HARDEE POWER STATION

SITE CERTIFICATION APPLICATION/ ENVIRONMENTAL ASSESSMENT

CHAPTER 2

SITE AND VICINITY CHARACTERIZATION

TABLE OF CONTENTS

TABLE OF CONTENTS

2.0 SITE AND VICINITY CHARACTERIZATION

2.1 SITE AND ASSOCIATED FACILITIES DELINEATION

The perimeter of the proposed Hardee Power Station site in relation to abutting and adjacent properties is shown in Figure 2.1-1. The site abuts Agrico on the north, west and south, and CFI on the east. The total size of the proposed station site is 526 ha (1,300 acres). The northern portion of the site is presently being mined and will be reclaimed to a cooling reservoir. The southern portion of the site is primarily in pastureland and will contain the power block, fuel oil storage tanks, site runoff detention pond and other facilities. The western boundary of the property is Payne Creek. Areas immediately adjoining the creek are in the 100-year floodplain. However, none of the proposed plant structures or associated facilities will be located in the 100-year floodplain of Payne Creek.

2.2 SOCIO-POLITICAL ENVIRONMENT

2.2.1 Governmental Jurisdiction

The proposed site is located in the northwest, unincorporated portion of Hardee County, approximately 3.2 to 4.8 km (2 to 3 miles) north of State Road (SR) 62 and 1.6 km (1 mile) west of CR 663 and extending north into an unincorporated portion of Polk County. The site is located about 12 km (7.5 miles) west of the City of Bowling Green, 16 km (10 miles) northwest of Wauchula, and 14 km (9 miles) southwest of Ft. Meade. The property on which the plant is to be constructed is currently owned by Agrico, but SECI holds a purchase option contract. Figure 2.2.1-1 shows the site in relation to the political boundaries within an approximate 8-km (5-mile) radius. With the exception of the county boundaries, there are no political boundaries in this area (the small communities of Ft. Green and Ft. Green Springs are not incorporated towns). Figure 2.2.1-2 is an aerial photo of the site and vicinity. None of the federal, state, regional, local, or private areas specified in FDER's instruction guide are located within 8 km (5 miles) of the proposed site.

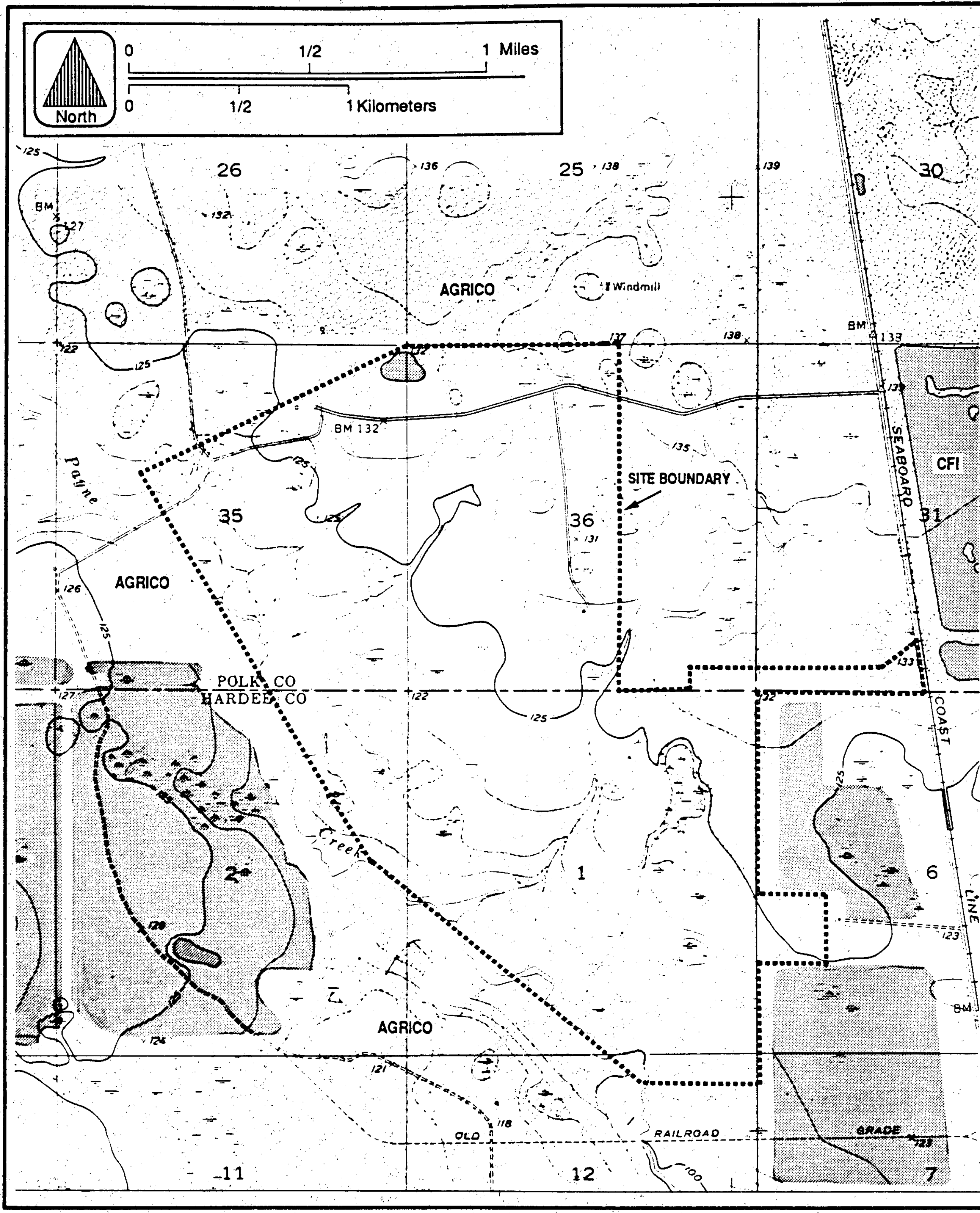


Figure 2.1-1 LOCATIONS OF SITE BOUNDARY (PERIMETERS) AND ADJACENT PROPERTIES

Hardee Power Station

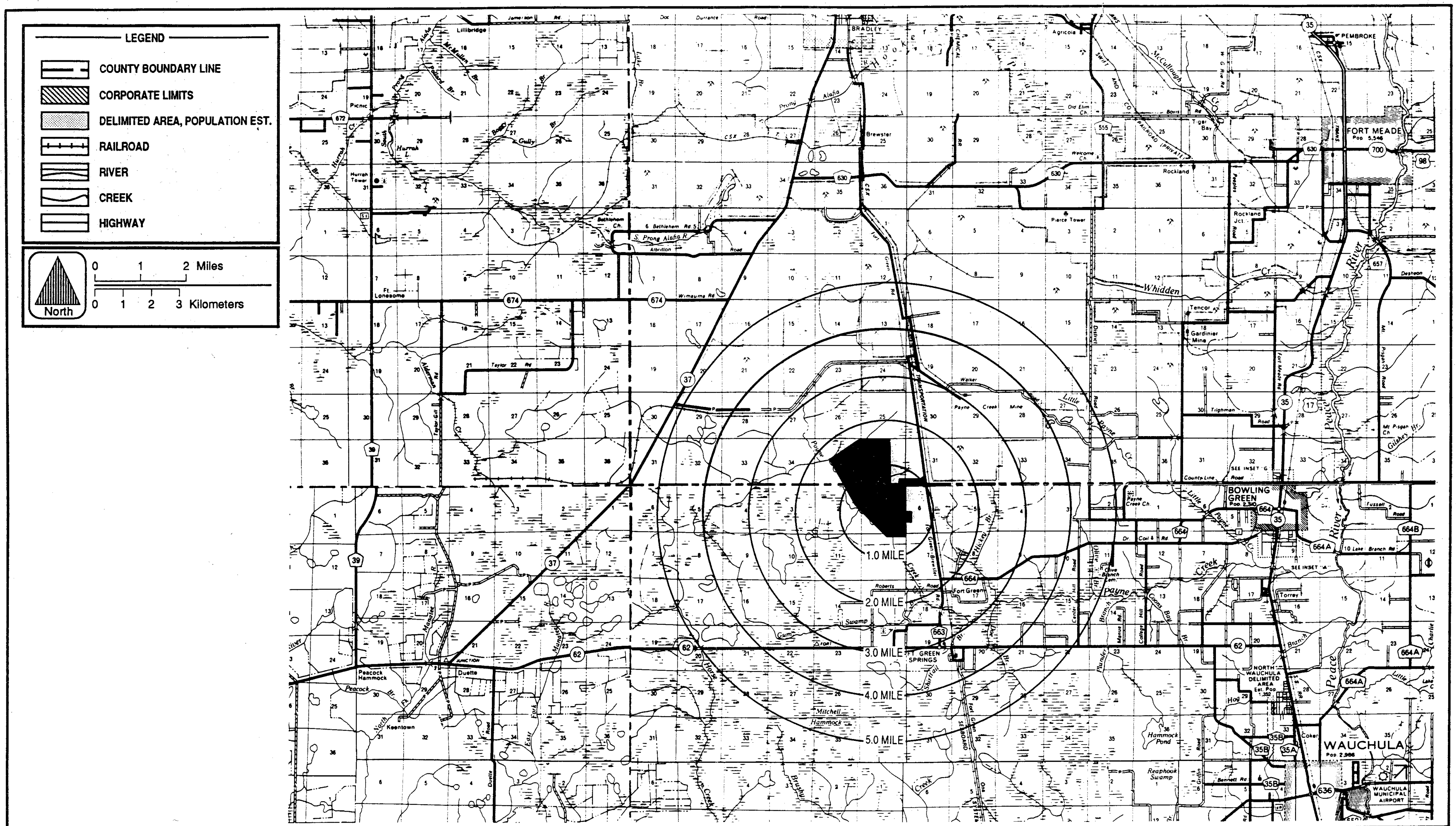


Figure 2.2.1-1 SITE LOCATION AND BOUNDARIES OF CITIES AND TOWNS WITHIN A 5 MILE RADIUS

Hardee Power Station

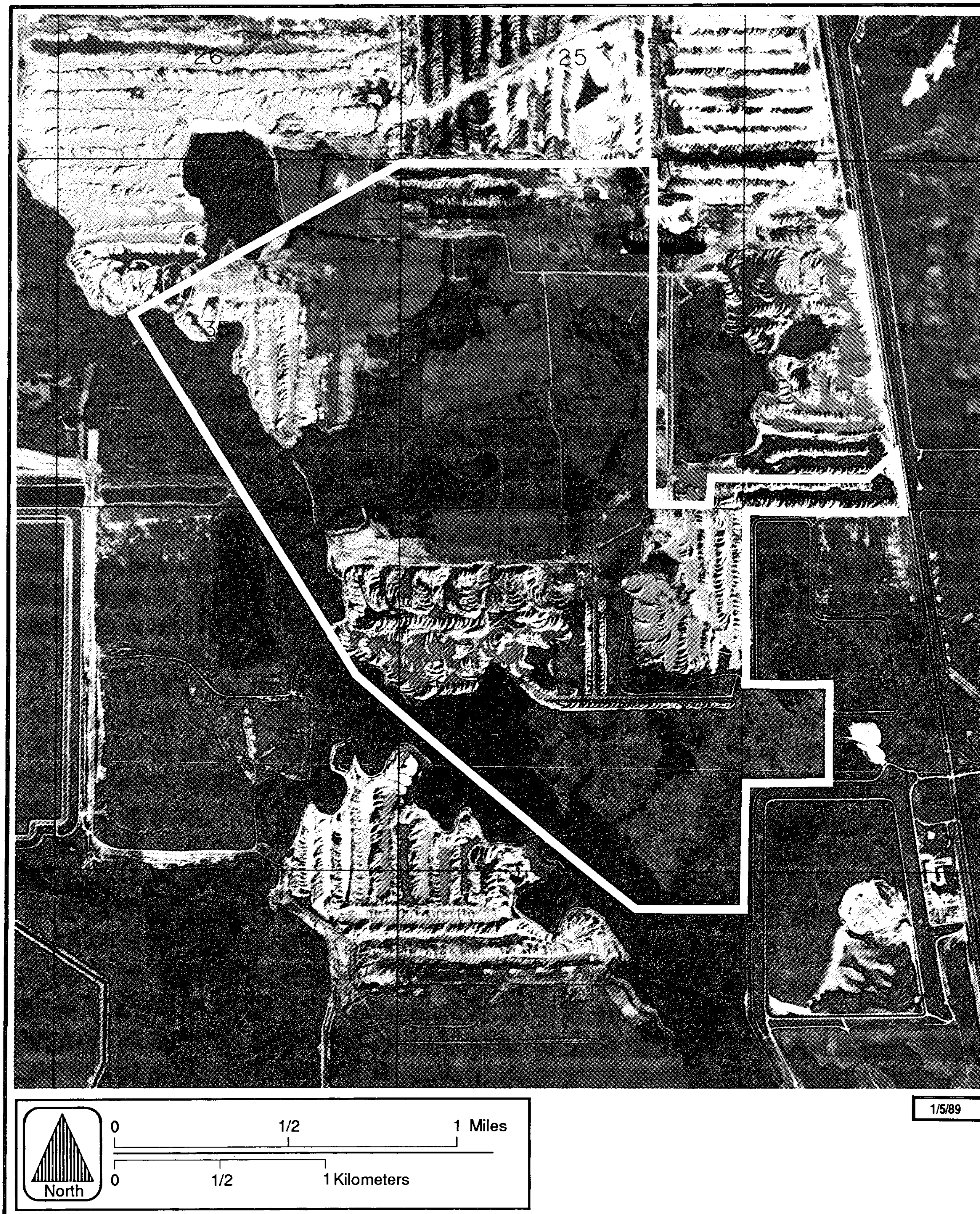


Figure 2.2.1-2 AREAS WITHIN A ONE MILE RADIUS OF HARDEE POWER STATION PLANT FACILITIES

Hardee Power Station

2.2.2 Zoning and Land Use Plans

The Hardee Power Station will be constructed in Hardee County, and the appurtenant cooling reservoir will lie in Hardee and Polk County. Local government comprehensive plans governing this site include the Hardee County Comprehensive Plan and the Polk County Comprehensive Plan. (Information relevant to other associated facilities, i.e., transmission lines, the natural gas pipeline, and liquid fuel pipeline, is found in Chapter 6.)

