWh per year are generated at the Jim Woodruff plant site located on the Apalachicola River and owned by the Corps of Engineers (Federal Power Commission, 1976). The undeveloped conventional hydroelectric potential within the state is very limited. Projected undeveloped capacity potential is estimated at 83,500 kW, with an average annual energy generation equaling 68,600 mWh per year (Federal Power Commission, 1976). Hence, the hydroelectric resource is not available within the state to fulfill the required 235 mW generating capacity of the proposed unit.

Geothermal

Four major types of geothermal resources are dry steam, wet steam, hot dry rock and geopressurized zones. Of these, only the least abundant, dry steam, is relatively well understood and used. Hot dry rock and geopressurized systems have not yet been exploited beyond the research and exploratory stages because of prohibitive economics and technical

uncertainties. Currently, the three geothermal areas using dry steam are Larderello, Italy (396 mW); the Geysers, California (502 mW); and Matsukawa, Japan. The largest geothermal electrical generating installation in the world is the Geysers, Pacific Gas and Electric Company's generating facility some 90 miles northeast of San Francisco. Several additional power units are scheduled in the future, raising the Geysers' output to more than 1,000 mW. Other geothermal areas that are producing electricity are the Wairakei and Kawerau fields of New Zealand (170 mW), using steam flashed from hot water wells; the Cerro Prieto plant in Northern Mexico (75 mW), using steam flashed from hot brine; four installations in Japan (in excess of 50 mW); and small geothermal pilot plants in Russia and Iceland (Atomic Industrial Forum, Inc.).

Cost estimates for geothermal power plants indicate that installation costs may range from $500 to $700 per kW, and operation costs for binary conversion systems may range from 20 to 40 mills/kWh (Kruger, 1975).

Potential adverse environmental impacts resulting from geothermal power plants are air pollution from hydrogen sulfide, ammonia, and other effluents; pollution of surface water and groundwater resulting from disposal of toxic and saline waters; land subsidence; and use of large amounts of land, which are thus unavailable for other purposes.

Most of the known geothermal resources in the United States are located in the western states. As part of the development of federal procedures

for utilizing geothermal resources, the U.S. Geological Survey has investigated geothermal areas in the western United States, and has identified certain of these as "Known Geothermal Resource Areas" (KGRAs) (Federal Register, 1975). Based on current information, the expected geothermal potential in the State of Florida does not indicate that it can provide the energy requirements of the proposed project (Geraghty, Miller, Van Der Leeden and Troise, 1973; White and Williams, 1975).

Nuclear

For several reasons, installation of a nuclear generating station to supply the projected energy needs of the proposed project is not considered an acceptable alternative. First, based on the energy requirements of the project, a nuclear generating station is not as economical as other alternatives. At present, to achieve economical competitiveness with other methods of generation, the nuclear unit size would have to be in excess of 850 mW. Finally, longer lead times are required for design and construction of nuclear units than for other types because of more extensive and more stringent regulatory requirements. Previous experience indicates that about 10 years are required from initiation of a nuclear project to startup. Therefore, such construction should have already begun to have a unit on-line by the early 1980's.

Oil and Gas

Of the resources utilized in the technically feasible generation systems (oil, gas, coal, uranium, water, dry steam), oil and gas are the most

critical in terms of availability. The United States collectively depends on oil and gas for about 75% of its total energy and for about 35% of its electricity (Federal Energy Administration, 1976). By contrast, oil and gas make up about 7% of the country's fossil energy resources (Federal Energy Administration, 1976). In response to this supply-demand imbalance, and to the threat of scarcity, inflationary prices, and uncertain availability of imported oil, the federal government has initiated efforts to reduce oil and gas usage in noncritical applications such as electric power generation (CFR, Title 10; Energy Supply and Coordination Act, 1974).

At the present time, RUB primarily utilizes oil and natural gas to fire its generating units. Utilization of oil or gas as boiler fuel in new plants would aggravate potentially serious fuel availability problems and contribute to potential increases in cost of service.

Solar

The application of a commercial solar power plant to meeting base load energy requirements is still in the developmental stages (Bradley, 1977). The United States Research and Development Administration (ERDA) has devised a program plan and schedule aimed at the eventual commercialization of solar power plants. This program began in 1975 and includes such goals as the operation of a 5 mW (thermal) solar test facility in 1977 at Sandia Laboratories, a 10 mW pilot plant by 1980 at Barstow, California, and the first commercial demonstration plant by 1985.

A potential environmental disadvantage of a solar power plant is its large land requirement. It is estimated that a 250 mW solar power plant would require about 6,400 acres. In addition, siting solar power plants would require integration of unique criteria such as high insolation and favorable meteorological conditions with transmission requirements to deliver the power to the load centers. The most important advantage of solar power plants is the use of a nonexhaustible fuel supply and emission of fewer pollutants into the atmosphere as compared to other types of generation.

In summary, solar power cannot be relied upon as an alternative energy source to generate the base load energy requirements of the proposed project by the early 1980's.

Wood

Wood waste from logging operations or wood-consuming processes has been used as both an auxiliary fuel and a primary fuel in steam and/or electric generating plants. It is unlikely that sufficient quantities of wood can be secured near the vicinity of the proposed site to be used as fuel for a 235 mW power plant.

Municipal Waste

The utilization of refused-derived fuel (RDF), as a supplementary fuel for a suspension-fired utility boiler, is still in the developmental stages, and, thus, has certain inherent risks. Five such facilities

are presently operating, starting-up, or under construction in the United States. These facilities are typically located in urban or suburban areas where the quantities of municipal waste generated and the difficulty of using traditional (landfill) disposal methods may combine to make this energy source an attractive alternative.

In July 1977, a study was completed which examined the feasibility of utilizing processed municipal refuse (refuse-derived fuel) produced within Alachua County as a supplementary fuel for Deerhaven Unit 2. It was determined that firing refuse-derived fuel (RDF) would not be economically feasible in the 1981 time frame. However, based on the assumptions made in the study, RDF would prove to be economically feasible when compared with disposal by sanitary landfill by 1991. For this reason RUB has determined that it will proceed on the basis of making minimum expenditures for provisions to use RDF in the future. In other words, allowances will be made in the design and construction of the project so as not to economically preclude future RDF firing.

Coal

The vast reserves of coal in the United States amount to three times the energy contained in the Middle East's oil reserves and currently account for more than 90% of the United States' proven energy reserves (Federal Energy Administration, 1976). The use of coal for the proposed unit would enable RUB to be less dependent on a relatively scarce resource such as oil, and would aid in reducing the dependence of the United

States on foreign imports of energy. When the proposed unit becomes operational, approximately 46% of the net winter capability will be supplied from coal as compared to none at the present time.

The move to a more abundant fuel such as coal will create certain environmental impacts more adverse than those expected from the use of oil and gas. The use of coal will result in greater impacts on air quality by emitting more pollutants into the atmosphere such as SO_2, particulates, and NO_x; greater impacts associated with water effluents and solid waste; and possibly greater transportation impacts. However, technologies do exist to enable coal-fired units to meet applicable air, water, and land environmental regulations.

Other Sources

Numerous other sources of energy have been advanced by the scientific community. These include systems such as wind, nuclear fusion, tides, magneto-hydrodynamics, and fuel cells. None of these is sufficiently developed at present to be used for base load generation in the early 1980's.

8.4 Alternatives to Acquiring Additional Generating Capacity

In order to supply required base load capability, this section examines alternatives that could preclude the construction of a new generating unit.

8.4.1 No Action

The need for the Deerhaven Unit 2 project is described in Chapter 1 of this report. Pursuant to that discussion, the no action alternative would not allow RUB to meet its projected demand, energy and reserve requirements.

8.4.2 Purchase Power

As an alternative to the construction of Deerhaven Unit 2, the potential exists for purchasing excess firm capacity and associated energy from other interconnected utilities. Based upon review of the current plans of the peninsular Florida utilities as presented in the 1977 Ten-Year Plan prepared by the FCG, it is most likely that any such available excess capacity on other peninsular Florida systems would be oil-fired.

During the 1981 to 1986 time frame, as shown in Table 1.6-1 in Chapter 1, of the seven systems in peninsular Florida comparable to or larger than RUB, the largest system, Florida Power & Light, projects reserves in excess of 20% only in the years 1982 and 1983 while the next larger, Florida Power Corporation, projects no reserves in excess of 20%.

In fact, both of these large systems will be capacity-short during most of that period. Of the remaining five systems, all except Tampa Electric Company and the City of Lakeland have essentially all oil-fired generation. The City of Lakeland has scheduled the addition of a 236 mW coal-fired addition in 1983, and prior to this addition, the system is essentially all oil-fired. Tampa Electric Company is projecting reserves below 20% in 1984 and 1985 prior to the addition of a 425 mW coal-fired unit in 1986.

8.4.3 Increased Utilization of Existing Facilities

The existing RUB system is comprised of a mixture of four fossil-steam turbines, five combustion turbines, one black start internal combustion diesel unit and a portion of Crystal River 3 nuclear plant. With the exception of Crystal River 3, the units are operated by oil or natural gas. All are operated as either peaking units or intermediate units, except Deerhaven Unit 1, which is operated as a base load unit. Therefore, the increased utilization of existing units would not alleviate the need for additional base load capacity. In addition, increased utilization of existing units would increase the dependence on natural gas and/or oil for base load generation.

8.5 Summary of Final Site and Fuel Selection

In order to supply required base load capability, RUB has elected to construct a 235 mW coal-fired generating unit in its service territory.

Economic site selection criteria indicate a preferred site would be collocational with the existing Deerhaven Unit 1. The site is of sufficient size to preclude the need for additional property aquisition and is linked to the existing transmission network as shown on Figure 8.1-4. Additional savings realized by using this site include: (1) a minimization of the total manpower needs for both units; (2) sharing of support facilities by both units; and (3) improved logistics and management efficiency resulting from having both facilities on the same site.

FEA stated in its construction order for this unit, dated June 21, 1977: "FEA cannot find that an adequate and reliable supply of coal is not reasonably expected to be available".

This finding by FEA, combined with further reviews of alternative energy sources and alternatives to the addition of base load capability, indicates that the installation of a 235 mW generating unit utilizing coal as the energy source appears to be the most practical alternative overall.

CHAP. 9-PLANT DESIGN ALTERNATIVES

CHAPTER 9

PLANT DESIGN AND DISCHARGE ALTERNATIVES

This chapter presents the alternatives considered during the preliminary design of the project for various in-plant systems and methods of effluent disposal. Of primary concern was the method and source of process water treatment and effluent disposal.

Section 9.1 discusses alternatives and ranks the alternatives into two categories, active and rejected. Active alternatives are those considered to be feasible by RUB from an economic, engineering, and environmental standpoint and would receive further consideration should deep well injection not be utilized. Rejected alternatives are those determined not to be feasible based on the above parameters and would not receive further consideration. The alternatives are presented in detail along with their projected environmental impacts. Detailed comparative economic and environmental data are presented for the active alternatives while similar, less detailed data are provided for rejected alternatives.

The remaining sections discuss various segments of the process water system and those provisions made regarding future use of flue gas desulfurization equipment.

9.1 Water Treatment and Discharge Alternatives

9.1.1 Active Alternatives

Several alternatives to the disposing of cooling tower blowdown and low volume waste have been investigated. These alternatives have been

evaluated by RUB and have been ranked in order of preference as shown on Table 9.1-1. This table presents the source of cooling water, whether from wells on the site or from the RUB's water distribution system; the cooling tower blowdown and low volume waste disposal method for each alternative; the total groundwater withdrawal for each alternative; the total liquid discharge from the power plant, both cooling tower blowdown and, where applicable, low volume waste; the concentration of sulfates, chlorides and total dissolved solids in the plant discharge stream; and the net groundwater withdrawal from the freshwater aquifer. If consumptive use is defined as the total groundwater withdrawn from the freshwater aquifer and not directly returned, Table 9.1-1 then provides a measure of the consumptive use associated with each alternative.

9.1.1.1 Description of Process Water Treatment, Wastewater Treatment and Use Alternatives

The process water treatment, wastewater treatment and use system presented in Chapter 3 is preferred in regard to capital costs, operation and maintenance costs, use of natural resources, and conservation of energy. Other alternatives are available should this system not be acceptable.

Alternative 1 - Deep Well Injection/Side Stream Treatment - The flow scheme (water and solids) for this alternative (Figure 9.1-1) is the same as for the chosen system (Figure 3.3-1) with the exception of the cooling cycle.

Table 9.1-1 Active Disposal and Treatment Alternatives

	Alternative Designation	Cooling Tower Conc.	Cooling Tower Blowdown								
			SO_4 Conc. (mg/l)	Cl Conc. (mg/l)	TDS Conc. (mg/l)	Flow (MGD)	Cooling Tower Makeup (MGD)	City Water Makeup (MGD)	On-Site Ground-Water Makeup (MGD)	Makeup From Floridan Aqu. (MGD)	Consumptive Water Use (MGD)
1.	GW-5-SST/DW	(5.3){46.6}	8,900	460	14,000	0.05(0.09)	3.84(5.44)	0.07(0.11)	4.01(5.77)	4.08(5.88)	4.05(5.83)
2.	GW-5-SST/BC*	(5.3){46.6}	8,900	460	14,000	0.05(0.09)	3.84(5.44)	0.01(0.01)	3.84(5.51)	3.85(5.52)	4.05(5.83)
3.	CW-2-NT/DW	2.8	184	86	500	2.05(2.90)	5.83(8.24)	5.90(8.35)	0.17(0.33)	6.07(8.68)	3.98(5.73)
4.	CW-1-NT/BC	3.7	250	117	666	1.37(1.94)	5.14(7.26)	5.04(7.11)	0.17(0.33)	5.21(7.44)	3.98(5.73)
5.	GW-1-FE/BC	3.6	250	122	786	1.42(2.02)	5.19(7.34)	0.01(0.01)	5.25(7.51)	5.26(7.52)	4.00(5.75)

*Essentially zero discharge system.

LEGEND: ((All Flows expressed in Million Gallons per Day (MGD))

0.00 = Average Monthly Flow Rate

(0.00) = Normal Maximum Monthly Flow Rate

( ) = Cooling Tower Concentrations Relative to Flow to Side Stream Treatment Plant from Cooling Towers

{ } = Cooling Tower Concentrations Relative to Flow to Process Waste Disposal System from Side Stream Treatment Plant

CW-1-NT/BC

- Process Waste Disposal Method:
  - BC = Brine Concentrator
  - DW = Deep Wells
- On-Site Cooling Water Treatment:
  - NT = No On-site Cooling Water Treatment
  - FE = Front End (Excess Lime Softening) Treatment
  - SST = Side Stream (Lime-Soda Softening) Treatment
- Relates to System Designation
- Cooling Tower Makeup Source:
  - CW = City Water
  - GW = On-Site Wells

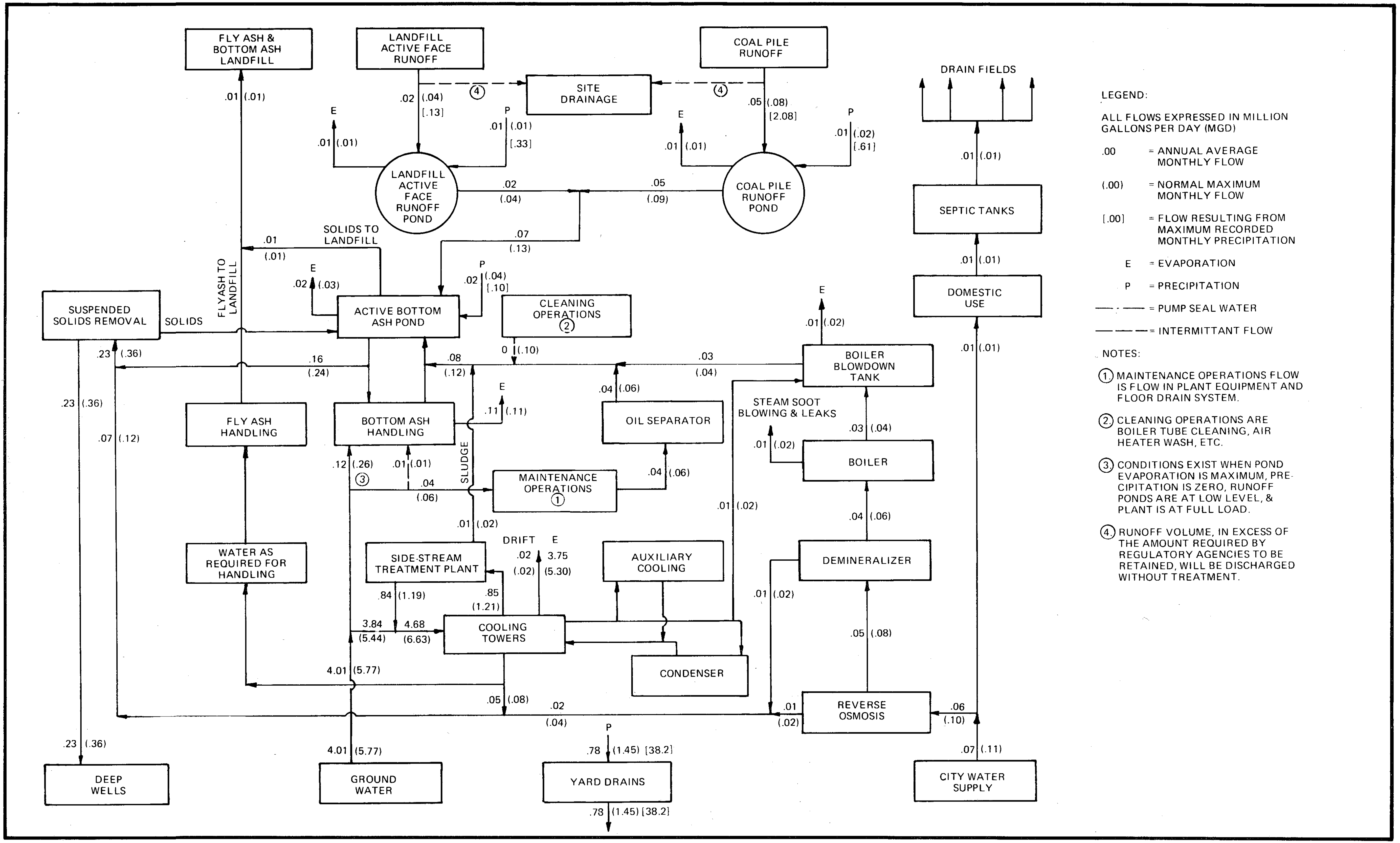

FIGURE 9.1-1 PROCESS FLOW DIAGRAM ALTERNATIVE 1.

The cooling water system for this alternative employs side-stream treatment for softening of the cooling water. This enables the system to operate at a higher number of concentrations than can a conventional cooling cycle which does not have treatment or which has only front-end treatment, thus reducing the quantity of blowdown.

With this scheme, a side-stream from the cooling towers (Units 1 and 2) is treated in a side-stream treatment plant. The flow rate of this stream is based on 5.3 concentrations in the cooling cycle. The lime-soda ash softening water treatment plant is capable of reducing the concentration of hardness causing ions (e.g. Ca^{++}, Mg^{++}, etc.) to their respective groundwater concentrations. The product water from the treatment plant is combined with raw groundwater for cooling tower makeup. Therefore, the concentration of hardness causing ions in the cooling water will be approximately 5.3 times their concentration in the groundwater. The sludge generated by the treatment plant will be disposed of in the active bottom ash pond, from which it will be incorporated into the ash landfill.

The quantity of blowdown from the entire cooling system, including the water treatment plant, will be that quantity of water required for sludge removal from the clarifiers. It is expected that this quantity would be 7% to 8% of the flow into the treatment plant. This would result in the cooling system as a whole being operated at approximately 46 concentrations, thus concentrating the nonhardness causing consti-

tuents to approximately 46 times their respective concentrations in the raw groundwater.

For a description of the manner in which all other plant systems would be operated, see Chapter 3.

The advantages of this alternative over the chosen system are that it requires approximately 86% of the average annual consumptive water use of the chosen system. Additionally it only injects approximately 25% of the average annual deep-well-injected waste and utilizes approximately 86% of the Floridan Aquifer withdrawal as compared to the chosen system.

The disadvantages over the preferred system are that it will require approximately 700 tons per year of lime, approximately 2,300 tons per year of soda ash, approximately 150 tons per year of polymer, and approximately 30,000 kilowatt hours per year more of electricity than the preferred system. The capital and operating costs are approximately 1.6 and 5.6, respectively, times the costs for the preferred system.

Alternative 2 - Zero Discharge - This alternative differs from the chosen system in that the cooling water system employs side-stream treatment and the process wastes are treated for dissolved solids removal and reused, thus not making use of deep-well injection. See Figure 9.1-2 for the water and solids flow scheme for this alternative.

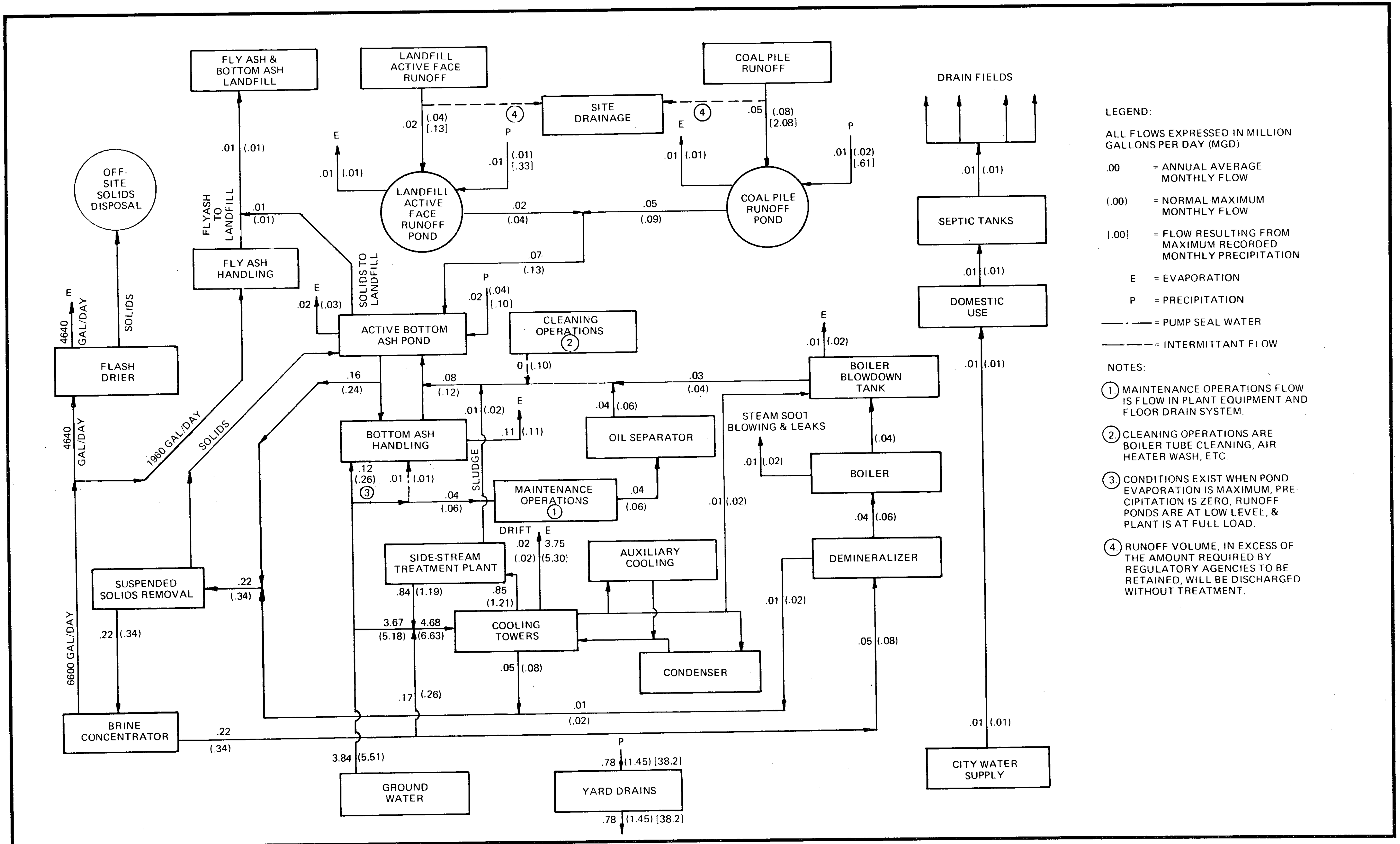

FIGURE 9.1-2 PROCESS FLOW DIAGRAM ALTERNATIVE 2.

The cooling water system for this alternative is the same as for Alternative 1.

The process wastes are generated, collected and undergo suspended solids removal in the same manner as for the chosen system and for Alternative 1. However, instead of being deep well injected, they are routed to a vapor-compression evaporator (brine concentrator) for dissolved solids removal. The brine concentrator evaporates the water from the waste, converts the vapor to condensation and recovers the condensate as a product water. This product water is then used as cooling system and boiler makeup.

A portion of the waste product (brine) produced by the evaporator is used to moisten the fly ash as required for proper handling. The remainder of the waste is either disposed of in the ash landfill where it is encapsulated with fly ash or is flash dried and the remaining solids hauled off-site for disposal by a disposal contractor.

The advantage of this alternative is that it requires approximately 81% of the average annual consumptive water use and approximately 81% of withdrawal from the Floridan Aquifer as compared to the chosen system.

The disadvantages over the chosen system are that it will require approximately 700 tons per year of lime, approximately 2,300 tons per year of soda ash, approximately 150 tons per year of polymer and approx-

imately 7.5 million kilowatt hours per year more of electricity than the preferred system. Also, the capital and operating costs for this alternative are approximately 2.4 and 6.8 times the respective costs of the chosen system. In addition, there is an expense and waste of energy in the form of gasoline or diesel fuel to haul the brine to Baton Rouge if not disposed of in the landfill.

Other Alternatives - Two other alternatives were considered wherein water from the RUB system or treated on-site groundwater is used for cooling tower makeup, cooling tower blowdown is shallow-well injected, and process wastes are deep well injected. However, these alternatives require large amounts of lime and polymer and have capital and operating costs ranging for RUB water from 4 to 5 and for on-site groundwater 5 to 8 times the respective costs of the chosen system.

These alternatives consider disposing of cooling tower blowdown by means of on-site shallow injection wells which would recharge the freshwater aquifer. In order to achieve an acceptable level of water quality in cooling tower blowdown prior to injection, softening of cooling tower makeup water would be required. Thus, if groundwater obtained from Deerhaven wells were used as cooling tower makeup water, an on-site water softening treatment plant would be required. Cost analyses favor utilizing previously softened water from the RUB distribution system rather than construction of an on-site water softening treatment plant. In addition, subsequently described evaluations indicate technical

difficulties associated with simultaneous on-site groundwater withdrawal and recharge. Although the RUB water system is the preferred water supply source for this alternative, evaluations are presented both for water withdrawal from on-site wells and for water supply from the RUB system. Pumping rates and injection rates for each evaluation are shown below:

WITHDRAWAL AND INJECTION RATES FOR DISPOSAL OF COOLING TOWER BLOWDOWN BY ON-SITE SHALLOW WELL INJECTION

Source of Water	Pumping Rate (mgd)	Injection Rate (mgd)
Wells on-site	6.6 (average)	2.85 (average)
	9.31 (max)	4.04 (max)
RUB's Murphee wellfield	5.79 (average)	2.05 (average)
	8.16 (max)	2.90 (max)

9.1.2 Rejected Alternatives

In addition to the discharge system alternatives previously discussed detailed investigations have been performed to evaluate the technical and environmental feasibility of other disposal alternatives. This section briefly summarizes each alternative and the rational leading to its rejection. Detailed information on the feasibility of discharging to the main branch of Rocky Creek, Mulatto Pen Branch, Cellon Creek, and on-site spray irrigation systems or percolation ponds can be found in "An Evaluation of Alternatives to the Present Releasing of Deerhaven Generating Station Blowdown to Turkey Creek" (Breedlove and Associates, and Jones, Edmunds and Associates, 1977).

Mulatto Pen Branch - This alternative calls for the introduction of a high quality cooling tower blowdown into Mulatto Pen Branch, a tributary of Rocky Creek, at its intersection with SR-121. The Mulatto Pen Branch drainage basin is shown on Figure 9.1-3 along with the assumed cooling water pipeline route and the proposed discharge location. As indicated, two discharge routes have been considered.

One route would require piping the cooling water discharge from point "A" to point "B", construction of a wholly excavated open channel from point "B" to point "C", followed by extensive modification to the natural channel of Mulatto Pen Branch down to SR-121. The right-of-way requirements for open channel modifications would vary from a minimum of 50 feet to a maximum of 75 feet with clearing and grubbing and berm construction within right-of-way limits. A continuing maintenance program would be necessary including biannual cleaning and reshaping of the water course and berms plus grass and brush cutting within the right-of-way.

The second route would involve pumping cooling tower blowdown via pipeline from point "A" to point "D". Discharge into Mulatto Pen Branch at point "D" would eliminate the open channel construction and maintenance discussed above. Hydrologic modeling of Mulatto Pen Branch by means of advanced computer models indicates that the tributary has sufficient channel capacity to accept and convey the discharge from point "D" to the primary channel of Rocky Creek without modification. Hydrological impacts would be limited to only local short-term adjustment in the

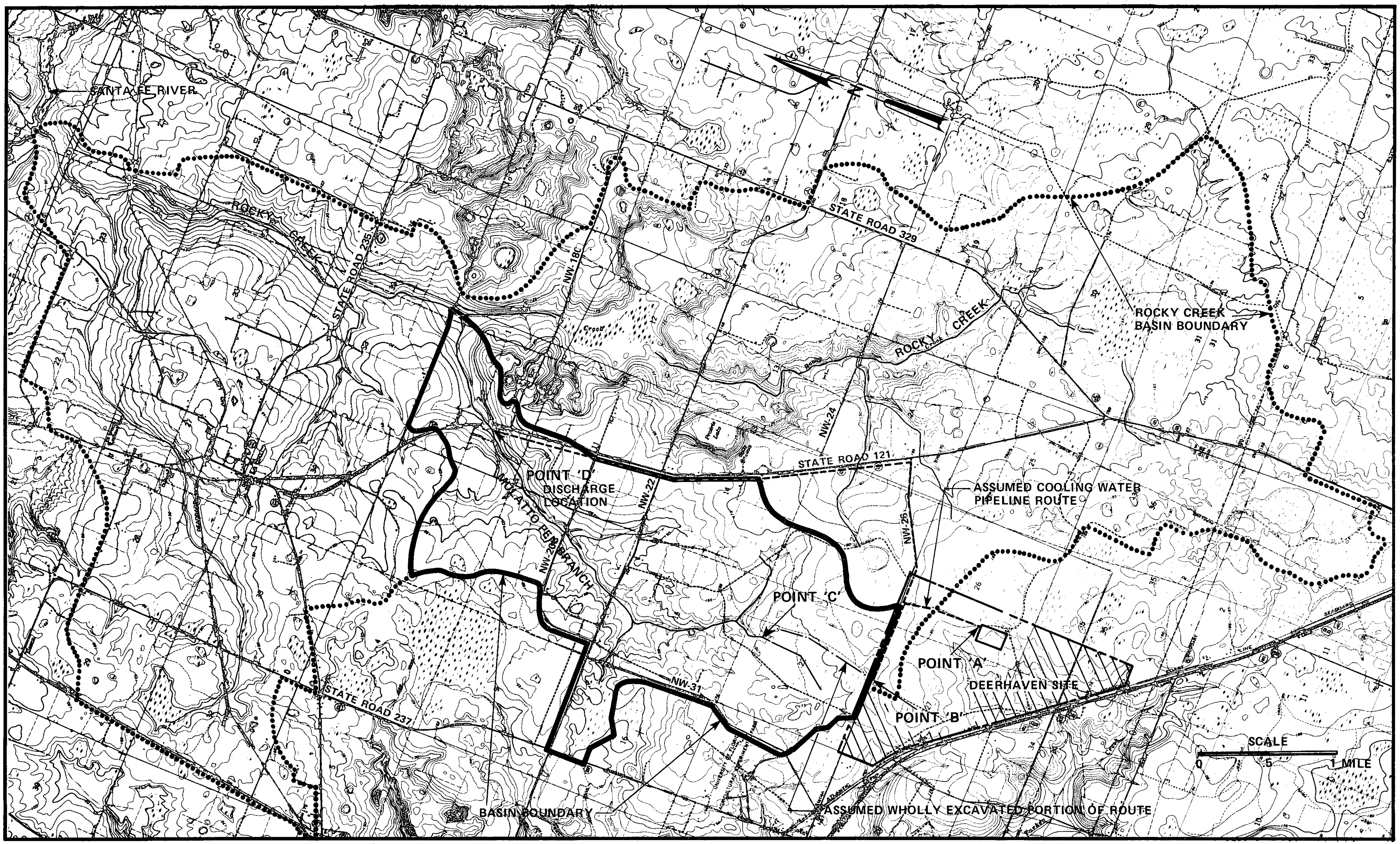

FIGURE 9.1-3 MULATTO PEN BRANCH DRAINAGE BASIN, SHOWING PROPOSED COOLING TOWER BLOWDOWN DISCHARGE ROUTES.

channel for the sustained increase in flow. With the exception of the improvement of two shallow farm crossings and construction of a simple outfall structure at point "D", no other channel improvements would be anticipated. Hydrologic modeling of Rocky Creek from its point of confluence with Mulatto Pen Branch down to its confluence with the Santa Fe River indicates little hydrological impact due to the introduction of the cooling tower blowdown flow.

Because of the minimized environmental impact of cooling tower blowdown discharge at point "D" in Mulatto Pen Branch, this is considered to be the most feasible and desirable surface stream discharge alternative.

Discharge Into Upper Rocky Creek Basin - This alternative assumed piping of blowdown from the power plant to a small stream in the southern end of the Rocky Creek drainage basin which is tributary to Rocky Creek at its upper reaches (Figure 2.5-9). Upon joining Rocky Creek, the discharge would pass south through two swamps and proceed to the Sante Fe River. High erosion in the tributary from Cross-section R101 to R003 were predicted by the analysis. Otherwise, little hydrological impact on natural stream channels was predicted. However, this alternative was rejected due to the potential for hydrogen sulfide generation in the swamp systems between Cross-sections R065 and R313.

Discharge Into Cellon Creek Drainage Basin - This alternative considered piping the cooling tower blowdown along U.S. 441 northwest of the Deer-

haven site into the Cellon Creek drainage basin (Figure 2.5-3). Two alternative discharge points were considered. Discharge point "A" is located at the box culvert where Cellon Creek passes beneath U.S. 441 near the General Electric battery plant. Discharge point "B" is just upstream of Cellon Creek's terminus at Lee Sink, where, it is believed, Cellon Creek connects with the Floridan Aquifer. Environmental investigations indicated that the Cellon Creek system is presently stressed from a biological standpoint and that the introduction of cooling tower blowdown water would have little additional impact. Hydrological analyses and modeling of the stream channel indicated that erosion would increase between Cross-sections C007 and C008. Stream water levels were predicted to increase insignificantly due to the additional flow. However, stage-discharge relationships developed for Lee Sink implied that the sinkhole would not accept the additional discharge without extensive flooding in the area of the sinkhole and, possibly, overflow into an adjacent drainage basin. Although the stage-discharge relationships were preliminary in nature and based on instrument recordings for only one storm event and only two flow tests of the sinkhole, it was felt that additional investigation was unwarranted unless all active discharge alternatives were to prove unfeasible.