HARDEE COUNTY

The Hardee County Comprehensive Plan Land Use Element primarily utilizes narrative standards and policies, as opposed to mapped designated areas. The Land Use Element identifies and describes a "growth corridor" that extends from the City of Bowling Green, southward through Wauchula, and terminating at Zolfo Springs. This "growth corridor" is several kilometers to the south and east of the plant site. The Hardee County portion of the Hardee Power Station is presently designated for phosphate mining.

In general, a Hardee County Comprehensive Plan "goal" for industrial land use is to achieve "sufficient industry to allow adequate employment opportunities for Hardee County residents" (Land Use Plan, p. H-4). Specific policies intended to further this goal include:

- Industrial growth should not be at the expense of the agricultural base of the Hardee County economy.

- Encourage environmentally acceptable industry to locate in Hardee County.

- Encourage public or private industrial development of a suitably located industrial park of at least 81 ha (200 acres) with provisions for incremental development as the demand necessitates. Such a park should have major rail, air or highway access.

- Encourage incoming industry to locate at existing industrial areas in the County.

- Preserve, where possible, the valuable railroad frontage necessary to heavier forms of industry.

The Electric Utility Element of the Hardee County Comprehensive Plan sets a goal of availability of electric power to all Hardee County residents. Policies to further this goal include:

- The County shall encourage the placement of utility facilities compatible with current and long range planning principles.

- The Ten Year Power Site Plan shall be reviewed every two years to determine compatibility with Hardee County's policies.

- Any power facility, i.e., substations and generating facilities (public or private), shall be buffered from residential areas.

- Coordination between the County and the various power companies and cooperatives on future power needs shall be encouraged (Utility Element, p. B-2).

As indicated above the Hardee County Comprehensive Plan's utility element states that all electric power generating plants shall be buffered from residential areas. This element also states that environmental considerations "relative to noise, air quality and water quality shall be observed when identifying new locations of power facilities."

The Hardee Power Station is consistent with Hardee County's Comprehensive Plan. The site is not proximate to any existing or future (planned) residential or commercial areas, and therefore is compatible with current and long range planning principles. The new plant will promote the availability of electric power to all Hardee County residents and will be sited for the most part on previously disturbed phosphate mining lands (essentially an "existing industrial area"). The plant will comply with all state and local environmental requirements.

On May 11, 1989, the Hardee County Commission approved the rezoning of the site property to light industrial (I-1) effective December 31, 1989. The plant is an authorized use in the I-1 district under the Hardee County Zoning Ordinance and is consistent with the Hardee County Comprehensive Plan.

POLK COUNTY

As in Hardee County, the Polk County Comprehensive Plan Land Use Element utilizes the so-called "policy plan technique," which forgoes graphic designations of specific uses of property (i.e., maps identifying projected land uses) in favor of a narrative "set of policies and standards" to "guide decision makers." The Polk County Comprehensive Plan sets forth an inventory of existing land uses. The Hardee Power Station Site has been identified in the Polk County Comprehensive Plan as an area utilized for phosphate mining. (The site is classified as Rural Conservation (RC) under the Polk County Zoning Ordinance). The Land Use Element notes that reclamation of such mined phosphate lands "may be directed toward a variety of productive land uses, including . . . industrial . . . use," and expressly encourages and promotes "the restoration of previously mined lands for beneficial uses" (Land Use Plan, pp. 4-5, 5-2). Moreover, an objective of the Land Use Plan is "to ensure that sufficient and appropriate lands are available for the development of industrial uses to broaden the economic/employment base of the county" (Land Use Plan, p. 5-3). To that end, the Land Use Plan specifies that:

- Each new [industrial] development shall be so located as to protect and complement existing or proposed future land use patterns of the immediate neighborhood.

- Each new [industrial] development shall be properly located with respect to highways and other transportation facilities adequate to serve the proposed development and the existing demand load.

- All new industrial development shall be properly buffered from existing and proposed residential areas through the use of space and/or natural vegetation.

- No industrial development shall be established which would create adverse environmental effects upon adjacent land uses or the larger urban community.

The Hardee Power Station is consistent with the Polk County Comprehensive Plan. The plant will broaden the economic/employment base of the county and will promote the general goal, articulated in the Comprehensive Plan's Electric Utility Element, of ensuring "an adequate source of electrical power capable of serving the present and future needs of the residents." Moreover, siting the Hardee Power Station on reclaimed phosphate lands promotes the goal of restoring mined lands to beneficial uses. The plant site is harmonious with existing and future land use patterns in the area, and is distant from any existing or foreseeable residential or commercial developments.

Appendix 11.2 includes a January 24, 1989, letter from Gerald C. Martin, Zoning Administrator of Polk County, and a January 20, 1989 memorandum from Ron Borchers, Chief of Current Planning for Polk County. The letter and memorandum demonstrate that all components of the Hardee Power Station to be located in Polk County are consistent and in compliance with the Polk County Zoning Ordinance and Comprehensive Plan. These plant components are specifically authorized as "essential services" under the Zoning Ordinance and Land Use Plan.

2.2.3 Demography and Ongoing Land Use

2.2.3.1 Demography

The area surrounding the Hardee Power Station site is sparsely populated. Table 2.2.3-1 lists county and local area historic and projected populations. Figure 2.2.1-1 shows the site location in relation to the surrounding communities. In 1980, the U.S. Census Bureau counted a total of 20,357 people as residents of Hardee County at an average density of 12 people per square km (32 people per square mile) (U.S. Bureau of the Census, 1988). Hardee County's population was estimated to grow by about 17.4% to a total of about 22,745 people in 1988 at an average density of 14 people per square km (36 people per square mile) [U.S. Bureau of the Census, 1988; Central Florida Regional Planning Council (CFRPC), 1988]. The population is projected to continue growing and is expected to reach a total of approximately 26,286 people by the year 2000 (CFRPC, 1988).

The Hardee County population centers nearest to the site are the cities of Bowling Green, about 12 km (7.5 miles) to the east of the site, and Wauchula about 14 km (9 miles) southeast of the site (see Figure 2.2.1-1). Wauchula is the county seat and largest city in Hardee County. The small unincorporated community of Ft. Green Springs is located about 4 km (2.5 miles) south of the southern border of the site. Based on a house count and average household size, it is estimated that approximately 100 people reside in the area.

Approximately 40 km (25 miles) to the north of the site are the Winter Haven and Lakeland census divisions of Polk County which in 1980 contained approximately 78,000 people and 136,445 people, respectively, or about 66% of Polk County's total population. The two divisions grew over 50% between 1970 and 1980 (U.S. Bureau of the Census, 1983). The Lakeland/Winter Haven area is highly urbanized and the focus of most of the growth in Polk County.

The City of Bowling Green showed a high growth rate between 1970 and 1980 during which time its population increased about 70%; from 1,357 to 2,310 people. This rate of increase appears to have slowed during the current

Table 2.2.3-1. Historic and Projected Population for Selected Communities in Hardee and Polk Counties

	1970	1980	1988*	1990*	2000*
HARDEE CO.	14,889	20,357	22,745	24,328	26,286
Bowling Green	1,357	2,310	2,361	2,378	2,437
Wauchula	3,007	2,296	3,294	3,294	3,292
Zolfo Springs	1,117	1,495	1,659	1,714	1,901
POLK CO.	228,515	321,652	398,557	410,902	484,885
Bartow	12,891	14,780	17,079	17,570	19,665
Ft. Meade	4,374	5,546	5,828	5,888	6,144
Frostproof	2,814	2,995	3,235	3,287	3,508
Lakeland	42,803	47,406	63,303	64,986	72,729
Winter Haven	16,136	21,119	25,738	26,725	30,934

* Projected from Central Florida Regional Planning Council, 1988.

Source: Central Florida Regional Planning Council, 1988.

U.S. Bureau of the Census, 1980 Census of Population. Number of Inhabitants - Florida. PC80-1-All Fla. 2/82.

U.S. Bureau of the Census, County and City Data Book, 1988, USGPO, 1988.

decade. The 1988 population was estimated at 2,361 people; only a 2.2% growth over the 1980 total (CFRPC, 1988). The unincorporated portions (Bowling Green Division, Wauchula Division, and Zolfo Springs Division) of Hardee County grew at a much slower rate of about 41% between 1970 and 1980. This more rural portion of the county was estimated to have grown at a rate of about 16% between 1980 and 1988 (CFRPC, 1988).

Polk County contained a population of 321,652 people in 1980 and is estimated to have grown to about 398,557 people between 1980 and 1988, an increase of 23.9% (U.S. Bureau of the Census, 1988; CFRPC, 1988). In 1980 over 70% of Polk County's population resided in urban areas, with a majority of that population located in the north central portion of the county in the Winter Haven and Lakeland vicinities. Population density in Polk County was estimated at 85 people per square km (219 people per square mile) in 1988 (CFRPC, 1988). This density, however, includes the high density areas in the north central part of the county. Population density in Polk County within an 8- or 16-km (5- or 10-mile) radius of the proposed site is actually more closely aligned to densities found in Hardee County.

The City of Ft. Meade, in Polk County, is about 16 km (10 miles) northeast of the site. Ft. Meade has experienced a similar growth pattern to Bowling Green. Its population increased 26.8% to a total of 5,546 between 1970 and 1980, but has slowed during this decade. Estimated population for 1988 indicates that Ft. Meade's population has increased by only 5.1% to a total of 5,828 people (CFRPC, 1988).

2.2.3.2 Ongoing Land Use

Most of the land within an 8-km (5-mile) radius of the site is actively being mined. Citrus groves are the predominant agricultural activity and occupy small pockets of land to the south of the site.

The only residential community within 8 km (5 miles) is Ft. Green Springs which contains about 60 houses (permanent dwellings and mobile homes) and is located about 4 km (2.5 miles) south of the proposed plant site. With the exception of the expansion of the phosphate mining activities to the west and south into Hardee County, no significant changes in land use have occurred in the past 30 years or are likely to occur in the near future. Figure 2.2.3-1 shows the existing land use within an approximate 8-km (5-mile) radius of the proposed plant. Data presented in the map are based on United States Geological Survey (USGS) 7.5 minute quadrangle maps of the site area, aerial photographs dated 1987 and 1988, and field reconnaissance during late 1988 and early 1989.

2.2.4 Easements, Title, Agency Works

The property on which the Hardee Power Station is to be constructed will be owned by SECI.

2.2.5 Regional Scenic, Cultural and Natural Landmarks

There are no federal, state, regional or local scenic, cultural or natural landmarks within an 8-km (5-mile) radius of the proposed facility.

2.2.6 Archaeological and Historic Sites

There are no significant archaeological or historical resources on the site or within the associated facilities area. The area appears to be one with infrequent sites, containing a sparse amount of cultural materials. None of these sites has been considered significant in terms of National Register of Historic Places criteria. One prehistoric archaeological site is recorded in the SW1/4 of the NE1/4 of the SW1/4 of Section 1, Township 33 South, Range 23 East. This site is known as 8-Hr-35 and is located in the Hardee County portion of the plant site. The prehistoric site was found by Jerald Milanich and Raymond Willis during a survey of the Ft. Green Mine Tract in 1976. Milanich and Willis concluded that the site was not significant in terms of National Register of Historic Places criteria as stated in 36 CFR 63. This recommendation was made to the Florida Division of Historical Resources (DHR) which concurred with the recommendation.

The Polk County portion of the plant site in Sections 35 and 36 of Township 32 South, Range 23 East and Section 31 of Township 32 South, Range 24 East

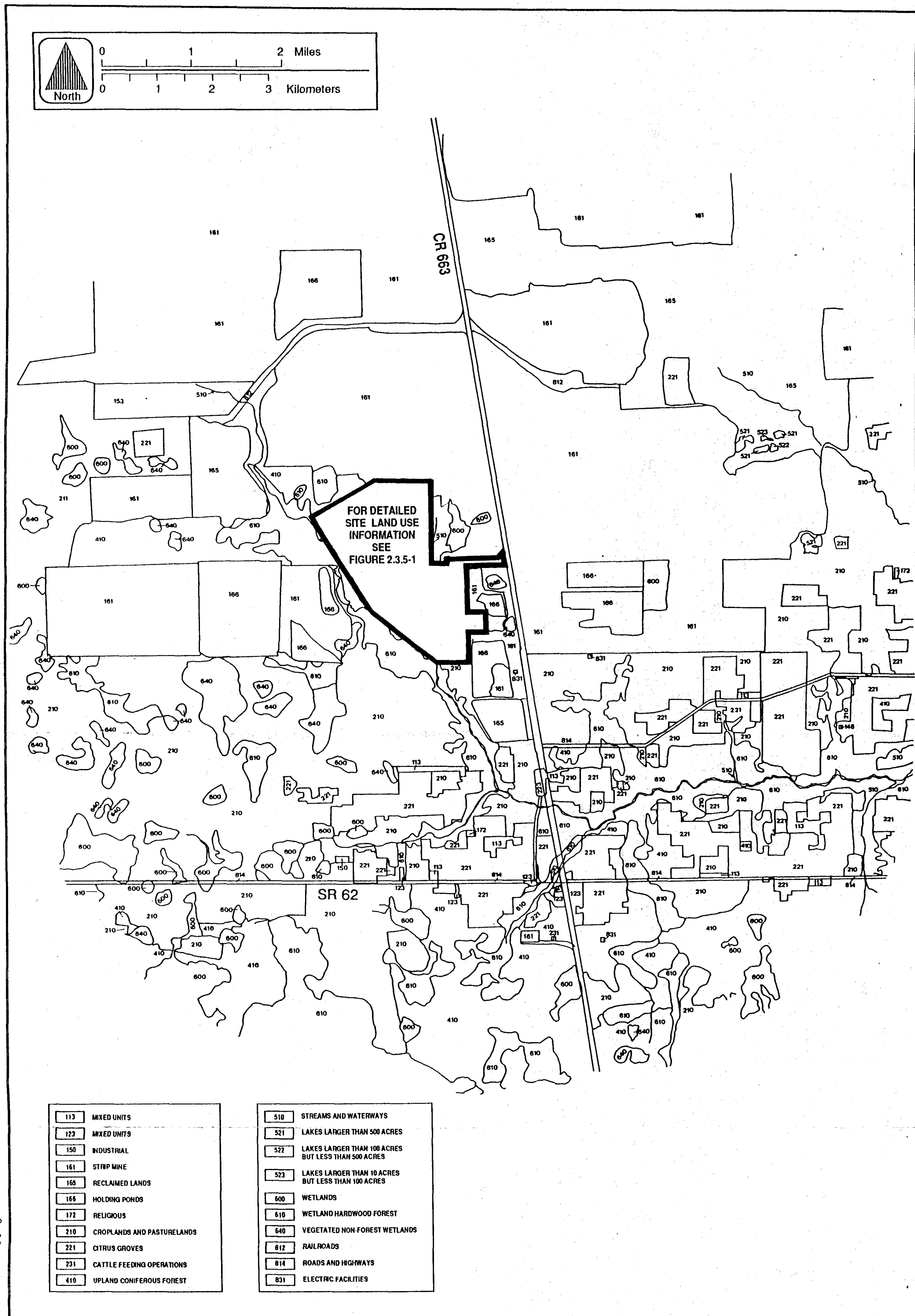


Figure 2.2.3-1 EXISTING AND PROJECTED LAND USE FOR THE HARDEE POWER STATION PROJECT AREA

Hardee Power Station

Rev. 2 10/30/89

has not been surveyed by professional archaeologists. There are, however, no recorded archaeological or historic sites and it is the opinion of the DHR (see Appendix 11.3) "that no significant archaeological and/or historical sites are recorded for or considered likely to be present within the project area...Therefore, it is the opinion of this office that the proposed project will have no effect on any sites listed, or eligible for listing, in the National Register of Historic Places, or otherwise of national, state, or local significance."