Disposal by On-site Spray Irrigation Systems or Percolation Ponds - This alternative considered the feasibility of on-site disposal of cooling tower blowdown by either an on-site spray irrigation system or by percolation ponds. Several borings were performed at selected locations

to determine the stratigraphy and properties of site soils. Samples were retained and subjected to permeability testing. Based on such information, mathematical and computer models were performed to determine whether cooling tower blowdown could be disposed of by spray irrigation on the Deerhaven site without surface runoff occurring. It was felt that if spray irrigation were feasible, the feasibility of percolation ponds would then be investigated. However, mathematical and computer model results indicated that the net quantity of water that can be infiltrated on the Deerhaven site is extremely small and that overland runoff of cooling tower blowdown would occur.

Discharge Into Turkey Creek - Cooling tower blowdown from Deerhaven Unit 1 has been discharged into an on-site tributary of Turkey Creek since plant startup (see Figure 2.5-2). Although environmental investigations imply that environmental impacts to the Turkey Creek system would not increase due to additional cooling water flow from the proposed Unit 2, this alternative is not under active consideration, because of extreme objection expressed by the Department of Natural Resources.

Use of Cooling Tower Blowdown for Water Supply at RUB's Murphee Water Treatment Plant - This alternative considered the transporting of cooling tower blowdown via pipeline to the Murphee Water Treatment Plant, approximately 7 1/2 miles southeast of the Deerhaven site, for treatment and use as potable water. This alternative was rejected because of the expense of conveyance and treatment of the cooling tower

blowdown, the degrading effect of the cooling tower blowdown water on treated water quality, and the doubtful acceptability of cooling tower blowdown as a source of potable water by regulatory agencies.

Disposal by Shallow Well Injection at RUB's Kanapaha Wastewater Treatment Plant - This alternative considered transporting the cooling tower blowdown by pipeline to the Kanapaha Wastewater Treatment Plant, approximately 12 miles south of the Deerhaven site, and injecting blowdown into shallow disposal wells constructed on that site. This alternative was rejected due to the costs of transporting the cooling tower blowdown to the wastewater treatment plant.

9.1.3 Impacts of Alternatives

9.1.3.1 Ecological Impacts of Plant Design Alternatives

9.1.3.1.1 Active Alternatives

There are three categories of active discharge alternatives: (1) modified deep well injection; (2) zero discharge; and (3) shallow well injection.

Those alternatives utilizing "side-stream treatment" (modified deep well and zero discharge) result in the concentration of dissolved constituents, and as a consequence salt drift (NaCl) becomes a matter of concern. If the same method for determining TDS deposition from blowdown is used as was used in Section 6.1.4, the expected TDS deposition is 2,950 lb./acre-year (Figure 9.1-4). Sodium chloride is approximately 3% of the TDS in the blowdown (Table 9.1-2). Therefore, NaCl deposition within the 2,000

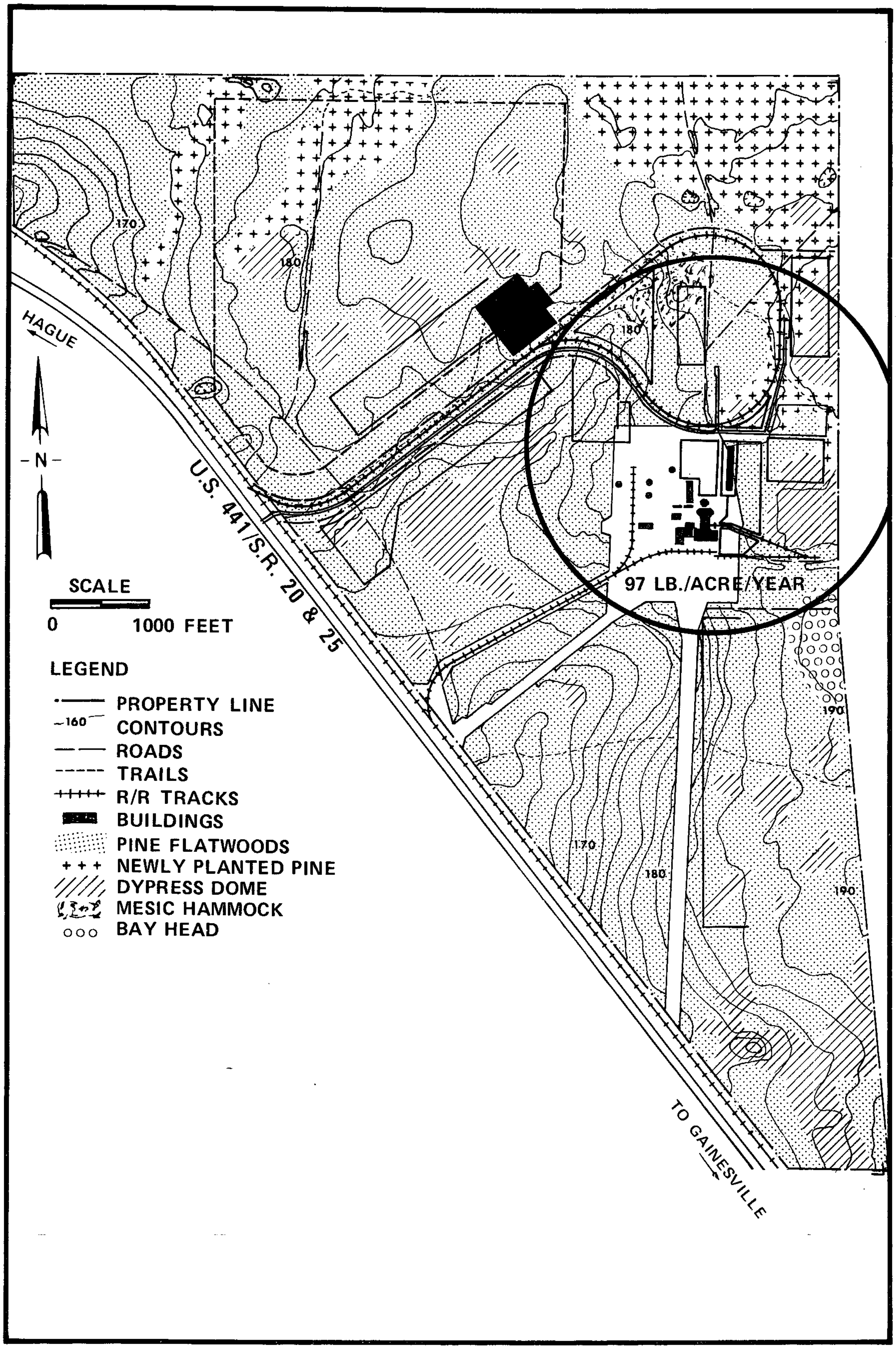

FIGURE 9.1-4 PROJECTED SALT DEPOSITION FROM COOLING TOWER DRIFT USING SIDE STREAM TREATMENT.

Table 9.1-2 Anticipated Concentration of Various Constituents in Deerhaven Blowdown Drift

Parameter	Deepwell Six Concentrations	Sidestream Treatment Forty-Six Concentrations
	(mg/l)	(mg/l)
NaCl	98.4	750
$CaSO_4$	1600	1000
$MgSO_4$	680	1300
KFl	9.0	140
Na_2SO_4	---	10500
TDS	2800	14000

foot radius is estimated to be 97 lb./acre-year over ambient levels. While the calculations are simplistic in nature, deposition at this rate could cause toxic responses in sensitive plant species (Table 5.2-1). Should one of these alternatives have to be seriously considered, further analyses and studies should be performed to: (1) ascertain whether the potential for injury truly exists; and (2) to more accurately map problematic areas.

The zero discharge alternative would use groundwater as a source of cooling water makeup, requiring a side-stream treatment facility to treat the cooling tower blowdown so that a portion can be recycled. Low volume plant wastes, including the unusable output from the side-stream treatment, are piped into a brine concentrator which condenses the effluent into a sludge. This sludge would be either landfilled on-site or hauled off-site for disposal by a disposal contractor. The brine concentrator produces a high quality water which is returned to the system for re-use. This method eliminates water effluent.

Ecological effects of construction and operation of the zero discharge alternative would be similar to and of the same magnitude as those discussed in Chapters 4 and 5. These anticipated effects are: (1) minimal adverse impacts to vegetation, aquatic life and wildlife; (2) a return of Turkey Creek flow to pre-Deerhaven conditions through removal of Deerhaven Unit 1 blowdown; (3) a subsequent change in presently affected vegetation and aquatic life in the on-site cypress swamp and

the chronically flooded portion of Sanchez Prairie to pre-Deerhaven Unit 1 conditions; and (4) impacts of a concentrated drift as described above for "side-stream treatment" alternatives.

Shallow Well Injection On-site

For the purpose of these evaluations, the Floridan Aquifer was considered to be the injection zone to a depth of 1,000 feet. Water below this zone was assumed to be brackish. The geologic formations overlying the Floridan Aquifer have permeabilities too low for injection to be feasible at the suggested rates. Available data for the study site and the surrounding area indicate that water in the Floridan Aquifer may either be confined or unconfined, depending upon the time of year. Water level responses to injection and withdrawal were calculated using the Theis non-equilibrum model. A storage coefficient of 1×10^{-1}, which reflects unconfined aquifer conditions, was used in the model to provide conservative estimates which would indicate the "worst possible case" for cone of depression and mounding effects. It should be noted that the Theis non-equilibrium model estimates changes only in a highly idealized situation where many assumptions must be made about the fluid and the media through which it flows. Unfortunately, little data exist which would permit a more accurate evaluation of groundwater system behavior.

Figure 9.1-5 shows the estimated net water level changes which would result from shallow well injection and groundwater withdrawal, both occuring on-site. The analysis on which this map is based assumed a

spacing of 4,500 feet between the injection and water supply wells, aquifer transmissibility of 200,000 gpd/ft. for the water supply wells, aquifer transmissibility of 251,000 gpd/ft. for the single assumed injection well (reflecting viscosity differences between 71° F Floridan Aquifer water and 90° F cooling tower blowdown water), and the storage coefficient of 1×10^{-1} previously referred to. An assumption was also made that both the injection and water supply wells were open to the same zones in the Floridan Aquifer. The contours shown represent theoretical changes in potentiometric surfaces after thirty years of simultaneous on-site injection and withdrawal, without allowing for variation in rates of natural recharge or potentiometric surface changes caused by groundwater withdrawal elsewhere in the region. The use of two different values for transmissibility for calculation of potentiometric surface change is not rigorously correct, in that the temperature effects do not extend outward equally in all directions. However, for the sake of simplicity, it is felt that this approach gives a better answer than using a single transmissibility value for both the pumping and injection wells.

The skewed pattern of potentiometric surface drawdown shown on Figure 9.1-5 represents the results of both drawdown and buildup of potentiometric surface around the wells. The drawdown is the dominant effect because the rate of pumping is greater than the cooling tower blowdown injection rate, and also because the transmissibility in the injection analysis is greater than that used for the water supply well withdrawal

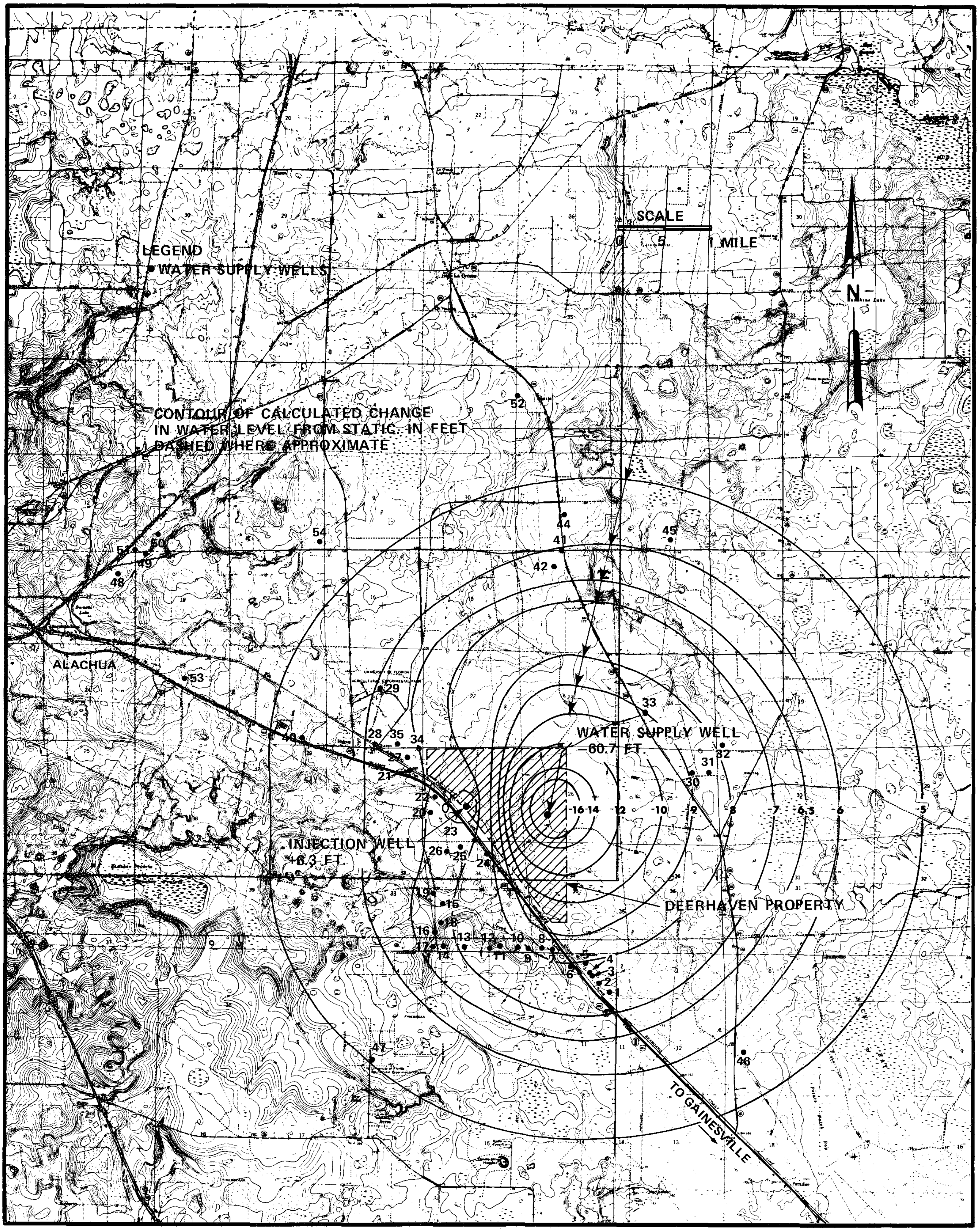

FIGURE 9.1-5 NET WATER LEVEL CHANGES IN AQUIFER IN RESPONSE TO ON-SITE WITHDRAWAL OF 6.6 MGD AND INJECTION OF 2.85 MGD.

analysis. The inference from this analysis is that the injected water would move essentially down-gradient from the injection well toward the pumping well and that none of it would escape from the cone of depression. The theoretical transit time between the injection and supply wells, calculated using Darcy's Law, is about one year. Should the injection and withdrawal wells tap different zones in the aquifer, the effects would be different from those indicated. Migration velocities of the injected water towards the water supply well would probably be slower due to the large differences between horizontal and vertical permeabilities in the aquifer. However, regardless of such differences, the flow from the injection well would still be toward the water supply wells. In either case, a plume would form and move down-gradient with the temperature of the water in the plume being higher than the temperature of the native groundwater. Temperatures at the outer perimeter of the plume would probably be close to background temperatures, whereas temperatures near its center and near the injection well would approach the original temperature of the injectant (assumed to be 90° F). An additional result would be that total dissolved solids contained in the injected cooling tower blowdown would ultimately recirculate into on-site water supply wells and thus into the recirculating cooling water system. It is doubtful that simultaneous shallow well injection of cooling tower blowdown and on-site water supply well operation will be considered for this reason.

In the event that the water supply for the power plant were to be imported and the injection were to take place on-site, the average injection rate would probably be 1,424 gal./min. (2.04 mgd). Figure 9.1-6 shows the estimated contours of net potentiometric surface change in the Floridan Aquifer after thirty years of injecting 90° F water, using an assumed transmissibility value of 251,000 gpd/ft. and an assumed storage coefficient of 1×10^{-1}. As indicated, the estimated potentiometric surface in the 14 inch diameter injection well would be 15.6 feet above the initial potentiometric surface when injection began. This injection would result in an increase in potentiometric surface elevation of approximately 2.3 feet at a radius of 3 miles from the injection well. If there were no regional pattern of groundwater flow in the aquifer, the injected fluid would move outward and perpendicular to the potentiometric surface contours shown. However, because natural flow in the Floridan Aquifer is to the west, the body of injected fluid would probably form a plume extending in that direction and moving at approximately the same velocity as water in the aquifer. Average rates of groundwater flow in the aquifer probably range from a few inches per day to as much as several feet per day. It is believed that large conduits occur in the aquifer which may transport groundwater at much higher rates. Any artificial gradients in the aquifer would change the direction and flow of the plume. This might occur, for instance, if a new nearby well were to begin pumping and if its zone of influence were to intersect the plume of injected water. The injected water then would alter its direction of movement, moving towards the pumping well. If drawdown

FIGURE 9.1-6 NET WATER LEVEL CHANGES IN AQUIFER IN RESPONSE TO INJECTING 2.05 MGD ON-SITE AND IMPORTING PLANT WATER SUPPLY.

from such a well produced large gradients in the potentiometric surface, the rate of movement of injected water toward the well could be appreciable compared with the natural rate of aquifer groundwater flow.

Temperature changes in the aquifer caused by the higher temperatures of the injected fluid would be similar to those cited in the first evaluation. Temperatures near the injection well would be close to the original injectant temperature and would rapidly drop off to ambient temperatures up-gradient from the well. Temperatures in the direction of movement of the injected water would fall off more slowly, approaching ambient temperatures only as the leading edge of the plume was neared.

Water in the Floridan Aquifer is essentially in chemical equilibrium with its environment. Foreign water introduced into the aquifer would probably go through various chemical reactions such as solution of the limestone and precipitation of various salts, until a new chemical equilibrium was reached. Temperature, pH, and concentration of chemical constituents would affect the rate at which equilibrium is established. Chemical and physical measurements of the cooling tower blowdown are compared with median values of parameters of the Floridan Aquifer water in Alachua County in Table 9.1-3. Shown are the characteristics both of cooling tower blowdown from existing Unit 1 cooling tower and characteristics which would be expected due to softening of supply water and reducing cooling water cycles for the combined cooling tower blowdown from Unit 1 and Unit 2 facilities.

Table 9.1-3 Chemical/Physical Analyses of Cooling Tower Blowdown and Floridan-Aquifer Water[1]

	Unit 1 Cooling Tower Discharge[2]	Proposed Cooling Tower Discharge for Shallow Well Injection	Floridan Aquifer Water[3]	Floridan Aquifer Water[4]
Calcium (Ca)	120	NA	50	57
Sodium (Na)	18	NA	10	NA
Bicarbonate (HCO_3)	12	NA	202	239
Chloride (Cl)	26	NA	12	15
Sulfate (SO_4)	480	161 to 184[5]	8	55
Dissolved solids residue @180°C	750	500	203	341[6]
Noncarbonate hardness	480	NA	5	28
pH (units)	6.8	6.8	7.9	7.7
Temperature (°F)	98.6	90	78	71[7]
Iron (Fe)	0.370	NA	0.07	0.04

[1]All chemical concentrations given in milligrams per liter.
[2]Date sampled May 30, 1975, analysis by USGS, Water Resources Division.
[3]The chemical analyses presented show the median value for the parameter as reported in IC43, "Water Resources Data for Alachua, Bradford, Clay, and Union Counties, Florida," for all wells in Alachua County.
[4]Water sample from supply well at power plant, sampled on May 4, 1970, analysis by Black, Crow and Eidsness, Inc.
[5]Sulfate content dependent on source of cooling water.
[6]Dissolved solids determined by conductivity.
[7]Temperature measured on July 21, 1977, in six-inch well at plant site.

As indicated, the cooling tower blowdown injectant would possibly have significantly higher TDS and sulfate contents than the Floridan Aquifer water; however, not enough is known of the chemistry of the injectant to predict its effect on the aquifer. The injected water would, as previously discussed, move down-gradient as a plume, with diffused mixed waters at the plume boundary and essentially undiluted injectant toward its center. The water quality in wells intercepting the plume would gradually be degraded as this plume moved into their cones of influence.

It should be noted that the region northwest, west, and southwest of the site is riddled with numerous sinkholes which indicate high solution activity. Past dye-tracer tests have shown that there are apparently excellent hydraulic connections between some sinkholes and down-gradient streams. In one such test, dye was detected in a deep sink 2.5 miles from the point of injection in less than 36 hours after the dye was injected. These facts point out the complexity and unpredictable nature of the hydrologic systems in the vicinity of the Deerhaven site. Thus, assumptions made in the models presented above pertaining to the homogeneity and isotropy of the Floridan Aquifer are not necessarily accurate.

For example, in homogeneous and isotropic aquifer systems, a plume would develop and migrate slowly down-gradient from a shallow injection well such as discussed herein whereas in an aquifer such as may exist near the Deerhaven site, the plume could enter a solution conduit and travel

many miles in a short period of time, essentially undiluted and at the same temperature at which it was first injected. Results of such rapid transport could be either favorable or unfavorable.

The possibility exists that such a conduit could convey the injected water rapidly out of the Deerhaven area, mixing it with additional groundwater and discharging into an area river at a spring. On the other hand, if a water supply well happened to tap that particular solution channel, the quality of its water could become rapidly degraded by the injected cooling tower blowdown.

Conference calls with the DER and the Suwannee River Water Management District (SRWMD) have been made to ascertain the thinking of regulatory officials with regard to shallow well injection of cooling tower blowdown at the Deerhaven site. Some of the officials contacted felt that injection into relatively fresh water might not constitute a severe problem, and, in a later conversation with DER (July 13, 1977), it was stated that as long as the injected water met all public health standards for drinking water, there should be no problem with permitting. It should be noted that the quality of the proposed cooling tower blowdown to be shallow well injected would meet such regulatory standards.

The U.S. Environmental Protection Agency (EPA) is now recommending to states that restrictive criteria be set for underground injection. The proposed regulation for injection practices, published by the EPA in

August, 1976, states that all underground drinking water sources of 3,000 mg/l total dissolved solids (TDS) or less shall be protected by casings cemented to the ground surface. The 3,000 mg/l value was established as a minimum and it was recommended that states protect all groundwater up to a 10,000 mg/l TDS content. The proposed EPA regulations are presently being revised. Upon final passage, these regulations will be the minimum standard upon which any state can base its own regulations. It is not known when these regulations will go into effect, nor is it known how the regulations will be applied to existing facilities.

As discussed above, insufficient information exists to determine whether recirculation between on-site shallow drainage wells and on-site water supply wells would result if the shallow wells were to inject into a permeable zone which might exist at an elevation deeper than, and separated by impermeable zones from, the on-site water supply wells. It is doubtful that this question can be resolved without a shallow well test injection program. Similarly, a shallow test injection well program would probably be required to determine whether area water supply wells would be affected by such on-site shallow wells.

Construction and operational effects would be similar to those described in Chapters 4 and 5. No further ecological effects are anticipated from injecting discharge water into the shallow aquifer.

9.1.3.1.2 Rejected Alternatives - Surface Streams

Surface stream discharge alternatives would utilize either groundwater or RUB water for cooling tower makeup. The cooling tower blowdown is of high quality and is discharged into a surface stream. Constructional and operational impacts from this method are considerably different from those of other alternatives and are therefore presented in more detail below.

In a previous investigation, Breedlove (1977) studied Turkey, Cellon and two branches of Rocky Creeks as potential surface stream blowdown discharge alternatives. Based upon ecological considerations, Turkey and Cellon Creeks were considered as the most suitable surface stream alternatives since both already showed evidence of industrial influences. However, each was rejected for other reasons. Turkey Creek flows through the Sanchez Prairie portion of San Felasco Hammock (Figure 2.7-4), recently purchased by the Florida Department of Natural Resources under the Environmentally Endangered Lands Program. The fact that Deerhaven Unit 1 blowdown may have affected a small part of Sanchez Prairie (Section 2.7) precluded the alternative of discharging the combined blowdown into Turkey Creek. Cellon Creek terminates in a swallow hole which discharges to the aquifer. Based upon predicted hydrological modeling (Breedlove, 1977) it was determined that the aquifer connection would not accomodate the stream's base flow, discharge from the General Electric plant, and the combined blowdown from Deerhaven Units 1 and 2.

The two other surface stream alternatives were Mulatto Pen Branch and an unnamed tributary designated "A". Both of these tributaries discharge into Rocky Creek (Figure 2.7-16 and Section 2.7) and are considered healthy and diverse intermittent stream systems (Breedlove, 1977). Mulatto Pen Branch, however, offers a clear difference in the projected impacts to Rocky Creek should a surface stream alternative become viable. Discharge into Rocky Creek "A" would result in blowdown flowing through two relatively large mixed hardwood swamps (Figures 2.7-16 and 2.7-19). Each of these swamps is a potential impact zone due to projected flooding (Figure 9.1-7) and the production of hydrogen sulfide. Mulatto Pen Branch, which bypasses the swamps, offers considerably less opportunity for a real impact.

Detailed evaluation of these alternatives are presented in "An Evaluation of Alternatives to the Present Releasing of Deerhaven Generating Station Blowdown to Turkey Creek" (Breedlove and Associates, and Jones, Edmunds and Associates, 1977).

9.2 Coal-pile, Ash Landfill, and Stormwater Runoffs

As discussed in Chapter 2 the majority of the Deerhaven site lies within Turkey Creek drainage basin and surface runoff naturally flows to Turkey Creek by means of either the north or south branch of that creek. Consequently, coal-pile runoff in excess of retention basin capacity, landfill runoff, and stormwater runoff from the site will flow into Turkey Creek. No alternative discharge routes for such flows have been

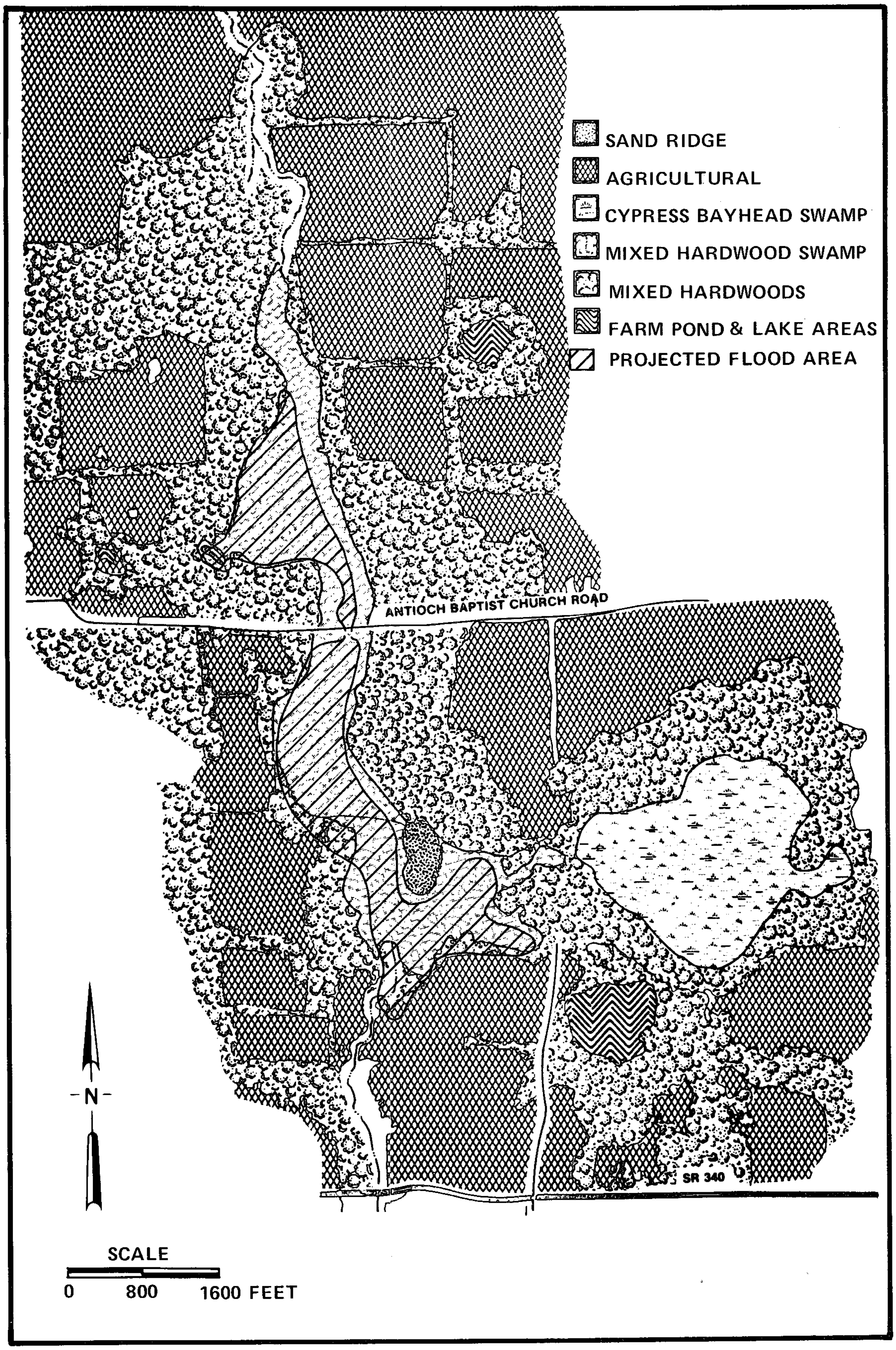

FIGURE 9.1-7 PROJECTED FLOODED AREA OF ROCKY CREEK SWAMPS UTILIZING ROCKY CREEK "A" DISCHARGE ALTERNATIVE (FROM BREEDLOVE, 1977).

evaluated due to the high cost of diverting these flows into other drainage basins and the legal principles which might prevent such diversion.

9.3 Sanitary Waste Systems

Use of the existing on-site septic tank system for the disposal of sanitary wastes from Unit 1 has demonstrated this sanitary waste treatment technique to be feasible for on-site disposal of sanitary wastewater. Discussions with the Alachua County Health Department have indicated that no objections exist to the expansion of the existing septic tank system to treat additional sanitary wastewater which will be produced by Unit 2 operating personnel.

Other systems which could have been considered as alternatives to the proposed septic tank system were a packaged secondary wastewater treatment plant with deep well disposal of effluent or on-site spray irrigation of effluent, a packaged advanced wastewater treatment plant with disposal of effluent to surface water, or pumping of untreated sanitary wastes to the nearest wastewater collection system. These alternative techniques are not presently under consideration due to the simplicity, feasibility, and economics of expanding the existing septic tank system.

9.4 Low-volume Wastes

Low-volume waste streams generated at the Deerhaven station will be from such activities as boiler fireside cleaning, boiler waterside cleaning, air preheater cleaning, condenser waterside cleaning, boiler blowdown,

demineralizer regeneration, stack cleaning, floor drainage, blowdown from recirculating ash sluicing water systems, and other miscellaneous maintenance operations. These waste-streams will be directly injected into on-site deep injection wells without treatment. The following alternative disposal techniques were considered. Prior to disposal of low-volume wastes by any of the following techniques, the wastes would be concentrated, probably in an on-site brine concentrator, to reduce the volume of free water and increase solids concentration.

1. Disposal with Fly Ash in Landfill - This technique would involve using the concentrated brine solution as a wetting agent prior to transporting of fly ash to the landfill area. Moisture content of the ash would be increased to approximately 15% to 20% by weight, reducing dust generation, permitting easier handling of moist fly ash and disposing of the concentrated brine solution.

2. Flash Drying - This technique would involve removing remaining water from the concentrated brine solution by means of a vacuum chamber and/or heat addition. The resulting solid residue would be buried at either an on-site or off-site landfill or, perhaps, removed to a controlled treatment center for disposal.

3. Truck Hauling to Controlled Treatment Center - In this disposal technique, the brine solution would be transported

to a commercial controlled treatment center and disposed of by an approved, environmentally safe technique.

9.5 Flue Gas Desulfurization

The flue gas duct system will be designed in such a manner as to be able to add a Flue Gas Desulfurization (FGD) system at a later date should compliance coal become unavailable. The proposed stack is designed to handle either dry or saturated flue gas should scrubbing become necessary.

Space is allotted and reserved in the plant yard for a future FGD system. It is anticipated at this time that such a system would be either a limestone or double alkali system.

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APPENDIX

LIST OF TABLES

CHAPTER 7 - ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND OPERATION

LIST OF FIGURES

CHAPTER 2 - THE SITE AND SURROUNDING AREAS

Table A2-1 Cultural Resources Survey Data Sources

Maps	Description
1850	Township 8 South, Range 19 East, Section Survey by A.M. Randolph. On file, Florida Bureau of State Lands, Tallahassee.
1966	Gainesville East, Florida. USGS Quadrangle sheet, 7½' Series, 1:24,000.
1966	Gainesville West, Florida. USGS Quadrangle sheet, 7½' Series, 1:24,000.
1966	Monteocha, Florida. USGS Quadrangle sheet, 7½' Series, 1:24,000.
1966	Alachua, Florida. USGS Quadrangle sheet, 7½' Series, 1:24,000.
Aerial Photographs	
1938	USDA IT 10136, 1" = 2640", index prints on file at Florida Department of Transportation, Tallahassee.
1949	USDA IT 442-49, 1" - 5280", contact prints on file at Florida Department of Transportation, Tallahassee.
1961	USDA IT C55-3-61-DC, 1:20,000, contact prints on file at Florida Department of Transportation, Tallahassee.
1974	A20-12001, 1:20,000, contact prints available from Florida Department of Revenue, Tallahassee.
1974	A20-12001, 1:4800, blue line prints available at Alachua County courthouse.

Interviews: Mr. R.W. Cellon, Hague
Mr. S.L. Rogers, Sr., Alachua
Mr. J.F. Parrish, Alachua
Mr. Dolphus Harrell, Hague
Mr. J.F. Griffis, Hague
Mr. Jerald Evans, Florida State Museum
Mr. Gerald T. Milanich, Florida State Museum
Dr. Charles H. Fairbanks, University of Florida, Department of Anthropology
Mr. George W. Percy, Florida Division of Archives, History and Records
Mr. J. Rodney Little, Florida Division of Archives, History and Records

Table A2-1 Cultural Resources Survey Data Sources

Documents	Alachua County
No Date	Alachua County Deed Book, No. 74, p. 408.
1899	Alachua County Tax Rolls, 1899.
1905	Alachua County Tax Rolls, 1905.
1909	Alachua County Tax Rolls, 1909.
1911	Alachua County Tax Rolls, 1911.
1925	Alachua County Tax Rolls, 1925.
1940	Alachua County Tax Rolls, 1940.
1945	Alachua County Tax Rolls, 1945.
	State of Florida
No Date	Tract Book, Vol. 16, Records of the Internal Improvement Fund, Bureau of State Lands, Tallahassee.
No Date	Deed Book E, p. 769, Records of the Internal Improvement Fund, Bureau of State Lands, Tallahassee.
No. Date	Records of Railroads Deeds, Records of the Internal Improvement Fund, Tallahassee.
1850	Surveyor's Field Notes, Township 8 South, Range 19 East, Records of the Internal Improvement Fund, Tallahassee.

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Table A2-2 Metals concentrations (mg/l) in Turkey, Cellon and Rocky Creek waters.

STATION	DATE	AL	AS	CD	CN	CR	CRHEX	CU
RC-4	082776	0.90	0.038	0.000	0.02	0.00	.	0.003
RC-5	082776	0.95	0.004	0.000	0.02	0.00	.	0.003
RC-6	082776	0.95	0.004	0.000	0.02	0.00	.	0.003
RC-7	083076	1.03	0.008	0.000	0.02	0.00	.	0.004
RC-8	083076	0.52	0.015	0.000	0.02	0.00	.	0.002
RC-15	083176	0.87	0.001	0.001	0.02	0.01	.	0.003
RC-16	083176	0.00	0.000	0.000	0.02	0.00	.	0.003
.....		.	.	.	.	.	.	.
CP-3	082576	1.60	0.065	0.001	0.00	0.00	0	0.007
CP-4	082676	0.14	0.058	0.001	0.00	0.00	0	0.005
CP-5	082576	0.61	0.118	0.024	0.00	0.01	0	0.014
CP-8	082576	0.58	0.057	0.015	0.00	0.01	0	0.004
CP-13	082676	1.94	0.119	0.011	0.00	0.01	0	0.004
.....		.	.	.	.	.	.	.
DH-1	082576	0.45	0.153	0.001	0.00	0.01	0	0.018
DH-1	090976	7.50	0.046	0.012	0.00	0.68	.	2.200
DH-6	090976	0.16	0.036	0.001	0.00	0.00	.	0.003
DH-7	090976	0.24	0.000	0.001	0.00	0.00	.	0.003
DH-8	090976	0.38	0.014	0.000	0.00	0.00	.	0.003
DH-9	090976	0.34	0.014	0.000	0.00	0.00	.	0.003

STATION	FE	PB	MN	HG	MO	NI	ZN
RC-4	1.01	0.02	0.01	0.00020	0.0	0.00	0.079
RC-5	1.02	0.06	0.02	0.00048	0.0	0.00	0.265
RC-6	1.02	0.06	0.02	0.00048	0.0	0.00	0.265
RC-7	1.24	0.01	0.12	0.00024	0.0	0.00	0.085
RC-8	0.65	0.02	0.17	0.00080	0.0	0.00	0.272
RC-15	4.49	0.02	0.03	0.00060	0.1	0.01	0.310
RC-16	0.29	0.02	0.01	0.00072	0.0	0.00	0.332
.....	.	.	.	.	.	.	.
CP-3	0.51	0.01	0.08	0.00044	0.0	0.00	0.041
CP-4	0.73	0.01	0.13	0.00070	0.0	0.00	0.277
CP-5	0.19	0.05	0.03	0.00060	0.0	0.03	0.031
CP-8	0.59	0.02	0.01	0.00050	0.0	0.02	0.023
CP-13	0.98	0.03	0.04	0.00056	0.0	0.02	0.119
.....	.	.	.	.	.	.	.
DH-1	2.17	0.05	0.11	0.00040	0.0	0.01	0.042
DH-1	1030.00	0.31	4.01	0.00090	0.0	54.80	1.440
DH-6	0.50	0.03	0.02	0.00080	0.0	0.01	0.110
DH-7	0.78	0.13	0.02	0.00088	0.0	0.01	0.170
DH-8	0.10	0.01	0.03	0.00084	0.0	0.01	0.057
DH-9	0.10	0.01	0.02	0.00080	0.0	0.01	0.036

Table A2-2 (continued) Metals concentrations (mg/l) in Mulatto Pen Branch waters.

STATION	DATE	AL	CD	CR	CRHEX	CU	FE	PB
RC-20	010577	0.59	< 0.001	< 0.01	< 0.01	0.003	0.36	< 0.01
RC-21	010577	0.63	< 0.001	< 0.01	< 0.01	0.003	0.40	< 0.01
RC-23	010577	1.12	< 0.001	< 0.01	< 0.01	0.003	0.46	< 0.01
RC-24	010577	1.09	< 0.001	< 0.01	< 0.01	0.003	0.32	< 0.01

STATION	DATE	MN	HG	MO	NI	ZN
RC-20	010577	0.01	0.00027	< 0.01	< 0.01	0.338
RC-21	010577	0.02	0.00034	< 0.01	< 0.01	0.790
RC-23	010577	0.10	0.00024	< 0.01	< 0.01	0.215
RC-24	010577	0.01	0.00020	< 0.01	< 0.01	0.174

Table A2-3 Nutrient, sulfate, sulfide, free mineral acidity and total organic carbon (mg/l) in Turkey, Cellon and Rocky Creek waters.

STATION	DATE	AMMUNIA	KJNITRO	NITRATE	TOTPHOS	ORTOPHOS
RC-4	082776	0.00	1.240	0.00	0.09	0.06
RC-5	082776	0.00	1.030	0.01	0.12	0.10
RC-6	082776	0.05	1.180	0.00	0.19	0.15
RC-7	083076	0.08	1.260	0.00	0.19	0.13
RC-8	083076	0.05	2.590	0.16	0.38	0.25
RC-15	083176	0.38	1.120	0.12	0.69	0.49
RC-16	083176	0.00	0.750	0.22	0.43	0.25
•••••		•	•	•	•	•
CP-3	082576	0.40	2.770	0.00	1.22	0.52
CP-4	082676	0.45	4.560	3.95	3.94	0.28
CP-5	082576	0.10	3.290	10.52	1.50	0.68
CP-8	082576	0.05	2.380	12.82	0.84	0.59
CP-13	082676	0.10	2.830	16.16	1.28	0.78
•••••		•	•	•	•	•
DH-1	082576	0.02	0.674	0.25	0.35	0.32
DH-1	090976	0.00	0.240	0.03	0.79	0.58
DH-6	090976	0.00	0.660	0.01	0.05	0.02
DH-7	090976	0.00	0.660	0.00	0.05	0.02
DH-8	090976	0.03	0.560	0.09	0.09	0.05
DH-9	090976	0.00	0.600	0.09	0.24	0.20

STATION	SO4	SULFIDE	FMA	TOC
RC-4	24.00	0	0	58
RC-5	26.40	0	0	50
RC-6	31.20	•	0	51
RC-7	38.40	0	0	80
RC-8	45.60	0	0	47
RC-15	16.80	0	0	28
RC-16	28.80	0	0	14
•••••	•	•	•	•
CP-3	37.80	0	0	46
CP-4	9.24	0	0	35
CP-5	306.00	0	0	12
CP-8	357.00	0	0	10
CP-13	481.00	0	0	9
•••••	•	•	•	•
DH-1	460.00	0	0	5
DH-1	3941.00	0	1643	94
DH-6	208.93	0	0	14
DH-7	192.12	0	0	16
DH-8	198.60	0	0	25
DH-9	120.30	0	0	27

Note: Hydrogen sulfide reported elsewhere for extended collections downstream of Deerhaven on-site swamp.

Table A2-3 (continued) Nutrient, sulfate, sulfide, free mineral acidity and total organic carbon (mg/l) in Mulatto Pen Branch waters.

STATION	DATE	AMMONIA	KJNITRO	NITRATE	TOTPHOS	ORTOPHOS	SO4
RC-20	010577	0.61	2.250	0.03	0.43	0.29	14.00
RC-21	010577	0.27	2.370	0.12	0.35	0.29	22.00
RC-23	010577	0.46	6.660	0.02	0.83	0.63	16.00
RC-24	010577	0.13	2.040	< 0.01	0.08	0.06	8.00

STATION	DATE	SULFIDE	FMA	TOC
RC-20	010577	< 0.01	0	25
RC-21	010577	< 0.01	0	12
RC-23	010577	< 0.01	0	44
RC-24	010577	< 0.01	0	38

Table A2-4 Other physical and chemical parameter concentrations in Turkey, Cellon and Rocky Creek waters (concentrations in mg/l except where noted).

STATION	DATE	MG	CA	ALKAL (mg/l $CaCO_3$)	HARDNESS (EDTA)	TDS	COLOR (pt-eb)	TURBITY (NTU)	CHLORIDE	FLUORIDE
RC-4	082776	2.59	6.25	0.0	26.3	151	40	0.71	12.0	0.045
RC-5	082776	2.71	7.81	5.0	34.8	137	36	1.00	12.0	0.060
RC-6	082776	2.71	7.81	6.0	30.7	154	28	1.30	12.0	0.078
RC-7	083076	2.67	10.94	8.0	38.3	164	40	2.90	11.0	0.072
RC-8	083076	3.84	12.50	21.5	48.0	127	24	1.00	12.0	0.260
RC-15	083176	3.57	12.45	20.0	46.0	.	32	13.00	16.5	0.170
RC-16	083176	3.67	14.06	16.0	50.4	.	10	10.00	11.0	0.170
.....		.	.	.	.	.	.	.	.	.
CP-3	082576	0.67	10.00	0.0	28.6	163	16	17.00	23.0	0.240
CP-4	082676	7.00	43.75	123.0	138.0	298	7	25.00	30.0	0.230
CP-5	082576	4.30	26.56	196.0	84.0	883	8	15.00	37.0	0.290
CP-8	082576	9.42	45.31	249.0	152.0	1006	2	2.80	39.0	0.350
CP-13	082676	5.52	40.63	278.0	124.0	1305	6	2.10	52.0	0.340
.....		.	.	.	.	.	.	.	.	.
DH-1	082576	73.50	117.20	23.0	480.0	902	0	24.00	27.0	0.830
DH-1	090976	363.00	143.20	0.0	1693.0	.	75	1800.00	13.8	0.450
DH-6	090976	21.50	64.50	37.5	250.0	.	32	0.70	18.5	0.490
DH-7	090976	21.72	62.50	42.0	240.0	.	28	0.75	27.5	0.470
DH-8	090976	18.92	56.69	47.5	232.0	.	64	1.00	4.5	0.460
DH-9	090976	12.47	41.77	37.5	152.0	.	64	2.30	15.0	0.350

STATION	NA	K	CONDUCT (µmhos/cm)	PH	TOD	BOD5	COD
RC-4	5.10	0.23	63	4.40	7.95	.	111
RC-5	4.90	0.34	70	5.20	8.10	.	294
RC-6	5.10	0.34	72	5.20	8.30	.	188
RC-7	5.31	0.69	81	5.00	5.30	.	171
RC-8	4.90	0.57	99	5.60	7.15	.	129
RC-15	6.60	4.49	72	5.50	5.60	.	67
RC-16	5.29	1.83	80	5.80	6.50	.	6
.....	.	.	.	.	.	.	.
CP-3	5.88	6.17	180	5.00	9.10	4	129
CP-4	8.82	21.72	369	6.90	8.35	10	110
CP-5	225.00	16.00	1100	7.30	8.65	6	59
CP-8	241.00	14.86	1500	7.80	9.10	5	39
CP-13	334.00	26.29	1590	7.30	9.20	6	37
.....	.	.	.	.	.	.	.
DH-1	12.90	25.15	800	7.10	8.90	2	61
DH-1	157.00	41.25	4700	2.80	7.05	.	246
DH-6	18.76	1.38	500	6.10	3.50	.	59
DH-7	18.05	1.72	495	6.15	3.50	.	55
DH-8	18.43	1.10	500	6.40	6.70	.	65
DH-9	12.73	1.79	342	6.70	7.45	.	87

Table A2-4 (Continued) Other physical and chemical parameter concentrations in Mulatto Pen Branch (m/l except where otherwise noted).

STATION	DATE	MG	CA	ALKAL (mg/l $CaCO_3$)	HARDNESS (EDTA)	TDS	COLOR (Pt. - Cb)
RC-20	010577	3.87	10.23	3.5	42.4	90	500+
RC-21	010577	4.16	11.36	7.5	46.4	94	500+
RC-23	010577	3.78	7.95	0.0	32.7	108	500+
RC-24	010577	2.65	2.76	0.0	21.8	68	500+

STATION	DATE	TURBIDITY (NTU)	CHLORIDE	FLUORIDE	AS	NA	K	CN
RC-20	010577	2.40	24.0	0.135	0.0006	8.70	4.95	< 0.001
RC-21	010577	2.90	25.0	0.151	0.0005	8.35	5.01	< 0.001
RC-23	010577	1.50	28.0	0.331	0.0003	11.30	3.72	< 0.001
RC-24	010577	3.20	16.0	0.081	0.0003	8.26	0.28	< 0.001

STATION	DATE	CONDUCT (μmhos/cm)	PH	TOD (@ 20°C)	BOD5	COD
RC-20	010577	123	5.40	8.65	8	65
RC-21	010577	132	5.90	8.90	4	37
RC-23	010577	140	3.90	6.65	8	133
RC-24	010577	93	3.90	9.00	5	90

Table A2-5 Oil and grease, phenols and detergent concentrations (mg/l) in Turkey, Cellon and Rocky Creek waters.

STATION	DATE	OILGRES	PHENOLS	DETRGNT
RC-4	082776	2.8	0.000	0.076
RC-5	082776	1.2	0.000	0.068
RC-6	082776	.	0.000	0.084
RC-7	083076	0.4	0.000	0.062
RC-8	083076	0.8	0.000	0.057
RC-15	083176	1.2	0.000	0.057
RC-16	083176	0.9	0.000	0.030
.....		.	.	.
CP-3	082576	0.1	0.000	0.005
CP-4	082676	0.7	0.000	0.016
CP-5	082576	0.4	0.000	0.073
CP-8	082576	1.0	0.000	0.065
CP-13	082676	4.6	0.003	0.014
.....		.	.	.
DH-1	082576	0.3	0.001	0.019
DH-1	090976	3.4	0.000	0.006
DH-6	090976	3.4	0.002	0.006
DH-7	090976	3.8	0.009	0.006
DH-8	090976	1.6	0.004	0.078
DH-9	090976	2.4	0.002	0.065

Table A2-5 Oil and grease, phenols and detergent concentrations (mg/l) in Mulatto Pen Branch waters.

STATION	DATE	OILGRES	PHENOLS	DETRGNT
RC-20	010577	2.6	0.010	0.002
RC-21	010577	1.6	0.010	0.002
RC-23	010577	0.8	0.010	0.005
RC-24	010577	0.6	0.010	0.002

Table A2-6 Sediment metals, sulfate and sulfide concentrations in Turkey, Cellon and Rocky Creeks. (mg/l)

STATION	DATE	SULFATE	SULFIDE	NICKEL	CADMIUM	LEAD	MOIST
CP-3	82576	63.40	2.89	1.49	0.070	8.97	12.5
CP-5	82576	38.10	10.63	8.16	4.420	4.45	13.4
CP-5	100176	68.10	6.00	3.51	1.730	3.28	12.9
CP-8	82576	847.70	1.64	0.73	0.250	1.09	9.4
CP-11	90976	684.60	6.00	26.13	7.190	4.33	37.7
CP-11	92476	57.30	36.60	3.45	1.130	3.45	.
CP-13	82676	26.30	0.00	10.26	6.250	4.40	11.8
CP-20	92376	161.80	48.60	5.59	5.490	3.35	.
.....	.	.	.	.	.	.	.
RC-4	82776	80.80	0.00	0.42	0.062	0.64	9.2
RC-5	82776	7.20	0.00	0.45	0.065	0.67	19.6
RC-5	82776	41.10	2.00	0.44	0.064	0.66	15.5
RC-5	100176	7.40	0.00	1.81	0.076	4.51	31.8
RC-6	83076	7.00	0.00	0.42	0.061	5.27	57.9
RC-6	100176	14.70	12.00	0.91	0.078	2.31	22.6
RC-7	83076	13.20	2.90	0.41	0.062	0.63	76.4
RC-7	93076	7.80	10.00	3.52	0.248	6.57	70.0
RC-8	100176	12.60	4.00	0.55	0.078	2.29	21.3
RC-8	83076	38.10	2.00	0.42	0.061	0.62	11.7
RC-12	83076	63.80	4.00	0.46	0.067	0.70	13.8
RC-15	83176	185.90	4.00	1.22	0.112	0.03	21.2
RC-16	83176	103.40	0.00	1.11	0.111	0.08	25.3

Table A2-6 (Continued)

DH-2	90976	443.30	.	62.22	0.109	2.18	9.9
DH-2	93076	13.90	0.00	45.35	0.077	4.52	15.6
DH-3	90976	1325.80	.	239.56	0.118	14.18	71.2
DH-3	93076	126.60	10.00	438.70	0.252	18.97	66.8
DH-4	90976	557.80	.	22.60	0.115	4.58	70.7
DH-4	93076	92.30	17.00	20.12	0.128	6.84	75.6
DH-5	90976	304.10	.	24.10	0.113	4.50	78.6
DH-5	93076	223.60	135.00	30.23	0.118	4.19	83.0
DH-5A	90976	595.60	.	26.41	0.115	4.59	77.0
DH-5A	93076	30.84	64.00	3.63	0.077	4.07	82.8
DH-5B	90976	250.40	.	34.49	0.108	4.34	83.1
DH-5B	93076	50.60	68.00	4.49	0.126	4.47	71.9
DH-5C	90976	620.60	.	36.66	0.113	4.54	80.2
DH-5C	93076	15.40	52.00	7.31	0.129	4.55	80.8
DH-17	93076	7.40	37.00	1.75	0.074	4.37	81.3
DH-6	93076	40.30	231.00	1.82	0.077	2.27	27.0
DH-7	93076	14.90	191.00	3.65	0.077	3.41	37.6
DH-8	90976	21.30	87.00	2.49	0.273	3.41	13.0
DH-8	93076	32.60	8.00	1.71	0.120	4.27	17.5
DH-9	90976	94.50	2.00	0.60	0.109	2.19	12.3
DH-9	93076	23.60	2.00	0.90	0.076	2.25	16.1
SF-A1	80176	248.00	8.44	.	.	.	.
SF-A2	80176	139.00	2.08	.	.	.	.
SF-B	80176	127.00	5.05	.	.	.	.
SF-C	80176	172.00	3.17	.	.	.	.
SF-D	80176	154.00	2.01	.	.	.	.
SF-E	80176	264.00	3.16	.	.	.	.
SF-F	80176	472.00	5.74	.	.	.	.
SF-G	80176	319.00	4.81	.	.	.	.
SF-H	80176	185.00	4.81	.	.	.	.
SFCOR	81076	202.00	15.53	.	.	.	.

Table A2-7 Sulfide concentrations (mg/l) immediately downstream of the Deerhaven on-site swamp and in Cellon and Rocky Creeks.

STATION	DATE	SULFIDE	PH	CONDUCT
RC-4	082776	0.0	4.40	63
RC-5	082776	0.0	5.20	70
RC-6	082776	.	5.20	72
RC-7	092176	0.0	.	.
RC-7	083076	0.0	5.00	81
RC-8	083076	0.0	5.60	99
RC-15	083176	0.0	5.50	72
RC-16	083176	0.0	5.80	80
.....		.	.	.
CP-3	082576	0.0	5.00	180
CP-4	082676	0.0	6.90	369
CP-5	082576	0.0	7.30	1100
CP-8	082576	0.0	7.80	1500
CP-13	082676	0.0	7.30	1590
.....		.	.	.
DH-1	082576	0.0	7.10	800
DH-1	090976	0.0	2.80	4700
DH-1	091576	0.0	.	.
DH-1	091876	0.0	.	.
DH-2	093076	0.0	.	.
DH-3	093076	0.0	.	.
DH-4	093076	0.0	.	.
DH-5	093076	0.3	.	.
DH-5A	093076	0.0	.	.
DH-5B	093076	0.1	.	.
DH-5C	093076	0.3	.	.
DH-17	091576	6.3	.	.
DH-17	091876	8.0	.	.

STATION	DATE	SULFIDE	PH	CONDUCT
DH-17	092276	2.4	.	.
DH-17	100176	9.5	.	.
DH-17	100476	9.5	.	.
DH-17	100676	9.5	.	.
DH-17	100876	11.0	.	.
DH-17	101176	7.5	.	.
DH-17	101376	6.5	.	.
DH-17	101876	0.8	.	.
DH-6	090976	0.0	6.10	500
DH-6	091576	2.4	.	.
DH-6	091876	2.7	.	.
DH-6	092276	0.4	.	.
DH-6	100176	3.0	.	.
DH-6	100476	2.0	.	.
DH-6	100676	1.4	.	.
DH-6	100876	1.7	.	.
DH-6	101176	2.4	.	.
DH-6	101376	1.0	.	.
DH-6	101876	0.2	.	.
DH-7	090976	0.0	6.15	495
DH-7	091576	0.3	.	.
DH-7	091876	0.4	.	.
DH-7	092276	0.0	.	.
DH-7	100176	0.6	.	.
DH-7	100476	0.1	.	.
DH-7	100676	0.1	.	.
DH-7	100876	0.0	.	.
DH-7	101176	0.1	.	.

STATION	DATE	SULFIDE	PH	CONDUCT
DH-7	101376	0	.	.
DH-7	101876	0	.	.
DH-8	090976	0	6.4	500
DH-8	091576	0	.	.
DH-8	091876	0	.	.
DH-8	100176	0	.	.
DH-8	100476	0	.	.
DH-8	100676	0	.	.
DH-8	100876	0	.	.
DH-8	101176	0	.	.
DH-8	101376	0	.	.
DH-8	101876	0	.	.
DH-9	090976	0	6.7	342
DH-9	090976	0	.	.
DH-9	091576	0	.	.
DH-9	091876	0	.	.
DH-9	100176	0	.	.
DH-9	100476	0	.	.
DH-9	100676	0	.	.

Table A2-8 Pesticide and herbicide concentrations in Turkey, Cellon and Rocky Creeks.

Compound	Concentrations (mg/l) *
Aldrin	<0.01
Chlordane	<0.03
DDT	<0.05
DDE	<0.05
Dieldrin	<0.01
Endrin	<0.002
Heptachlor	<0.001
Heptachlor Epoxide	<0.001
Lindane	<0.04
Toxaphene	<0.05
2,4 D (Acid)	<0.1
2,4,5 TP (Silvex)	<0.1
Chloroform	<0.1
Other Chlorinated Hydrocarbons	ND **

* All Stations
** Not Detected

Table A2-9 Sediment pesticide and herbicide concentrations in Turkey, Cellon and Rocky Creeks

Parameter	Concentration (ppm) *
Aldrin	<0.01
Chlordane	<0.03
DDT	<0.05
DDE	<0.05
Dieldrin	<0.01
Endrin	<0.002
Heptachlor	<0.001
Heptachlor Epoxide	<0.001
Lindane	<0.04
Toxaphene	<0.05
2,4 D (Acid)	<0.1
2,4,5 TP (Silvex)	<0.1
Chloroform	<0.1
Other Chlorinated Hydrocarbons	ND **

* All Stations
** Not Detected

PERTINANT DATA FOR TABLES A2-10 THRU A2-47

WATER QUALITY

DUNCAN'S NEW MULTIPLE RANGE TEST

Station Grouping Used for Duncan's Multiple Range Test

Group	Stream Segment Description	Included Stations
D	Cellon Creek upstream of battery plant.	CP-3 and CP-4
E	Cellon Creek downstream of battery plant.	CP-5, CP-8 and CP-13
F	Upper half of Rocky Creek basin.	RC-4, RC-5, RC-6 and RC-7
G	Lower half of Rocky Creek basin.	RC-8, RC-15 and RC-16
J	Deerhaven outfall to site main entrance road.	DH-1, DH-6 and DH-7
K	Deerhaven site boundary to Turkey Creek connection.	DH-8 and DH-9

Contents

Note: The following parameters were not significantly different for any of the station groupings (Tables A2-10 through A2-17).

Table A2-14 Duncan's new multiple range test for nickel.

Table A2-15 Duncan's new multiple range test for potassium.

Table A2-16 Duncan's new multiple range test for total phosphorus.

Table A2-17 Duncan's new multiple range test for orthophosphorus.

Table A2-18 Duncan's new multiple range test for fluoride.

Table A2-19 Duncan's new multiple range test for total organic carbon.

Table A2-20 Duncan's new multiple range test for color.

Table A2-21 Duncan's new multiple range test for turbidity.

Table A2-22 Duncan's new multiple range test for pH.

Table A2-23 Duncan's new multiple range test for phenols.

Table A2-24 Duncan's new multiple range test for oil and grease.

Table A2-25 Duncan's new multiple range test for five-day biological oxygen demand (BOD).

Note: The following parameters were not significantly greater for stream segments below the battery plant discharge and/or the Deerhaven cooling tower blowdown discharge (Tables A2-18 and A2-30).

Table A2-26 Duncan's new multiple range test for conductivity.

Table A2-27 Duncan's new multiple range test for total dissolved solids.

Table A2-28 Duncan's new multiple range test for sulfates.

Table A2-29 Duncan's new multiple range test for alkalinity.

Table A2-30 Duncan's new multiple range test for arsenic.

Table A2-31 Duncan's new multiple range test for cadmium.

Table A2-32 Duncan's new multiple range test for chromium.

Table A2-33 Duncan's new multiple range test for chloride.

Table A2-34 Duncan's new multiple range test for sodium.

Note: The following parameters were not significantly greater for stream segments not receiving industrial discharge (Tables A2-31 and A2-38).

Others:

Table A2-10 Duncan's new multiple range test for aluminum.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.27

GROUPING	MEAN	N	GRP	Included Stations
A	1.043333	3	E	CP-5, CP-8, CP-13
A				
A	0.970000	2	D	CP-3, CP-4
A				
A	0.957500	4	F	RC-4, RC-5, RC-6, RC-7
A				
A	0.463333	3	G	RC-8, RC-15, RC-16
A				
A	0.360000	2	K	DH-8, DH-9
A				
A	0.283333	3	J	DH-1, DH-6, DH-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-11 Duncan's new multiple range test for copper.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=28000E-8

GROUPING	MEAN	N	GRP	Included Stations
A	0.008000	3	J	DH-1, DH-6, DH-7
A				
A	0.007333	3	E	CP-5, CP-8, CP-13
A				
A	0.006000	2	D	CP-3, CP-4
A				
A	0.003250	4	F	RC-4, RC-5, RC-6, RC-7
A				
A	0.003000	2	K	DH-8, DH-9
A				
A	0.002667	3	G	RC-8, RC-15, RC-16

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-12 Duncan's new multiple range test for mercury.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.0028

GROUPING	MEAN	N	GRP	Included Stations
A	0.000820	2	K	DH-8, DH-9
A	0.000707	3	G	RC-8, RC-15, RC-16
A	0.000693	3	J	DH-1, DH-6, DH-7
A	0.000570	2	D	CP-3, CP-4
A	0.000553	3	E	CP-5, CP-8, CP-13
A	0.000350	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-13 Duncan's new multiple range test for lead.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=1.16

GROUPING	MEAN	N	GRP	Included Stations
A	0.070000	3	J	DH-1, DH-6, DH-7
A	0.037500	4	F	RC-4, RC-5, RC-6, RC-7
A	0.033333	3	E	CP-5, CP-8, CP-13
A	0.020000	3	G	RC-8, RC-15, RC-16
A	0.010000	2	D	CP-3, CP-4
A	0.010000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-14 Duncan's new multiple range test for nickel.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=61000E-8

GROUPING	MEAN	N	GRP	Included Stations
A	0.023333	3	E	CP-5, CP-8, CP-13
A	0.010000	3	J	DH-1, DH-6, DH-7
A	0.010000	2	K	DH-8, DH-9
A	0.003333	3	G	RC-8, RC-15, RC-16
A	0.000000	4	F	RC-4, RC-5, RC-6, RC-7
A	0.000000	2	D	CP-3, CP-4

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-15 Duncan's new multiple range test for potassium.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=633.76

GROUPING	MEAN	N	GRP	Included Stations
A	19.050000	3	E	CP-5, CP-8, CP-13
A	13.945000	2	D	CP-3, CP-4
A	9.416667	3	J	DH-1, DH-6, DH-7
A	2.296667	3	G	RC-8, RC-15, RC-16
A	1.445000	2	K	DH-8, DH-9
A	0.400000	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-16 Duncan's new multiple range test for total phosphorus.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=2.18

GROUPING	MEAN	N	GRP	Included Stations
A	2.580000	2	D	CP-3, CP-4
A	1.206667	3	E	CP-5, CP-8, CP-13
A	0.500000	3	G	RC-8, RC-15, RC-16
A	0.165000	2	K	DH-8, DH-9
A	0.150000	3	J	DH-1, DH-6, DH-7
A	0.147500	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-17 Duncan's new multiple range test for ortho-phosphorus.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.37

GROUPING	MEAN	N	GRP	Included Station
A	0.683333	3	E	CP-5, CP-8, CP-13
A	0.400000	2	D	CP-3, CP-4
A	0.330000	3	G	RC-8, RC-15, RC-16
A	0.125000	2	K	DH-8, DH-9
A	0.120000	3	J	DH-1, DH-6, DH-7
A	0.110000	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-18 Duncan's new multiple range test for fluoride.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=25.58

GROUPING	MEAN	N	GRP	Included Stations
A	0.596667	3	J	DH-1, DH-6, DH-7
A				
A	0.405000	2	K	DH-8, DH-9
A				
A	0.326667	3	E	CP-5, CP-8, CP-13
A				
A	0.235000	2	D	CP-3, CP-4
A				
A	0.200000	3	G	RC-8, RC-15, RC-16
A				
A	0.063750	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-19 Duncan's new multiple range test for total organic carbon.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=11   MS=5930.87

GROUPING	MEAN	N	GRP	Included Stations
A	59.750000	4	F	RC-4, RC-5, RC-6, RC-7
A				
A	40.500000	2	D	CP-3, CP-4
A				
A	29.666667	3	G	RC-8, RC-15, RC-16
A				
A	26.000000	2	K	DH-8, DH-9
A				
A	11.666667	3	J	DH-1, DH-6, DH-7
A				
A	10.333333	3	E	CP-5, CP-8, CP-13

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-20 Duncan's new multiple range test for color.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=4407.01

GROUPING	MEAN	N	GRP	Included Stations
A	64.000000	2	K	DH-8, DH-9
A	36.000000	4	F	RC-4, RC-5, RC-6, RC-7
A	22.000000	3	G	RC-8, RC-15, RC-16
A	20.000000	3	J	DH-1, DH-6, DH-7
A	11.500000	2	D	CP-3, CP-4
A	5.333333	3	E	CP-5, CP-8, CP-13

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-21 Duncan's new multiple range test for turbidity.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=91.92

GROUPING	MEAN	N	GRP	Included Stations
A	21.000000	2	D	CP-3, CP-4
A				
A	8.483333	3	J	DH-1, DH-6, DH-7
A				
A	8.000000	3	G	RC-8, RC-15, RC-16
A				
A	6.633333	3	E	CP-5, CP-8, CP-13
A				
A	1.650000	2	K	DH-8, DH-9
A				
A	1.477500	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-22 Duncan's new multiple range test for pH.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=20725

GROUPING	MEAN	N	GRP	Included Stations
A	7.466667	3	E	CP-5, CP-8, CP-13
A	6.550000	2	K	DH-8, DH-9
A	6.450000	3	J	DH-1, DH-6, DH-7
A	5.950000	2	D	CP-3, CP-4
A	5.633333	3	G	RC-8, RC-15, RC-16
A	4.950000	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-23 Duncan's new multiple range test for phenols.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=2362.71

GROUPING	MEAN	N	GRP	Included Stations
A	0.004000	3	J	DH-1, DH-6, DH-7
A				
A	0.003000	2	K	DH-8, DH-9
A				
A	0.001000	3	E	CP-5, CP-8, CP-13
A				
A	0.000000	4	F	RC-4, RC-5, RC-6, RC-7
A				
A	0.000000	3	G	RC-8, RC-15, RC-16
A				
A	0.000000	2	D	CP-3, CP-4

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-24 Duncan's new multiple range test for oil and grease.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=3 MS=6.22

GROUPING	MEAN	N	GRP	Included Stations
A	2.500000	3	J	DH-1, DH-6, DH-7
A	2.000000	3	E	CP-5, CP-8, CP-13
A	2.000000	2	K	DH-8, DH-9
A	1.466667	3	F	RC-4, RC-5, RC-6, RC-7
A	0.966667	3	G	RC-8, RC-15, RC-16
A	0.400000	2	D	CP-3, CP-4

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-25 Duncan's new multiple range test for Biological Oxygen Demand (BOD).