There have been other professional archaeological surveys near the site. Harry Piper, Jacquelyn Piper and Mark Thomsen surveyed Agrico property in northwest Hardee County in 1981. This Agrico Tract was approximately 10 km (6 miles) west of the plant site, and no sites were found in the approximately 91 ha (225 acres) surveyed.

To the north, the Agrico Hookers Prairie Tract was surveyed in 1980 by David Swindell, Dale Benton, Mildred Fryman and James Miller. This tract is, at its closest point, 8 km (5 miles) north-northeast of the Hardee Power Station site. It consisted of approximately 486 ha (1,200 acres) and contained four prehistoric sites. It was the opinion of Swindell, Benton, Fryman and Miller that the sites were not significant in terms of National Register of Historic Places criteria, and the DHR also concurred with this opinion.

2.2.7 Socioeconomics and Public Services

2.2.7.1 Social and Economic Characteristics

EMPLOYMENT

According to the Central Florida Comprehensive Regional Policy Plan, employment opportunities emerged as a regional issue after central Florida's largest employers were affected by economic downturns in the late 1970s and early 1980s (CFRPC, 1987). From 1980 to 1985, the Central Florida Region (comprised of Polk, Hardee, DeSoto, Highlands and Okeechobee Counties) had an annual average unemployment rate of 11.4%; 4.5 percentage points higher than the state's rate of 6.9%. The CFRPC indicates that this situation is not likely to change in the near future (CFRPC, 1987). Table 2.2.7-1 lists recent and projected employment for the region.

A majority of the population in Hardee County is employed in agriculture. The 1980 census reported that over 30% of the personal income in Hardee County was derived from farm related activities; less than 6% of the personal income was derived from manufacturing (U.S. Bureau of the Census, 1983). Agriculture was still the highest employment sector in 1985 in Hardee County as reflected in average monthly employment (Table 2.2.7-2), but was followed closely by government, which employed approximately 18% of the county labor force [Florida Department of Labor & Employment Security (FDLES), 1988].

Employment in Polk County is focused in the retail trade services and manufacturing employment sectors (Table 2.2.7-2). In 1985, over 50% of its employed labor force was engaged in one of those sectors. About 14% of the employed labor force was employed by the government. While a significant portion of land in Polk County is dedicated to the mining industry, less than 14% of the county's workforce is employed in mining (FDLES, 1988). Less than 15% of the manufacturing labor force in Polk County is organized, but nearly 90% of the county's unionized workers are involved in the phosphate industry [Economic Development Council (EDC, undated)]. Employment and average annual pay in Polk and Hardee Counties are listed by industry in Table 2.2.7-2.

Hardee and Polk Counties contained a combined labor force of 158,575 workers in 1986 (University of Florida, 1987). During that same year the unemployment rate was estimated at 11.9% in Hardee County and 10.6% in Polk. The unemployment rates for both counties have exceeded 10% since at least the early 1980s and remain among the highest in the state and the country (U.S. Bureau of the Census, 1988).

Table 2.2.7-1. Employment Distribution by Industry for Service Delivery Area 18*

Industry Division	1985 Employment	Percent Of Total Employment	Projected 1995 Employment	Percent Of Total Employment	Percent Growth 1985-1995
Total, All industries	199,501	100.0	269,629	100.0	35.2
Agriculture	15,826	7.9	16,506	6.1	4.3
Mining	4,912	2.5	5,168	1.9	5.2
Construction	10,466	5.3	13,391	5.0	28.0
Manufacturing	23,875	12.0	32,692	12.1	36.9
Durable Goods	10,185	5.1	14,666	5.4	44.0
Nondurable Goods	13,690	6.9	18,026	6.7	31.7
Transportation, Communications & Public Utilities	8,000	4.0	10,250	3.8	28.1
Wholesale & Retail Trades	44,593	22.4	66,727	24.8	49.6
Wholesale	8,035	4.0	10,478	3.9	30.4
Retail	36,558	18.4	56,249	20.9	53.9
Finance, Insurance & Real Estate	9,048	4.5	13,550	5.0	49.8
Services	50,666	25.4	73,397	27.2	44.9
Government	9,387	4.7	12,093	4.5	28.8
Self Employed Workers	22,727	11.4	25,855	9.7	13.8

* Service Delivery Area 18 includes the DeSoto, Hardee, Highlands, Okeechobee, and Polk Counties.

Source: Florida Department of Labor and Employment Security, Bureau of Labor Market Information. SDA Profiles, Labor Market Information, 1988.

Table 2.2.7-2. Employment and Wages of Hardee and Polk County Workers Covered by the Florida Unemployment Compensation Law - 1985

	HARDEE COUNTY			POLK COUNTY		
Industry Division	Average Reporting Units	Average Monthly Employment	Average Annual Pay	Average Reporting Units	Average Monthly Employment	Average Annual Pay
Agriculture, Forestry & Fishing	115	1,761	$ 7,753	555	9,432	$ 9,957
Mining	-	-	-	26	4,716	24,769
Construction	29	134	12,170	988	8,442	16,849
Manufacturing	14	292	12,571	445	21,678	19,370
Transportation, Communication, & Public Utilities	15	113	21,155	307	5,329	20,012
Wholesale Trade	23	196	12,500	583	6,690	19,634
Retail Trade	103	845	9,959	1,664	29,407	11,552
Finance, Insurance, and Real Estate	26	191	14,109	639	6,562	16,997
Services	100	536	12,474	2,396	26,088	14,280
Government	32	1,148	14,951	123	16,984	17,771
Federal	6	45	22,316	22	1,133	25,538
State	15	134	16,560	66	3,051	17,291
Local	11	969	14,386	35	12,800	17,198

Source: Florida Department of Labor and Employment Security, Bureau of Labor Market Information. SDA Profiles, Labor Market Information, 1988.

Polk and Hardee Counties recently have been in the top ten unemployment areas of the country. According to the Polk County Economic Development Council (EDC) as the phosphate industry has reduced operations/employment, a large number of persons in the unskilled and semi-skilled labor categories have been left unemployed. These individuals are, in general, stable, lifelong residents of the area who provide a very strong base for training and adaptation to new jobs (EDC, undated).

Polk County has been designated a labor surplus area by the U.S. Department of Labor, which means companies located in the Polk Urban Area become eligible for preference in obtaining federal contracts. The unskilled labor supply of the county consistently exceeds local demands. A state sponsored Industrial Services Training Program is actively promoted within Polk County to help in establishing training programs for employees of new and existing businesses. The program is designed to give immediate response to meet training requirements by providing custom-tailored training services (EDC, undated).

ECONOMIC CHARACTERISTICS

Personal per capita income in the area varies considerably on a county basis. Per capita income in Hardee County was estimated in 1985 at $7,333, a figure considerably below the state average of $11,271. Polk County was somewhat higher, with a per capita income in 1985 of $9,447 (U.S. Bureau of the Census, 1988).

In 1979, about 19% of the families in Hardee County and 10% of the families in Polk County had incomes below the poverty level and over 41% and 34% earned incomes less than $10,000 in Hardee and Polk Counties, respectively (U.S. Bureau of the Census, 1983). Income characteristics by county are listed in Table 2.2.7-3. Table 2.2.7-4 identifies source of personal income by industry sector.

Table 2.2.7-3. Income Characteristics for Hardee and Polk Counties By Industry

Income Characteristic	Hardee County	Polk County
Average wage/salary earnings per job (1984)	$11,290	$15,273
Per Capita Income (1984)	$ 7,333	$ 9,447
Median Income - Family (1979)	$13,661	$16,512
Median Income - Household (1979)	$12,028	$15,273
% of Families below Poverty Level (1979)	19%	10%

Source: U.S. Bureau of the Census. 1988 County and City Data Book, July 1988.

Bureau of Economic & Business Research, College of Business Administration, University of Florida, 1987. Florida Statistical Abstract, 1987.

Table 2.2.7-4. Hardee and Polk County Personal Income By Industry Private Nonfarm Earnings on Place-of-Work Basis

Industry Division	Percentage of County Total Hardee County	Polk County
Manufacturing	10.86	23.24
Mining	*	6.33
Contract Construction	*	8.48
Wholesale Trade	5.92	7.10
Retail Trade	19.19	17.15
Finance, Insurance and Real Estate	7.01	5.70
Transportation, Communications and Public Utilities	8.16	7.97
Services	19.75	21.24
Other	14.37	2.78

Source: Bureau of Economic and Business Research, College of Business Administration, University of Florida, 1987. Florida Statistical Abstract, 1987.

HOUSING

Hardee County contained 6,253 households in 1980 at an average size of 3.05 people per household. This represents a 43.2% increase in the number of households from those counted in the 1970 federal census, but a 9.2% decrease in household size during the same time period. The average household size is somewhat above the average for the state of 2.55 people per household in 1980 and 2.90 in 1970. The number of households is anticipated to continue to increase and was estimated to have grown to approximately 7,321 households at an average size of 2.94 people in 1986. Polk County was estimated to contain approximately 139,724 households in 1986 at an average household size of 2.59 people (University of Florida, 1987).

Housing in Hardee County is primarily owner-occupied and single family structures, a majority of which have been constructed since 1960. In 1985, 33 building permits were issued for new single family homes one of which was to be located in the Bowling Green area. Forty-nine new single family structures were authorized in 1986, with one being located in Bowling Green (University of Florida, 1987).

Polk County experienced a much higher demand for new housing and authorized 2,057 single family homes and 1,009 multi-family structures in 1985 and 2,146 single family and 721 multi-family structures in 1986. A majority of the new units authorized in Polk County are located in the Lakeland/Winter Haven areas (University of Florida, 1987).

In 1980, the median value of an owner occupied home was $26,300 in Hardee County and $43,000 in Polk County. Both counties fell below the median for the State of $45,300 (U.S. Bureau of the Census, 1988). In 1988, the average price for a 2 to 3 bedroom home in the portion of Polk County within 16 km (10 miles) of the site was estimated at $41,600; the average price in Hardee County was $40,000 (Bartow Realty, 1989; Davis, 1989). Apartments rented for between $250 and $300 per month (Davis, 1989).

2.2.7.2 Area Public Service and Utilities

EDUCATION

In the 1986-87 school year, a total of 3,937 persons were enrolled in public schools (including kindergarten) in Hardee County and 59,233 persons were enrolled in Polk County. Hardee County had a per capita expenditure for education in 1982 of $527; Polk County spent slightly less, with a per capita expenditure of $417 (U.S. Bureau of the Census, 1988).

About 45% of the population of Hardee County over the age of 25 years hold high school diplomas and about 7.4% have attended up to 4 years of college. In Polk County about 60% attended high school and 11.4% went through 4 years of college (U.S. Bureau of the Census, 1988).

TRANSPORTATION

Access in and around the area surrounding the Hardee Power Station site is by private vehicle. There are no public transit facilities serving the local area and communities. Figure 2.2.7-1 shows major access routes to the Hardee Power Station.

SR 37 is the primary north-south state highway in southwest Polk County. This is a two-lane facility south of SR 60 in Mulberry and is expected to serve as the primary access route (to its intersection with CR 630) for workers coming from the Lakeland area, and smaller communities such as Mulberry, and Bradley Junction north of the plant site. It is anticipated that workers from these areas will take SR 37 south to CR 630, then turn east to CR 663 and then south to access the site. The 1988 ADT count for the section of SR 37 from SR 60 to SR 630 was 3,969 vehicles (total two-way) [Florida Department of Transportation (FDOT, 1989)]. There are four at-grade railroad crossings on this section, and some truck traffic (about 5%).

The section of SR 37 south of CR 630, down to SR 674 is also likely to be used by workers coming from west of Polk County on SR 674. From SR 674, workers would travel north on SR 37 to CR 630 where they would turn east.