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=6 MS=17281.7

GROUPING	MEAN	N	GRP	Included Stations
A	7.000000	2	D	CP-3, CP-4
A A	5.666667	3	E	CP-5, CP-8, CP-13
A A	2.000000	1	J	DH-1, DH-6, DH-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-26 Duncan's new multiple range test for conductivity.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=52.72

GROUPING	MEAN	N	GRP	Included Stations
A	1396.666667	3	E	CP-5, CP-8, CP-13
B	598.333333	3	J	DH-1, DH-6, DH-7
C	421.000000	2	K	DH-8, DH-9
D	274.500000	2	D	CP-3, CP-4
E	83.666667	3	G	RC-8, RC-15, RC-16
E E E	71.500000	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-27 Duncan's new multiple range test for total dissolved solids.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=10 MS=2.12

GROUPING	MEAN	N	GRP	Included Stations
A	1064.666667	3	E	CP-5, CP-8, CP-13
B	902.000000	1	J	DH-1, DH-6, DH-7
C	230.500000	2	D	CP-3, CP-4
D	151.500000	4	F	RC-4, RC-5, RC-6, RC-7
E	127.000000	1	G	RC-8, RC-15, RC-16

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-28 Duncan's new multiple range test for sulfates.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.015

GROUPING	MEAN	N	GRP	Included Stations
A	381.333333	3	E	CP-5, CP-8, CP-13
B	287.016667	3	J	DH-1, DH-6, DH-7
C	159.450000	2	K	DH-8, DH-9
D	30.400000	3	G	RC-8, RC-15, RC-16
E	30.000000	4	F	RC-4, RC-5, RC-6, RC-7
F	23.520000	2	D	CP-3, CP-4

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-29 Duncan's new multiple range test for alkalinity.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=255.37

GROUPING		MEAN	N	GRP	Included Stations
	A	241.000000	3	E	CP-5, CP-8, CP-13
	B	61.500000	2	D	CP-3, CP-4
	B				
C	B	42.500000	2	K	DH-8, DH-9
C	B				
C	B	34.166667	3	J	DH-1, DH-6, DH-7
C					
C	D	19.166667	3	G	RC-8, RC-15, RC-16
	D				
	D	4.750000	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-30 Duncan's new multiple range test for arsenic.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.0015

GROUPING		MEAN	N	GRP	Included Stations
	A	0.098000	3	E	CP-5, CP-8, CP-13
	A				
B	A	0.063000	3	J	DH-1, DH-6, DH-7
B	A				
B	A	0.061500	2	D	CP-3, CP-4
B					
B		0.014000	2	K	DH-8, DH-9
B					
B		0.013500	4	F	RC-4, RC-5, RC-6, RC-7
B					
B		0.005333	3	G	RC-8, RC-15, RC-16

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-31 Duncan's new multiple range test for cadmium.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=8100E-9

GROUPING	MEAN	N	GRP	Included Stations
A	0.016667	3	E	CP-5, CP-8, CP-13
B	0.001000	3	J	DH-1, DH-6, DH-7
B	0.001000	2	D	CP-3, CP-4
B	0.000333	3	G	RC-8, RC-15, RC-16
B	0.000000	4	F	RC-4, RC-5, RC-6, RC-7
B	0.000000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-32 Duncan's new multiple range test for chromium.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=12000E-9

GROUPING	MEAN	N	GRP	Included Stations
A	0.010000	3	E	CP-5, CP-8, CP-13
B	0.003333	3	G	RC-8, RC-15, RC-16
B				
B	0.003333	3	J	DH-1, DH-6, DH-7
B				
B	0.000000	2	D	CP-3, CP-4
B				
B	0.000000	4	F	RC-4, RC-5, RC-6, RC-7
B				
B	0.000000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-33 Duncan's new multiple range test for chloride.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=52.74

GROUPING	MEAN	N	GRP	Included Stations
A	42.666667	3	E	CP-5, CP-8, CP-13
B	26.500000	2	D	CP-3, CP-4
B	24.333333	3	J	DH-1, DH-6, DH-7
B	13.166667	3	G	RC-8, RC-15, RC-16
B	11.750000	4	F	RC-4, RC-5, RC-6, RC-7
B	9.750000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-34 Duncan's new multiple range test for sodium.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.0087

GROUPING	MEAN	N	GRP	Included Stations
A	266.666667	3	E	CP-5, CP-8, CP-13
B	16.570000	3	J	DH-1, DH-6, DH-7
C	15.580000	2	K	DH-8, DH-9
D	7.350000	2	D	CP-3, CP-4
E	5.596667	3	G	RC-8, RC-15, RC-16
F	5.102500	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-35 Duncan's new multiple range test for nitrates.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.36

GROUPING	MEAN	N	GRP	Included Stations
A	13.166667	3	E	CP-5, CP-8, CP-13
B	1.975000	2	D	CP-3, CP-4
C	0.166667	3	G	RC-8, RC-15, RC-16
C	0.090000	2	K	DH-8, DH-9
C	0.086667	3	J	DH-1, DH-6, DH-7
C	0.002500	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-36 Duncan's new multiple range test for hardness.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=1029.14

GROUPING		MEAN	N	GRP	Included Stations
	A	323.333333	3	J	DH-1, DH-6, DH-7
	B	192.000000	2	K	DH-8, DH-9
	C	120.000000	3	E	CP-5, CP-8, CP-13
D	C	83.300000	2	D	CP-3, CP-4
D		48.133333	3	G	RC-8, RC-15, RC-16
D		32.525000	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-37 Duncan's new multiple range test for magnesium.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=115.39

GROUPING	MEAN	N	GRP	Included Stations
A	38.906667	3	J	DH-1, DH-6, DH-7
B	15.695000	2	K	DH-8, DH-9
B	6.413333	3	E	CP-5, CP-8, CP-13
B	3.935000	2	D	CP-3, CP-4
B	3.693333	3	G	RC-8, RC-15, RC-16
B	2.670000	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-38 Duncan's new multiple range test for calcium.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=168.09

GROUPING		MEAN	N	GRP	Included Stations
	A	81.400000	3	J	DH-1, DH-6, DH-7
	B	49.230000	2	K	DH-8, DH-9
	B				
	B	37.500000	3	E	CP-5, CP-8, CP-13
	B				
C	B	26.875000	2	D	CP-3, CP-4
C					
C		13.003333	3	G	RC-8, RC-15, RC-16
C					
C		8.202500	4	F	RC-4, RC-5, RC-6, RC-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-39 Duncan's new multiple range test for ammonia.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.007

GROUPING	MEAN	N	GRP	Included Stations
A	0.425000	2	D	CP-3, CP-4
B	0.143333	3	G	RC-8, RC-15, RC-16
B	0.083333	3	E	CP-5, CP-8, CP-13
B	0.032500	4	F	RC-4, RC-5, RC-6, RC-7
B	0.015000	2	K	DH-8, DH-9
B	0.006667	3	J	DH-1, DH-6, DH-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-40 Duncan's new multiple range test for total Kjeldahl nitrogen.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.0085

GROUPING	MEAN	N	GRP	Included Stations
A	3.665000	2	D	CP-3, CP-4
B	2.833333	3	E	CP-5, CP-8, CP-13
C	1.486667	3	G	RC-8, RC-15, RC-16
D	1.177500	4	F	RC-4, RC-5, RC-6, RC-7
E	0.664667	3	J	DH-1, DH-6, DH-7
E				
E	0.580000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-41 Duncan's new multiple range test for iron.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=20000E-9

GROUPING	MEAN	N	GRP	Included Stations
A	1.810000	3	G	RC-8, RC-15, RC-16
B	1.150000	3	J	DH-1, DH-6, DH-7
C	1.072500	4	F	RC-4, RC-5, RC-6, RC-7
D	0.620000	2	D	CP-3, CP-4
E	0.586667	3	E	CP-5, CP-8, CP-13
F	0.100000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-42 Duncan's new multiple range test for manganese.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=74000E-8

GROUPING		MEAN	N	GRP	Included Stations
	A	0.105000	2	D	CP-3, CP-4
B	A	0.070000	3	G	RC-8, RC-15, RC-16
B	A	0.050000	3	J	DH-1, DH-6, DH-7
B		0.042500	4	F	RC-4, RC-5, RC-6, RC-7
B		0.026667	3	E	CP-5, CP-8, CP-13
B		0.025000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-43 Duncan's new multiple range test for molybdenum.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=2000E-11

GROUPING	MEAN	N	GRP	Included Stations
A	0.033333	3	G	RC-8, RC-15, RC-16
B	0.000000	4	F	RC-4, RC-5, RC-6, RC-7
B				
B	0.000000	2	D	CP-3, CP-4
B				
B	0.000000	3	E	CP-5, CP-8, CP-13
B				
B	0.000000	3	J	DH-1, DH-6, DH-7
B				
B	0.000000	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-44 Duncan's new multiple range test for zinc.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=12000E-9

GROUPING	MEAN	N	GRP	Included Stations
A	0.304667	3	G	RC-8, RC-15, RC-16
B	0.173500	4	F	RC-4, RC-5, RC-6, RC-7
C	0.159000	2	D	CP-3, CP-4
D	0.107333	3	J	DH-1, DH-6, DH-7
E	0.057667	3	E	CP-5, CP-8, CP-13
F	0.046500	2	K	DH-8, DH-9

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-45 Duncan's new multiple range test for Chemical Oxygen Demand (COD).

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=2.49

GROUPING	MEAN	N	GRP	Included Stations
A	191.000000	4	F	RC-4, RC-5, RC-6, RC-7
B	119.500000	2	D	CP-3, CP-4
C	81.000000	2	K	DH-8, DH-9
D	67.333333	3	G	RC-8, RC-15, RC-16
E	58.333333	3	J	DH-1, DH-6, DH-7
F	45.000000	3	E	CP-5, CP-8, CP-13

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-46 Duncan's new multiple range test for detergents.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=4200E-9

GROUPING	MEAN	N	GRP	Included Stations
A	0.072500	4	F	RC-4, RC-5, RC-6, RC-7
A	0.071500	2	K	DH-8, DH-9
B	0.050667	3	E	CP-5, CP-8, CP-13
B	0.048000	3	G	RC-8, RC-15, RC-16
C	0.010500	2	D	CP-3, CP-4
C	0.010333	3	J	DH-1, DH-6, DH-7

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-47 Duncan's new multiple range test for total oxygen demand.

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=11 MS=0.28

GROUPING		MEAN	N	GRP	Included Stations
	A	8.983333	3	E	CP-5, CP-8, CP-13
	A				
	A	8.725000	2	D	CP-3, CP-4
		7.412500	4	F	RC-4, RC-5, RC-6, RC-7
	B				
	B	7.075000	2	K	DH-8, DH-9
C	B				
C		6.416667	3	G	RC-8, RC-15, RC-16
C					
		5.300000	3	J	DH-1, DH-6, DH-7
	D				

Note: See pages A-14 through A-16 for description of station grouping and other information.

Table A2-48 Benthic macroinvertebrates collected by Ekman grab from Turkey Creek.

Taxa	Beck's Biotic Index	Station Number No./m²								
		DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
Nematoda	II			131		NONE COLLECTED	NONE COLLECTED			NONE COLLECTED
Oligochaeta	III		203	1103	6			83	6	
Hirudinea										
Helobdella sp.	III									
Placobdella sp.	II									
Amphipoda										
Hyalella azteca	II									
Isopoda										
Asellus sp.	I									
Decapoda										
Palaemonetes paludosus	II									
Procambarus sp.	II									
Ephemeroptera										
Caenis diminuta	III									
Stenonema sp.	I									
Odonata										
Aeschna sp.	V									
Agria sp.	I									
Agrion sp.	II									
Boyeria sp.	V							3		
Calopteryx sp.	II									
Chromagrion sp.	V									
Cordulegaster sp.	V									
Enallagma sp.	II								3	
Gomphus sp.	II									

Table A2-48 (Continued) Turkey Creek - Ekman

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number No./m²								
Odonata (Continued)						NONE COLLECTED	NONE COLLECTED			NONE COLLECTED
Hyponeura sp.	V									
Macromia sp.	I									
Pachydiplax longipennis	II									
Progomphus obscurus	I				14			14	19	
Somatochlora sp.	---									
Tauriphila sp.	V									
Tetragoneuria sp.	V									
Hemiptera										
Belostoma sp.	IV									
Gerris sp.	IV									
Notonecta sp.	IV									
Pelocoris sp.	IV									
Ranatra sp.	IV									
Trichocorixa sp.	IV									
Veliidae sp.	IV									
Plecoptera										
Acroneuria sp.	I									
Trichoptera										
Cheumatopsyche sp.	II							33		
Limnephilus sp.	V									
Oecetis sp.	II									
Phylocentropus sp.	V									
Megaloptera										
Corydalus cornutus	I									
Sialis sp.	V									

Table A2-48 (Continued) Turkey Creek - Ekman

Taxa	Beck's Biotic Index	Station Number No./m² DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
Coleoptera						NONE COLLECTED	NONE COLLECTED			NONE COLLECTED
Dineutus sp.	IV									
Dubiraphia sp.	II							22		
Hydaticus sp.	IV									
Microcylloepus sp.	II									
Peltodytes sp.	IV			3						
Stenelmis sp.	II				8			56		
Tropisternus sp.	IV									
Acarina	I									
Diptera										
Ablabesmyia aspera	I									
Ablabesmyia peleensis	II									
Bezzia sp.	III	3	3					8		
Bezzia - group sp.	III									
Bezzia/Probezzia sp.	---									
Chironomus attenuatus	III		58	2472						
Chironomus decorus	III									
Chironomus fulvipilus	III			792						
Chironomus stigamterus	III									
Chrysops sp.	IV									
Cladotanytarsus sp.	II									
Clinotanypus sp.	II									
Cricotopus bicinctus	I									
Cryptochironomus fulvus	III									
Dicrotendipes sp.	II									
Dicrotendipes nervosus	II									
Glyptotendipes sp.	III									
Hexatoma sp.	IV									

Table A2-48 (Continued) — Turkey Creek - Ekman

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number No./m^2								
Diptera (Continued)						NONE COLLECTED	NONE COLLECTED			NONE COLLECTED
Lauterborniella sp.	V									
Odonotomyia sp.	II									
Palpomyia tibialis	III									
Parachironomus sp.	II									
Paratendipes sp.	V									
Polypedilum halterale	I				19			3		
Polypedilum illinoense	II									
Polypedilum scalaenum	III									
Polypedilum tritum	II				6					
Procladius sp.	II									
Psychodidae sp.	V									
Rheotanytarsus sp.	II									
Stenochironomus hilaris	I									
Stictochironomus sp.	I									
Tanytarsus sp.	II									
Tipulidae sp.	IV									
Tribelos sp.	I									

Table A2-48 (Continued) — Turkey Creek - Ekman

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number No./m²								
Lepidoptera										
Pyralididae sp.	I									
Mollusca										
Campeloma sp.	V									
Corbicula manilensis	V									
Elliptio sp.	V									
Helisoma sp.	IV									
Helisoma duryi	IV									
Lampsilis sp.	II							3		

Table A2-48 (Continued)

Turkey Creek - Ekman

Taxa	Beck's Biotic Index	Station Number No./m^2 DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
Mollusca (Continued)										
Lithasia sp.	---					NONE COLLECTED	NONE COLLECTED			NONE COLLECTED
Physa sp.	III									
Pisidium sp.	III									
Pseudosuccinea sp.	II									
Sphaerium sp.	III							111		
No. organisms/m^2/station		3	264	4501	53			336	28	
No. taxa		1	3	5	5			10	3	

Table A2-49 Macroinvertebrates collected by sweep net from Turkey Creek.

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number								
		Number Collected								
Nematoda	II			1						
Oligochaeta	III			3		1	2		4	1
Hirudinea										
Helobdella sp.	III									
Placobdella sp.	II									
Amphipoda										
Hyalella azteca	II									2
Isopoda										
Asellus sp.	I									1
Decapoda										
Palaemonetes paludosus	II									
Procambarus sp.	II						4	1		
Ephemeroptera										
Caenis diminuta	III									
Stenonema sp.	I								2	
Odonata										
Aeschna sp.	V			1				2		
Agria sp.	I								1	
Agrion sp.	II									
Boyeria sp.	V						1		2	
Calopteryx sp.	II						2			
Chromagrion sp.	V							2		
Cordulegaster sp.	V								2	
Enallagma sp.	II									
Gomphus sp.	II			1			3		10	1

Table A2-49 (Continued) Turkey Creek - Sweep Net

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number / Number Collected								
Odonata (Continued)										
<u>Hyponeura</u> sp.	V									
<u>Macromia</u> sp.	I							4	8	
<u>Pachydiplax longipennis</u>	II									
<u>Progomphus</u> <u>obscurus</u>	I						16	10	4	6
<u>Somatochlora</u> sp.	---									
<u>Tauriphila</u> sp.	V									
<u>Tetragoneuria</u> sp.	V						3			
Hemiptera										
<u>Belostoma</u> sp.	IV						1		1	
<u>Gerris</u> sp.	IV									
<u>Notonecta</u> sp.	IV									
<u>Pelocoris</u> sp.	IV									
<u>Ranatra</u> sp.	IV									
<u>Trichocorixa</u> sp.	IV									
<u>Veliidae</u> sp.	IV									
Plecoptera										
<u>Acroneuria</u> sp.	I									
Trichoptera										
<u>Cheumatopsyche</u> sp.	II						3	8		
<u>Limnephilus</u> sp.	V									
<u>Oecetis</u> sp.	II									1
<u>Phylocentropus</u> sp.	V									
Megaloptera										
<u>Corydalus</u> <u>cornutus</u>	I				4	2	3	3	3	1
<u>Sialis</u> sp.	V									

Table A2-49 (Continued)

Turkey Creek - Sweep Net

Taxa	Beck's Biotic Index	Station Number / Number Collected DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
Coleoptera										
Dineutus sp.	IV			1			11		4	
Dubiraphia sp.	II						1	4	2	
Hydaticus sp.	IV									
Microcylloepus sp.	II								1	
Peltodytes sp.	IV									
Stenelmis sp.	II				14	7	2	9		
Tropisternus sp.	IV									
Acarina	I									
Diptera										
Ablabesmyia aspera	I									
Ablabesmyia peleensis	II									
Bezzia sp.	III									
Bezzia - group sp.	III									
Bezzia/Probezzia sp.	---									
Chironomus attenuatus	III			2						
Chironomus decorus	III									
Chironomus fulvipilus	III									
Chironomus stigamterus	III									
Chrysops sp.	IV									
Cladotanytarsus sp.	II									
Clinotanypus sp.	II									
Cricotopus bicinctus	I							1		
Cryptochironomus fulvus	III									
Dicrotendipes sp.	II							1		
Dicrotendipes nervosus	II									
Glyptotendipes sp.	III									
Hexatoma sp.	IV									

Table A2-49 (Continued) Turkey Creek - Sweep Net

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number Number Collected								
Diptera (Continued)										
Lauterborniella sp.	V									
Odonotomyia sp.	II									
Palpomyia tibialis	III									
Parachironomus sp.	II									
Paratendipes sp.	V									
Polypedilum halterale	I									
Polypedilum illinoense	II									1
Polypedilum scalaenum	III									
Polypedilum tritum	II									
Procladius sp.	II									
Psychodidae sp.	V									
Rheotanytarsus sp.	II									
Stenochironomus hilaris	I									
Stictochironomus sp.	I									
Tanytarsus sp.	II									
Tipulidae sp.	IV									
Tribelos sp.	I									
Lepidoptera										
Pyralididae sp.	I									
Mollusca										
Campeloma sp.	V							2		
Corbicula manilensis	V									
Elliptio sp.	V									
Helisoma sp.	IV									
Helisoma duryi	IV									
Lampsilis sp.	II									

Table A2-49 (Continued) Turkey Creek - Sweep Net

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number / Number Collected								
Mollusca (Continued)										
Lithasia sp.	---				6	2				2
Physa sp.	III									2
Pisidium sp.	III									
Pseudosuccinea sp.	II									
Sphaerium sp.	III							3		
No. collected				9	24	12	52	50	44	18
No. taxa				6	3	4	13	13	13	10

Table A2-50 Macroinvertebrates collected by block net seine from Turkey Creek.

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected)								
		DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
Nematoda	II									
Oligochaeta	III									
Hirudinea										
Helobdella sp.	III									
Placobdella sp.	II									
Amphipoda										
Hyalella azteca	II									
Isopoda										
Asellus sp.	I									
Decapoda										
Palaemonetes paludosus	II									
Procambarus sp.	II							0.033 (4)	0.029 (5)	
Ephemeroptera										
Caenis diminuta	III									
Stenonema sp.	I								0.006 (1)	
Odonata										
Aeschna sp.	V									
Agria sp.	I							0.008 (1)	0.023 (4)	
Agrion sp.	II							0.024 (3)		
Boyeria sp.	V						0.034 (1)			
Calopteryx sp.	II								0.029 (5)	
Chromagrion sp.	V									
Cordulegaster sp.	V								0.011 (2)	
Enallagma sp.	II							0.024 (3)		
Gomphus sp.	II						0.103 (3)		0.011 (2)	

Table A2-50 (Continued)

Turkey Creek - Block Net Seine

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number No./m² (Number Collected)								
Odonata (Continued)										
Hyponeura sp.	V							0.024 (3)		
Macromia sp.	I						0.069 (2)	0.154 (18)	0.097 (17)	
Pachydiplax longipennis	II									
Progomphus obscurus	I						0.517 (15)	0.211 (26)	0.303 (53)	
Somatochlora sp.	---									
Tauriphila sp.	V									
Tetragoneuria sp.	V						0.034 (1)	0.016 (2)		
Hemiptera										
Belostoma sp.	IV						0.034 (1)	0.008 (1)		
Gerris sp.	IV									
Notonecta sp.	IV									
Pelocoris sp.	IV									
Ranatra sp.	IV								0.011 (2)	
Trichocorixa sp.	IV							0.032 (4)		
Veliidae sp.	IV								0.063 (11)	
Plecoptera										
Acroneuria sp.	I									
Trichoptera										
Cheumatopsyche sp.	II						0.103 (3)	0.122 (15)	0.006 (1)	
Limnephilus sp.	V									
Oecetis sp.	II									
Phylocentropus sp.	V									
Megaloptera										
Corydalus cornutus	I						0.034 (1)	0.106 (13)	0.017 (3)	
Sialis sp.	V									

Taxa	Beck's Biotic Index	DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
		Station Number No./m² (Number Collected)								
Coleoptera										
Dineutus sp.	IV						0.103 (3)	0.366 (45)	0.006 (1)	
Dubiraphia sp.	II						0.034 (1)	0.008 (1)		
Hydaticus sp.	IV									
Microcylloepus sp.	II									
Peltodytes sp.	IV							0.008 (1)		
Stenelmis sp.	II									
Tropisternus sp.	IV									
Acarina	I									
Diptera										
Ablabesmyia aspera	I									
Ablabesmyia peleensis	II									
Bezzia sp.	III									
Bezzia - group sp.	III									
Bezzia/Probezzia sp.	---									
Chironomus attenuatus	III									
Chironomus decorus	III									
Chironomus fulvipilus	III									
Chironomus stigamterus	III									
Chrysops sp.	IV									
Cladotanytarsus sp.	II									
Clinotanypus sp.	II									
Cricotopus bicinctus	I									
Cryptochironomus fulvus	III									
Dicrotendipes sp.	II									
Dicrotendipes nervosus	II									
Glyptotendipes sp.	III									
Hexatoma sp.	IV									

Table A2-50 (Continued)

Turkey Creek - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m2 (Number Collected) DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
Diptera (Continued)										
Lauterborniella sp.	V									
Odonotomyia sp.	II									
Palpomyia tibialis	III									
Parachironomus sp.	II									
Paratendipes sp.	V									
Polypedilum halterale	I									
Polypedilum illinoense	II									
Polypedilum scalaenum	III									
Polypedilum tritum	II									
Procladius sp.	II									
Psychodidae sp.	V									
Rheotanytarsus sp.	II									
Stenochironomus hilaris	I									
Stictochironomus sp.	I									
Tanytarsus sp.	II							0.008 (1)		
Tipulidae sp.	IV									
Tribelos sp.	I									
Lepidoptera										
Pyralididae sp.	I							0.008 (1)		
Mollusca										
Campeloma sp.	V									
Corbicula manilensis	V									
Elliptio sp.	V									
Helisoma sp.	IV									
Helisoma duryi	IV									
Lampsilis sp.	II									

Table A2-50 (Continued) Turkey Creek - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected) DH-1	DH-6	DH-7	DH-8	DH-8A	DH-8B	DH-9	DH-10	HS-1
Mollusca (Continued)										
Lithasia sp.	---									
Physa sp.	III							0.063 (8)		
Pisidium sp.	III									
Pseudosuccinea sp.	II									
Sphaerium sp.	III									
Total Collected							31	150	107	
Total Species							10	18	13	

Station No.	Collection Area (m^2)
DH-8B	29
DH-9	126
DH-10	175

Table A2-51 Benthic macroinvertebrates collected by Ekman grab from Cellon Creek.

Taxa	Beck's Biotic Index	Station Number No./m² CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Nematoda	II		3	NONE COLLECTED					NONE COLLECTED
Oligochaeta	III	89	159		125	2123	839		
Hirudinea									
Helobdella sp.	III							3	
Placobdella sp.	II								
Amphipoda									
Hyalella azteca	II	47	3			17			
Isopoda									
Asellus sp.	I								
Decapoda									
Palaemonetes paludosus	II								
Procambarus sp.	II	3	3						
Ephemeroptera									
Caenis diminuta	III								
Stenonema sp.	I								
Odonata									
Aeschna sp.	V								
Agria sp.	I	3				3		8	
Agrion sp.	II								
Boyeria sp.	V								
Calopteryx sp.	II								
Chromagrion sp.	V								
Cordulegaster sp.	V								
Enallagma sp.	II								
Gomphus sp.	II	3						3	

Table A2-51 (Continued) Cellon Creek - Ekman

Taxa	Beck's Biotic Index	CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
		Station Number No./m^2							
Odonata (Continued)				NONE COLLECTED					NONE COLLECTED
Hyponeura sp.	V								
Macromia sp.	I								
Pachydiplax longipennis	II	3						3	
Progomphus obscurus	I				11		3		
Somatochlora sp.	---								
Tauriphila sp.	V								
Tetragoneuria sp.	V								
Hemiptera									
Belostoma sp.	IV								
Gerris sp.	IV								
Notonecta sp.	IV								
Pelocoris sp.	IV								
Ranatra sp.	IV								
Trichocorixa sp.	IV								
Veliidae sp.	IV								
Plecoptera									
Acroneuria sp.	I								
Trichoptera									
Cheumatopsyche sp.	II							300	
Limnephilus sp.	V								
Oecetis sp.	II								
Phylocentropus sp.	V								
Megaloptera									
Corydalus cornutus	I								
Sialis sp.	V								

Table A2-51 (Continued) Cellon Creek - Ekman

Taxa	Beck's Biotic Index	Station Number No./m2 CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Coleoptera				NONE COLLECTED					NONE COLLECTED
Dineutus sp.	IV								
Dubiraphia sp.	II								
Hydaticus sp.	IV								
Microcylloepus sp.	II								
Peltodytes sp.	IV								
Stenelmis sp.	II		3						
Tropisternus sp.	IV					3			
Acarina	I								
Diptera									
Ablabesmyia aspera	I								
Ablabesmyia peleensis	II							3	
Bezzia sp.	III	6	3			11	3		
Bezzia - group sp.	III								
Bezzia/Probezzia sp.	---					25			
Chironomus attenuatus	III								
Chironomus decorus	III					6			
Chironomus fulvipilus	III								
Chironomus stigamterus	III					33			
Chrysops sp.	IV					25			
Cladotanytarsus sp.	II						3		
Clinotanypus sp.	II		3			14	6		
Cricotopus bicinctus	I								
Cryptochironomus fulvus	III	17	3				8		
Dicrotendipes sp.	II								
Dicrotendipes nervosus	II	6						3	
Glyptotendipes sp.	III								
Hexatoma sp.	IV								

Table A2-51 (Continued) Cellon Creek - Ekman

Taxa	Beck's Biotic Index	Station Number No./m²							
		CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Diptera (Continued)				NONE COLLECTED					NONE COLLECTED
Lauterborniella sp.	V								
Odonotomyia sp.	II					3			
Palpomyia tibialis	III		3	3					
Parachironomus sp.	II								
Paratendipes sp.	V					3			
Polypedilum halterale	I	31	9		3				
Polypedilum illinoense	II					3		39	
Polypedilum scalaenum	III	3							
Polypedilum tritum	II								
Procladius sp.	II					25			
Psychodidae sp.	V								
Rheotanytarsus sp.	II	6							
Stenochironomus hilaris	I								
Stictochironomus sp.	I								
Tanytarsus sp.	II	3				8			
Tipulidae sp.	IV					3			
Tribelos sp.	I								
Lepidoptera									
Pyralididae sp.	I								
Mollusca									
Campeloma sp.	V								
Corbicula manilensis	V								
Elliptio sp.	V								
Helisoma sp.	IV								
Helisoma duryi	IV							6	
Lampsilis sp.	II								

Cellon Creek - Ekman

Table A2-51 (Continued)

Taxa	Beck's Biotic Index	Station Number No./m²							
		CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Mollusca (Continued)				NONE COLLECTED					NONE COLLECTED
Lithasia sp.	---					14	3	6	
Physa sp.	III								
Pisidium sp.	III	6							
Pseudosuccinea sp.	II								
Sphaerium sp.	III	3							
No. organisms/m^2/station		229	192		139	2319	865	374	
No. taxa		15	10		3	17	7	10	

Table A2-52 Macroinvertebrates collected by sweep net from Cellon Creek.

Taxa	Beck's Biotic Index	Station Number Number Collected CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Nematoda	II								
Oligochaeta	III					11			
Hirudinea									
Helobdella sp.	III								
Placobdella sp.	II								
Amphipoda									
Hyalella azteca	II					3			
Isopoda									
Asellus sp.	I								
Decapoda									
Palaemonetes paludosus	II								
Procambarus sp.	II								
Ephemeroptera									
Caenis diminuta	III								
Stenonema sp.	I								
Odonata									
Aeschna sp.	V								
Agria sp.	I								
Agrion sp.	II								
Boyeria sp.	V								
Calopteryx sp.	II								
Chromagrion sp.	V								
Cordulegaster sp.	V								
Enallagma sp.	II								
Gomphus sp.	II								

Table A2-52 (Continued)

Cellon Creek - Sweep Net

Taxa	Beck's Biotic Index	CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
		Station Number / Number Collected							
Odonata (Continued)									
Hyponeura sp.	V								
Macromia sp.	I								
Pachydiplax longipennis	II					3			
Progomphus obscurus	I								
Somatochlora sp.	---								1
Tauriphila sp.	V								
Tetragoneuria sp.	V								
Hemiptera									
Belostoma sp.	IV					2			
Gerris sp.	IV								
Notonecta sp.	IV								
Pelocoris sp.	IV								
Ranatra sp.	IV								
Trichocorixa sp.	IV								
Veliidae sp.	IV								
Plecoptera									
Acroneuria sp.	I								
Trichoptera									
Cheumatopsyche sp.	II					2			1
Limnephilus sp.	V								
Oecetis sp.	II								
Phylocentropus sp.	V								
Megaloptera									
Corydalus cornutus	I								
Sialis sp.	V								

Table A2-52 (Continued)

Cellon Creek - Sweep Net

Taxa	Beck's Biotic Index	Station Number / Number Collected CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Coleoptera									
Dineutus sp.	IV								
Dubiraphia sp.	II								
Hydaticus sp.	IV								
Microcylloepus sp.	II								
Peltodytes sp.	IV								
Stenelmis sp.	II								
Tropisternus sp.	IV								
Acarina	I								
Diptera									
Ablabesmyia aspera	I								
Ablabesmyia peleensis	II								
Bezzia sp.	III								
Bezzia - group sp.	III								
Bezzia/Probezzia sp.	---								
Chironomus attenuatus	III								
Chironomus decorus	III								
Chironomus fulvipilus	III								
Chironomus stigamterus	III								
Chrysops sp.	IV					2			
Cladotanytarsus sp.	II								
Clinotanypus sp.	II					6			
Cricotopus bicinctus	I								1
Cryptochironomus fulvus	III								
Dicrotendipes sp.	II								
Dicrotendipes nervosus	II								
Glyptotendipes sp.	III								
Hexatoma sp.	IV								

Table A2-52 (Continued)

Cellon Creek - Sweep Net

Taxa	Beck's Biotic Index	Station Number / Number Collected CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Diptera (Continued)									
Lauterborniella sp.	V								
Odonotomyia sp.	II					6			
Palpomyia tibialis	III								
Parachironomus sp.	II								
Paratendipes sp.	V								
Polypedilum halterale	I								
Polypedilum illinoense	II								
Polypedilum scalaenum	III								
Polypedilum tritum	II								
Procladius sp.	II					1			
Psychodidae sp.	V								
Rheotanytarsus sp.	II								
Stenochironomus hilaris	I								
Stictochironomus sp.	I								
Tanytarsus sp.	II								
Tipulidae sp.	IV								
Tribelos sp.	I								
Lepidoptera									
Pyralididae sp.	I								
Mollusca									
Campeloma sp.	V								
Corbicula manilensis	V								
Elliptio sp.	V								
Helisoma sp.	IV								4
Helisoma duryi	IV								
Lampsilis sp.	II								

Table A2-52 (Continued)

Cellon Creek - Sweep Net

Taxa	Beck's Biotic Index	CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
		Station Number Number Collected							
Mollusca (Continued)									
Lithasia sp.	---								
Physa sp.	III					7			
Pisidium sp.	III					3			
Pseudosuccinea sp.	II								
Sphaerium sp.	III								
No. collected						46			7
No. taxa						11			4

Table A2-53 Macroinvertebrates collected by block net seine from Cellon Creek.

Taxa	Beck's Biotic Index	CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
		Station Number No./m^2 (Number Collected)							
Nematoda	II								
Oligochaeta	III			0.004 (1)					
Hirudinea									
Helobdella sp.	III								
Placobdella sp.	II								
Amphipoda									
Hyalella azteca	II							0.061 (9)	0.177(11)
Isopoda									
Asellus sp.	I								
Decapoda									
Palaemonetes paludosus	II								
Procambarus sp.	II								
Ephemeroptera									
Caenis diminuta	III								
Stenonema sp.	I								
Odonata									
Aeschna sp.	V							0.018 (1)	0.097 (6)
Agria sp.	I								
Agrion sp.	II								
Boyeria sp.	V								
Calopteryx sp.	II		0.01 (1)						
Chromagrion sp.	V								
Cordulegaster sp.	V								0.016 (1)
Enallagma sp.	II							0.196 (11)	
Gomphus sp.	II								

Taxa	Beck's Biotic Index	Station Number No./m² (Number Collected) CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Odonata (Continued)									
Hyponeura sp.	V								
Macromia sp.	I							0.036 (2)	
Pachydiplax longipennis	II		0.01 (1)					0.036 (2)	
Progomphus obscurus	I		0.01 (1)	0.012 (3)				0.911 (51)	
Somatochlora sp.	---								
Tauriphila sp.	V								
Tetragoneuria sp.	V								
Hemiptera									
Belostoma sp.	IV								
Gerris sp.	IV		0.01 (1)						
Notonecta sp.	IV								
Pelocoris sp.	IV								
Ranatra sp.	IV								
Trichocorixa sp.	IV								
Veliidae sp.	IV								
Plecoptera									
Acroneuria sp.	I			0.004 (1)					
Trichoptera									
Cheumatopsyche sp.	II							0.875 (49)	0.355 (22)
Limnephilus sp.	V								
Oecetis sp.	II								
Phylocentropus sp.	V								
Megaloptera									
Corydalus cornutus	I		0.01 (1)	0.004 (1)				0.268 (15)	
Sialis sp.	V								

Table A2-53 (Continued)

Cellon Creek - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m² (Number Collected) CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Coleoptera									
Dineutus sp.	IV			0.004 (1)				0.018 (1)	
Dubiraphia sp.	II								
Hydaticus sp.	IV								
Microcylloepus sp.	II							0.036 (2)	
Peltodytes sp.	IV								
Stenelmis sp.	II							0.018 (1)	
Tropisternus sp.	IV							0.036 (2)	
Acarina	I								
Diptera									
Ablabesmyia aspera	I								
Ablabesmyia peleensis	II								
Bezzia sp.	III								
Bezzia - group sp.	III								
Bezzia/Probezzia sp.	---								
Chironomus attenuatus	III								
Chironomus decorus	III								
Chironomus fulvipilus	III								
Chironomus stigamterus	III								
Chrysops sp.	IV								
Cladotanytarsus sp.	II								
Clinotanypus sp.	II							0.089 (5)	
Cricotopus bicinctus	I								
Cryptochironomus fulvus	III								
Dicrotendipes sp.	II								
Dicrotendipes nervosus	II								
Glyptotendipes sp.	III								
Hexatoma sp.	IV								

Table A2-53 (Continued) Cellon Creek - Block Net Seine

Taxa	Beck's Biotic Index	CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
		Station Number No./m^2 (Number Collected)							
Diptera (Continued)									
Lauterborniella sp.	V								
Odonotomyia sp.	II								0.048 (3)
Palpomyia tibialis	III								
Parachironomus sp.	II								
Paratendipes sp.	V								
Polypedilum halterale	I								
Polypedilum illinoense	II								
Polypedilum scalaenum	III								
Polypedilum tritum	II								
Procladius sp.	II								
Psychodidae sp.	V								
Rheotanytarsus sp.	II								
Stenochironomus hilaris	I								
Stictochironomus sp.	I								
Tanytarsus sp.	II								
Tipulidae sp.	IV								
Tribelos sp.	I								
Lepidoptera									
Pyralididae sp.	I								
Mollusca									
Campeloma sp.	V								
Corbicula manilensis	V								
Elliptio sp.	V								
Helisoma sp.	IV								
Helisoma duryi	IV								
Lampsilis sp.	II								

Table A2-53 (Continued) Cellon Creek - Block Net Seine

Taxa	Beck's Biotic Index	Station Number: No./m2 (Number Collected) CP-4	CP-5	CP-6	CP-8	CP-11	CP-13A	CP-13B	CP-20
Mollusca (Continued)									
Lithasia sp.	---								
Physa sp.	III			0.004 (1)				0.036 (2)	0.016 (1)
Pisidium sp.	III								
Pseudosuccinea sp.	II								
Sphaerium sp.	III								
No. Organisms			5	8				153	44
No. Species			5	6				14	6

Station No.	Collection Area (m^2)
CP-5	97
CP-6	257
CP-14	56
CP-20	62

Table A2-54 Benthic macroinvertebrates collected by Ekman grab from Rocky Creek.

Taxa	Beck's Biotic Index	Station Number No./m^2 RC-4	RC-5	RC-6	RC-7A	RC-7B	RC-7C	RC-9	RC-15
Nematoda	II		3			NONE COLLECTED	NONE COLLECTED		3
Oligochaeta	III	331	250	139	247			111	109
Hirudinea									
Helobdella sp.	III		3	6					3
Placobdella sp.	II		3						
Amphipoda									
Hyalella azteca	II			3				8	
Isopoda									
Asellus sp.	I				14				
Decapoda									
Palaemonetes paludosus	II								
Procambarus sp.	II							3	
Ephemeroptera									
Caenis diminuta	III			6				6	
Stenonema sp.	I								
Odonata									
Aeschna sp.	V								
Agria sp.	I							3	
Agrion sp.	II								
Boyeria sp.	V								
Calopteryx sp.	II							3	
Chromagrion sp.	V								
Cordulegaster sp.	V							3	
Enallagma sp.	II								
Gomphus sp.	II			3				14	

Table A2-54 (Continued)

Taxa	Beck's Biotic Index	RC-4	RC-5	RC-6	RC-7A	RC-7B	RC-7C	RC-9	RC-15
		Station Number No./m²							
Odonata (Continued)						NONE COLLECTED	NONE COLLECTED		
Hyponeura sp.	V								
Macromia sp.	I								
Pachydiplax longipennis	II								
Progomphus obscurus	I								
Somatochlora sp.	---								
Tauriphila sp.	V								
Tetragoneuria sp.	V								
Hemiptera									
Belostoma sp.	IV								
Gerris sp.	IV								
Notonecta sp.	IV								
Pelocoris sp.	IV								
Ranatra sp.	IV								
Trichocorixa sp.	IV								
Veliidae sp.	IV								
Plecoptera									
Acroneuria sp.	I								
Trichoptera									
Cheumatopsyche sp.	II	11							3
Limnephilus sp.	V	8							
Oecetis sp.	II								
Phylocentropus sp.	V	3		6				6	
Megaloptera									
Corydalus cornutus	I								
Sialis sp.	V							3	

Table A2-54 (Continued) Rocky Creek - Ekman

Taxa	Beck's Biotic Index	Station Number No./m2 RC-4	RC-5	RC-6	RC-7A	RC-7B	RC-7C	RC-9	RC-15
Coleoptera						NONE COLLECTED	NONE COLLECTED		
Dineutus sp.	IV								
Dubiraphia sp.	II	3		64				47	3
Hydaticus sp.	IV				14				
Microcylloepus sp.	II	3		14				8	
Peltodytes sp.	IV								
Stenelmis sp.	II	20	14					19	8
Tropisternus sp.	IV								
Acarina	I			25				33	6
Diptera									
Ablabesmyia aspera	I								
Ablabesmyia peleensis	II							3	
Bezzia sp.	III	8	9	28	3			11	6
Bezzia - group sp.	III	169		8				95	6
Bezzia/Probezzia sp.	---								
Chironomus attenuatus	III		6						
Chironomus decorus	III								
Chironomus fulvipilus	III								
Chironomus stigamterus	III								
Chrysops sp.	IV	11			11			6	
Cladotanytarsus sp.	II	8						14	
Clinotanypus sp.	II	3		3				17	
Cricotopus bicinctus	I								
Cryptochironomus fulvus	III								
Dicrotendipes sp.	II	3							
Dicrotendipes nervosus	II								
Glyptotendipes sp.	III								
Hexatoma sp.	IV	3							

Table A2-54 (Continued)

Taxa	Beck's Biotic Index	RC-4	RC-5	RC-6	RC-7A	RC-7B	RC-7C	RC-9	RC-15
		Station Number No./m²							
Diptera (Continued)						NONE COLLECTED	NONE COLLECTED		
Lauterborniella sp.	V				3				
Odonotomyia sp.	II								
Palpomyia tibialis	III		3						
Parachironomus sp.	II			14					
Paratendipes sp.	V				31				
Polypedilum halterale	I	25		8				22	
Polypedilum illinoense	II	8						6	
Polypedilum scalaenum	III		20						
Polypedilum tritum	II	8	6	3					
Procladius sp.	II		14	3	11				
Psychodidae sp.	V				3				
Rheotanytarsus sp.	II	11							
Stenochironomus hilaris	I								8
Stictochironomus sp.	I			3					
Tanytarsus sp.	II								
Tipulidae sp.	IV							133	
Tribelos sp.	I	3		6					
Lepidoptera									
Pyralididae sp.	I								
Mollusca									
Campeloma sp.	V								11
Corbicula manilensis	V							11	6
Elliptio sp.	V								
Helisoma sp.	IV								
Helisoma duryi	IV							8	3
Lampsilis sp.	II	3							

Table A2-54 (Continued)

Rocky Creek - Ekman

Taxa	Beck's Biotic Index	Station Number No./m^2 RC-4	RC-5	RC-6	RC-7A	RC-7B	RC-7C	RC-9	RC-15
Mollusca (Continued)									
Lithasia sp.	---					NONE COLLECTED	NONE COLLECTED	3.	
Physa sp.	III			11					
Pisidium sp.	III								
Pseudosuccinea sp.	II								
Sphaerium sp.	III	14	3	14					25
No. organisms/m^2/station		656	334	367	337			596	200
No. taxa		21	12	20	9			26	14

Table A2-55 Macroinvertebrates collected by sweep net from Rocky Creek. *

Taxa	Beck's Biotic Index	RC-4	RC-5	RC-6	RC-7A	RC-7B	RC-7C	RC-9	RC-15
		Station Number / Number Collected							
Nematoda	II								
Oligochaeta	III								
Hirudinea									
Helobdella sp.	III								
Placobdella sp.	II								
Amphipoda									
Hyalella azteca	II								
Isopoda									
Asellus sp.	I								
Decapoda									
Palaemonetes paludosus	II								
Procambarus sp.	II								
Ephemeroptera									
Caenis diminuta	III								
Stenonema sp.	I								
Odonata									
Aeschna sp.	V								
Agria sp.	I								
Agrion sp.	II								
Boyeria sp.	V							1	
Calopteryx sp.	II								
Chromagrion sp.	V								
Cordulegaster sp.	V								
Enallagma sp.	II								
Gomphus sp.	II								

* Note: Only one specimen (*Boyeria* sp.) was collected by sweep net from Rocky Creek.

Table A2-56 Macroinvertebrates collected by block net seine from Rocky Creek.

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected)					
		RC-4A	RC-4B	RC-5	RC-6 (9/20)	RC-6 (9/21)	RC-7A
Nematoda	II				0.008 (1)		
Oligochaeta	III						
Hirudinea							
Helobdella sp.	III						
Placobdella sp.	II						
Amphipoda							
Hyalella azteca	II						
Isopoda							
Asellus sp.	I						
Decapoda							
Palaemonetes paludosus	II				0.136 (18)		0.170 (53)
Procambarus sp.	II	0.014 (1)			0.045 (6)	0.076 (10)	0.013 (4)
Ephemeroptera							
Caenis diminuta	III						
Stenonema sp.	I						
Odonata							
Aeschna sp.	V				0.015 (2)		
Agria sp.	I						
Agrion sp.	II				0.015 (2)		
Boyeria sp.	V					0.008 (1)	0.010 (3)
Calopteryx sp.	II	0.043 (3)				0.008 (1)	
Chromagrion sp.	V						
Cordulegaster sp.	V						
Enallagma sp.	II						
Gomphus sp.	II	0.043 (3)	0.014 (1)			0.023 (3)	

Table A2-56. (Continued) Rocky Creek (Stations RC-7B - RC-15B) - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected)					
		RC-7B	RC-7C	RC-8A	RC-8B	RC-15A	RC-15B
Nematoda	I						
Oligochaeta	III						
Hirudinea							
Helobdella sp.	III						
Placobdella sp.	II						
Amphipoda							
Hyalella azteca	II						
Isopoda							
Asellus sp.	I						
Decapoda							
Palaemonetes paludosus	II		12.727 (140)	0.217 (13)	0.170 (9)	0.037 (5)	0.012 (2)
Procambarus sp.	II	0.011 (1)	0.636 (7)			0.007 (1)	
Ephemeroptera							
Caenis diminuta	III						
Stenonema sp.	I						
Odonata							
Aeschna sp.	V						
Agria sp.	I						
Agrion sp.	II						
Boyeria sp.	V						
Calopteryx sp.	II						
Chromagrion sp.	V						
Cordulegaster sp.	V						
Enallagma sp.	II						
Gomphus sp.	II						

Table A2-56 (Continued) Rocky Creek (Stations RC-4A - RC-7A) - Block Net Seine

Taxa	Beck's Biotic Index	RC-4A	RC-4B	RC-5	RC-6 (9/20)	RC-6 (9/21)	RC-7A
		Station Number No./m² (Number Collected)					
Odonata (Continued)							
Hyponeura sp.	V						
Macromia sp.	I						
Pachydiplax longipennis	II				0.030 (4)		
Progomphus obscurus	I	0.072 (5)				0.076 (10)	
Somatochlora sp.	---					0.008 (1)	
Tauriphila sp.	V		0.014 (1)				
Tetragoneuria sp.	V					0.008 (1)	0.006 (2)
Hemiptera							
Belostoma sp.	IV	0.014 (1)					
Gerris sp.	IV	0.072 (5)	0.042 (3)		0.023 (3)	0.008 (1)	
Notonecta sp.	IV						0.003 (1)
Pelocoris sp.	IV						0.003 (1)
Ranatra sp.	IV						
Trichocorixa sp.	IV				0.008 (1)		
Veliidae sp.	IV						
Plecoptera							
Acroneuria sp.	I						
Trichoptera							
Cheumatopsyche sp.	II						
Limnephilus sp.	V						
Oecetis sp.	II						
Phylocentropus sp.	V		0.014 (1)				
Megaloptera							
Corydalus cornutus	I						
Sialis sp.	V		0.014 (1)				

Table A2-56 (Continued) Rocky Creek (Stations RC-7B - RC-15B) - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected) RC-7B	RC-7C	RC-8A	RC-8B	RC-15A	RC-15B
Odonata (Continued)							
Hyponeura sp.	V						
Macromia sp.	I						0.006 (1)
Pachydiplax longipennis	II		0.273 (3)				
Progomphus obscurus	I						
Somatochlora sp.	---						
Tauriphila sp.	V						
Tetragoneuria sp.	V						
Hemiptera							
Belostoma sp.	IV						
Gerris sp.	IV		0.091 (1)				
Notonecta sp.	IV		0.091 (1)				
Pelocoris sp.	IV						
Ranatra sp.	IV						
Trichocorixa sp.	IV	0.111 (1)	0.091 (1)				
Veliidae sp.	IV						
Plecoptera							
Acroneuria sp.	I						
Trichoptera							
Cheumatopsyche sp.	II			0.017 (1)			
Limnephilus sp.	V						
Oecetis sp.	II						
Phylocentropus sp.	V						
Megaloptera							
Corydalus cornutus	I		0.091 (1)				
Sialis sp.	V						

Table A2-56 (Continued) Rocky Creek (Stations RC-4A - RC-7A) - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected) RC-4A	RC-4B	RC-5	RC-6 (9/20)	RC-6 (9/21)	RC-7A
Coleoptera							
Dineutus sp.	IV	0.565 (39)	0.042 (3)			0.008 (1)	0.003 (1)
Dubiraphia sp.	II				0.008 (1)		
Hydaticus sp.	IV						
Microcylloepus sp.	II						
Peltodytes sp.	IV						
Stenelmis sp.	II						
Tropisternus sp.	IV						
Acarina	I						
Diptera							
Ablabesmyia aspera	I		0.014 (1)				
Ablabesmyia peleensis	II						
Bezzia sp.	III						
Bezzia - group sp.	III						
Bezzia/Probezzia sp.	---						
Chironomus attenuatus	III						
Chironomus decorus	III						
Chironomus fulvipilus	III						
Chironomus stigamterus	III						
Chrysops sp.	IV				0.008 (1)	0.008 (1)	
Cladotanytarsus sp.	II						
Clinotanypus sp.	II						
Cricotopus bicinctus	I						
Cryptochironomus fulvus	III						
Dicrotendipes sp.	II						
Dicrotendipes nervosus	II						
Glyptotendipes sp.	III						
Hexatoma sp.	IV						

Table A2-56 (Continued) Rocky Creek (Stations RC-7B - RC-15B) - Block Net Seine

Taxa	Beck's Biotic Index	RC-7B	RC-7C	RC-8A	RC-8B	RC-15A	RC-15B
		Station Number No./m^2 (Number Collected)					
Coleoptera							
Dineutus sp.	IV						
Dubiraphia sp.	II						
Hydaticus sp.	IV						
Microcylloepus sp.	II						
Peltodytes sp.	IV		0.091 (1)				
Stenelmis sp.	II				0.091 (1)		
Tropisternus sp.	IV						
Acarina	I						
Diptera							
Ablabesmyia aspera	I						
Ablabesmyia peleensis	II						
Bezzia sp.	III						
Bezzia - group sp.	III						
Bezzia/Probezzia sp.	---						
Chironomus attenuatus	III						
Chironomus decorus	III						
Chironomus fulvipilus	III						
Chironomus stigamterus	III						
Chrysops sp.	IV		0.091 (1)				
Cladotanytarsus sp.	II						
Clinotanypus sp.	II						
Cricotopus bicinctus	I						
Cryptochironomus fulvus	III						
Dicrotendipes sp.	II						
Dicrotendipes nervosus	II						
Glyptotendipes sp.	III						
Hexatoma sp.	IV						

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected) RC-4A	RC-4B	RC-5	RC-6 (9/20)	RC-6 (9/21)	RC-7A
Diptera (Continued)							
Lauterborniella sp.	V						
Odonotomyia sp.	II						
Palpomyia tibialis	III						
Parachironomus sp.	II						
Paratendipes sp.	V						
Polypedilum halterale	I						
Polypedilum illinoense	II						
Polypedilum scalaenum	III						
Polypedilum tritum	II						
Procladius sp.	II				0.008 (1)		
Psychodidae sp.	V						
Rheotanytarsus sp.	II						
Stenochironomus hilaris	I		0.014 (1)				
Stictochironomus sp.	I						
Tanytarsus sp.	II						
Tipulidae sp.	IV						0.006 (2)
Tribelos sp.	I		0.127 (9)				
Lepidoptera							
Pyralididae sp.	I						
Mollusca							
Campeloma sp.	V						
Corbicula manilensis	V						
Elliptio sp.	V						
Helisoma sp.	IV						
Helisoma duryi	IV						
Lampsilis sp.	II						

Table A2-56 (Continued) Rocky Creek (Stations RC-7B - RC-15B) - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected) RC-7B	RC-7C	RC-8A	RC-8B	RC-15A	RC-15B
Diptera (Continued)							
Lauterborniella sp.	V						
Odonotomyia sp.	II						
Palpomyia tibialis	III						
Parachironomus sp.	II						
Paratendipes sp.	V						
Polypedilum halterale	I						
Polypedilum illinoense	II						
Polypedilum scalaenum	III						
Polypedilum tritum	II						
Procladius sp.	II						
Psychodidae sp.	V						
Rheotanytarsus sp.	II						
Stenochironomus hilaris	I						
Stictochironomus sp.	I						
Tanytarsus sp.	II						
Tipulidae sp.	IV						
Tribelos sp.	I						
Lepidoptera							
Pyralididae sp.	I						
Mollusca							
Campeloma sp.	V						
Corbicula manilensis	V						
Elliptio sp.	V						
Helisoma sp.	IV						
Helisoma duryi	IV						
Lampsilis sp.	II						

Table A2-56 (Continued) Rocky Creek (Stations RC-4A - RC-7A) - Block Net Seine

Taxa	Beck's Biotic Index	Station Number No./m2 (Number Collected) RC-4A	RC-4B	RC-5	RC-6 (9/20)	RC-6 (9/21)	RC-7A
Mollusca (Continued)							
Lithasia sp.	---						
Physa sp.	III						
Pisidium sp.	III						
Pseudosuccinea sp.	II						
Sphaerium sp.	III						0.010 (3)
Total Collected		57	21		40	30	70
Total Species		7	9		11	10	9

Station Number	Collection Area (m^2)
RC-4A	69
RC-4B	71
RC-6	132
RC-7A	311

Table A2-56 (Continued) Rocky Creek (Stations RC-7B - RC-15B) - Block[illegible]t Seine

Taxa	Beck's Biotic Index	Station Number No./m^2 (Number Collected)					
		RC-7B	RC-7C	RC-8A	RC-8B	RC-15A	RC-15B
Mollusca (Continued)							
Lithasia sp.	---						
Physa sp.	III						
Pisidium sp.	III						
Pseudosuccinea sp.	II						
Sphaerium sp.	III						
Total Collected		2	156	14	10	6	3
Total Species		2	9	2	2	2	2

Station Number	Collection Area (m^2)
RC-7B	9
RC-7C	11
RC-8A	60
RC-8B	53
RC-15A	136
RC-15B	162

Table A2-57 Benthic macroinvertebrates collected by Ekman grab from Mulatto Pen Branch - Ekman

Taxa	Beck's Biotic Index	Station Number No./m^2 RC-19	RC-20	RC-26
Oligochaeta	III	39	287	592
Hirudinea				
Helobdella sp.	III	3		
Amphipoda				
Hyalella azteca	II		3	
Decapoda				
Procambarus sp.	II			3
Ephemeroptera				
Caenis diminuta	III		108	
Leptophlebia sp.	---	3		
Odonata				
Agrion sp.	II		22	
Gomphus sp.	II		8	
Pachydiplax longipennis	II	3	14	
Progomphus obscurus	I	17	3	
Coleoptera				
Agabus johannis	IV	3		
Dubiraphia sp.	II		14	
Dytiscidae sp.	IV	17		3
Stenelmis sp.	II		3	
Acarina				
Hydracarina sp.	---		3	

Table A2-57 (Continued)

Taxa	Beck's Biotic Index	Station Number No./m² RC-19	RC-20	RC-26
Diptera				
Ablabesmyia philosphanos	---	3		
Bezzia sp.	III	25	36	11
Chaoborus sp.	---		11	
Chironomus crassicaudatus	III	8		
Chrysops sp.	IV	11	8	
Cladotanytarsus sp.	II		3	
Clinotanypus pinguis	II	3	6	
Cricotopus bicintus	I		3	
Cryptochironomus fulvus	III	3		
Dicrotendipes sp.	II		42	
Endochironomus sp.	II	11		
Harnischia nr. *boydi*	---		36	
Hexatoma sp.	IV		20	6
Holorusia sp.	IV	8		6
Microtendipes sp.	---		3	
Palpomyia tibialis	III	3		3
Polypedilum halterale	I	8	25	3
Polypedilum illinoense	II		28	
Polypedilum tritum	II		8	3
Procladius sp.	II		33	
Rheotanytarsus exiguus	I	17	28	
Rheotantarsus sp.	II	3		
Tanytarsus guerla	---	17	3	
Tanytarsus sp.	II	3	28	6

Table A2-57 (Continued)

Mulatto Pen Branch - Ekman

Taxa	Beck's Biotic Index	Station Number No./m² RC-19	RC-20	RC-26
Mollusca				
Elliptio sp.	V		8	
Physa sp.	III	3	17	
Sphaerium sp.	III		6	
No. organisms/m²/station		211	817	636
No. Taxa		22	30	10

Table A2-58 Fish collection data for Rocky, Cellon and Turkey Creeks.

SPECIES Scientific Name	Common Name	Station	Collection Date - 1976	Method of Collection	No. Specimens Collected	Weight (g)
Amia calva	Bowfin	RC-7	10/1	Trot Line*(4)	2	450.00 1400.00
		RC-7	10/4	Trot Line (3)	2	230.00 260.00
		RC-7	10/4	Trot Line (4)	2	180.00 300.00
		RC-7	10/5	Trot Line (1)	1	240.00
Esox americanus: americanus x vermiculatus	Redfin Pickerel	RC-6	10/14	Trot Line (4)	1	4.80
Ictalurus nebulosus	Brown Bullhead	RC-7	10/1	Trot Line (2)	1	110.00
		RC-7	10/1	Trot Line (3)	1	Head Only
		RC-7	10/4	Trot Line (3)	1	110.00
		RC-7	10/4	Trot Line (4)	1	140.00
		RC-7	10/6	Trot Line (3)	1	57.00
Ictalurus natalis	Yellow Bullhead	RC-6	9/20	Block Seine	1	0.71
		RC-6	10/12	Trot Line (1)	1	28.00
		RC-6	10/12	Trot Line (3)	1	57.00
		RC-6	10/12	Trot Line (4)	2	71.00 170.00
		RC-6	10/12	Trot Line (4)	5	64.00 71.00 (2) 85.00 99.00
		RC-6	10/13	Trot Line (3)	1	92.00
		RC-6	10/13	Trot Line (4)	9	28.00 (3) 43.00 (3) 57.00 85.00 160.00

Table A2-58 (Continued)

Species: Scientific Name	Species: Common Name	Station	Collection Date - 1976	Method of Collection	No. Specimens Collected	Weight (g)
Ictalurus natalis (Continued)	Yellow Bullhead	RC-6	10/14	Trot Line (4)	4	71.00
						85.00
						110.00 (2)
		RC-6	10/15	Trot Line (4)	2	43.00
						71.00
		RC-7	10/1	Trot Line (2)	1	110.00
		RC-7	10/1	Trot Line (3)	2	57.00
						230.00
		RC-7	10/1	Trot Line (4)	1	230.00
		RC-7	10/5	Trot Line (2)	1	85.00
		RC-7	10/5	Trot Line (3)	3	85.00
						260.00 (2)
		RC-7	10/6	Trot Line (1)	1	85.00
		RC-7	10/6	Trot Line (2)	3	71.00
						99.00
						110.00
		RC-7	10/6	Trot Line (3)	2	130.00
						180.00
		RC-7	10/6	Trot Line (4)	2	99.00
						110.00
		RC-7	10/7	Trot Line (3)	2	71.00
						110.00
Notemigonus crysoleucas	Golden Shiner	DH-9	9/20	Block Seine	1	3.90
		RC-15A	9/22	Block Seine-30 M	1	0.09
Notropis hypselopterus	Sailfin Shiner	RC-8B	9/22	Block Seine-16 M	3	1.10
Notropis petersoni	Coastal Shiner	RC-15B	9/22	Block Seine-50 M	1	1.10
Notropis chalybaeus	Ironcolor Shiner	RC-8B	9/22	Block Seine-16 M	2	0.60
		RC-15B	9/22	Block Seine-50 M	1	0.46

Table A2-58 (Continued)

SPECIES Scientific Name	Common Name	Station	Collection Date - 1976	Method of Collection	No. Specimens Collected	Weight (g)
Fundulus chrysotus	Golden Topminnow	RC-15B	9/22	Block Seine-50 M	1	0.87
Gambusia affinis	Mosquitofish	DH-7	9/9	Sweep Net	2	0.47
		DH-7	9/9	B-sweep	7	1.20
		DH-8B	9/20	Block Seine	25	4.60
		DH-9	9/20	Block Seine	253	27.00
		RC-4	9/20	Block Seine	1	0.16
		RC-4B	9/20	Block Seine	3	0.38
		RC-6	9/20	Block Seine	3	0.48
		RC-6	9/20	Block Seine	21	2.10
		RC-7A	9/21	Block Seine	4	0.25
		RC-7B	9/21	Block Seine	29	5.40
		RC-7C	9/21	Block Seine	91	11.00
		RC-8B	9/22	Block Seine-16 M	1	0.08
		RC-15A	9/22	Block Seine-20 M	1	0.05
		RC-15B	9/22	Block Seine-50 M	6	1.30
		CP-5	9/23	Block Seine	1	0.01
		CP-14	9/23	Block Seine-30 M	40	10.00
		CP-20	9/23	Block Seine	15	6.80
		CP-20	9/23	B-sweep	1	1.40
		CP-11	9/24	Sweep Net	38	3.80
		HS-1	9/24	B-sweep	6	4.10
		DH-10	10/28	Block Seine	31	6.90
		DH-10	10/28	B-sweep	5	0.22
Heterandria formosa	Least Killifish	DH-9	9/20	B-sweep	1	0.02
		DH-9	9/20	Block Seine	10	0.69
		RC-6	9/20	Block Seine	3	0.08
		RC-6	9/20	Block Seine	1	0.02
		RC-7B	9/21	Block Seine	6	0.36
		RC-7C	9/21	Block Seine	78	2.20
		CP-14	9/23	Block Seine-30 M	8	0.31
		CP-20	9/23	Block Seine	6	0.78
		CP-11	9/24	Sweep Net	105	3.20

Table A2-58 (Continued)

SPECIES Scientific Name	Common Name	Station	Collection Date - 1976	Method of Collection	No. Specimens Collected	Weight (g)
Aphredoderus sayanus	Pirateperch	RC-4	9/20	Block Seine	1	1.30
		RC-6	9/20	Block Seine	1	1.10
		RC-7A	9/21	Block Seine	2	3.00
		RC-7C	9/21	Block Seine	1	0.56
Micropterus salmoides	Largemouth Bass	RC-7C	9/21	Block Seine	2	1.90
Lepomis punctatus	Spotted Sunfish	DH-9	9/20	Block Seine	4	0.13
Lepomis auritus	Redbreast Sunfish	RC-4	9/20	Block Seine	1	3.80
		RC-6	9/20	Block Seine	1	3.10
		RC-8A	9/22	Block Seine	1	4.50
		RC-15B	9/22	Block Seine-50 M	7	13.00
Lepomis macrochirus	Bluegill	CP-20	9/23	Block Seine	5	19.00
Lepomis gulosus	Warmouth	RC-7C	9/21	Block Seine	1	1.90
Enneacanthus gloriosus	Bluespotted Sunfish	RC-7C	9/21	Block Seine	1	0.50
Elassoma okefenokee	Okefenokee Pygmy Sunfish	RC-6	9/20	Block Seine	1	0.03
Etheostoma edwini	Brown Darter	RC-15A	9/22	Block Seine-30 M	1	0.14
Etheostoma fusiforme	Swamp Darter	RC-7A	9/21	Block Seine	2	0.61
Labidesthes sicculus	Brook Silverside	RC-6	9/20	Block Seine	11	2.00
		RC-8B	9/22	Block Seine-16 M	1	0.33

* Note: Number following trot line under Method of Collection refers to the line number.

Table A2-59 Fish mass per unit area collected by block seining from Rocky, Cellon and Turkey Creeks

Creek/ Subsystem	Station	Species	kg	lbs	Acres	Hectares	kg/Hectare	lbs/Acre
Cellon Creek: Fast Flowing High Scour Subsystem	CP-5	*Gambusia affinis*	.001	.002	.024	.010	.001	.001
	CP-6	None Collected						
Cellon Creek: Deep - weedy stream subsystem	CP-14	*Gambusia affinis*	.010	.022	.014	.006	1.802	1.623
		Heterandria formosa	.0003	.0007	.014	.006	.055	.050
	CP-20	*Gambusia affinis*	.007	.015	.015	.006	1.097	.974
		Heterandria formosa	.0008	.002	.015	.006	.126	.112
		Lepomis macrochirus	.019	.042	.015	.006	3.092	2.744
Rocky Creek: Shaded Flowing Stream Subsystem	RC-4 (A & B)	*Gambusia affinis*	.0005	.001	.033	.013	.041	.037
		Aphredoderus sayanus	.001	.003	.033	.013	.096	.085
		Lepomis auritus	.004	.008	.033	.013	.286	.255
	RC-6	*Ictalurus natalis*	.0001	.0002	.033	.013	.005	.005
		Gambusia affinis	.003	.006	.033	.013	.196	.175
		Heterandria formosa	.0001	.0002	.033	.013	.008	.007
		Aphredoderus sayanus	.001	.002	.033	.013	.083	.074
		Lepomis auritus	.003	.007	.033	.013	.237	.212
		Elassoma okefenokee	.00003	.00007	.033	.013	.002	.002
		Labidesthes sicculus	.002	.004	.033	.013	.149	.133

Table A2-59 (Continued)

Creek/ Subsystem	Station	Species	kg	lbs	Acres	Hectares	kg/Hectare	lbs/Acre
	RC-7A	Gambusia affinis	.0003	.0006	.077	.031	.008	.007
		Aphredoderus sayanus	.003	.007	.077	.031	.095	.085
		Etheostoma fusiforme	.0006	.0013	.077	.031	.020	.017
	RC-7B	Gambusia affinis	.005	.012	.002	.0009	6.044	5.213
		Heterandria formosa	.0004	.0008	.002	.0009	.400	.344
	RC-7C	Gambusia affinis	.011	.024	.003	.001	9.718	8.414
		Heterandria formosa	.002	.005	.003	.001	1.991	1.725
		Aphredoderus sayanus	.0006	.001	.003	.001	.509	.439
		Micropterus salmoides	.002	.004	.003	.001	1.764	1.527
		Lepomis gulosus	.002	.005	.003	.001	1.719	1.489
		Enneacanthus gloriosus	.0005	.001	.003	.001	.455	.393
	RC-8 A & B	Lepomis auritus	.004	.010	.028	.011	.396	.354
		Notropis hypselopterus	.001	.002	.028	.011	.100	.090
		Notropis chalybaeus	.0006	.001	.028	.011	.053	.048
		Gambusia affinis	.0001	.0002	.028	.011	.007	.007
		Labidesthes sicculus	.0003	.0007	.028	.011	.029	.026
	RC-15A	Notemigonus crysoleucas	.0009	.0019	.034	.014	.053	.056
		Gambusia affinis	.0005	.0012	.034	.014	.039	.035
		Etheostoma edwini	.0001	.0003	.034	.014	.010	.009

Table A2-59 (Continued)

Creek/ Subsystem	Station	Species	kg	lbs	Acres	Hectares	kg/Hectare	lbs/Acre
	RC-15B	Notropis petersoni	.001	.002	.040	.016	.069	.062
		Notropis chalybaeus	.0005	.001	.040	.016	.028	.025
		Fundulus chrysotus	.0009	.002	.040	.016	.054	.048
		Gambusia affinis	.001	.003	.040	.016	.079	.071
		Lepomis auritus	.013	.028	.040	.016	.793	.708
Turkey Creek: Flowing Stream Subsystem	DH-8B	Gambusia affinis	.005	.010	.007	.003	1.579	1.443
	DH-9	Notemigonus crysoleucas	.004	.009	.031	.013	.309	.276
		Gambusia affinis	.027	.061	.031	.013	2.181	1.948
		Heterandria formosa	.0007	.0015	.031	.013	.055	.049
		Lepomis punctatus	.0001	.0003	.031	.013	.010	.009
	DH-10	Gambusia affinis	.007	.015	.043	.018	.396	.355

Note: Surface area obtained from stream area and volume data.
1 Acre = 43.560 sq. ft.
1 Hectare = 10,000 sq. meters

Table A2-60 Habitat preference summary of fish species found in Rocky, Cellon and Turkey Creeks.

Scientific Name	Common Name	Habitat Preference
Amia calva	Bowfin	Found in weedy, slow moving or non-moving waters.
Esox americanus: americanus x vermiculatus	Redfin Pickerel	Found in shallow flowing brown-water streams and pools.
Ictalurus nebulosus	Brown Bullhead	Found in slow moving or non moving water with vegetation.
Ictalurus natalis	Yellow Bullhead	Prefers slow moving water with vegetation but may be found in faster moving situations.
Notemigonus crysoleucas	Golden Shiner	Found in all situations; tolerant of poor temperature and quality.
Notropis hypselopterus	Sailfin Shiner	Found in the whole gamut of streams but not in lakes or pools; needs moving water.
Notropis petersoni	Coastal Shiner	Found in the whole gamut of streams but not in lakes or pools; needs moving water.
Notropis chalybaeus	Ironcolor Shiner	Found in the whole gamut of streams but not in lakes or pools; needs moving water.
Fundulus chrysotus	Golden Topminnow	Found near the surface in slower moving water.
Gambusia affinis	Mosquitofish	Found in almost all situations. Especially slower moving water such as pools and stream edges. Able to gasp air and thus tolerate lower oxygen levels.
Heterandria formosa	Least Killifish	Found generally among floating vegetation in slower moving situations.
Aphredoderus sayanus	Pirateperch	Prefers slow or non-moving water such as ditches, pools, etc. with heavy mud or silt bottom. Found sitting on or embedded in this layer.
Micropterus salmoides	Largemouth Bass	Found in any water situation where quality is tolerable.
Lepomis punctatus	Spotted Sunfish	Found in association with vegetation and slow or non-moving water, generally in a stream environment.

Table A2-60 (Continued)

Creek/ Subsystem	Station	Species	kg	lbs	Acres	Hectares	kg/Hectare	lbs/Acre
	RC-15B	*Notropis petersoni*	.001	.002	.040	.016	.069	.062
		Notropis chalybaeus	.0005	.001	.040	.016	.028	.025
		Fundulus chrysotus	.0009	.002	.040	.016	.054	.048
		Gambusia affinis	.001	.003	.040	.016	.079	.071
		Lepomis auritus	.013	.028	.040	.016	.793	.708
Turkey Creek: Flowing Stream Subsystem	DH-8B	*Gambusia affinis*	.005	.010	.007	.003	1.579	1.443
	DH-9	*Notemigonus crysoleucas*	.004	.009	.031	.013	.309	.276
		Gambusia affinis	.027	.061	.031	.013	2.181	1.948
		Heterandria formosa	.0007	.0015	.031	.013	.055	.049
		Lepomis punctatus	.0001	.0003	.031	.013	.010	.009
	DH-10	*Gambusia affinis*	.007	.015	.043	.018	.396	.355

Note: Surface area obtained from stream area and volume data.
1 Acre = 43.560 sq. ft.
1 Hectare = 10,000 sq. meters

Table A2-61 Vertebrates Expected to Occur in the Area of Concern.