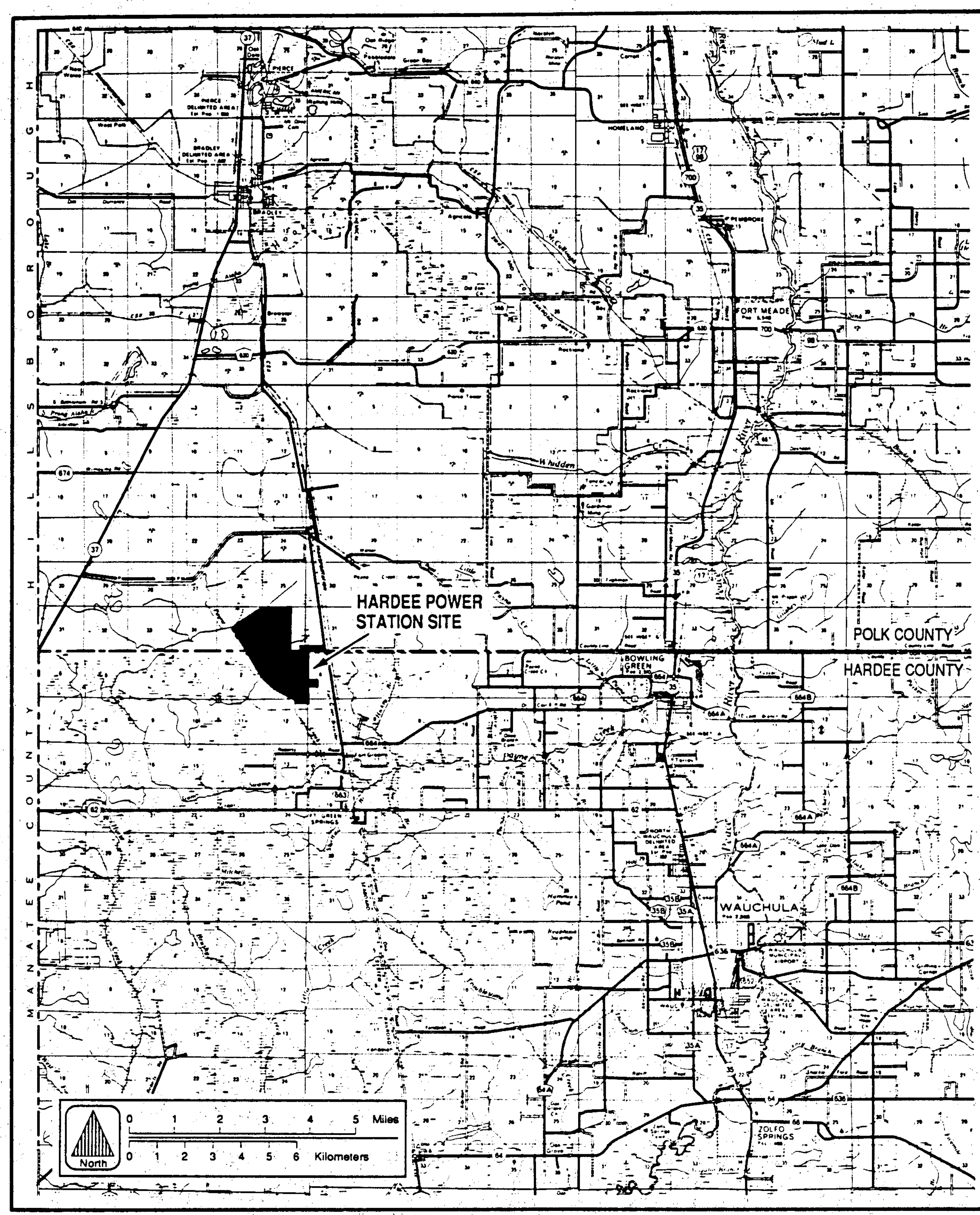


Figure 2.2.7-1 MAJOR ACCESS ROUTES IN THE VICINITY OF HARDEE POWER STATION

Hardee Power Station

The section of SR 37 between SR 674 and CR 630 had a 1988 ADT of 3,660. There are no rail crossings on this section of the road.

Access to the site from Polk County communities of Winter Haven and Bartow, northeast of the site, and Ft. Meade to the east is provided over US 17/SR 35. This is a four lane-divided highway from SR 60 in Bartow to its intersection with SR 700 in Ft. Meade. While this highway follows a somewhat southeasterly direction (away from the site) between Bartow and Ft. Meade, its high speed/high capacity design and its absence of rail crossings will likely induce many workers coming from northern communities to take it south to CR 630, where they will turn west to CR 663 to gain access to the site. Its current ADT in 1988 was 13,903 north of the intersection with CR 630/SR 700, and 8,982 south of that location.

While US 17/SR 35 carries a strong volume of almost 9,000 ADT south to Bowling Green in Hardee County, it is not likely that site workers will follow that route to the site (via CR 664 and CR 663) since it is a longer route to the site than the one through Polk County (via CR 630 and CR 663). The only portion of US 17/SR 35 in Hardee County that is likely to be used by workers would be that portion south of its intersection with SR 62. This segment would provide access for workers coming from Wauchula and Zolfo Springs in Hardee County, and Arcadia in DeSoto County. These workers would turn west at SR 62 to head toward the site. The current (1988) ADT on the portion of US 17/SR 35 just south of SR 62 is 10,167. There is moderate truck traffic, and no at-grade rail crossings along this route.

CR 555 was built by the state and is currently maintained by Polk County and provides northeast-southwest access to the site from SR 60 in Bartow to CR 630 west of Ft. Meade. This road provides a direct, low volume alternative (to US 17/SR 35) for workers coming from the Winter Haven-Bartow area. Its current ADTs are 3,112 south of SR 60, and 2,512 just north of CR 630. At its intersection with CR 630, workers would turn west toward the site. This segment has a low traffic volume and has three at-grade railroad crossings.

CR 630 provides a direct east-west connection between SR 37 and US 17/SR35. This two lane Polk County highway was also originally a state highway. Site workers would use this route both eastbound from SR 37, and westbound from either US 17/SR 35 or CR 555 to CR 663, where they would turn south toward the site. ADT volumes on CR 630 are generally low; 2,851 and 1,485 to the east and west of CR 555, respectively. East of CR 663 the ADT is 2,091 and west of it the ADT is 1,857. There is a high level of truck traffic on this road as well as four at-grade rail crossings.

Access to the site from western coastal communities and the population centers of Hillsborough County is provided over SR 674. This two-lane, east-west highway terminates at its intersection with SR 37. At that point workers would travel north to CR 630 to the site. The 1988 ADT for SR 674 just west of SR 37 was 1,449.

CR 663 is a two-lane, county-maintained highway extending from Bradley Junction to the south of the site entrance. South of SR 62, CR 663 is an unpaved road and is not a viable alternative to other local roads. CR 663 will provide the principal access for workers coming south from all directions. While the road has generally good surface condition, and presently carries a very low ADT (about 450 in 1986 in Polk County and 430 in 1987 in Hardee County), the Polk County portion has some alignment changes and rail crossings. Traveling south from CR 630, the road makes four 90-degree turns as it crosses first to the east, then back to the west of the CSX rail line. The CSX trains average 8-12 movements a day through this area, with a possibility of at least 1 or 2 trains during the morning and afternoon shift changes.

Within Hardee County, SR 62 is a two-lane state highway that runs east-west, and will provide workers with access from points west and from the southeast (via US 17/SR 35). Worker traffic coming from either the west or the east on SR 62 would turn north on CR 663 to access the site. The ADT on the section of SR 62 just east of CR 663, was 2,589 in 1988. There is moderate truck traffic on this road.

CR 664 is a two lane county highway that proceeds southwest from Bowling Green (and its intersection with US 17/SR 35) to an intersection with CR 663 south of the site. Workers using this highway would probably be those coming west from Bowling Green. While no recent ADT was available for this route it was estimated by Hardee County Road staff to be about 300, including some truck traffic, and possibly some seasonal (December-June) farm equipment. There is one rail crossing on CR 664 just east of CR 663.

The CSX Transportation branchline (Brewster Subdivision - Tampa Division) provides north/south rail service to the area. The railroad is located about 0.8 km (1/2 mile) to the east of the center of the site and extends south from Edison (between Keysville and Bradley junction) and interchanges with the Seminole Gulf Railway, a Class III short-line, at Arcadia. Numerous spurs off of this line to the north provide private access to phosphate companies.

No airports or airfields are located within an 8-km (5-mile) radius of the proposed site.

MEDICAL FACILITIES

A variety of medical service is available in the region. The average physician/patient rate in Polk County was 123.4 per 100,000 people in 1980; Hardee County's rate was somewhat lower at 51.6. Both rates are below the state average of 170.7 (U.S. Bureau of the Census, 1983).

Hardee County contains one general hospital with 50 beds and Polk County contains eight hospitals with a total capacity of 1,811 beds. Both counties contain nursing homes and nursing and personal care facilities.

Emergency medical services are located in both Hardee and Polk counties. Within Hardee County, one ambulance and an emergency medical team are located in Wauchula (Jones, 1989). In Polk County, within an approximate 16-km (10-mile) radius of the facility, Ft. Meade and Mulberry each contain one ambulance and medical team. Bartow, located further north, also contains two ambulances and two emergency medical teams (Geiger, 1989).

FIRE FIGHTING FACILITIES

Fire fighting equipment is available throughout the area. Within Hardee County, the fire departments in Bowling Green and Zolfo Springs are voluntary; the Wauchula Fire Department has a full time force of 21 (Jones, 1989).

In Polk County, Ft. Meade's force of 25 is entirely voluntary, however, the fire department in Bartow contains 15 full-time firefighters and 35 voluntary members. Bradley Junction has one full-time and seven volunteer members (Gunter, 1989). Table 2.2.7-5 lists firefighting equipment by communities.

POLICE PROTECTION

The Hardee County Sheriff Department maintains a force of 55 with 24 vehicles and is responsible for police protection in the unincorporated portions of the county (Maddox, 1989). Bowling Green, Wauchula and Zolfo Springs have police departments which serve those communities. The police force in Bowling Green consists of five full-time employees, five part-time employees and five vehicles (Pearson, 1989). Wauchula's police department consists of 11 full-time, one part-time, and five auxiliary employees, and eight vehicles (Morin, 1989). Zolfo Springs' police department consists of four employees and three vehicles (Vickery, 1989). In addition to county and local police the area is also served by the Florida Highway Patrol, with three to four officers stationed in Hardee County (Maddox, 1989).

As of January 1, 1989, Polk County had 345 certified law enforcement full-time employees and 27 certified law enforcement part-time employees. Within the unincorporated portion of the county are four primary patrol zones. Each patrol zone is normally staffed by one uniform deputy sheriff per shift, 24 hours a day. In addition, Bartow, Mulberry, and Ft. Meade each have police departments which service these communities (Lawton, 1989).

Table 2.2.7-5. Firefighting Equipment for Communities Within Approximately 10 Miles of the Hardee Power Station Site

	EQUIPMENT		
	PUMPERS	TANKERS	
HARDEE CO.			
Bowling Green	1	1	
Wauchula	2	1	
Zolfo Springs	1	1	
Polk Co.			
Ft. Meade	3	2	
Bartow	3	2	(Plus 1 Aerial truck)
Bradley Junction	1	1	

Source: Captain Harold Jones, Hardee Fire & EMS Dept., 1989.
W. Gunter, Bartow & Ft. Meade Fire Depts., 1989.
L. Webb, Bradley Fire Dept., 1989.
D. Geiger, Polk County Public Safety, 1989.

RECREATION FACILITIES

There are no federal, state or local recreation facilities within an 8-km (5-mile) radius of the project site. The nearest local facility is the Little Cypress Golf and Country Club which is located about 16 km (10 miles) away, just west of Wauchula.

Two state parks, Highlands Hammock and Payne Creek, and one state recreation trail, Peace River, are located within Hardee County. Payne Creek State Park and the Peace River Recreational Trail are located about 13.7 km (8.5 miles) east of the site. Highlands Hammock State Park is located in the southeastern edge of the county, over 32 km (20 miles) away.

Polk County contains two state parks (Lake Kissimmee and Lake Arbuckle), one special water area, and several state owned Fish Management Areas. None of these facilities are located within 16 km (10 miles) of the proposed site.

ELECTRIC AND GAS

Electricity is supplied to the area by the Peace River Electric Cooperative, Florida Power & Light and Tampa Electric (Polk County only). Hardee County contains no natural gas pipelines. The Florida Gas Transmission Company distributes gas to Ft. Meade.

WATER SUPPLY FACILITIES

Hardee County has no county-owned water facilities; all are municipal or private. The rural unincorporated areas of the county receive water from private wells. Municipal service is provided in Wauchula, Bowling Green and Zolfo Springs. Table 2.2.7-6 lists usage and capacity of each system.

Polk County provides water to certain communities within the county, however, Bartow, Ft. Meade and Mulberry each contain municipal distribution systems.

Table 2.2.7-6. 1989 Municipal Water Supply Usage and Capacity for Selected Communities in Hardee and Polk Counties

	Current Use	Capacity
HARDEE COUNTY		
Bowling Green	0.4 MGD	1.2 MGD
Wauchula	0.875 MGD	2.0 MGD
Zolfo Springs	0.225 MGD	0.4 MGD
POLK COUNTY		
Ft. Meade	1.0 MGD	1.0 MGD*
Bartow	3.6 MGD	4.0 MGD

* Amount permitted - estimated capacity is 6.0 MGD.

Source: D. Allen, Bartow Water Dept., 1989.
M. Hodge, Polk Co. Water Dept., 1989.
Zolfo Springs Municipal Office, 1989.
M. Bryan, Bowling Green Municipal Offices, 1989.
J. Colson, Polk Co. Water & Sewer Dept., 1989.
G. Heine, Wauchula Municipal Offices, 1989.
L. Messer, Ft. Meade Municipal Offices, 1989.

SEWAGE TREATMENT FACILITIES

Sewage treatment facilities in Polk and Hardee counties are located only in the more urbanized areas; the unincorporated areas use private septic systems.

Sewage treatment systems serve Wauchula, Bowling Green and Zolfo Springs in Hardee County and Ft. Meade and Bartow in Polk County. Table 2.2.7-7 lists usage and capacity for each system.

SOLID WASTE DISPOSAL

One solid waste disposal area, a landfill, is located in Wauchula in Hardee County. The landfill has a capacity of 10 to 15 years and an average usage of 200,000 tons per year.

Polk County contains three county landfills: North Central at Lakeland; Southeast at Lake Wales; and Northeast at Lake Hamilton. The area in Polk County surrounding the proposed site would use the North Central landfill which has an average usage of about 1,100 tons per day with an anticipated capacity of 45 years.

Table 2.2.7-7. 1989 Municipal Sewage Systems Usage and Capacity for Selected Communities in Hardee and Polk Counties

	Current Use	Capacity
HARDEE COUNTY		
Bowling Green	0.175 MGD	0.3 MGD
Wauchula	0.83 MGD	1.0 MGD
Zolfo Springs	0.11 MGD	0.2 MGD
POLK COUNTY		
Ft. Meade	0.45 MGD	1.0 MGD
Bartow	2.3 MGD	2.75 MGD

Source: M. Bryan, Bowling Green Municipal Offices, 1989.
J. Colson, Polk Co. Water & Sewer Dept., 1989.
Zolfo Springs Municipal Offices, 1989.
G. Heine, Wauchula Municipal Offices, 1989.
D. Allen, Bartow Water Dept., 1989.

2.3 **BIOPHYSICAL ENVIRONMENT**

2.3.1 Geohydrology

2.3.1.1 Geologic Description of the Site-Area

REGIONAL STRATIGRAPHY

The Hardee Power Station lies within Polk and Hardee Counties and is underlain by soils and rock primarily of Tertiary age (Stewart, 1966; Wilson, 1977). Most of the immediate site area has been or is in the process of being mined, however, these activities directly affect only the upper 9 to 12 m (30 or 40 ft) of substrate. After mining, reclamation estimates will result in a mixture of upper-sand layers. Unmined or deeper soils will conform to the following description.

A generalized stratigraphic section for the two county area near the site is shown in Figure 2.3.1-1. The deepest formation is the Cedar Keys which overlies rocks deeper than 610 m (2,000 ft). Above these formations is the Oldsmar Limestone which underlies all of the Florida peninsula. The Avon Park Limestone thickens to greater than 305 m (1,000 ft) and is found above the Oldsmar. The Avon Park is the primary aquifer across Florida (see Section 2.3.2). Overlying the Avon Park is the Ocala Group which consists of (in ascending order) the Inglis formation, the Williston formation, and the Crystal River formation. The Ocala crops out in the Green Swamp area of northern Polk County and increases in thickness from 90 to 180 m (300 to 600 ft).

The Suwannee Limestone formation ranges in thickness from 25 to 75 m (80 to 250 ft), crops out in northeastern Hillsborough County and pinches out in Polk County. Overlying the Suwannee are the Hawthorn Group strata. Current practice is to subdivide the lower part into the Tampa member which consists of a lowermost "sand and clay" unit and an upper limestone unit. The overlying Hawthorn formations rest upon a weathered contact, and are subdivided into a lower calcareous formation, an interbedded middle member,

System	Series	Group	Formation	Description	Aquifer
	RECENT		UNNAMED SANDS	SAND, CLAYEY, VERY FINE TO MEDIUM MOSTLY FINE GRAINED; WHITE TO BROWN, TRACE PHOSPHATE IN LOWER PART, MINOR THIN BEDS OF LIMESTONE AND BLUE GRAY CLAYEY SAND AND CLAY.	SURFICIAL AQUIFER
	PLEIST-OCENE				
TERTIARY	PLIOCENE				
	MIOCENE	HAWTHORN GROUP	BONE VALLEY	CLAYEY SAND AND SANDY CLAY, FINE-GRAINED, CALCAREOUS TO NON-CALCAREOUS; ABUNDANT PHOSPHORITE NODULES TO PEBBLE SIZE, WHITE TO GRAY IN UPPER PART, AMBER & BLACK IN LOWER PART; BEDS OF CLEAN PHOSPHATE.	INTERMEDIATE AQUIFER
			PEACE RIVER	PREDOMINANTLY A CLASTIC UNIT BROWN TO BLACK; FINE GRAINED TO SANDY OR PEBBLY; W/OCCASIONAL CARBONATE BEDS; CLAYEY, DOLOMITIC, PHOSPHATIC	
			ARCADIA	VERY CALCAREOUS OR DOLOMITIC QUARTZ SAND TO VERY SANDY CARBONATE, W/SANDY CALCAREOUS TO DOLOMITIC CLAYS; 15-20% PHOSPHATE.	
			TAMPA	DOLOMITIC LIMESTONE NEAR TOP WITH CLAYEY INTERBEDS, BECOME GREENISH SAND - CLAY AT BASE.	
	OLIG-OCENE		SUWANNEE	LIMESTONE, NODULAR, GRANULAR, CHALKY, FOSSILS, CREAM TO WHITE IN COLOR.	FLORIDAN AQUIFER
	EOCENE	OCALA	CRYSTAL RIVER WILLISTON INGLIS	LIMESTONE, CHALKY, NODULAR, GRANULAR, FRAGMENTAL, SOME OOLITIC, FOSSILIFEROUS; CREAM WHITE, SOME BUFF; W/OCC DOLOMITE IN LOWER PART; SUCROSIC TO DENSE AND CHERTY, YELLOWISH BROWN TO DARK - BROWN AND GRAY.	
			AVON PARK	LIMESTONE, CHALKY, NODULAR, FRAGMENTAL, W/ANHYDRITE AND GYPSUM; CREAM WHITE TO BUFF.	
			OLDSMAR	LIMESTONE, AS ABOVE, WITH RUBBLE ZONES.	
	PALEO-CENE		CEDAR KEYS	ANHYDRITE AND DOLOMITE BEDS WITH GYPSUM NODULES.	

SOURCES: AD HOC COMMITTEE ON FLORIDA HYDROSTRATIGRAPHIC UNIT DEFINITION (1986)
WILSON (1977)
STEWART (1966)

Figure 2.3.1-1 GENERALIZED STRATIGRAPHIC COLUMN OF THE SITE VICINITY

Hardee Power Station

and an upper clastic member. Total thickness of the Hawthorn Group varies from very thin to as much as 90 m (300 ft) in Polk and Hardee counties.

The Tamiami formation and the overlying Caloosahatchee marl generally occur south of the site but are discontinuous near the site area where the Bone Valley member predominates. The Bone Valley ranges in thickness from 6 to 18 m (20 to 60 ft) and is exposed in stream cuts, and on high plateaus in Polk County.

The most recent deposits are the unnamed terrace deposits which range from 0 to 21 m (0 to 70 ft) thick. These deposits are described more fully in Section 2.3.1.3.

LITHOLOGY

Generalized descriptions (from Wilson, 1977, except as noted) of the formations in the site area are summarized here in ascending order.

<u>Oldsmar (Lake City) Formation</u>--Limestones and dolomites with evaporites, soft to hard, chalky zones, occasional fine honeycomb, abundant nodules and nests of nodules of gypsum altered from anhydrite, some selenite cemented fractures (Stewart, 1966).

<u>Avon Park Formation</u>--Limestone, chalky, nodular, oolitic, fragmental, intergranular anhydrite and gypsum, very fossiliferous, cream, white, and buff; commonly thin dolomite in middle part, dense to finely crystalline or sucrosic, yellow to grayish brown. Lower dolomite unit massive, dense to finely crystalline or sucrosic, some coarsely crystalline, pale-yellow and brown to dark-brown and gray, mottled.

<u>Ocala Group</u>--Limestone, chalky, nodular, granular, fragmental, some oolitic, generally very fossiliferous, cream, white, some buff; occasional

dolomite in lower part, sucrosic to dense and cherty, yellowish brown to dark-brown and gray.

Suwannee Formation--Limestone, nodular, granular, chalky, some fragmental, some oolitic, usually very fossiliferous, cream to white, occasionally some clear quartz grains.

Sand and Clay Unit of Tampa Limestone--Sand, fine-coarse grained, clean to silty, limey, grayish green; and clay, silty, sandy, marly, gray to pale green, and hard, waxy, dark green to black, marly; minor limestone.

Tampa Limestone Unit--Limestone, massive or thick-bedded, hard, dense, cherty, fossiliferous, phosphatic, white to gray and brown; minor thin bedded sand and clay. Where underlying sand and clay unit is absent, equivalent beds are limestone, predominantly sandy, fossiliferous, gray, cherty; in places marly, soft, pebbly.

Hawthorn Group--Predominantly marl, dolomite and limestone; soft, chalky, fine-grained to sandy or pebbly; abundant brown or black phosphorite grains or pebbles; minor thin-bedded sand and clay. Generally the uppermost limestone in the section, less clastic than the underlying sand and clay unit, phosphatic throughout.

Bone Valley Member--Clayey sand and sandy clay, fine-grained, calcareous to noncalcareous; abundant phosphorite nodules up to pebble size, white to gray in upper part, amber or black in lower part; includes beds of clean phosphatic sand and sand and gravel.

Unnamed Sand Unit--Sand, clayey, very fine to medium grained, predominantly fine-grained; white to brown; trace of phosphate in lower part, minor thin beds of limestone and bluish gray clayey sand and clay.

SITE-AREA STRATIGRAPHY

The results of four deep borings were used to prepare the general stratigraphic section for the site. These borings are the Southwest Florida Water Management District (SWFWMD) Regional Observation Monitoring Program (ROMP) #40 well near Duette, the United States Steel Agri-Chemicals (USSAC) South Rockland Well in Section 1 of T33S R24E about 2 miles west of Bowling Green (Dames & Moore, 1979), and the CFI Production Test Well and Deep Floridan Test Well both in Section 26 of T34S R23E about 2 miles southwest of Fort Green Springs. The Terrace sands range in thickness from 9 to 12 m (30 to 40 ft), and the Hawthorn lies from 9 to 113 m (30 to 370 ft) deep. The Tampa formation lies at depths of from 67 to 146 m (220 to 480 ft); the top 18 to 29 m (60 to 95 ft) is limestone, and the bottom 9 to 14 m (30 to 45 ft) is sand and clay. The Suwannee Limestone lies at depths of from 108 to 204 m (355 to 670 ft) and the Ocala Limestone ranges from 146 to 283 m (480 to 930 ft) deep. Two of the deep wells reached the Avon Park Limestone at depths of 223 and 482 m (730 and 1,580 ft). The Deep Floridan test well reached the Lake City (Oldsmar) Limestone at a total depth of 550 m (1,800 ft).

SITE-AREA STRUCTURE

The major geologic structure is the Peninsular Arch which forms the backbone of the Florida Peninsula striking S 35°E. Subparallel to this and to the north of the site is the Ocala Uplift which is a faulted elliptical area in Levy County where this structure is 370 km (230 miles) long and 113 km (70 miles) wide. The nearest structure to the site is the Kissimmee flexure which strikes east of northeast through central part of southern Polk County. To the south of the site is the South Florida Basin which is a gentle structure trending S 45°W. Faulting has not been identified within the immediate site vicinity to date.

SITE-AREA PHYSIOGRAPHY

The area falls into the geomorphic province known as the Polk Upland (White, 1970), occurring above the Wicomico Shoreline which is a Pleistocene terrace landform occurring at Elevation +30 m (+100 ft) several miles south of the site. South of the site is the geomorphic terrain mapped as the DeSoto Plain. The Polk Upland is flat and covered with a blanket of permeable sand; seepage is rapid and little dissected by streams resulting in a subdued topography. Only remnants of the ancient shoreline, i.e., bars, spits, and terrace scarps, mark the landform as it gently slopes towards the south.

2.3.1.2 Detailed Site Lithologic Description

The presence of pebble-sized phosphate grains in localized areas or very thin zones within the Bone Valley strata dominates the detailed site geohydrology. Parts of the site containing economic deposits of pebble-phosphate have either been recently strip mined or are scheduled to be mined in the near future. This mining activity typically removes the unnamed surficial sands (overburden) and places them in the adjacent pit bottom at a lower elevation. Mixing with clayey sand overburden is inevitable so that the entire zone, typically less than 9 m (30 ft), is altered where mining activity is complete. Strip mining has been conducted and is presently taking place on portions of the site resulting in deep ponds of standing water surrounded by arcuate spoil piles rising as much as 6 to 9m (20 to 30 ft) above natural grade. Other parts of the site have not been mined and remain undisturbed.

An exploratory program was conducted to characterize the hydrogeologic units under the site. The site subsurface investigations consisted of:

1. Ten Standard Penetration Test (SPT) borings. These borings are identified as B-1 through B-10 and were drilled to depths varying from 12 m (40 ft) to over 61 m (200 ft).

2. Six shallow surficial aquifer piezometers drilled and developed from an approximate depth of 6.1 m (20 ft). These piezometers are identified as B-1, B-2, B-3, B-10, B-11 and B-12.

3. Three deep intermediate aquifer piezometers drilled and developed to depths greater than 61 m (200 ft). These piezometers are identified as B-3A, B-10A and B-12A.

The logs of these borings and piezometer installations were submitted to FDER under separate cover and are also included in the Appendix 11.4.

These borings were advanced with casing and water to approximately 9 m (30 ft), except for the deep borings which were advanced with casing to 25 m (80 ft) and then open hole using native drilling mud to bottom of hole. Geologic logs of these borings have been submitted to FDER under separate cover and are available on request.

Split spoon samples, Shelby tube samples, and wash samples were obtained. The laboratory testing program consisted primarily of moisture content, dry density, organic content, Atterberg limits, sieve analyses, and permeability testing, with some shear strength testing (see Section 2.3.1.4) for foundation design. A total of 86 grain size analyses were conducted, 16 of which included a hydrometer test on the silt and clay fraction. Soil classification tests according to the Unified Method (ASTM D2487) were prepared for all samples. The group symbols ranged from SP to SM to ML for the clastic units, and from CH and CL to SC for the cohesive soil units. The definitions of these symbols are provided in Figure 2.3.1-2.

An east-west cross section of the upper 30 m (100 ft) of soil is shown in Figure 2.3.1-3, and a north-south cross section showing the deeper units is shown in Figure 2.3.1-4. Cross sections across the site have been developed (see Figure 2.3.1-5 for locations).