I. Mammals

Opposum	Didelphis virginiana
Southeastern Shrew	Sorex longirostis longirostis
Short-tailed Shrew	Blarina lirevidauda
Least Shrew	Cryptotis parva
Eastern Mole	Scolopus aquaticus
Southeastern Myotis	Myotis austroriparius
Gray Myotis	Myotis grisescens
Eastern Pipistrelle	Pipistrellus subflavus
Big Brown Bat	Eptesicus fuscus
Red Bat	Lasiurus borealis
Hoary Bat	Lasiurus cinereus
Florida Yellow Bat	Lasiurus intermedius
Seminole Bat	Lasiurus seminolus
Evening Bat	Nysticeius fumeralus
Big-eared Bat	Plecotus rafinesquii
Brasilian Free-tailed Bat	Todarida brasiliensis
Nine-banded Armadillo	Dasypus novemcinctis
Eastern Cottontail	Sylvilogue floridanus
Marsh Rabbit	Sylvilogue polustris
Gray Squirrel	Sciurus carolinensis
Fox Squirrel	Sciurus niger
Southern Flying Squirrel	Glaucomys volans
Southeastern Pocket Gopher	Geomys pinetis
Marsh Rice Rat	Oryzomys polustris
Eastern Harvest Mouse	Reithrodontomys humulis
Florida Mouse	Peromyscus floridanus
Cotton Mouse	Peromyscus gossypinus
Golden Mouse	Peromyscus nuttalli
Oldfield Mouse	Peromyscus polionotus
Hispid Cotton Rat	Sigmodon hispidus
Eastern Wood Rat	Neotoma floridana
Pine Vole	Microtus pinetorum
Round-tailed Muskrat	Neofiber alleni
Norway Rat	Rattus norvegicus
Black Rat	Rattus rattus
House Mouse	Mus musculus
Gray Fox	Urocyon cinereourgenteus
Florida Black Bear	Ursus americanus floridanus
Raccoon	Procyon lotor
Long-tailed Weasel	Mustela frenata olivacea
Mink	Mustela vison

Table A2-61 (Continued)

Spotted Skunk	Spilogale putorius
Striped Skunk	Mephitis mephitis
River Otter	Lutra canadensis
Bobcat	Lynx rufus
Wild Hog	Sus scrofa
White-tailed Deer	Odocoileus virginiana

II. Birds

Pied-billed Grebe	Podilymbus podiceps
Double-crested Cormorant	Phalacrocorax auritus
Anhinga	Anhinga anhinga
Great Blue Heron	Ardea herodias
Green Heron	Butorides virescens
Little Blue Heron	Florida caerulea
Cattle Egret	Bubulcus ibis
Common Egret	Casmerodius albus
Snowy Egret	Leucophoyx thula
Louisiana Heron	Hydranassa tricolor
Black-crowned Night Heron	Nycticorax nycticorax
Yellow-crowned Night Heron	Nyctanassa violacea
Least Bittern	Ixobrychus exilis
American Bittern	Botaurus lentiginosus
Wood Stork	Mycteria americana
Glossy Ibis	Plegadis falcinellus
White Ibis	Eudocimus albus
Mallard	Anas platyrhynchos
Black Duck	Anas rubripes
Mottled Duck	Anas fulvigula
Pintail	Anas acuta
Gadwall	Anas strepera
Baldpate	Anas americana
Shoveler	Anas clypeata
Blue-winged Teal	Anas discors
Green-winged Teal	Anas carolinensis
Wood Duck	Aix sponsa
Ring-necked Duck	Aythya collaris
Lesser Scaup	Aythya affinis
Ruddy Duck	Oxyura jamaicensis
Hooded Merganser	Mergus cucullatus
Turkey Vulture	Cathartes aura
Black Vulture	Coragyps atratus

Table A2-61 (Continued)

Swallow-tailed Kite	Elanoides forficatus
Mississippi Kite	Ictinia mississippiensis
Sharp-shinned Hawk	Accipiter striatus
Cooper's Hawk	Accipiter cooperii
Red-tailed Hawk	Buteo jamaicensis
Red-shouldered Hawk	Buteo lineatus
Broad-winged Hawk	Buteo platypterus
Marsh Hawk	Circus cyaneus
Osprey	Pandion haliaetus
Merlin	Falco columbarius
Kestrel	Falco sparuerius
Bobwhite	Colinus virginianus
Turkey	Meleagris gallopauo
Sandhill Crane	Grus canadensis
Limpkin	Aramus guarauna
King Rail	Rallus elegans
Virginia Rail	Rallus limicola
Sora Rail	Porzana carolina
Purple Gallinule	Porphyrula martinica
Common Gallinule	Gallinula chloropus
American Coot	Fulica americana
Killdeer	Charadrius vociferus
Woodcock	Philohela minor
Common Snipe	Capello gallinago
Spotted Sandpiper	Actitis macularia
Solitary Sandpiper	Tringa solitaria
Greater Yellowlegs	Totanus melanoleucus
Lesser Yellowlegs	Totanus flavipes
Least Sandpiper	Erolia minutilla
Pigeon	Columba livia
Mourning Dove	Zenaidura macroura
Ground Dove	Columbigallina passerina
Yellow-billed Cuckoo	Coccyzus americanus
Barn Owl	Tyto alba
Screech Owl	Otus asio
Great Horned Owl	Bubo virginianus
Barred Owl	Strix varia
Chuck-will's Widow	Caprimulgus carolinensis
Nighthawk	Chordeiles minor
Chimney Swift	Chaetura pelagica
Ruby-throated Hummingbird	Archilochus colubris
Belted Kingfisher	Megaceryle alcyon
Flicker	Colaptes auratus
Pileated Woodpecker	Dryocopus pileatus
Red-bellied Woodpecker	Centurus carolinus
Red-headed Woodpecker	Melanerpes erythrocephalus

Table A2-61 (Continued)

Yellow-bellied Sapsucker	Sphyrapicus varius
Downy Woodpecker	Dendrocopos pubescens
Red-cockaded Woodpecker	Dendrocopos borealis
Eastern Kingbird	Tyrannus tyrannus
Crested Flycatcher	Myiarchus crinitus
Pheobe	Sayornis phoebe
Acadian Flycatcher	Empidonax virescens
Eastern Wood Pewee	Contopus virens
Tree Swallow	Iridoprocne bicolor
Rough-winged Swallow	Stelgidopteryx ruficollis
Barn Swallow	Hirundo rustica
Purple Martin	Progne subis
Blue Jay	Cyarocitta cristata
Common Crow	Corvus brachyrhynchos
Fish Crow	Corvus ossifragus
Carolina Chickadee	Parus carolinensis
Tufted Titmouse	Parus bicolor
Brown-headed Nuthatch	Sitta pusilla
White-breasted Nuthatch	Sitta carolinensis
Brown Creeper	Certhia familiaris
House Wren	Troglodytes aedon
Winter Wren	Troglodytes troglodytes
Carolina Wren	Thryothorus ludovicianus
Long-billed Marsh Wren	Telmatodytes palustris
Short-billed Marsh Wren	Cistothorus platensis
Mockingbird	Mimus polyglottos
Catbird	Dumetella carolinensis
Brown Thrasher	Toxostoma rufum
Robin	Turdus migratorius
Wood Thrush	Hylocichla mustelina
Hermit Thrush	Hylocichla guttata
Swainson's Thrush	Hylocichla ustulata
Gray-cheeked Thrush	Hylocichla minima
Veery	Hylocichla fuscescens
Bluebird	Sialia sialis
Blue-gray Gnatcatcher	Polioptila caerulea
Golden-crowned Kinglet	Regulus satrapa
Ruby-crowned Kinglet	Regulus calendula
Water Pipit	Anthus spinoletta
Cedar Waxwing	Bombycilla cedrorum
Loggerhead Shrike	Lanius ludovicianus
Starling	Sturnus vulgaris
White-eyed Vireo	Vireo griseus
Yellow-throated Vireo	Vireo flavifrons
Solitary Vireo	Vireo solitarius
Red-eyed Vireo	Vireo olivaceus

Table A2-61 (Continued)

Black-and-white Warbler	Mniotitta varia
Prothonotary Warbler	Protonotaria citrea
Worm-eating Warbler	Helmitheros vermivorus
Tennessee Warbler	Vermivora peregrina
Orange-crowned Warbler	Vermivora celata
Parula Warbler	Parula americana
Yellow Warbler	Dendroica petechia
Magnolia Warbler	Dendroica magnolia
Cape May Warbler	Dendroica tigrina
Black-throated Blue Warbler	Dendroica caerulescens
Myrtle Warbler	Dendroica coronata
Yellow-throated Warbler	Dendroica dominica
Black-poll Warbler	Dendroica striata
Pine Warbler	Dendroica pinus
Prairie Warbler	Dendroica discolor
Palm Warbler	Dendroica palmarum
Ovenbird	Seiurus aurocapillus
Northern Waterthrush	Seiurus noveboracensis
Louisiana Waterthrush	Seiurus motacilla
Yellowthroat	Geothlypis trichas
Hooded Warbler	Wilsonia citrina
Redstart	Setophaga ruticilla
House Sparrow	Passer domesticus
Bobolink	Dolichonyx oryzivorus
Meadowlark	Sturnella magna
Red-winged Blackbird	Agelaius phoeniceus
Orchard Oriole	Icterus spurius
Baltimore Oriole	Icterus galbula
Rusty Blackbird	Euphagus carolinus
Brewer's Blackbird	Euphagus cyanocephalus
Boat-tailed Grackle	Cassidix mexicanus
Common Grackle	Quiscalus quiscula
Brown-headed Cowbird	Molothrus ater
Scarlet Tanager	Piranga olivacea
Summer Tanager	Piranga rubra
Cardinal	Richmondena cardinalis
Rose-breasted Grosbeak	Pheucticus ludovicianus
Blue Grosbeak	Guiraca caerulea
Indigo Bunting	Passerina cyanea
Painted Bunting	Passerina ciris
Dickcissel	Spiza americana
Purple Finch	Carpodacus purpureus
Goldfinch	Spinus tristis
Rufous-sided Towhee	Pipilo erythrophthalmus
Savannah Sparrow	Passerculus sandwichensis
Grasshopper Sparrow	Ammodramus savannarum

Table A2-61 (Continued)

Henslow's Sparrow	*Passerherbulus henslowii*
Vesper Sparrow	*Pooecetes gramineus*
Bachman's Sparrow	*Aimophila aestivalis*
Slate-colored Junco	*Junco hyemalis*
Chipping Sparrow	*Spizella passerina*
Field Sparrow	*Spizella pusilla*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-throated Sparrow	*Zonotrichia albicollis*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*

III. Reptiles

American Alligator	*Alligator mississippiensis*
Florida Snapping Turtle	*Chelydra serpentina osceola*
Common Snapping Turtle	*Chelydra serpentina serpentina*
Stinkpot	*Sternothaerus odoratus*
Loggerhead Musk Turtle	*Sternothaerus minor minor*
Striped Mud Turtle	*Kinosternon bauri*
Florida Mud Turtle	*Kinosternon subrubrum steindachneri*
Florida Box Turtle	*Terrapene carolina bauri*
Pensinsula Cooter	*Pseudemys floridana peninsularis*
Yellow-bellied Turtle	*Pseudemys scripta scripta*
Florida Red-bellied Turtle	*Pseudemys nelsoni*
Florida Chicken Turtle	*Deirochelys reticularia*
Gopher Tortoise	*Gopherus polyphemus*
Florida Softshell	*Trionyx ferox*
Green Anole	*Anolis carolinensis carolinensis*
Southern Fence Lizard	*Sceloporus undulatus undulatus*
Ground Skink	*Lygosoma laterale*
Southern Five-lined Skink	*Eumeces inexpectatus*
Broad-headed Skink	*Eumeces laticeps*
Brown Red-tailed Skink	*Eumeces egregius onocrepis*
Six-lined Racerunner	*Cnemidophorus sexlineatus*
Eastern Glass Lizard	*Ophisaurus ventralis*
Eastern Slender Glass Lizard	*Ophisaurus attenuatus longicaudus*
Island Glass Lizard	*Ophisaurus compressus*
Worm Lizard	*Rhineura floridana*
Florida Green Water Snake	*Natrix cyclopion floridana*
Brown Water Snake	*Natrix taxispilota*
Red-bellied Water Snake	*Natrix erythrogaster erythrogaster*

Table A2-61 (Continued)

North Florida Swamp Snake	Seminatrix pygaea
Florida Brown Snake	Storeria dekayi victa
Banded Water Snake	Natrix sipedon fasciata
Eastern Garter Snake	Thamnophis sirtalis sirtalis
Striped Swamp Snake	Liodytes alleni
Southern Ribbon Snake	Thamnophis sauritus sackeni
Rainbow Snake	Abastor erythrogrammus
Yellow-lipped Snake	Rhadinaea flavilata
Eastern Mud Snake	Farancia abacura
Eastern Hognose Snake	Heterodon platyrhinos
Southern Hognose Snake	Heterodon simus
Southern Ringneck Snake	Diadophis punctatus punctatus
Southern Black Racer	Coluber constrictor priapus
Eastern Coachwhip	Masticophis flagellum
Eastern Indigo Snake	Drymarchon corais
Rough Green Snake	Opheodrys aestivus
Yellow Rat Snake	Elaphe obsoleta quadrivittata
Florida Pine Snake	Pitouphis melanoleucas mugitus
Corn Snake	Elaphe guttata guttata
Short-tailed Snake	Stilosoma extenuatum
Scarlet Snake	Cemophora coccinea
Scarlet Kingsnake	Lampropeltis doliata doliata
Mole Snake	Lampropeltis calligastor
Eastern Kingsnake	Lampropeltis getulus
Florida Crowned Snake	Tantilla coronata wagneri
Eastern Coral Snake	Micrurus fulvius
Eastern Cottonmouth	Agkistrodon piscivorus piscivorus
Dusky Pigmy Rattlesnake	Sistrurus miliarius barbouri
Eastern Diamondback Rattlesnake	Crotalus adamanteus

IV. Amphibians

Amphiuma	Amphiuma means
Eastern Lesser Siren	Siren intermedia
Greater Siren	Siren lacertina
Narrow-striped Dwarf Siren	Pseudobranchus striatus axanthus
Mole Salamander	Ambystoma talpoideum
Marbled Salamander	Ambystoma opacum
Eastern Tiger Salamander	Ambystoma tigrinum tigrinum
Peninsula Newt	Diemictylus viridescens piaropicola
Central Newt	Notrophthalmus viridescens

Table A2-61 (Continued)

Striped Newt	Diemictylus perstriatus
Slimy Salamander	Plethodon glutinosus glutinosus
Eastern Mud Salamander	Pseudotriton montanus montanus
Dwarf Salamander	Manculus quadridigitatus
Eastern Spade Foot	Scaphiopus holbrooki
Southern Toad	Bufo terristris
Oak Toad	Bufo quercicus
Eastern Narrow-mouth Toad	Gastrophryne carolinensis
Greenhouse Frog	Eleutherodactylus ricordi planirostris
Spring Peeper	Hyla crucifer
Green Tree Frog	Hyla cinerea
Pine Woods Tree Frog	Hyla femoralis
Eastern Gray Tree Frog	Hyla versicolor versicolor
Squirrel Tree Frog	Hyla squirella
Little Grass Frog	Hyla ocularis
Barking Tree Frog	Hyla gratiosa
Florida Cricket Frog	Acris gryllus dorsalis
Florida Chorus Frog	Pseudacris nigrita verrucosa
Ornate Chorus Frog	Pseudacris ornata
Bullfrog	Rana catesbeiana
River Frog	Rana heckscheri
Pig Frog	Rana grylio
Bronze Frog	Rana clamitans clamitans
Southern Leopard Frog	Rana pipiens sphenocephala
Florida Gopher Frog	Rana areolata aesopus

V. Fishes

Bowfin	Amia calva
Mud Minnow	Umbra pygmaea
Redfin Pickerel	Esox americanus
Chain Pickerel	Esox niger
Southeastern Golden shiner	Notemigonus crysoleucas bosci
Iron-colored Shiner	Notropis chalybaeus
Lowland Shiner	Notropis cummingsae cummingsae
Pugnose Minnow	Notropis emiliae
Sailfin Shiner	Notropis hypselopterus
Red Minnow, Taillight Shiner	Notropis maculatus
Peterson's Shiner	Notropis petersoni
Spring Redeye Chub	Hybopsis harperi
Yellow Bullhead	Ictalurus natalis
Southern Brown Bullhead	Ictalurus nebulosus marmoratus

Table A7-1 Total Employment By Occupation - Gainesville

Occupational Title	1970	1974	Estimated 1977	Estimated 1978	Projected 1985
Crafts and Kindred Workers	3742	5780	6710	7040	9180
Construction Crafts Workers	1665	2690	3120	3260	4310
Carpenters and Apprentices	444	690	820	870	1180
Brick and Stonemasons and Apprentices	120	160	190	200	2700
Bulldozer Operators	59	120	130	130	160
Cement and Concrete Finishers	111	200	230	240	330
Electricians and Apprentices	255	460	520	540	690
Excavating, Grading, Machine Operators	103	170	190	190	220
Floor Layers, Exc. Tile Setters	0	*	*	*	*
Painters and Apprentices	200	280	340	360	500
Paperhangers	0	*	*	*	*
Plasterers and Apprentices	37	30	40	50	80
Plumbers, Pipefitters and Apprentices	200	310	350	370	480
Roofer and Slaters	78	170	190	190	240
Structural Metal Craft Workers	20	40	40	40	50
Tilesetters	38	60	80	80	110
Blue Collar Worker Supvr., Mec.	316	440	520	540	710
Metalworking Craft Workers Exc. Mec.	117	140	180	180	250
Blacksmiths	0	*	*	*	*
Boilermakers	0	*	*	*	*
Heat Treaters, Annealers, Etc.	0	*	*	*	*
Forge and Hammer Operators	0	*	*	*	*
Job and Die Setters, Metal	0	*	*	*	*
Machinists and Apprentices	46	60	80	80	110
Millwrights	4	*	10	10	10
Molders, Metal and Apprentices	9	*	*	*	*
Jewelers and Watchmakers	11	10	10	10	20
Millers, Grain, Flour, Feed	0	*	*	*	*
Motion Picture Projectionists	4	*	*	*	10
Opticians, Lens Grinder, Polisher	15	40	40	40	40
Piano, Organ Tuners, Repairers	0	*	*	*	*
Shipfitters	0	*	*	*	*
Shoe Repairers	6	*	*	*	10
Sign Painters and Letterers	0	*	*	*	*
Stationary Engineers	43	80	90	90	110
Stone Cutters, Stone Carvers	0	*	*	*	*
Tailors	5	*	10	10	10
Upholsterers	6	10	10	10	20
Crafts, Kindred Workers, Nec.	26	60	60	60	80

Table A7-1 Total Employment By Occupation - Gainesville (continued)

Occupational Title	1970	1974	Estimated 1977	Estimated 1978	Projected 1985
Operatives	2897	3540	4200	4410	5960
Operatives, Exc. Transport	1822	2120	2500	2630	3530
Semiskilled Metalworking	91	160	180	190	240
Drill Press Operatives	0	*	*	*	*
Furnace Tendrs, Smeltrs, Pourers	0	*	*	*	*
Grinding Machine Operatives	4	*	*	*	10
Heaters, Metal	0	*	*	*	*
Lathe, Millin Mach. Operatives	5	10	10	10	10
Metal Platers	10	20	20	20	30
Other Precision Mach. Operators	0	*	*	*	*
Punch Stamping Press Operative	0	*	*	*	*
Solderers	0	*	*	*	*
Welders and Flame Cutters	72	130	150	160	190
Semiskilled Textile	0	*	*	*	*
Carding, Lapping, Combing Oprs.	0	*	*	*	*
Knitters, Loopers, and Toppers	0	*	*	*	*
Spinners, Twisters, Winders	0	*	*	*	*
Weavers	0	*	*	*	*
Other Textile Operatives	0	*	*	*	*
Semiskilled Packing, Inspecting	276	310	360	380	520
Checkers, Examiners, Etc., Mfg.	88	130	150	160	210
Graders, and Sorters, Mfg.	13	10	10	10	20
Meat Wrappers, Retail Trade	24	40	50	50	60
Packer, Wrapper, Ex. Meat, Produce	127	90	110	120	180
Prod. Ordr, Packer, Exc. Fact, Farm	24	40	40	40	50
Other Operatives, Exc. Transport	1455	1650	1960	2060	2770
Asbestos, Insulation Workers	6	10	10	10	10
Assemblers	179	350	410	420	550
Blasters	0	*	*	*	*
Bottling, Canning Operatives	17	20	20	20	30
Surveyor Helpers	15	20	30	30	40
Clothing Ironers and Pressers	46	20	30	30	50
Pattern and Model Makers	0	*	*	*	*
Rollers and Finishers, Metal	0	*	*	*	*
Sheetmetal Workers and Appr.	43	60	70	70	100
Tool and Diemakers and Appr.	15	20	20	20	30
Mechanics, Repairers, Installers	893	1360	1550	1620	2070
Air Cond., Heating, Refrig Mech.	73	150	170	170	200
Aircraft Mechanics	0	*	*	*	*
Auto Accessories Installers	0	*	*	*	*
Auto Body Repairers	85	80	110	110	170
Auto Mechanics and Appr.	347	450	520	550	720
Data Processing Machine Repairers	9	30	30	30	30

Table A7-1 Total Employment By Occupation - Gainesville (continued)

Occupational Title	1970	1974	Estimated 1977	Estimated 1978	Projected 1985
Farm Implement Mechanics	11	30	30	30	30
Heavy Equip. Mech, Includes Diesel	142	240	270	280	250
Household Appliance Mechanics	57	80	90	100	120
Loom Fixers	0	*	*	*	*
Office Machine Repairers	16	40	40	40	40
Radio, Television Repairers	74	90	100	100	130
Railroad, Car Shop Repairers	14	40	50	60	80
Other Mechanics and Appr.	65	130	140	150	180
Printing Trade Crafts Workers	68	80	90	100	130
Bookbinders	8	10	10	10	10
Compositors and Typesetters	26	30	30	40	50
Electrotypers, Stereotypers	0	*	*	*	*
Engravers Exc. Photoengravers	0	*	*	*	*
Photoengravers, Lithographers	5	10	10	10	10
Printing Press Opers. & Apprentices	29	40	40	40	60
Transportation, Public Utility Craft	322	560	650	670	880
Elec. Power Line Installer, Reprs.	72	110	130	130	170
Locomotive Engineers	29	140	160	170	210
Locomotive Engineer Helpers	0	*	*	*	*
Power Station Operators	9	20	20	20	30
Telephone Installers, Repairers	157	240	280	290	380
Telephone Line Instalr, Splicer	55	50	60	60	90
Other Crafts, Kindred Workers	361	510	600	620	830
Bakers	78	70	90	90	130
Cabinetmakers	61	80	90	100	140
Carpet Installers	22	40	50	50	70
Crane, Derrick, and Hoist Operator	5	10	10	10	10
Decorators, Window Dressers	22	30	30	40	50
Dental Laboratory Tech.	9	10	10	10	10
Furniture and Wood Finishers	6	10	10	10	10
Furriers	0	*	*	*	*
Glaziers	15	30	40	40	50
Inspectors, Log and Lumber	7	*	10	10	10
Inspectors, Other	20	30	40	40	50
Cutting Operatives, Nec.	30	20	30	30	50
Dressmakers, Exc. Factory	64	80	90	100	140
Drillers, Earth	5	10	10	10	10
Dry Wall Installers, Lathes	43	90	100	120	160
Dyers	0	*	*	*	*
Filer, Polisher, Sander, Buffer	7	10	10	10	20
Garge Workers, Gas Station Attendant	258	220	260	270	360
Laundry, Dry Cleaning Oprs, Nec.	107	70	90	90	130
Meat Cutters, Butchers, Exc. Mfg.	127	150	190	200	290
Meat Cutters, Butchers	55	20	30	30	50
Milleners	0	*	*	*	*
Mine Operatives, Nec.	0	*	*	*	*

Table A7-1 Total Employment By Occupation - Gainesville (continued)

Occupational Title	1970	1974	Estimated 1977	Estimated 1978	Projected 1985
Mixing Operatives	26	30	30	40	50
Oilers, Greasers, Exc. Auto	6	10	10	10	10
Painters, Mfg. Articles	23	40	40	40	50
Photographic Process Workers	39	80	90	90	100
Riveters and Fasteners	0	*	*	*	*
Sailors and Deckhands	0	*	*	*	*
Sawyers	14	10	20	20	30
Sewers and Stitchers	74	20	20	30	30
Shoemaking Machine Operatives	0	*	*	*	*
Furnace Tender, Stoker Exc. Metal	33	30	40	40	60
Winding Operatives, Nec.	14	40	40	40	50
Misc. Mach. Operatives	112	150	180	190	240
Operatives, Nec.	155	150	180	190	260
Transport Equipment Operatives	1075	1420	1700	1780	2430
Boat Operators	0	*	*	*	*
Bus Drivers	116	210	230	240	310
Conductors and Opr. Urban Rail	0	*	*	*	*
Delivery and Route Workers	461	500	600	630	850
Fork Lift Tow Motor Operatives	17	20	20	30	40
Rail Vehicle Operators Nec.	6	*	10	10	10
Parking Attendants	9	10	10	10	20
Railroad Brake Operators	0	*	*	*	*
Railroad Switch Operators	26	80	100	100	140
Taxicab Drivers, Chauffeurs	23	20	30	30	50
Truck Drivers	417	580	700	740	1010

* = Data not available.

Source: Office of Research and Statistics, Florida Department of Commerce (unpublished report).

Table A7-2 1975 Existing Educational Facilities

Facility	Grade Levels	1975-76 Enrollment	Capacity*
Elementary Schools			
Alachua	K - 4	643	670
Archer	K - 6	398	490
Duval	K - 5	449	515
J.J. Finley	K - 5	571	610
Stephen Foster	K - 5	687	650
Glen Springs	K - 5	695	655
High Springs	K - 4	383	270
Idlywild	K - 5	484	690
Kirby-Smith	K - 5	423	475
Lake Forest	K - 5	510	625
Sidney Lanier	K - 5	114	415
Littlewood	K - 5	629	640
Metcalfe	K - 5	479	625
Newberry	K - 6	426	475
Prairie View	K - 5	501	655
M.K. Rawlings	K - 5	554	655
Shell	K - 6	552	620
Terwilliger	K - 5	753	640
Waldo	K - 6	232	240
Williams	K - 5	556	710
		10,039	11,325
Middle Schools			
Howard Bishop	6 - 8	976	1,075
Fort Clarke	6 - 8	1,094	913
Lincoln	6 - 8	996	1,230
A.L. Mebane	5 - 8	576	1,083
Spring Hill	5 - 8	342	333
Westwood	6 - 8	991	1,139
		4,975	5,773
Secondary Schools			
Buchholtz	9 - 12	1,622	1,876
Eastside	9 - 12	1,122	1,316
Gainesville	9 - 12	1,998	1,885
Hawthorne	7 - 12	666	1,007
Newberry	7 - 12	746	909
Santa Fe	9 - 12	872	1,056
		7,026	8,049
TOTAL:		22,040	25,147

*Does not include portable classrooms.

Source: North Central Florida Regional Planning Council, 1976a.

Table A7-3 Regional Utilities Projected Electric Revenue Requirements
-Based on Load Growth of 8 Percent Through 1980 and 7 Percent Thereafter
(Dollars in Thousands)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1) Minimum Net Revenue Requirements											
Low-Sulfur Oil	$15,535	$18,962	$21,013	$19,213	$21,147	$21,445	$21,439	$21,393	$21,734	$22,319	$22,907
Low-Sulfur Coal	15,020	17,822	20,445	22,578	23,864	24,600	24,603	24,596	24,603	24,977	25,631
2) Total System Operating & Maintenance Expense											
Low-Sulfur Oil	5,633	6,308	7,065	7,901	8,740	9,668	10,691	11,831	13,075	14,458	15,990
Low-Sulfur Coal	5,633	6,308	7,065	7,901	9,336	10,351	11,392	12,659	14,007	15,314	17,098
3) System Fuel Cost											
Low-Sulfur Oil	15,858	17,682	20,639	24,819	26,471	30,367	34,369	39,247	44,871	51,197	58,237
Low-Sulfur Coal (Contract)	15,858	17,682	20,639	24,819	20,741	23,244	26,051	29,671	33,657	38,204	43,663
Low-Sulfur Coal (Lease)	15,858	17,682	20,639	24,819	16,888	18,844	21,014	24,174	27,563	31,433	35,863
4) Florida Power Corporation Sales											
Low-Sulfur Oil					(1,631)	(1,698)	(1,849)				
Low-Sulfur Coal (Contract)					(3,648)	(3,954)	(4,359)				
Low-Sulfur Coal (Lease)					(4,637)	(4,810)	(4,826)				
Total Revenue Requirements (Sum of Items 1,2,3, & 4)											
Low-Sulfur Oil	37,026	42,952	48,717	51,933	54,727	59,782	64,650	72,471	79,680	87,974	97,134
Low-Sulfur Coal (Contract)	36,511	41,812	48,149	55,298	50,293	54,241	57,687	66,926	72,267	78,495	86,392
Low-Sulfur Coal (Lease)	36,511	41,812	48,149	55,298	45,451	48,985	52,183	61,429	66,173	71,823	78,592

Average Revenues in Mills Per kWh

	Levelized 1977-1987	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Low-Sulfur Oil	61.52	53.74	57.73	60.52	59.69	58.78	59.96	60.59	63.40	65.10	67.16	69.33
Low-Sulfur Coal (Contract)	57.69	52.99	56.20	59.81	63.56	54.02	54.40	54.06	58.55	59.04	60.00	61.66
Low-Sulfur Coal (Lease)	54.37	52.99	56.20	59.81	63.56	48.82	49.13	48.91	53.74	54.06	54.83	56.10

Table A7-4 Regional Utilities Projected Electric Revenue Requirements
-Based on 5 Percent Load Growth
(Dollars in Thousands)

	Levelized 1977-1987	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1) Required Net Operating Revenue												
Low-Sulfur Oil		$15,535	$18,962	$21,013	$19,213	$21,147	$21,445	$21,439	$21,393	$21,734	$22,319	$22,907
Low-Sulfur Coal		15,020	17,822	20,445	22,578	23,864	24,600	24,630	24,596	24,603	24,977	25,631
2) System Production Operating & Maintenance Expense												
Low-Sulfur Oil		5,546	6,210	6,956	7,779	8,605	9,618	10,525	11,648	12,872	14,234	15,742
Low-Sulfur Coal		5,546	6,210	6,956	7,779	9,171	10,167	11,191	12,434	13,708	15,142	16,795
3) System Fuel Cost												
Low-Sulfur Oil		14,402	15,254	17,376	19,531	21,245	23,914	26,508	29,679	33,346	37,180	41,527
Low-Sulfur Coal (Contract)		14,402	15,254	17,376	19,531	16,746	18,631	19,844	22,638	25,201	27,674	30,513
Low-Sulfur Coal (Lease)		14,402	15,254	17,376	19,531	13,605	15,201	16,968	18,419	20,547	22,462	24,763
4) Florida Power Corporation Sales												
Low-Sulfur Oil						(1,631)	(1,698)	(1,849)				
Low-Sulfur Coal (Contract)						(3,648)	(3,954)	(4,359)				
Low-Sulfur Coal (Lease)						(4,637)	(4,810)	(4,826)				
Total Revenue Requirements (Sum of Items 1,2,3, & 4)												
Low-Sulfur Oil		35,483	40,426	45,345	46,343	49,366	53,179	56,523	62,720	67,952	73,733	80,176
Low-Sulfur Coal (Contract)		34,968	39,286	44,777	49,888	46,133	49,444	51,279	59,668	63,512	67,793	72,939
Low-Sulfur Coal (Lease)		45,968	39,286	44,777	49,888	42,003	45,158	47,936	55,449	58,858	62,581	67,189
Average Revenue in Mills Per kWh												
Low-Sulfur Oil	63.08	52.96	57.50	61.36	59.80	60.65	62.20	63.05	66.51	68.64	70.97	73.49
Low-Sulfur Coal (Contract)	60.20	52.19	55.88	60.59	64.37	56.67	57.83	57.10	63.27	64.15	65.25	66.86
Low-Sulfur Coal (Lease)	57.27	52.19	55.88	60.59	64.37	51.60	52.82	53.38	58.80	59.45	60.23	61.58

Table A7-5 Regional Utilities Economic Comparison of Project Cancellation -Based on Load Growth of 8 Percent Through 1980 and 7 Percent Thereafter (Dollars in Thousands)

	Levelized 1977-1987	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Minimum Net Revenue Requirements												
Includes Defeasement of 1976 Issue		$12,464	$22,400	$22,601	$22,794	$23,078	$22,863	$21,832	$22,585	$22,917	$23,423	$23,986
Without Defeasement of 1976 Issue		12,089	17,149	17,386	17,661	17,990	18,069	18,236	18,597	18,937	19,451	19,435
Without Defeasement of 1976 Issue and Without Maintaining Transfers		12,089	14,985	16,024	17,085	17,856	18,069	18,236	18,597	18,937	19,451	19,935
Total System Operating & Maintenance Expense		5,633	6,308	7,065	8,102	8,531	9,441	10,255	11,386	12,549	13,309	14,703
System Fuel Cost		15,858	17,862	20,639	24,819	19,545	22,549	19,344	23,320	25,587	8,176	10,799
Purchase or Participation Expenses												
Demand Charges						1,239	1,323	3,465	3,714	3,964	12,262	12,275
Delivered Energy Cost (Fuel Cost)						7,480	8,290	17,400	18,100	22,000	34,000	37,200
Transmission and O&M Expense						878	973	3,252	3,393	4,121	7,810	8,659
Subtotal:						9,596	10,586	24,117	25,207	30,085	54,072	58,134
Total Revenue Requirements												
Includes Defeasement of 1976 Issue		33,955	46,570	50,305	55,715	60,750	65,439	75,548	82,498	91,138	98,980	107,622
Without Defeasement of 1976 Issue		33,580	41,319	45,090	50,582	55,662	60,645	71,952	78,510	87,158	95,008	103,571
Without Defeasement of 1976 Issue and Without Maintaining Transfers		33,580	39,155	43,728	50,006	55,528	60,645	71,952	78,510	87,158	95,008	103,571
		Average Revenue in Mills Per kWh										
Includes Defeasement of 1976 Issue	67.30	49.28	62.59	62.49	64.04	65.25	65.64	70.80	72.18	74.46	75.56	76.82
Without Defeasement of 1976 Issue	63.11	48.74	55.54	56.01	58.14	59.79	60.83	67.43	68.69	71.21	72.53	73.93
Without Defeasement of 1976 Issue and Without Maintaining Transfers	62.63	48.74	52.63	54.32	57.48	59.64	60.83	67.43	68.69	71.21	72.53	73.93

Table A7-6 Deerhaven Unit 2 Construction Cost Estimates

	Oil-Fired	Coal-Fired	
	Low Sulfur	Low Sulfur	High Sulfur
Existing Contracts	$ 365,400	$ 365,400	$ 365,400
Oil Storage Tanks	8,505,964	8,505,964	8,505,964
Turbine Generator	30,068,474	10,800,000[a]	10,800,000[a]
Steam Generator (Oil-Fired)	1,569,904	1,569,904	1,569,904
Transformers	154,752	154,752	154,752
Start Transformer	360,000	360,000	360,000
Site Improvement	2,217,010	2,217,010	2,217,010
Condenser and Heaters	161,429	161,429	161,429
Deareating Heater	1,528,390	1,528,390	1,528,390
Feedwater Pumps	937,635	937,635	937,635
Circulating Pumps	416,667	416,667	416,667
Turbine & Condenser Installation	1,649,172	1,649,172	1,649,172
Electrical Equipment	1,019,691	1,019,691	1,019,691
Subtotal:	48,954,488	29,686,014	29,686,014
Existing Contract Modifications			
Additional Transformer Capacity		250,000	320,000
Steam Generator (Coal-Fired)		35,200,000	35,200,000
Additional Site Improvements		365,000	365,000
Additional Electrical Equipment		381,000	471,000
Subtotal:	--	36,196,000	36,356,000
Items Not Under Contract			
Foundations and Buildings	3,400,000	4,500,000	4,700,000
Piping and Equipment	9,200,000	9,530,000	9,530,000
Wiring and Equipment	3,350,000	3,450,000	3,500,000
Cooling Towers	2,400,000	2,600,000	2,600,000
Chimney	750,000	845,000	845,000
Railroads		300,000	300,000
Ash Storage Ponds		235,000	235,000
Ash Handling Equipment		210,000	210,000
Coal Handling Equipment		7,800,000	7,800,000
Wastewater Treatment		500,000	500,000
Electrostatic Precipitator		10,750,000	8,750,000
Limestone Slurry Scrubber			20,000,000
Contingency	1,359,279	5,000.000	6,000,000
Subtotal	20,459,272	45,720,000	64,970,000
Total	60,413,767	111,602,014	131,012,014
Engineering and Project Management	3,043,446	4,893,200	5,744,200
Total Construction Cost:[b]	$72,457,213 or $308/kW	$116,495,214 or $496/kW	$136,756,214 or $582/kW

NOTES: [a]Estimated cancellation charge is based on a re-order for a coal-fired boiler.
[b]Excludes fuel inventory, interest during construction and other financial costs, sales taxes are included.

Table A7-7 Regional Utilities Deerhaven Unit 2 Estimated Capital Budget (Dollars in Thousands)

	Construction Years					Total
	7/76-6/77	7/77-6/78	7/78-6/79	7/79-6/80	7/80-12/80	Expenditures
Capital Construction Requirements						
Generation Construction Alternatives						
Low-Sulfur Oil[1]	$18,764	$33,439	$14,232	$ 6,022	$ --	$72,457
Low-Sulfur Coal[1]	18,764	30,436	36,781	25,431	5,083	116,495
High-Sulfur Coal[1]	18,764	37,440	43,672	30,260	6,620	136,756
Related Facilities						
Oil Inventory Requirement[1]	--	--	--	1,000	--	1,000
Coal Inventory Requirement[1]	--	--	--	2,000	2,000	4,000
Unit Coal Train[1]	--	--	--	2,500	--	2,500
Total Construction						
Low-Sulfur Oil	18,764	33,439	14,232	7,022	--	73,457
Low-Sulfur Coal	18,764	30,436	36,781	29,931	7,083	122,995
High-Sulfur Coal	18,764	37,440	43,672	34,760	8,620	143,256
Financing Costs, Interest, and Fund Requirements						
Net Interest During Construction[2]						
Low-Sulfur Oil	2,905	2,803	4,848	5,840	--	16,396
Low-Sulfur Coal	2,905	2,499	4,811	7,173	4,302	21,690
High-Sulfur Coal	2,905	2,674	5,378	8,142	4,907	24,006
Bond Reserves, Contingency Fund Requirements, and Financing Fees[3]						
Low-Sulfur Oil	2,625	4,880	2,513	1,074	--	11,092
Low-Sulfur Coal	2,475	3,565	4,313	3,738	1,139	15,230
High-Sulfur Coal	2,475	4,163	5,049	4,370	1,326	17,383
Total Capital Requirements						
Low-Sulfur Oil	24,294	41,122	21,593	13,936	--	100,945
Low-Sulfur Coal	24,144	36,500	45,905	40,842	12,524	159,915
High-Sulfur Coal	24,144	44,277	54,099	47,272	14,853	184,645

Table A7-7 Regional Utilities Deerhaven Unit 2 Estimated Capital Budget (continued)
(Dollars in Thousands)

	Construction Years					Total
	7/76-6/77	7/77-6/78	7/78-6/79	7/79-6/80	7/80-12/80	Expenditures
Capital Sources						
Bond Financing						
Low-Sulfur Oil[1 4]	$21,520	$40,000	$20,600	$ 8,800	$ --	$90,920
Low-Sulfur Coal[1]	21,520	31,000	37,500	32,500	9,900	132,420
High-Sulfur Coal[1]	21,520	36,200	43,900	38,000	11,530	151,150
Internal Capital Required						
Low-Sulfur Oil	2,774	1,122	993	5,136	--	10,025
Low-Sulfur Coal	2,624	5,500	8,405	8,342	2,624	27,495
High-Sulfur Coal	2,624	8,077	10,199	9,272	3,323	33,495
Total Capital Sources						
Low-Sulfur Oil	24,294	41,122	21,593	13,936	--	100,945
Low-Sulfur Coal	24,144	36,500	45,905	40,842	12,524	159,915
High Sulfur Coal	24,144	44,277	54,099	47,272	14,853	184,645

NOTES: [1]Amounts obtained from RUB's Status Report, Deerhaven Unit 2, November 1976.
[2]Amounts calculated assuming interest expense rate of 6 3/4 percent. Interest expense assumed to be offset in year of issue by investment earnings at 6 3/4 percent.
[3]Amounts estimated at 12.2 percent of bond issues for oil alternative and 11.5 percent for coal based on financing fees of 3 percent, contingency fund requirements of 0.5 percent, and bond reserve fund requirements assumed to equal level debt service, reflecting interest expense of 6 3/4 percent (oil for 23 retirements and coal for 28 retirements).
[4]Projected oil financing issues include interest during construction for one year and bond reserve and contingency fund requirements. Projected coal issues do not assume capitalization of these items.