SOIL CLASSIFICATION CHART
ASTM D 2487

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COURSE-GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	SANDS MORE THAN 50% OF COARSE FRACTION PASSESS NO. 4 SIEVE	CLEAN SANDS	SP	POORLY GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE -GRAINED SOILS 50% OR MORE PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML	INORGANIC SILTS, VERY FIND SANDS, SILTY OR CLAYEY FINE SANDS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS

Figure 2.3.1-2 DEFINITION OF SOIL TYPES UNDERLYING THE HARDEE POWER STATION SITE

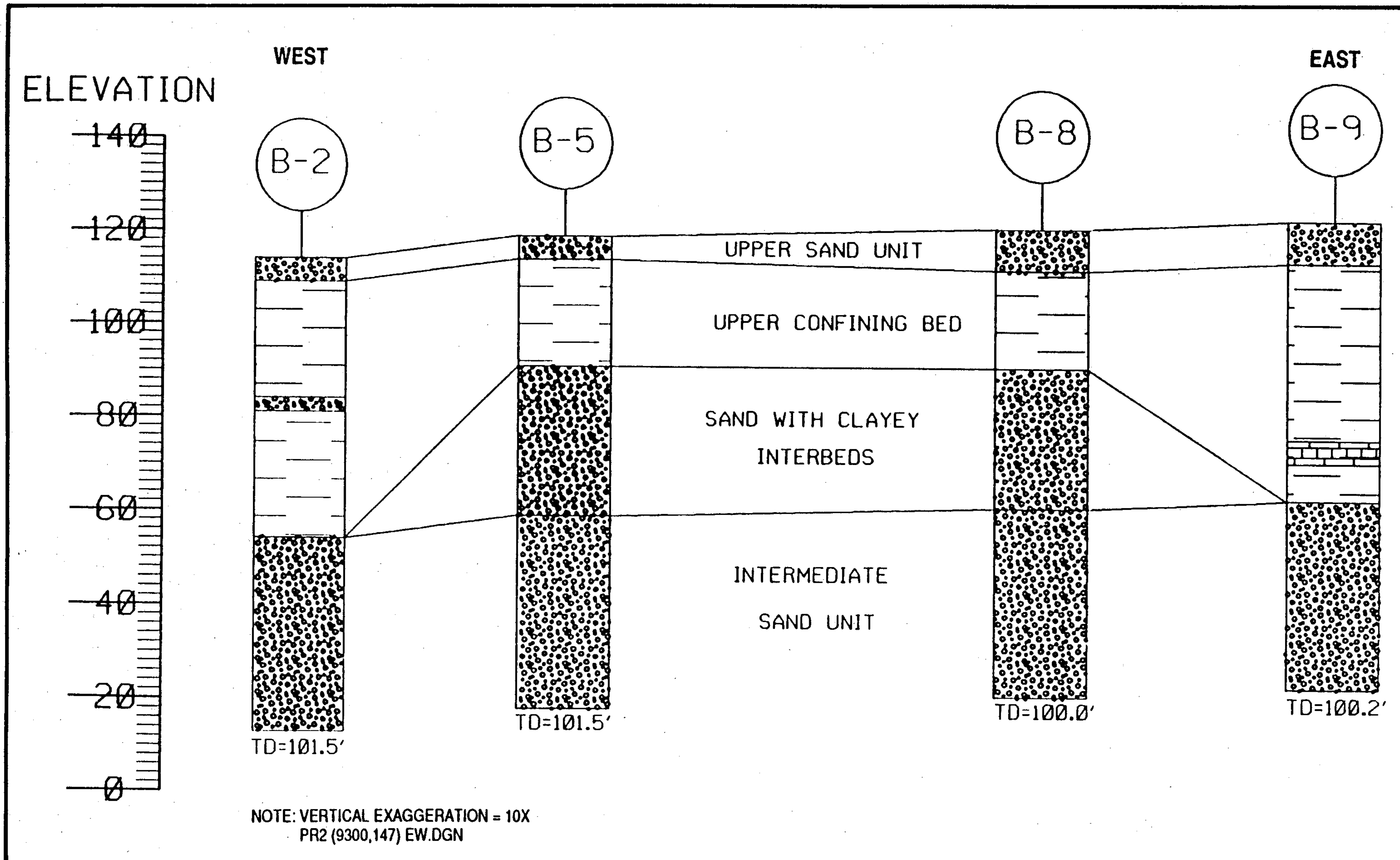
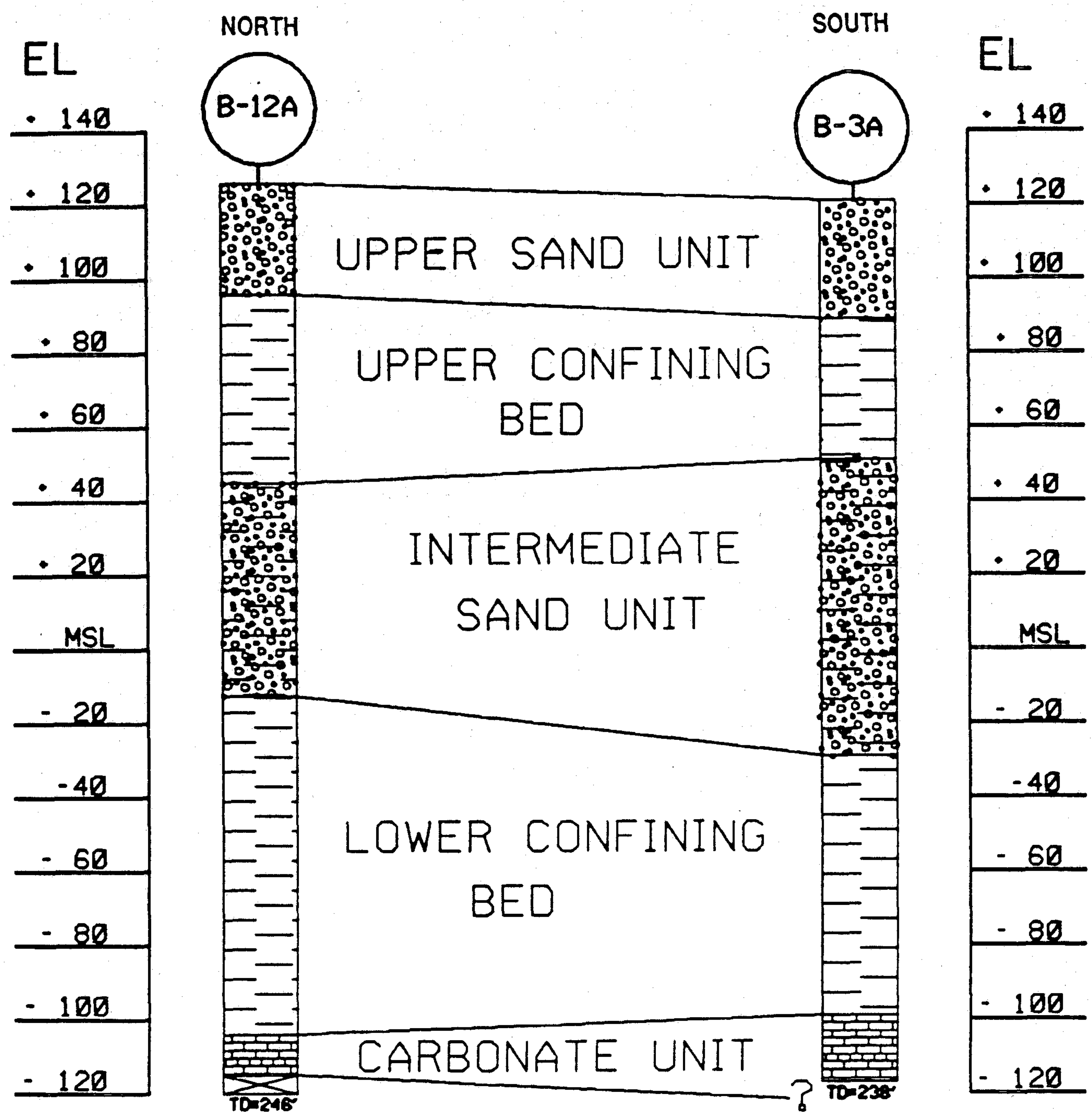


Figure 2.3.1-3 GENERALIZED EAST-WEST STRATIGRAPHIC CROSS-SECTION OF THE HARDEE POWER STATION SITE

Hardee Power Station



NOTE: VERTICAL EXAGGERATION = 40X

Figure 2.3.1-4 GENERALIZED NORTH-SOUTH STRATIGRAPHIC CROSS-SECTION OF THE HARDEE POWER STATION SITE

Hardee Power Station

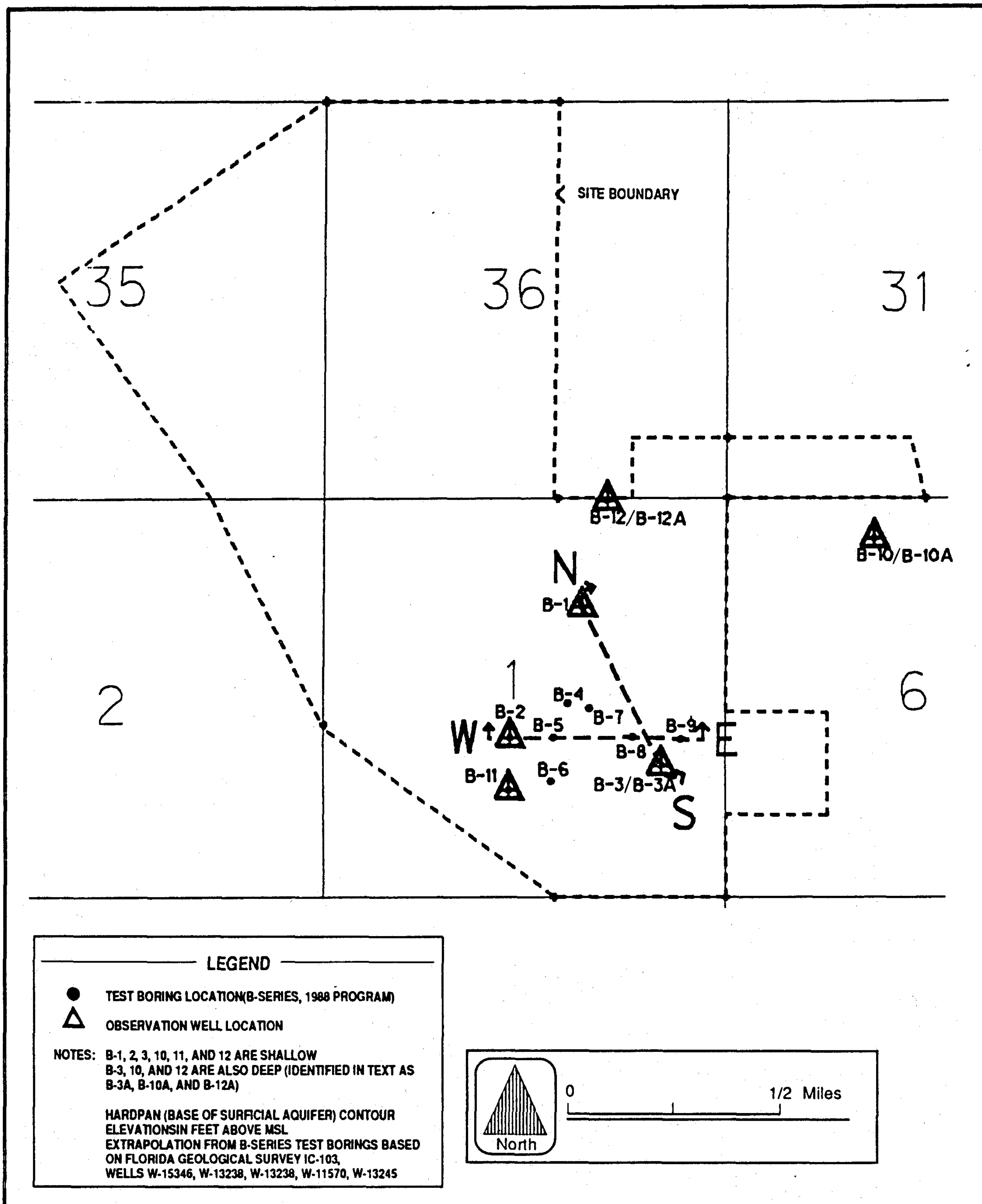


Figure 2.3.1-5 BORING LOCATION PLAN WITH CROSS-SECTION LINES

Hardee Power Station

The Upper Sand Unit is being mined and replaced with tailing sands on portions of the site. The material is a gray, fine grained sand which becomes browner and siltier with depth. The natural water content of these soils averages 12% and the percent fines ranged from 18 to 34% in 8 tests. Thickness of this unit is typically 1.5 to 3 m (5 to 10 ft) except in mined areas where it can be up to 8 m (25 ft) thick.

The Upper Confining Bed underlies the Upper Sand Unit and consists of sandy clay, clayey sand, and cemented sand layers. The unit is typically a light gray to tan clayey sand underlain by light gray to light brown sandy clay which may interfinger towards the base. Water contents range from 25-60% from 37 tests on these materials. Liquid limits averaging 90% and plastic limits averaging 30% were found in 27 tests. Dry densities from tube samples were extremely variable from 18 tests yielding total porosities of 30 to 70%. From 30 grain size tests, the percent fines ranged from 18 to 62%. Kaolinite, palygorskite, and montmorillonite clay minerals are present according to the literature and the presence of montmorillonite is confirmed by the very high liquid limits of 185% found in some samples. Cation exchange capacities are expected to be as high as 100 milliequivalents (meq)/100 grams (gms) for the clays which are predominant near the base of the upper confining bed. Near the top of the bed, where the clays are kaolinitic, the cation exchange capacity is expected to be only 5 to 15 meq/100 gms. The relationship between ion exchange capacity and movement of contaminants is discussed in Section 2.3.1.3. Three laboratory permeability tests ranged from a low of 7.4 x 10E-9 cm/sec to a high of 6.7 x 10E-6 cm/sec. Thickness ranges from 6 to 15 m (20 to 50 ft) at the site, although silty sand and even gravelly sand seams (the phosphate deposit) may be found as inclusions within this unit. Where mining has taken place, this unit may be as thin as 3 to 5 m (10 to 15 ft). Typically a hardpan or "pit bottom" of limestone or calcareous cement zone is found at depths of from 8 to 16 m (25 to 50 ft). These are materials of the Bone Valley formation.

The Intermediate Sand Unit is found directly underlying the Upper Confining Bed and consists of gray phosphatic sands and silts of the upper Hawthorn formation. The Water content ranged from 28% to 50%, the liquid limit was 74% (avg) and the plastic limit was 37% (avg) based on results of tests conducted on the clayey interbeds. This suggests that the cation exchange capacity of this layer is similar to that of the overlying clays; montmorillonite is present in the clay interbeds. Tests conducted on undisturbed tube sample gave total porosity values of 52% and 64% and percent fines ranged from 15 to 45%. This unit contains numerous beds which are similar to the layers above, but layers of gray to black fine grained sands with sandy silt are abundant enough to form an interconnected porous media which is 12 to 21 m (40 to 70 ft) thick on the site. Thin cemented layers and silty clay interbeds are characteristic inclusions.

The Lower Confining Bed that underlies the Intermediate Sand Unit consists of clayey sands and silts of the lower Hawthorn formation. Tests performed on samples collected from this layer show water content ranging from 41% to 53%, an average liquid limit of 60%, plastic limit of 38%, and percent fines ranged from 35 to 60%. These beds include silty clay, phosphatic clayey sand, clay, sandy clays, sand and clay, and sand with brown clay near the base. Very thin carbonate beds and calcareous cemented interbeds are found throughout this unit. Based on boring data this unit appears to be 24 to 30 (80 to 100 ft) thick at the site.