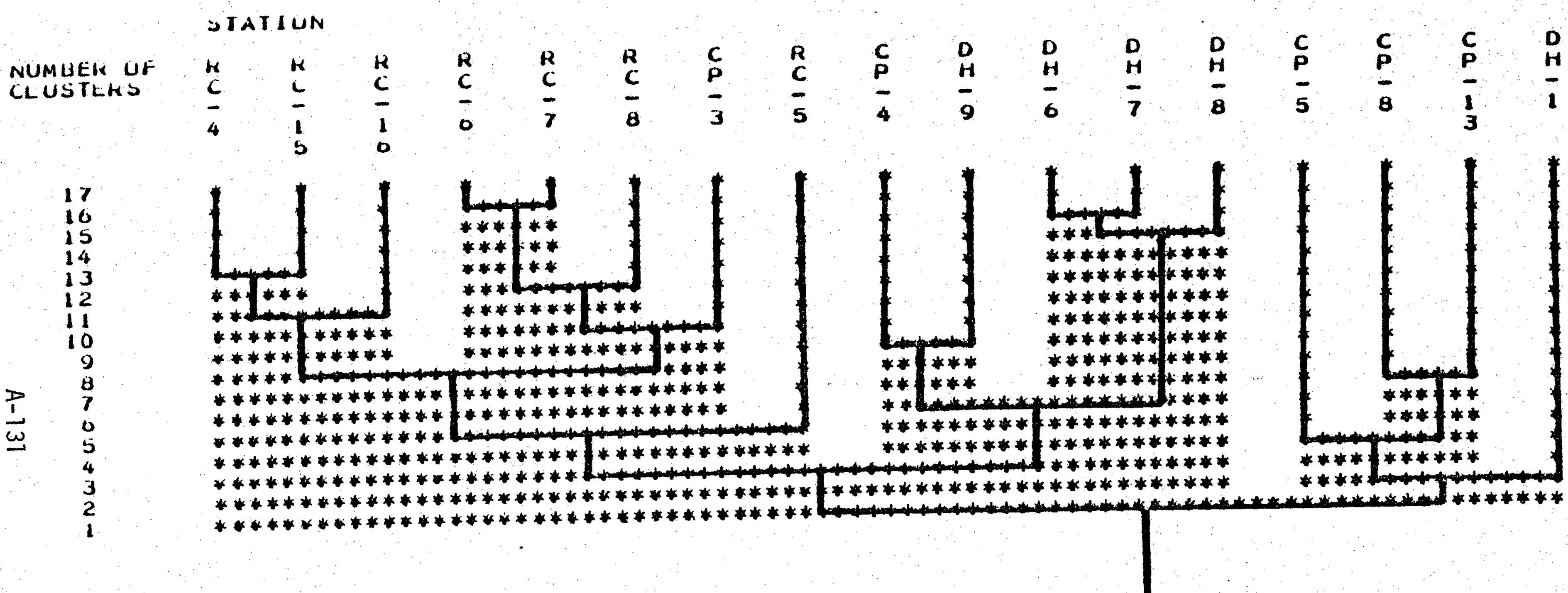

Figure A2-1 Cluster analysis map using all parameters found significantly different by Duncan's new multiple range test.

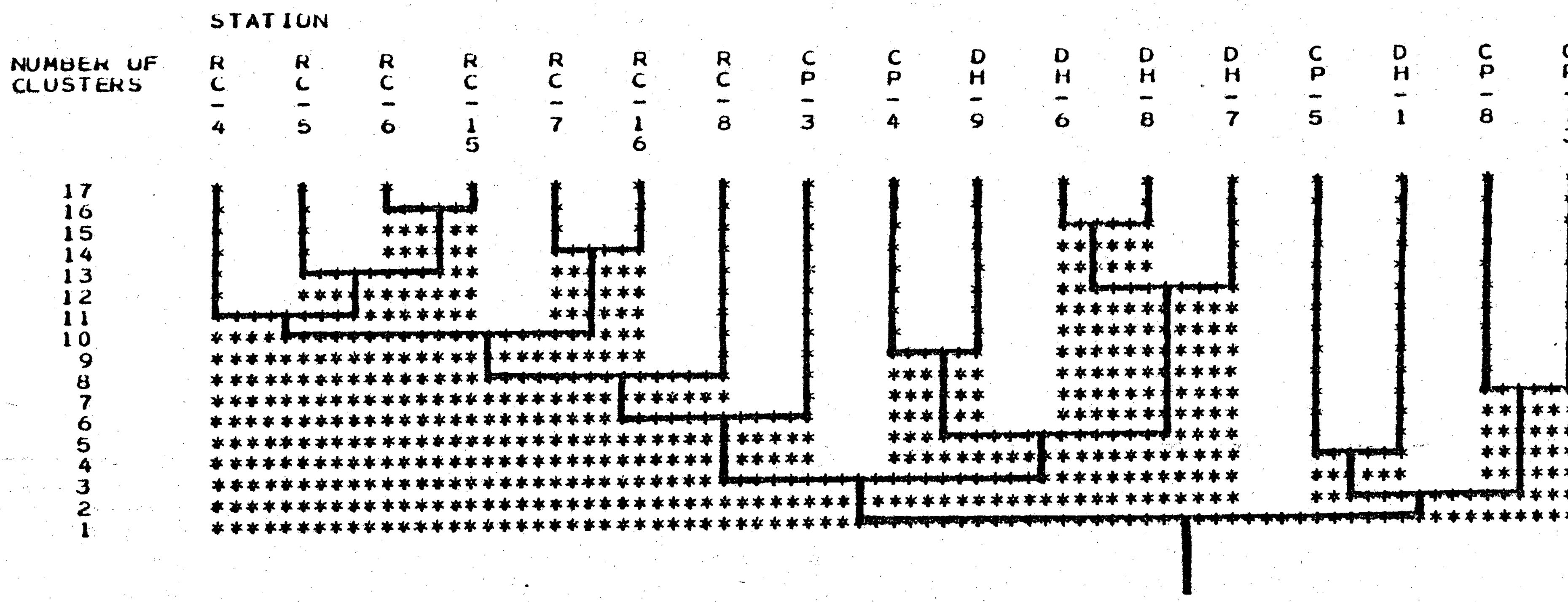

Figure A2-2 Cluster analysis map for conductivity.

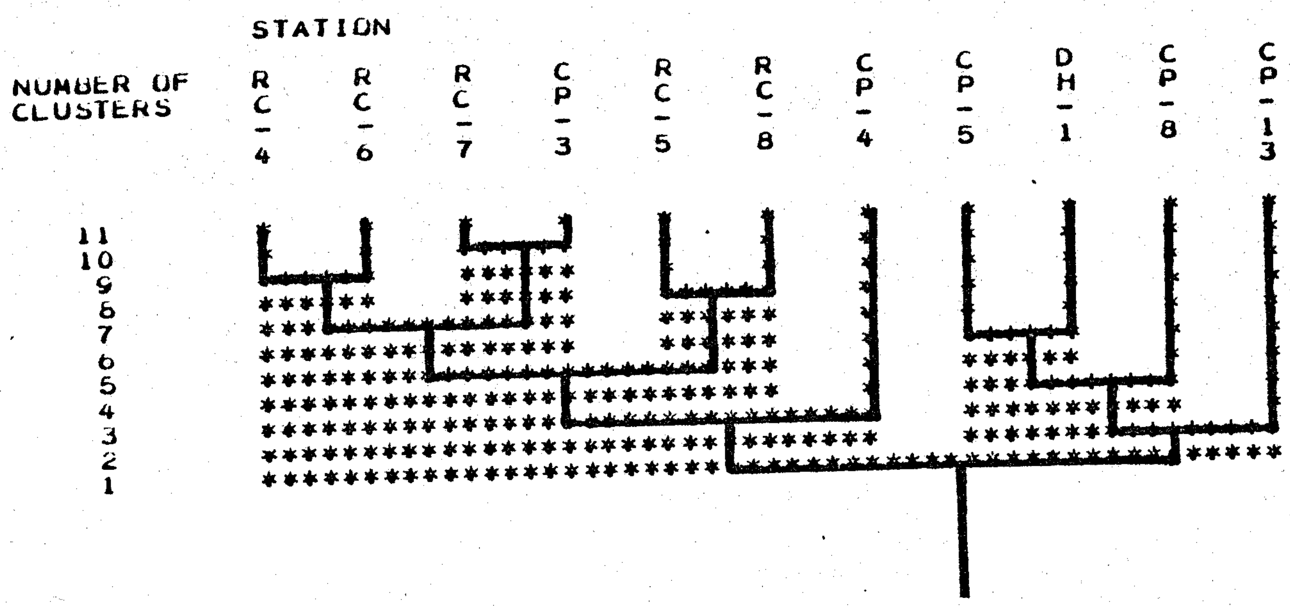

Figure A2-3 Cluster analysis map for total dissolved solids.

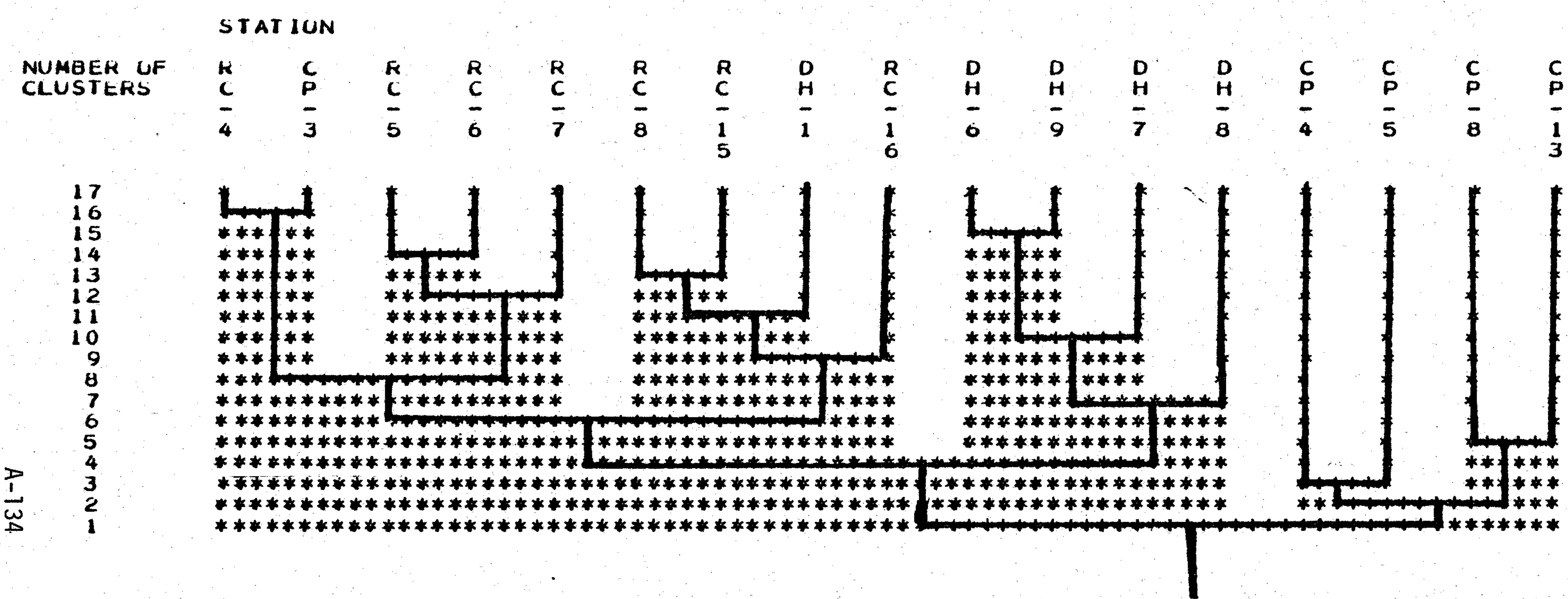

Figure A2-4 Cluster analysis map for alkalinity.

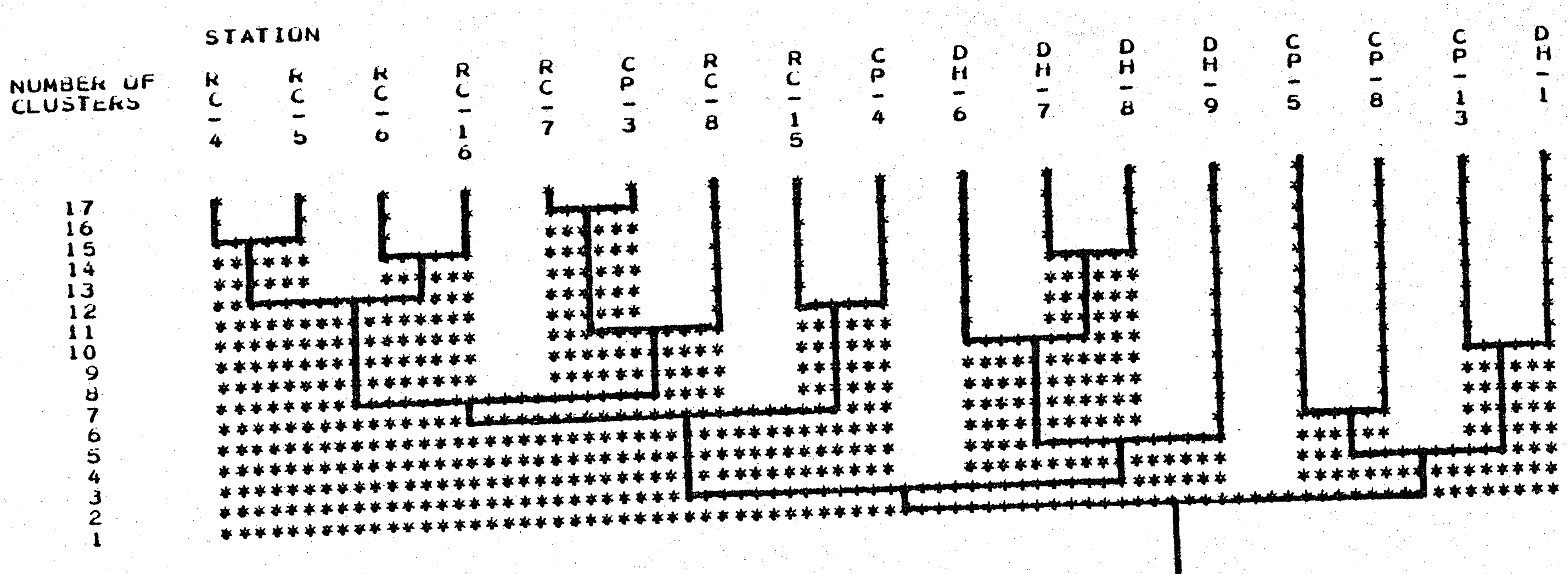

Figure A2-5 Cluster analysis map for sulfates.

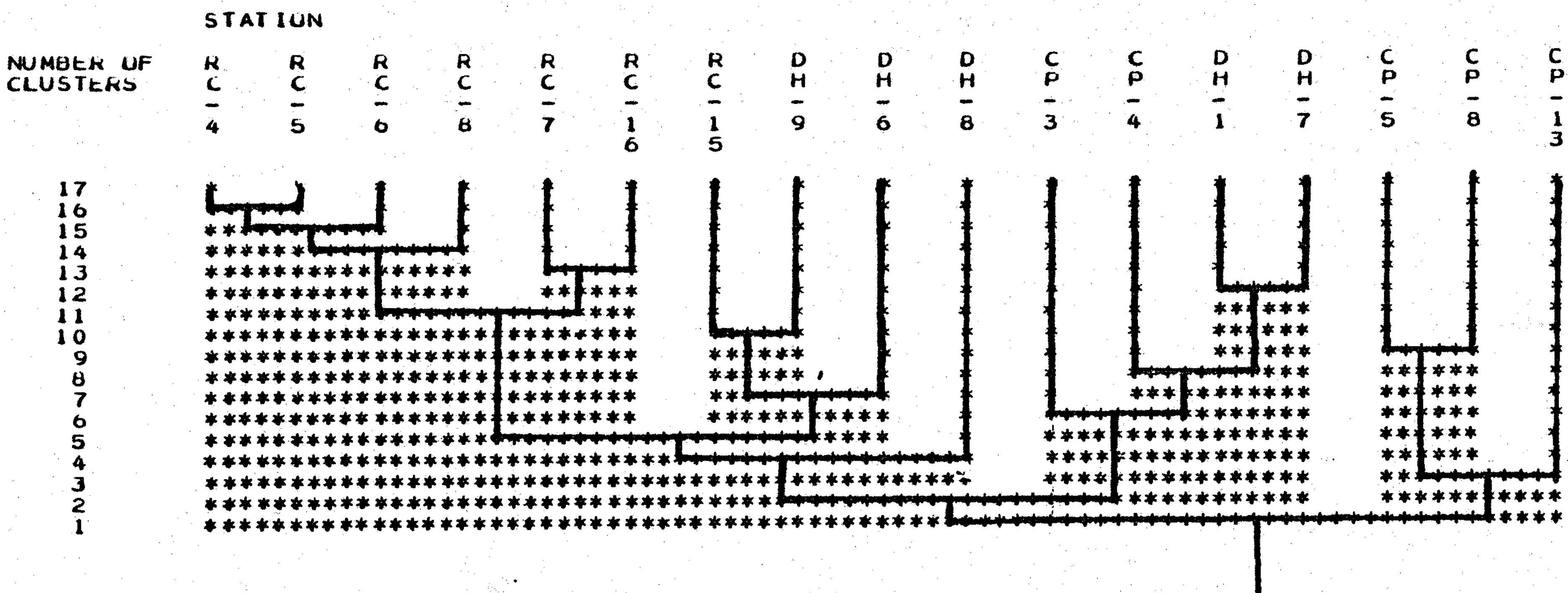

Figure A2-6 Cluster analysis map for chloride.

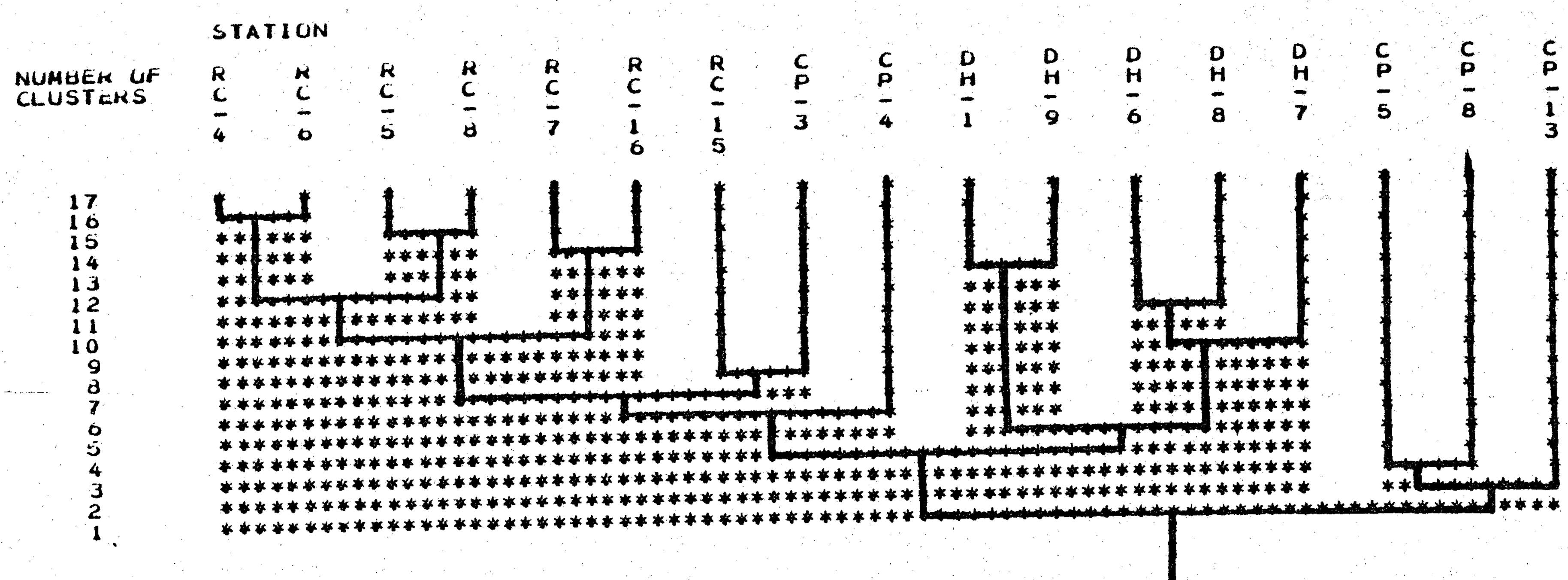

Figure A2-7 Cluster analysis map for sodium.

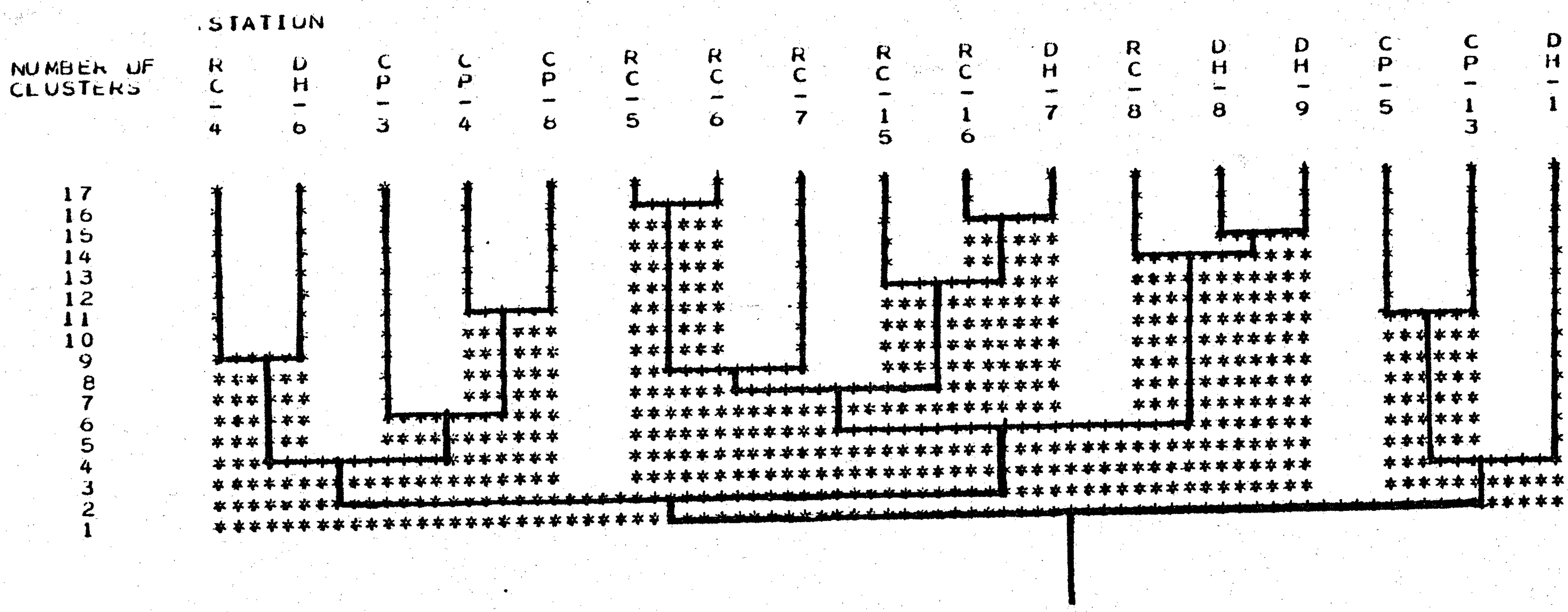

Figure A2-8 Cluster analysis map for arsenic.

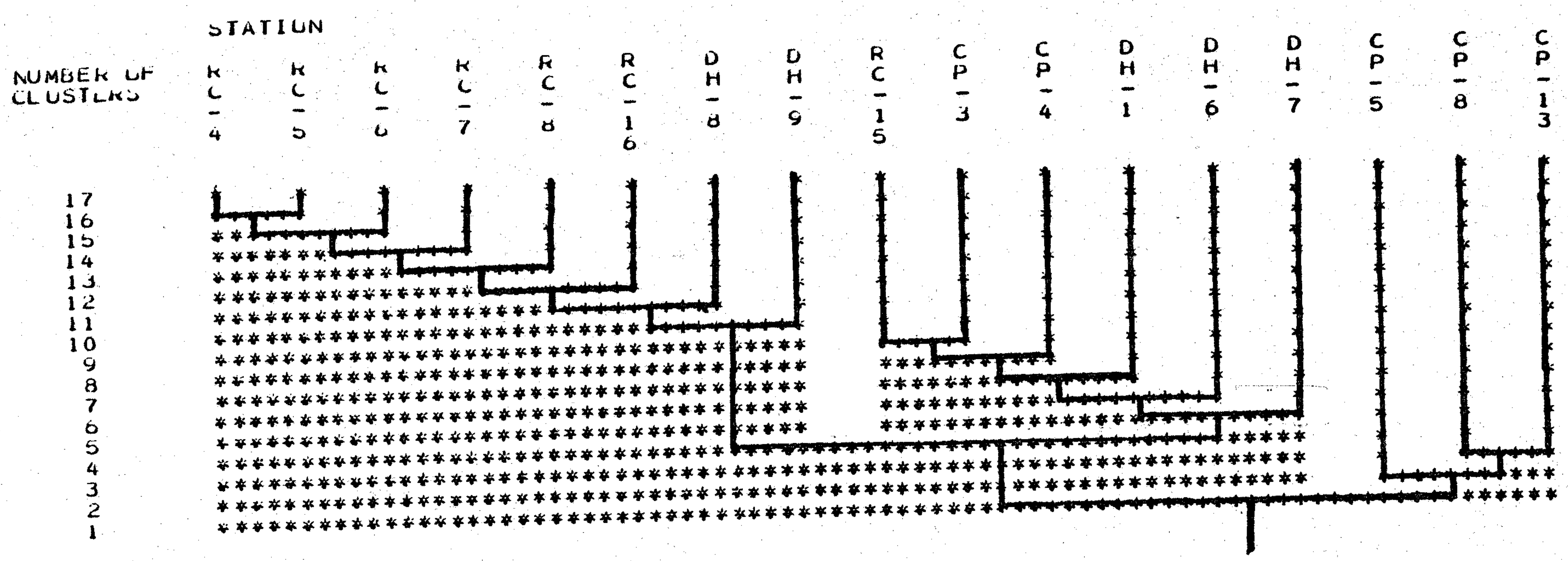

Figure A2-9 Cluster analysis map for cadmium.

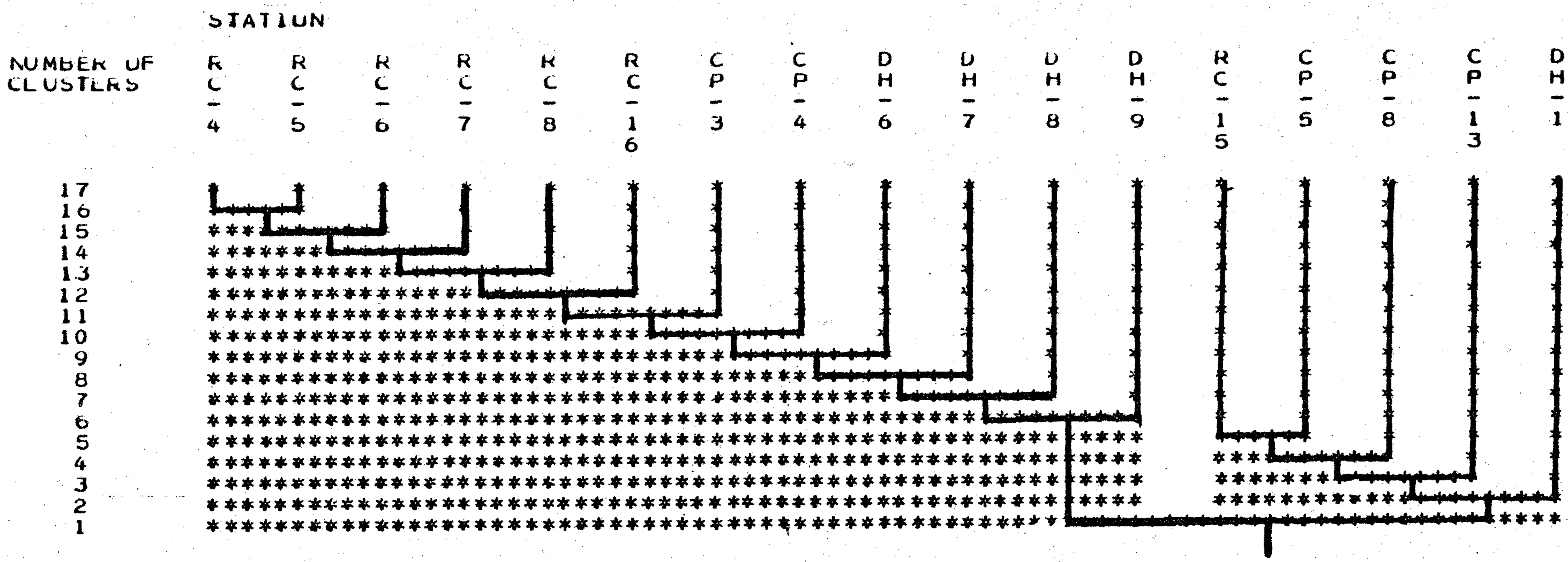

Figure A2-10 Cluster analysis map for chromium.

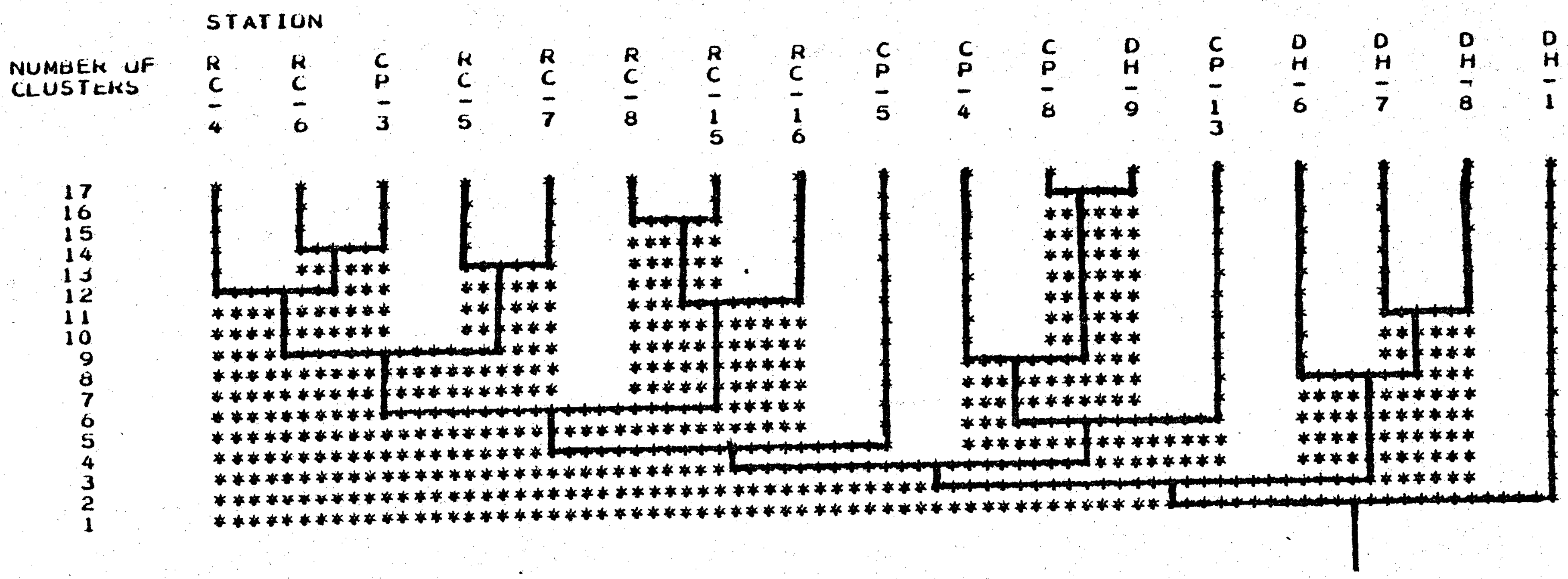

Figure A2-11 Cluster analysis map for hardness.

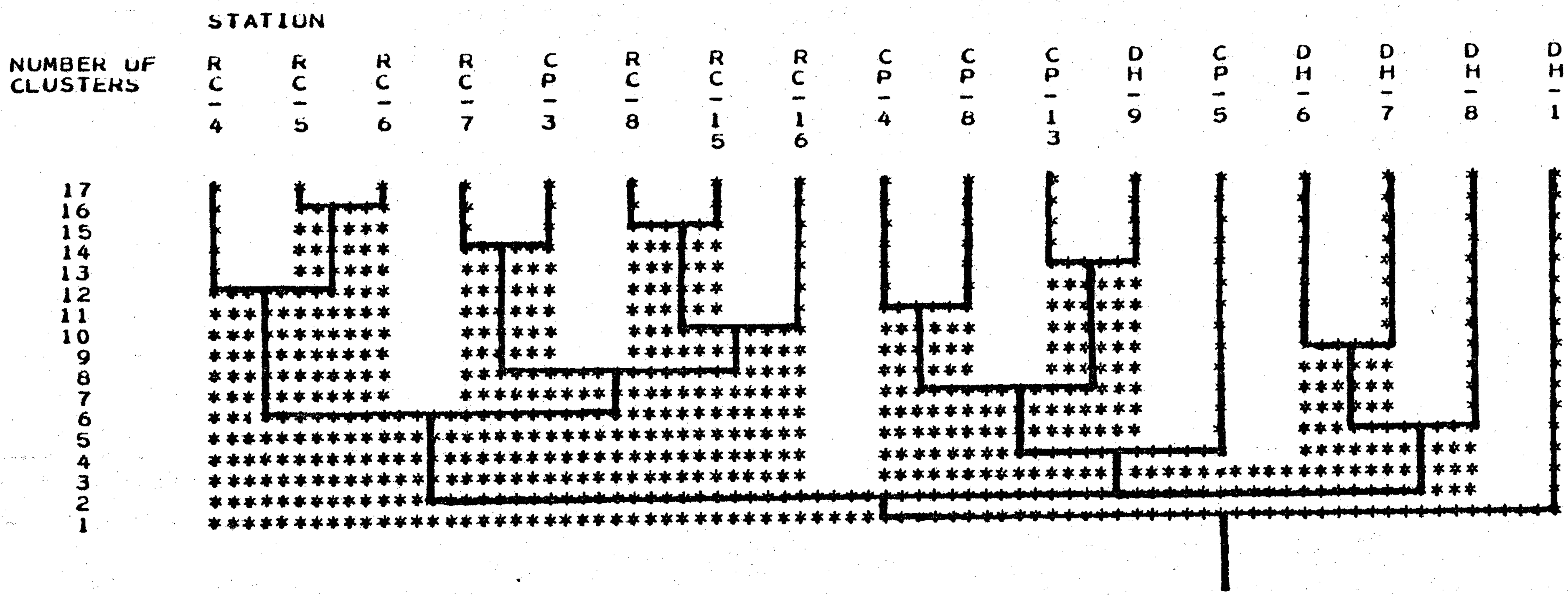

Figure A2-12 Cluster analysis map for calcium.

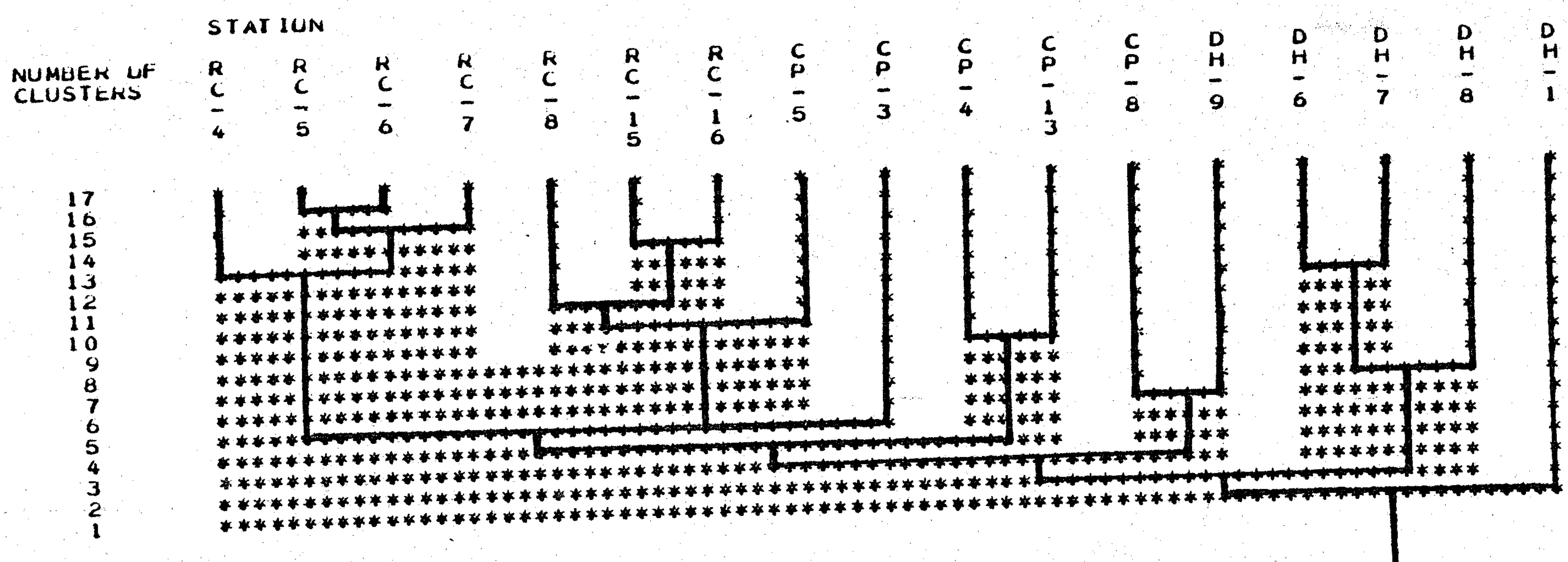

Figure A2-13 Cluster analysis map for magnesium.

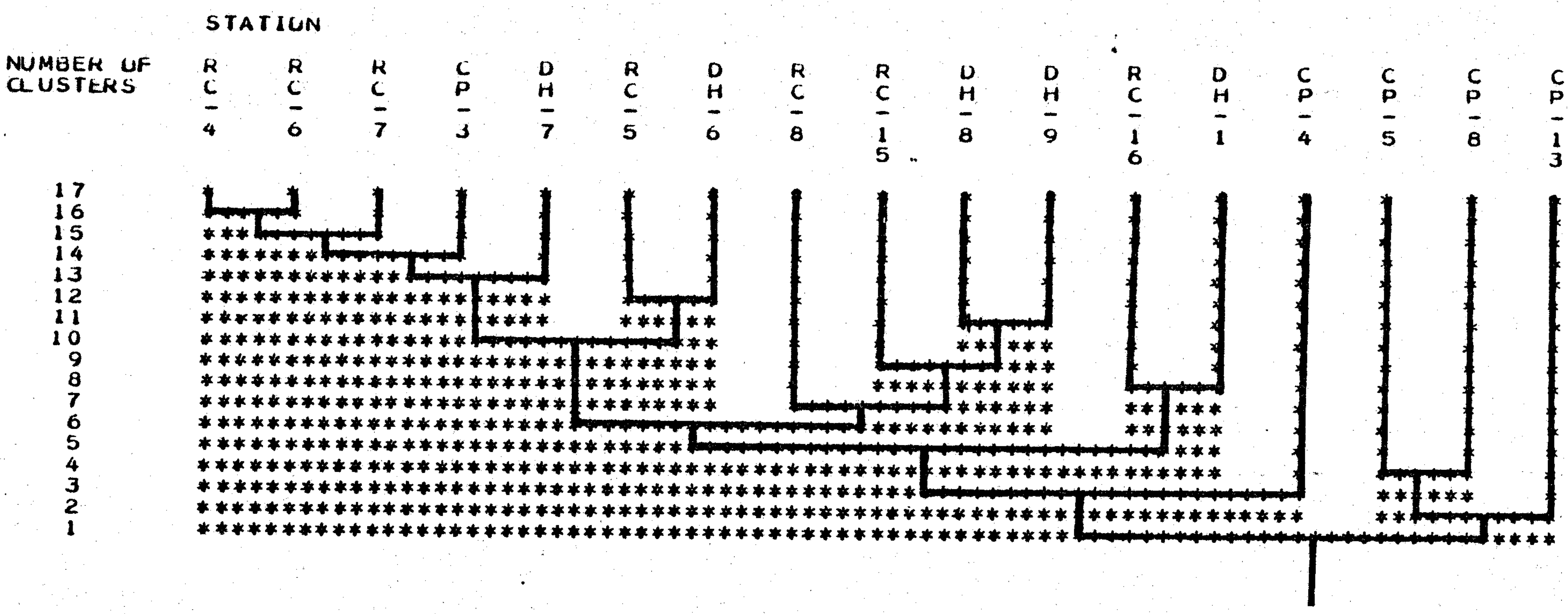

Figure A2-14 Cluster analysis map for nitrates.

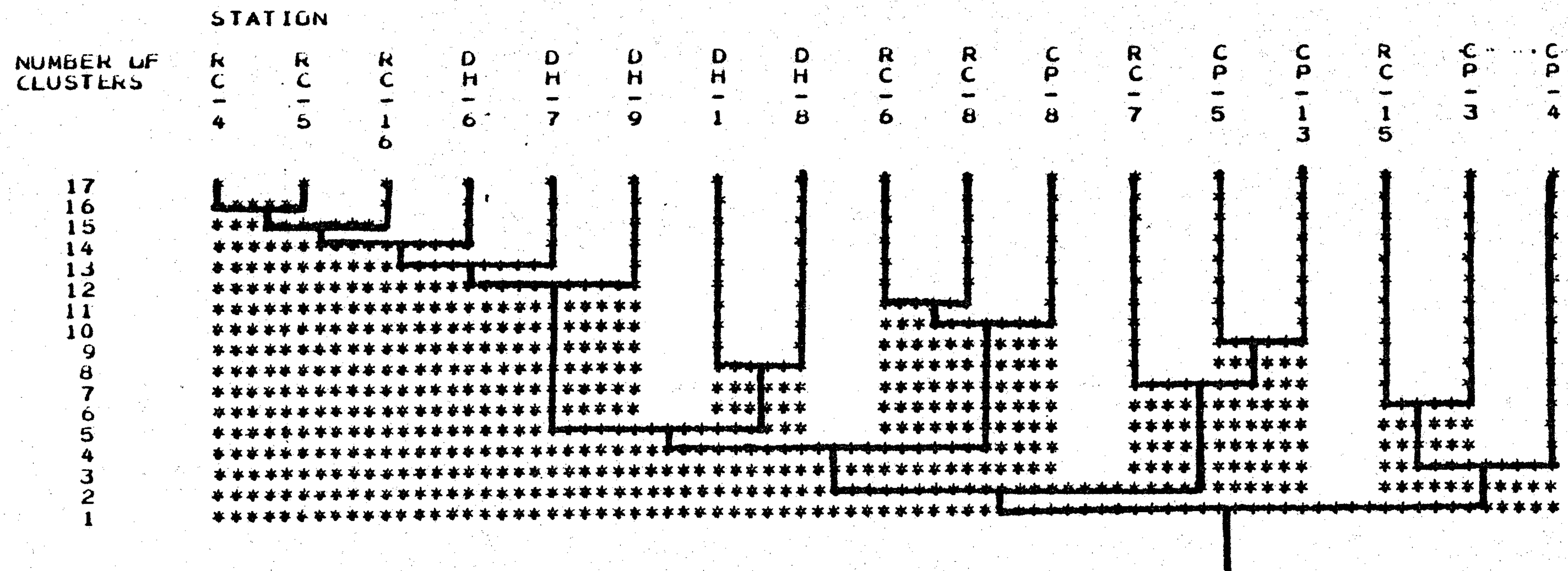

Figure A2-15 Cluster analysis map for ammonia.

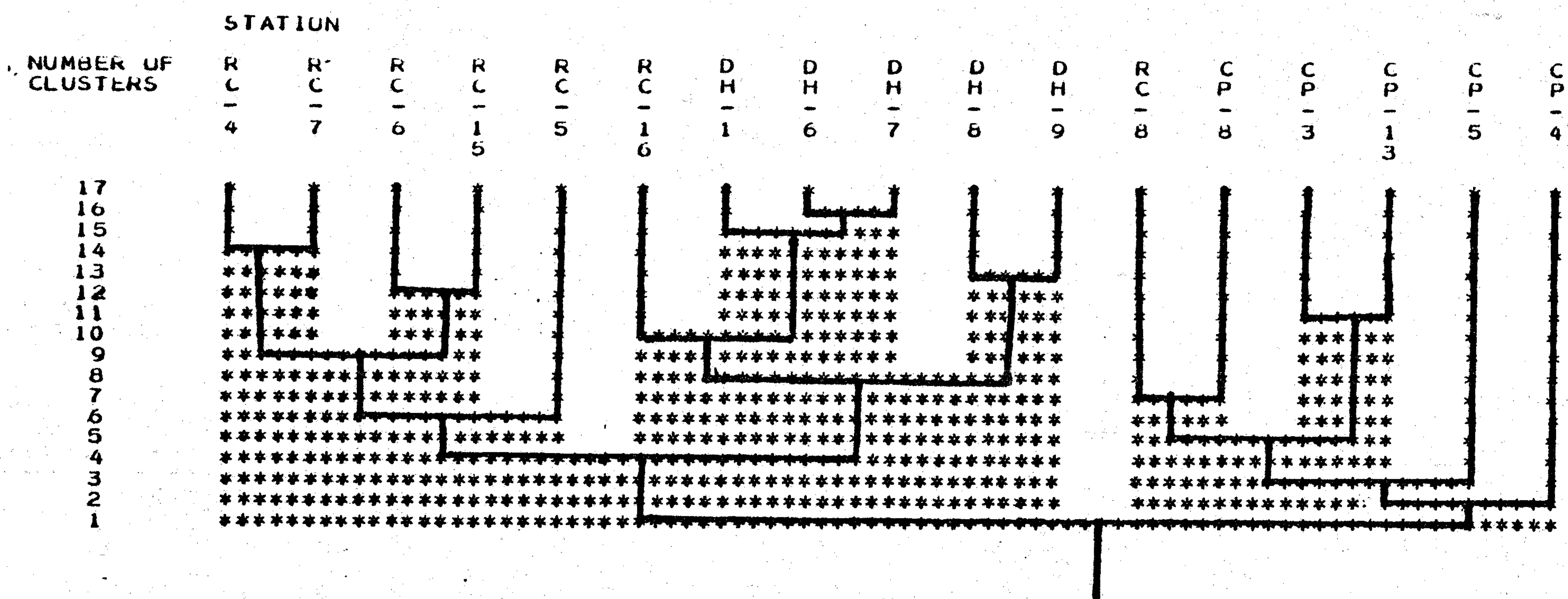

Figure A2-16 Cluster analysis map for total Kjeldahl nitrogen.

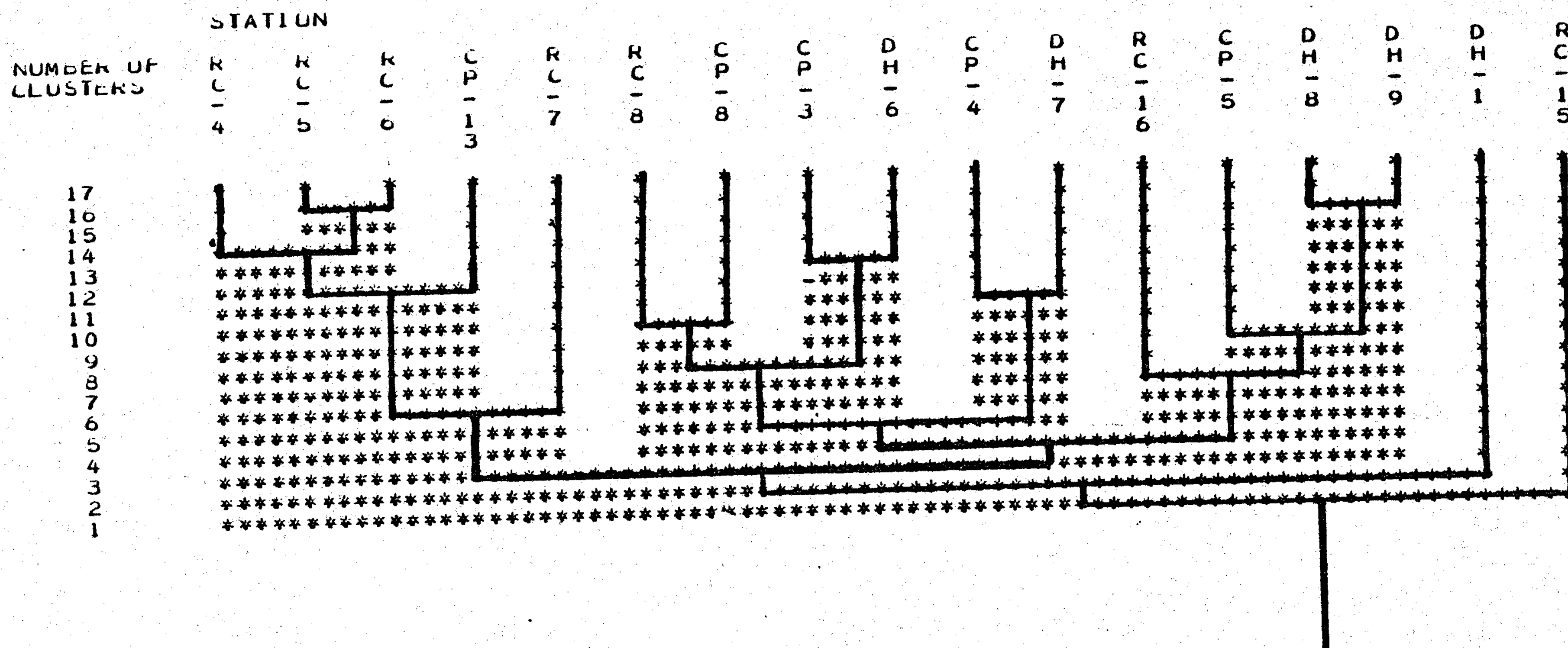

Figure A2-17 Cluster analysis map for iron.

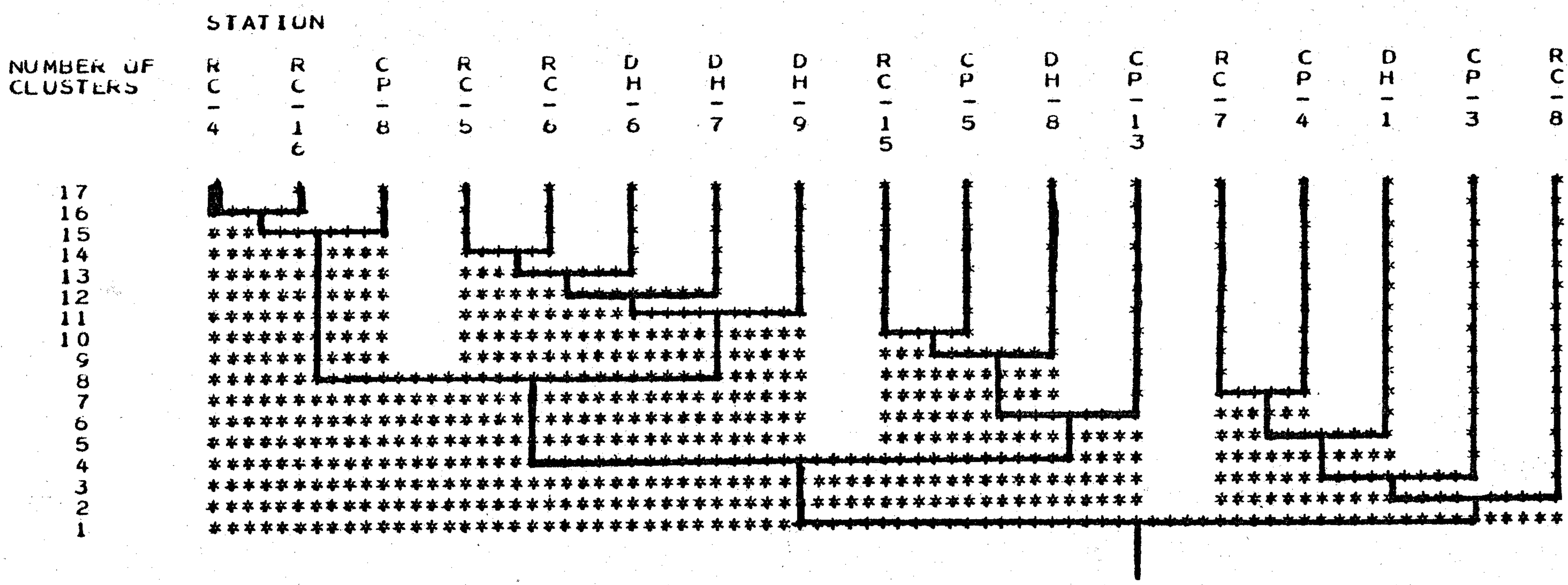

Figure A2-18 Cluster analysis map for manganese.

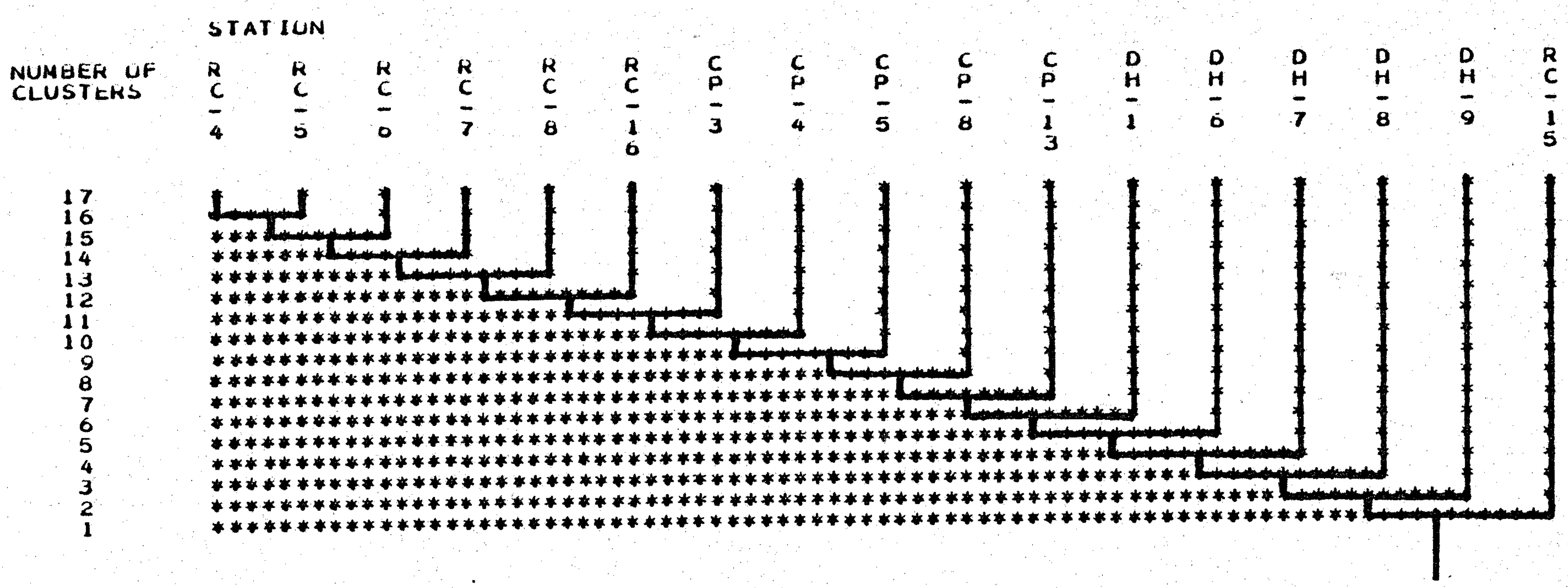

Figure A2-19 Cluster analysis map for molybdenum.

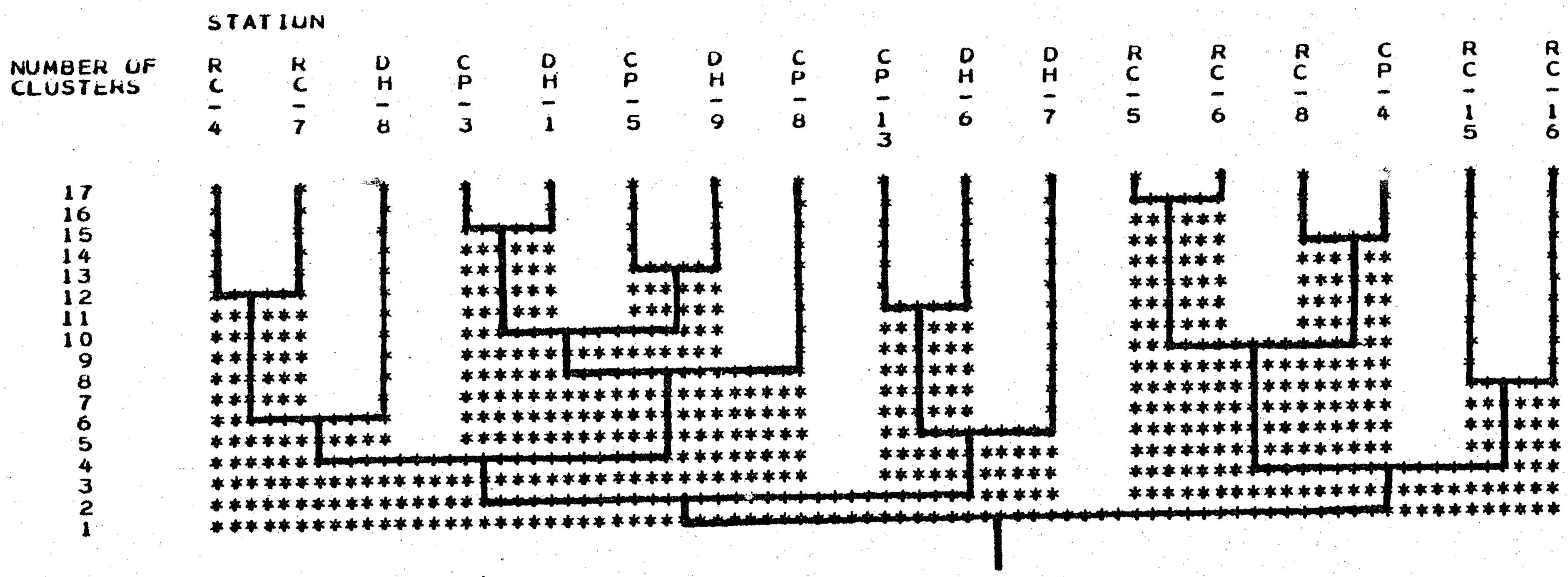

Figure A2-20 Cluster analysis map for zinc.

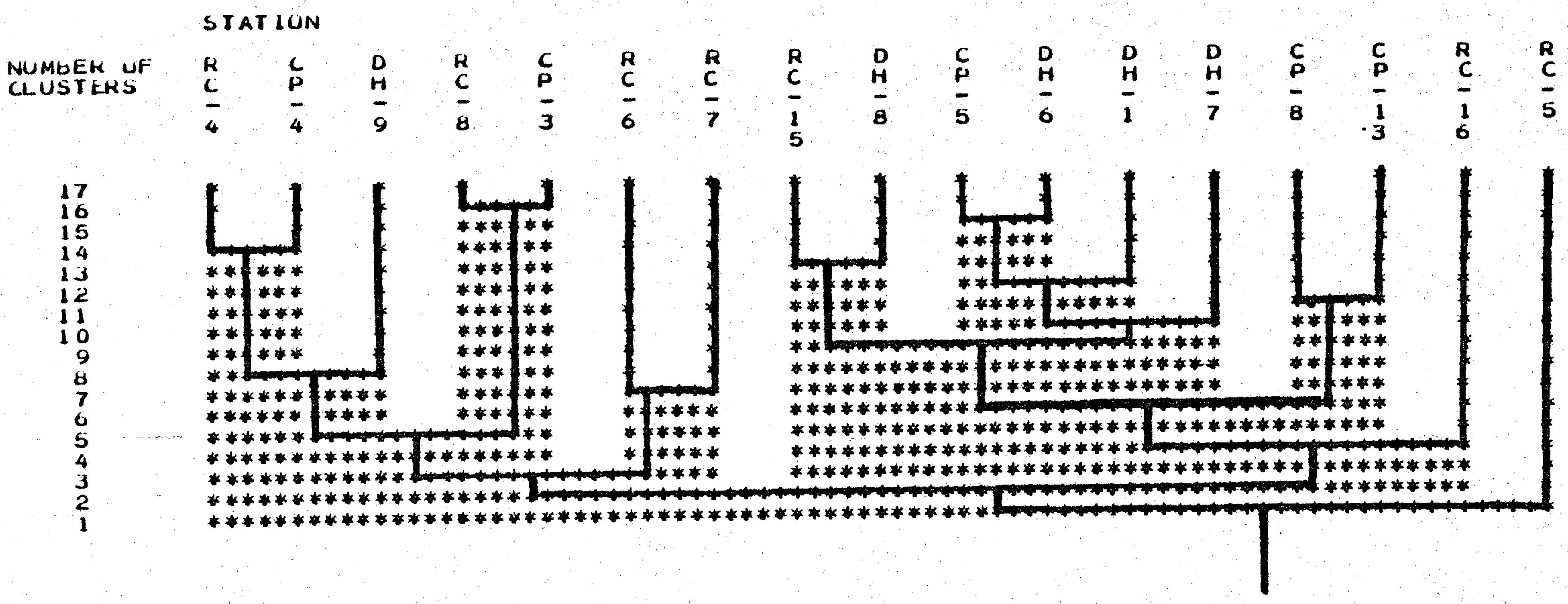

Figure A2-21 Cluster analysis map for Chemical Oxygen Demand (COD).

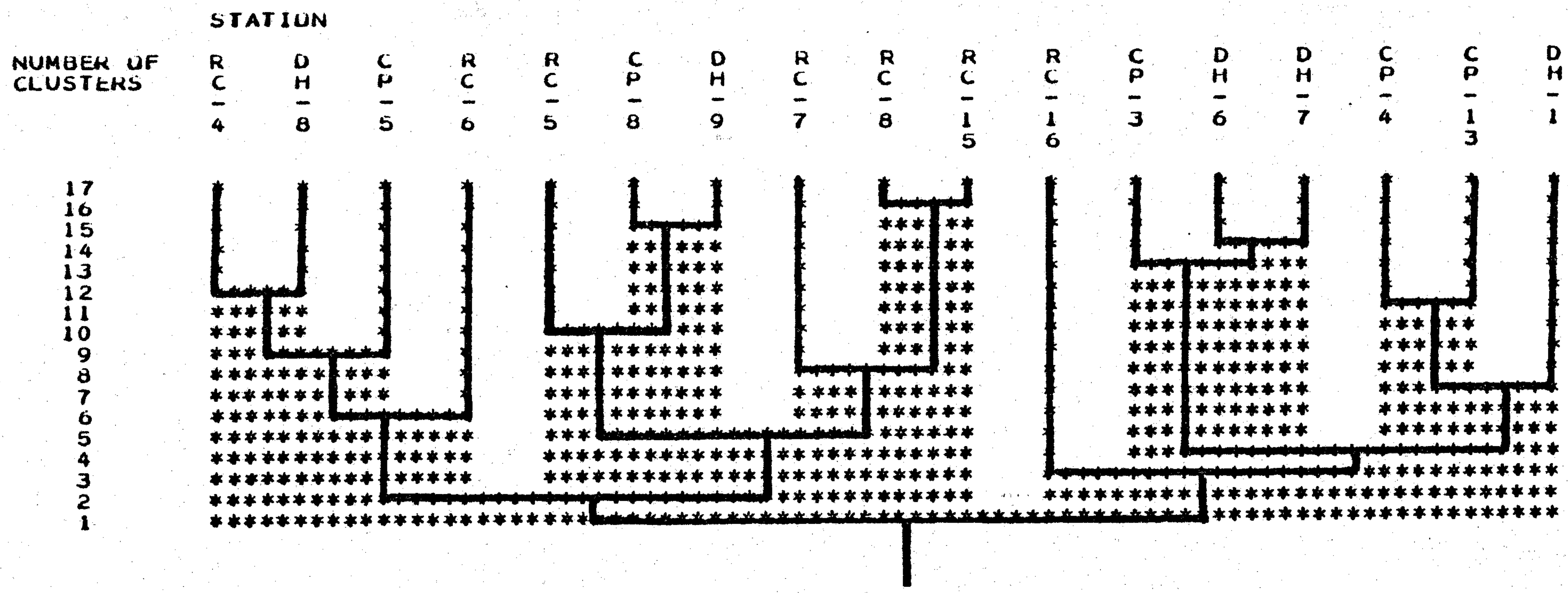

Figure A2-22 Cluster analysis map for detergents.

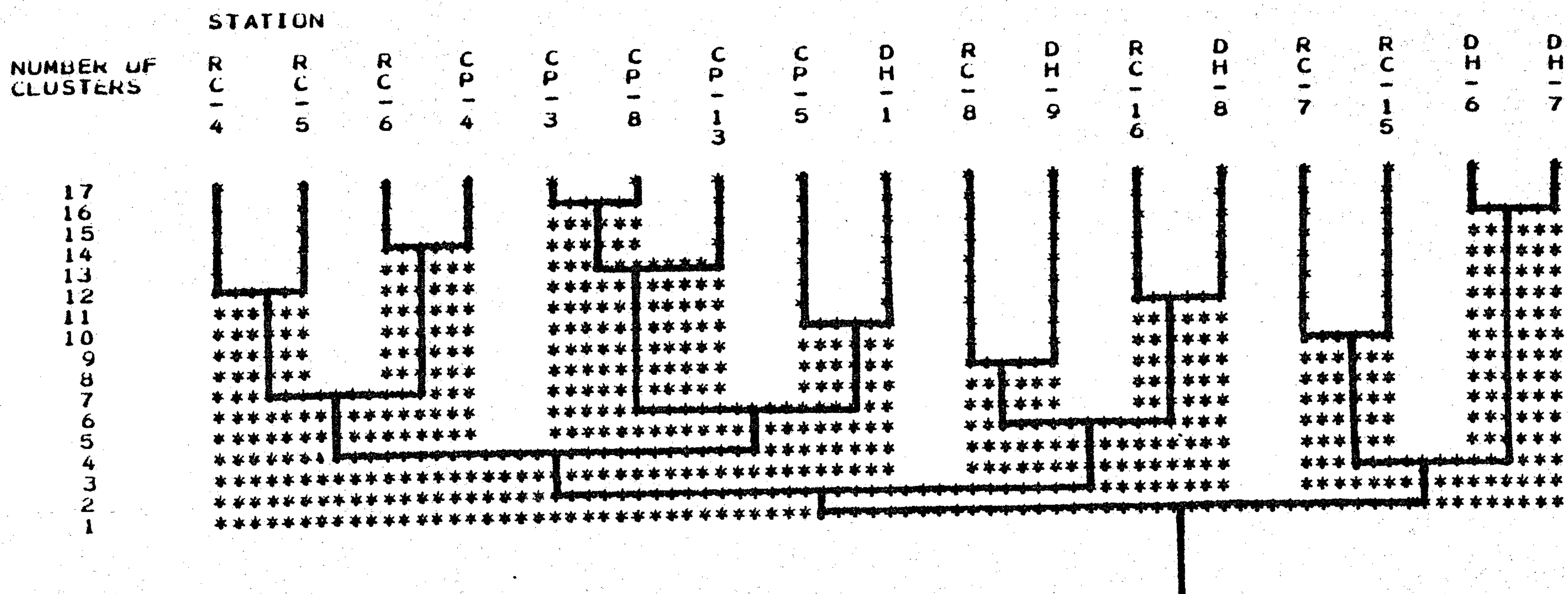

Figure A2-23 Cluster analysis map for total oxygen demand.

Gainesville
Alachua County
Regional Electric
Water & Sewer
Utilities Board

Progress
Through
Cooperation

December 9, 1977

Mr. Joseph W. Landers, Jr., Secretary
Department of Environmental Regulation
2562 Executive Center Circle East
Montgomery Building
Tallahassee, Florida 32301

RE: Site Certification Application for Deerhaven Unit 2

Dear Mr. Landers:

In accordance with Section 403.506 of the Florida Electrical Power Plant Siting Act and the rules and regulations of the Department of Environmental Regulation, the City of Gainesville and the Gainesville-Alachua County Regional Electric, Water & Sewer Utilities Board are pleased to submit this amended application for its new 235 mW Deerhaven 2 generating unit.

This environmental assessment herein has been prepared in accordance with the Department of Environmental Regulation rules and regulations, Chapter 17-17. Enclosed under separate cover is the required application fee.

As your agency and other state agencies review this application, we are sure that many questions and comments will arise. We welcome these questions and comments and stand ready to respond to them. In order to effectively handle these comments, we request that you direct all queries to Mr. Larry R. Gawlik, Project Manager, P. O. Box 490, Gainesville, Florida, 32602, 904/374-2910.

Respectively submitted,

Aaron Green
Mayor-Commissioner
City of Gainesville

Respectively submitted,

Shellie Downs, Chairman
Gainesville-Alachua County
Regional Utilities Board

AG:SD:pm

555 Southeast Fifth Avenue / Post Office Box 490 / Gainesville, Florida 32602 / (904) 376-1271