The Carbonate Unit underlies the Lower Confining Bed and consists of dolomite and limestone of the lowermost Hawthorn and Tampa formations. This unit occurs where the carbonate layers became relatively massive or where 50% of the section is dominated by carbonate beds. This can be a white limestone to a gray dolomite with occasional chert. In boring P-12A this unit was as thin as 3.3 m (11 ft).

2.3.1.3 Geologic Maps

Soils have been mapped in both Polk County and Hardee County by the U.S. Department of Agriculture in cooperation with the county soil conservation services (USDA, 1984; and Polk County SCS, unpublished, 1988). The site occurs predominantly with the Smyrna-Myakka-Ona general soil grouping which consists of nearly level, poorly drained soils that are sandy throughout and that have a dark colored subsoil at a depth of less than 76 cm (30 inches). Individual soil mapping units include Smyrna sand, Myakka fine sand, Ona fine sand, Basinger fine sand, Ft. Green fine sand on 2 to 5% slopes, Immokalee fine sand, Wabasso fine sand, Placid fine sand (depressional, in sinkholes), Samsula muck, and Bradenton-Fleda-Chobee association (frequently flooded, in wetlands). In Polk County, areas of mined land are described as:

> #11 - Arents - Water complex consists of overburden material (material removed to get to the "matrix" material or phosphate bearing strata) piled into mounds of narrow ridges with very steep sides separated by narrow pits that may or may not contain water. The water table of this complex is variable but primarily the arents part has a water table greater than 2 m (80 inches) from the surface.

This statement describes the present topography and soils at the site prior to reclamation and construction.

The lowest point on the site is at Elevation +30 m (+100 ft) where Payne Creek flows southeastward from the extreme southern end of the site. The floodplain of Payne Creek forms the southwestern boundary of the site and the elevations raise up somewhat steeply to Elevation +35 m (+115 ft). The land slopes gently upward towards the north and northeast at a fairly uniform grade to a maximum elevation +42 m (+137 ft) at the extreme northeastern corner of the site. Several circular depressions are shown on the air-photos and topographic maps which predate the mining activity. These features are discussed in Section 2.3.2.2.

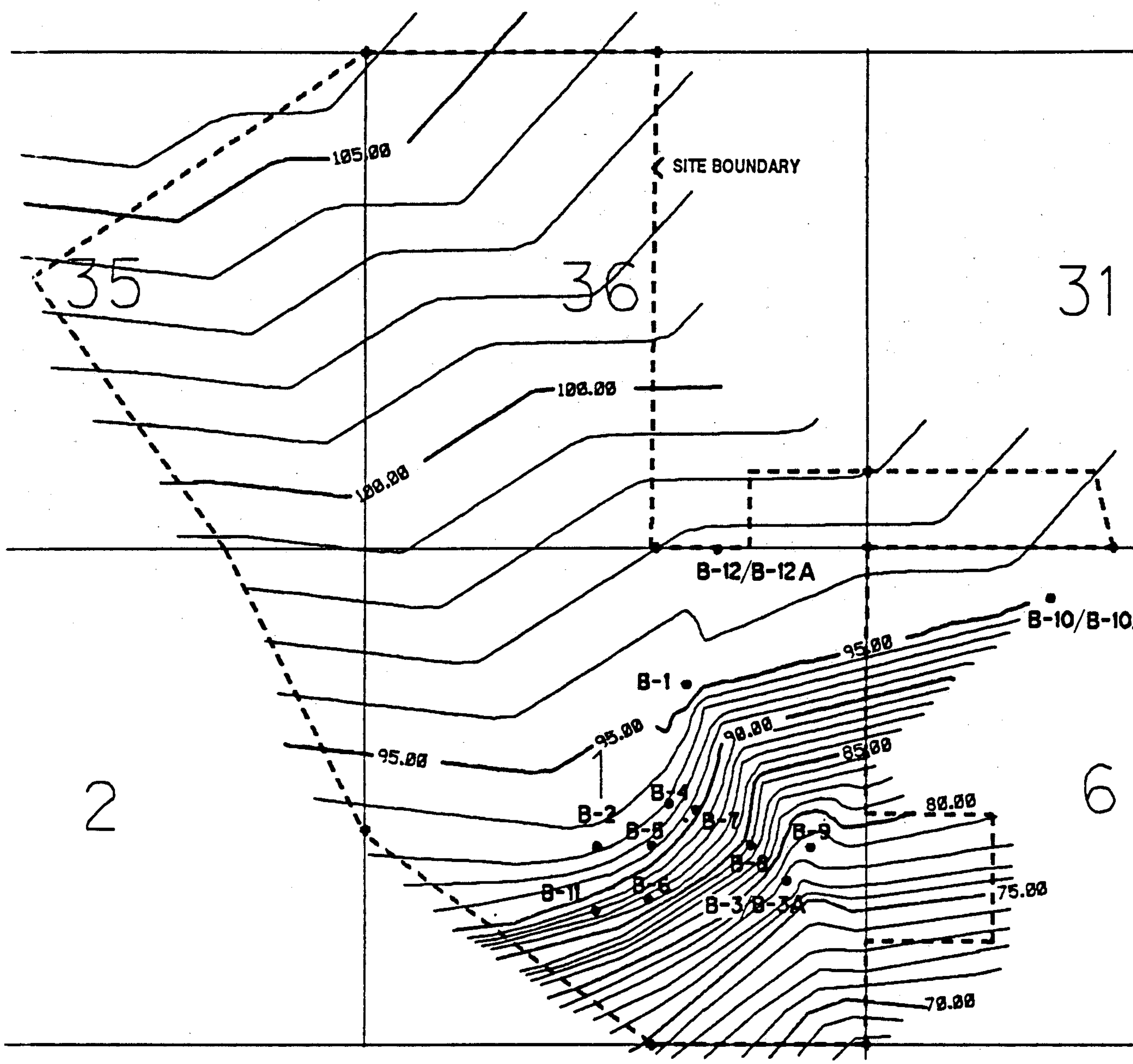
Polk County has been geologically mapped in detail (Campbell, 1986) while Hardee County has not. Significant geologic units in the site area (Brooks, 1981) include mainly the Pliocene Bone Valley (Pbv) formation which is mapped in the site area. To the east along the Peace River, the Miocene Hawthorn (Mh2) formation is mapped, and to the south of the site deposits are mapped as Miocene Hawthorn of the Statenville Type (Mh3).

Differentiating the uppermost Unnamed Sand unit from the Bone Valley member is based on a noticeable change in clay content. Typically the top of the Bone Valley is represented by a clayey sand often yellowish gray and poorly indurated. Since this clayey sand is only 1.5 m (5 ft) thick and occasionally underlain by a white to light gray fine grain sand, it can not be relied upon as a confining bed. Presence of ditch drains (see Section 4.1.4) and deeper mine pits on site provide an interconnection between the recent sand deposits and the sand units contained within the Bone Valley member. For these reasons, the most significant geologic horizon is the "hardpan" or "pit bottom" strata where calcareous cementation marks the first Hawthorn Group carbonate.

Figure 2.3.1-5 shows the boring location plan for the site. It also includes locations of cross sections and piezometers. Figure 2.3.1-6 shows the elevation of geologic "hardpan" layer which separates the water table aquifer from the intermediate confined aquifer.

2.3.1.4 Bearing Strength

Ten test borings (B-1 through B-10) were executed near the power plant site and two (B-5 and B-6) were drilled in the power block area. Test borings, using the standard penetration test were performed in accordance with ASTM-D1586. The bearing strengths of the overburden soils were determined from standard penetration tests (performed in accordance with ASTM D1586) in the coarser material and unconsolidated undrained triaxial compression tests (per ASTM 2850) in the finer material. The coarser material had blow counts



CROSS SECTION LOCATIONS (FIG. 2.3-2, 2.3-3)

TEST BORING LOCATION(B-SERIES, 1988 PROGRAM)

OBSERVATION WELL LOCATION

NOTES: B-1, 2, 3, 10, 11, AND 12 ARE SHALLOW
B-3, 10, AND 12 ARE ALSO DEEP (IDENTIFIED IN TEXT AS B-3A, B-10A, AND B-12A)

HARDPAN (BASE OF SURFICIAL AQUIFER) CONTOUR ELEVATIONSIN FEET ABOVE MSL
EXTRAPOLATION FROM B-SERIES TEST BORINGS BASED ON FLORIDA GEOLOGICAL SURVEY IC-103,
WELLS W-15346, W-13238, W-13238, W-11570, W-13245

North

0 1/2 Miles

Figure 2.3.1-6 GEOLOGIC MAP OF HARDPAN

Hardee Power Station

varying from five blows per foot to over 50 blows per foot, with the higher blow count material generally indicating a cemented layer. The shear strengths and settlement characteristics of the finer materials were determined through triaxial and consolidation testing, performed in accordance with ASTM D2850 and D2435 respectively, and in situ dilatometer tests. The dilatometer tests were performed in accordance with the recommendations of ASTM subcommittee D18.02.10. These results are included in Appendix 11.4. The strength of the Hawthorn Formation was determined from standard penetration tests. The blow counts were generally greater than 50 blows per ft indicating well compacted material.

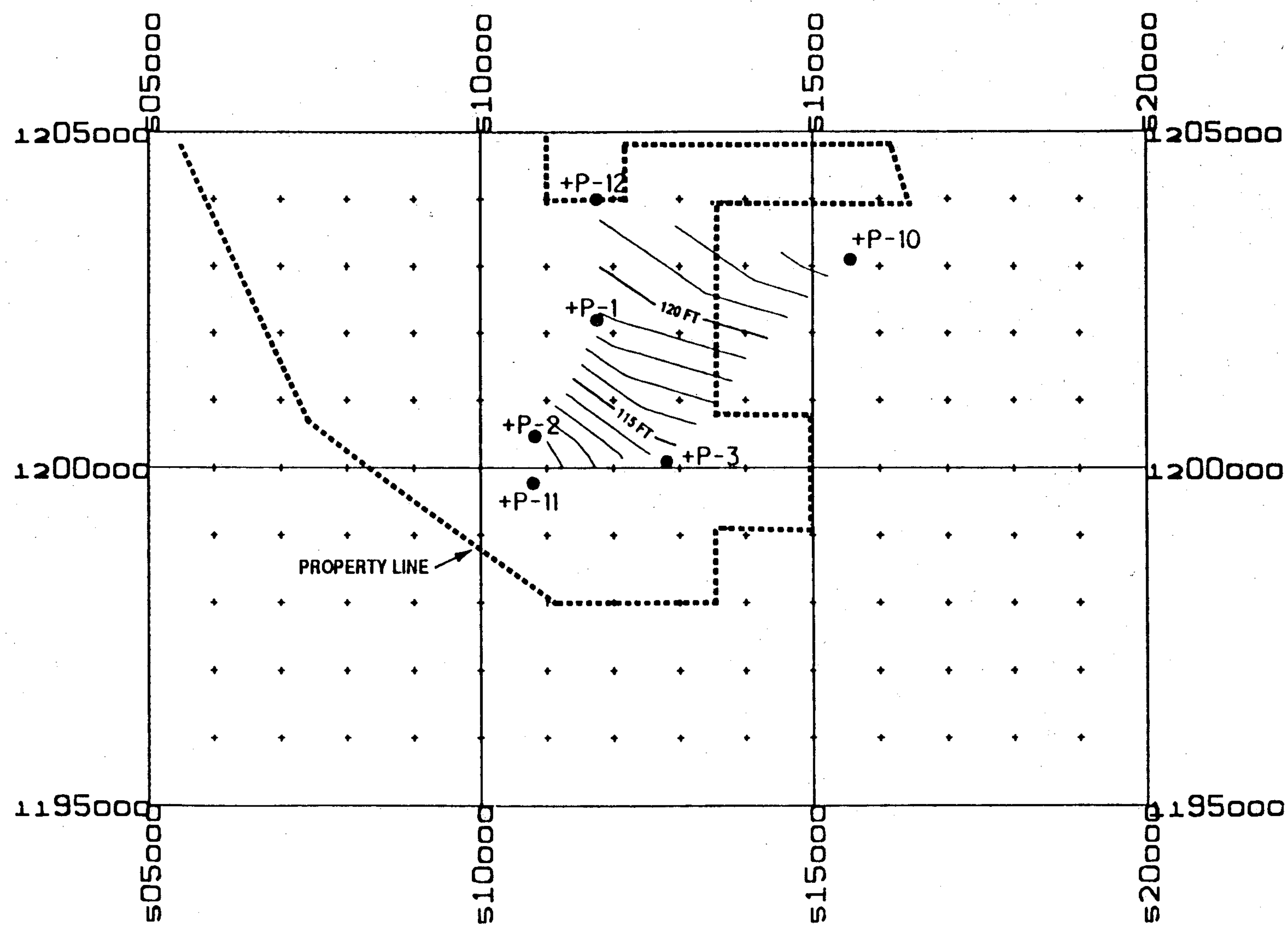
The main plant structures, while relatively lightly loaded, have stringent settlement requirements. Using mat foundations, the estimated settlements will exceed those requirements, primarily due to the compressible shallow clay deposits. Therefore, foundations for the main plant structures will be supported on either driven displacement piles with predrilling or auger cast piles. The displacement piles will enact friction and end bearing for resistance, while the auger cast pile will enact only friction for resistance. Both pile types will be placed to an approximate depth of 15 m (50 ft). More lightly loaded structures may be founded on shallow spread footings. Tanks will be founded on ring-beam footings.

2.3.2 Subsurface Hydrology

2.3.2.1 Subsurface Hydrologic Data for the Site

SHALLOW AQUIFER

Groundwater on this aquifer is classified as G-II. The shallow water table was monitored at the site at six locations (see Figure 2.3.1-5) using 5.1 cm (2-inch) PVC observation wells. These wells have 1.5 m (5 ft) screens at depths of 4.5 to 6 m (15 to 20 ft) below ground. (See Appendix 11.4 for well construction details.) Figure 2.3.2-1 shows the time dependent shallow water table contours across the site. Horizontal gradients are 0.00267 m/m. Falling head borehole permeability testing was conducted in these



NOTE: COORDINATES SHOWN ARE FLORIDA EAST STATE PLANE COORDINATES,
IN FEET CONTOUR INTERVAL EQUALS 1.0 FEET
PR2: (300,147) SITE.DGN

Figure 2.3.2-1 POTENTIOMETRIC SURFACE OF THE WATER TABLE AQUIFER (DECEMBER 1988)

Hardee Power Station

piezometers on December 11, 1988. Results are shown in Table 2.3.2-1. The objective of these tests was to determine the permeability and hydrologic characteristics of the shallow groundwater aquifer. Continuous monitoring of this aquifer such as at the SWFWMD #40 shallow well near Duette, Florida, indicated that the water levels in the surface water aquifer fluctuated approximately 1.5 m (5 ft) during a 5-year period of record.

Flows in the shallow aquifer are generally towards Payne Creek to the south at a typical rate of 0.5 millimeters (mm) per day. Saturated flows closely parallel the top of the clayey sand which is considered to be the top of the Bone Valley formation.

Data from a total of 13 pump tests within a 24 km (15 miles) radius of the site were obtained from SWFWMD (SWFWMD, 1988, Table 4). These tests suggest that for the shallow aquifer, the coefficient of transmissibility (T) equals 1,500 square ft per day and that the specific yield (Sy) equals 0.13 or 13% by volume. The ratio of horizontal to vertical hydraulic conductivity is on the order of 200.

Water quality in the shallow aquifer is highly dependent on the surface activities and the chemical makeup of the rainfall. Based on the SWFWMD (SWFWMD, 1988, Figure 20) ambient groundwater quality monitoring program, the following regional trends are considered as background levels: total dissolved solids (TDS) is expected to be less than 250 milligrams/liter (mg/L) total hardness (TH) less than 180 mg/L; chlorides (Cl) less than 25 mg/L and sulfates (SO_4) less than 25 mg/L. Site specific water quality parameters were confirmed in February and March 1989, with results listed in Table 2.3.2-2. Pertinent parameters tested met primary and secondary drinking water standards.

Table 2.3.2-1. Results of Permeability Testing of Shallow Water Table Observation Wells at the Hardee Power Station Site (December 1988)

Piezometer No.	Ground Surface Elevation (ft) Mean Sea Level	Ground Water Elevations (ft) Mean Sea Level	Permeability (cm/sec)
P-1	122.3	118.8	2.0 x 10E-4
P-2	114.2	109.4	2.0 x 10E-4
P-3	121.7	114.3	4.9 x 10E-4
P-10	127.4	123.9	1.3 x 10E-4
P-11	113.1	109.8	1.7 x 10E-4
P-12	126.3	121.7	3.2 x 10E-4

Table 2.3.2-2 Water Quality Characteristic of the Shallow Aquifer at the Hardee Power Station Site (February/March 1989)

Parameters	Well Number P3*	Well Number P12*
Total Alkalinity, mg/L as $CaCO_3$	6.0	12.0
Chloride, mg/L	15.5	24.2
Nitrate+Nitrite Nitrogen, mg/L	<0.005	0.009
Ortho-Phosphorous	0.980	1.70
Silica, Total mg/L	16.8	21.2
Silica, Dissolved mg/L	5.21	9.83
Total Dissolved Solids, mg/L	78.7	111
Total Suspended Solids, mg/L	93.3	694
Specific Conductance, umhos/cm	120	222
Sulfate, mg/L	4.1	3.2
Total Calcium, mg/L	10.8	26.3
Total Iron, mg/L	7.9	10.3
Total Magnesium, mg/L	3.0	6.7
Total Manganese, ug/L	14	12
Total Potassium, mg/L	0.96	1.77
Total Sodium, mg/L	7.5	16.6
Dissolved Iron, mg/L	0.67	2.37
Dissolved Manganese, ug/L	4.0	6.0

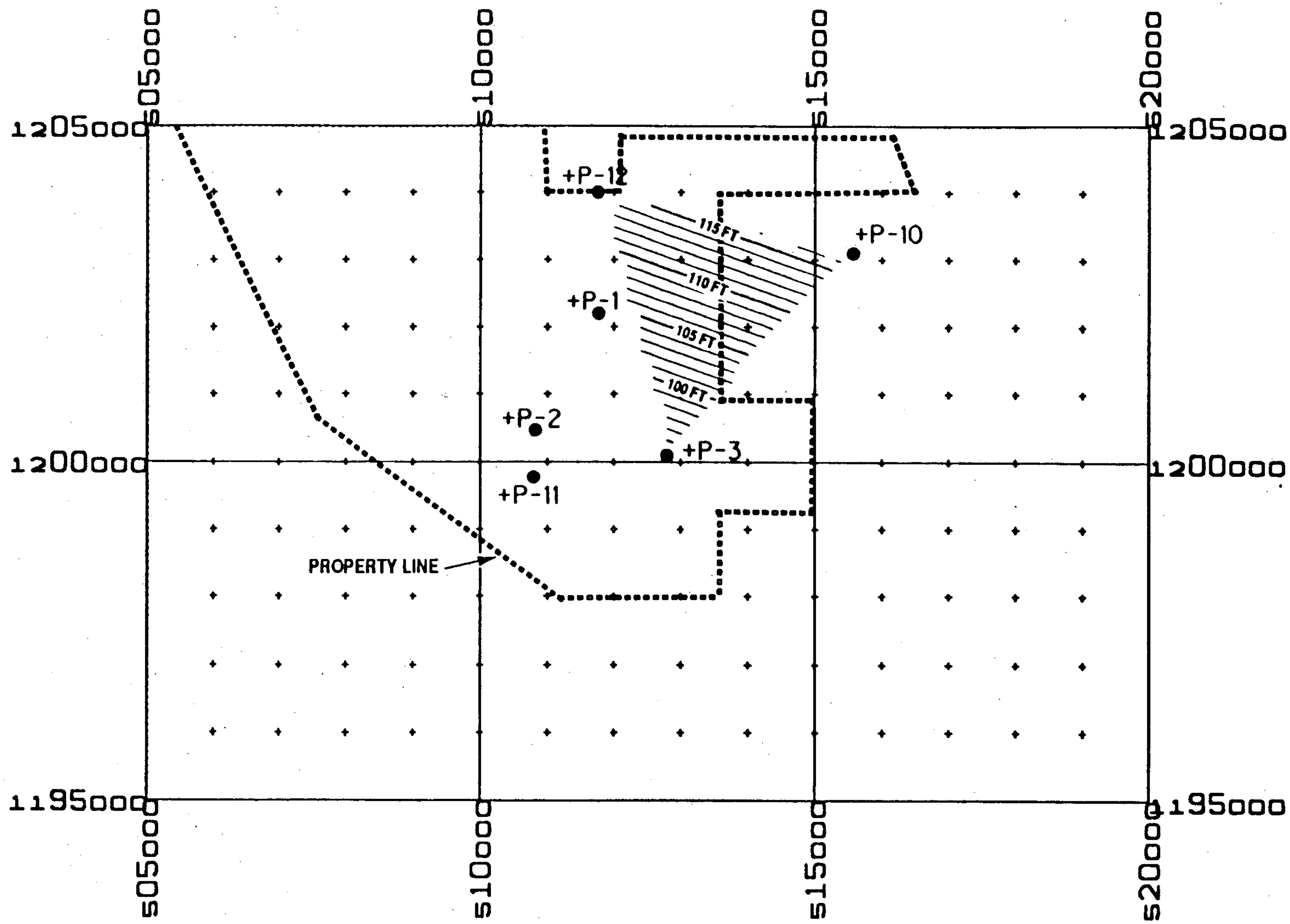
* These wells are 30 feet below present existing grade

INTERMEDIATE AQUIFER

The Intermediate aquifer was monitored at the site at three locations (B-3A, B-10A and B-12A) using 2-inch PVC observation wells. These wells were screened between depths of 30 and 60 m (100 and 200 ft) below existing grade. (For construction details, see Section 10.5.3.) Figure 2.3.2-2 shows the time dependent intermediate aquifer piezometric contours across the site. Horizontal gradients were 0.00625 m/m. Falling head borehole permeability testing was conducted in these piezometers on December 11, 1988 to determine the permeability and hydrologic characteristics of the intermediate aquifer. Results are shown in Table 2.3.2-3. When B-3A was developed, the groundwater level was measured at an elevation of 29.7 m (97.3 ft). This elevation was slightly lower than the reported average elevation range [30.4 to 33.5 m (100 to 110 ft)] of the intermediate aquifer (SWFWMD, 1988) and the measured elevations at piezometers B-10A and B-12A. Measurements taken later indicate that groundwater at B-3A was at an elevation of 16.7 m (54.7 ft) suggesting that the piezometer was drilled and developed in the Upper Floridan Aquifer reported by SWFWMD (1988) to have an average range in elevation of 15.2 to 18.3 m (50 to 60 ft).

A total of nine pump tests within a 24 km (15 miles) radius of the site were obtained from SWFWMD (SWFWMD, 1988, Table 4). These tests suggest that for the intermediate aquifer, the coefficient of transmissibility (T) equals 2,400 square ft per day; storativity (S) equals 0.0002; and leakance coefficient (L) equals 0.0002 cu ft per day per cu ft. The ratio of horizontal to vertical hydraulic conductivity is on the order of 2000.

Based on the SWFWMD (1988, Figure 27) ambient groundwater quality monitoring program, the following regional trends are considered as background levels: total dissolved solids (TDS) is expected to be between 200 and 300 mg/L; total hardness (TH) less than 120 mg/L; chlorides (Cl) less than 25 mg/L; and sulfates (SO4) less than 25 mg/L. Site specific water quality results



NOTE: COORDINATES SHOWN ARE FLORIDA EAST STATE PLANE COORDINATES,
IN FEET CONTOUR INTERVAL EQUALS 1.0 FEET
PR2: (300,147) SITE.DGN

Figure 2.3.2-2 POTENTIOMETRIC SURFACE OF THE INTERMEDIATE AQUIFER (DECEMBER 1988)

Hardee Power Station

Table 2.3.2-3. Results of Permeability Testing of Intermediate Aquifer Observation Wells at the Hardee Power Station Site (December 1988)

Piezometer No.	Ground Surface Elevation (ft) Mean Sea Level	Ground Water Elevations (ft) Mean Sea Level	Permeability Centimeters/second
B-3A	121.7	93.7*	4.4 x 10E-5
B-10A	127.4	117.2	1.7 x 10E-5
B-12A	126.3	114.8	9.3 x 10E-6

* Depth to water dropped to EL. 54.7 Ft. on 2/16/89 suggesting that this is a Floridan Aquifer observation well.

are listed in Table 2.3.2-4. The sampled parameters generally meet state drinking water quality standards.

FLORIDAN AQUIFER

The Floridan Aquifer is presently not monitored at the site. Figure 2.3.2-3 shows the piezometric contours for the Floridan Aquifer in May 1987. Continuous monitoring, such as at the SWFWMD Romp #40 Avon Park well near Duette, Florida, indicated that the water levels in the Floridan Aquifer can fluctuate approximately 8.5 m (28 ft) during a 5-year period of record. Periodic monitoring results in 2 Floridan wells approximately 2.4 km (1.5 miles) from the site are shown in Figure 2.3.2-4.

Flows in the Floridan Aquifer are generally towards Payne Creek to the south-southwest. Saturated flows are thought to be concentrated in the fractured rock zone in the Avon Park carbonates.

Data from a total of 11 pump tests within a 24 km (15 mile) radius of the site were obtained from SWFWMD (SWFWMD, 1988, Table 4). These tests indicated that for the Floridan Aquifer T equals 133,000 square ft per day, S equals 0.0014, and L equals 0.00015 cu ft per day per cu ft. The ratio of horizontal to vertical hydraulic conductivity is on the order of 2.

Water quality in the Floridan Aquifer is dependent on the recharge from the overlying aquifers. Based on the SWFWMD (SWFWMD, 1988, Figure 36) ambient groundwater quality monitoring program, the following regional trends are considered as background levels: TDS is expected to be between 200 and 300 mg/L; total hardness (TH) between 120 and 180 mg/L; CL less than 25 mg/L; and SO_4, 25 and 250 mg/L range. Additional water quality characteristics are provided in Table 3.5.1-1, based on available data collected offsite.

Table 2.3.2-4 Water Characteristics (Inorganics) at the Hardee Power Station Site for Intermediate Aquifer (February/March 1989) Page (1 of 2)

Parameters	Well Number P12A
Total Alkalinity, mg/L as CaCO3	216
Chloride, mg/L	27.9
Nitrate+Nitrite Nitrogen, mg/L	0.072
Ortho-phosphorous	0.034
Silica, total mg/L	58.1
Cyanide, mg/L	<0.004
Total dissolved solids, mg/L	327
Total Suspended solids, mg/L	23
Specific Conductance, umhos/cm	458
Sulfate, mg/L	21
Fluoride, mg/L	1.80
MBAS, mg/L	0.14
Ammonia Nitrogen, mg/L	0.33
TKN, mg/L	0.79
Oil and Grease, mg/L	<5
BODm, mg/L	5.4
COD, mg/L	<10
Turbidity, NTU	6.8
Aluminum, ug/L	67
Antimony, ug/L	<10
Arsenic, ug/L	2.0
Beryllium, ug/L	<2
Cadmium, ug/L	0.5
Calcium, mg/L	43.0
Chromium, ug/L	<11
Copper, ug/L	<7
Iron, ug/L	198
Lead, ug/L	<3
Magnesium, mg/L	19.8
Manganese, ug/L	<6
Mercury, ug/L	<0.2
Nickel, ug/L	<26
Potassium, mg/L	4.4
Selenium, ug/L	<2
Silver, ug/L	<0.05
Sodium, mg/L	35.6
Zinc, ug/L	18.0
Phenols, ug/L	<5
Aldrin, ug/L	<0.003
Dieldrin, ug/L	<.0003
Chlordane, ug/L	<.01
4,4'DDT, ug/L	<.001
Demeton, ug/L	<.1

Table 2.3.2-4 Water Characteristics (Inorganics) at the Hardee Power Station Site for Intermediate Aquifer (February/March 1989) Page (2 of 2)

Parameters	Well Number P12A
Endosulfan, ug/L	<.003
Endrin, ug/L	<.004
Guthion, ug/L	<.01
Heptachlor, ug/L	<.001
Lindane, ug/L	<.01
Malathion, ug/L	<.1
Methoxychlor, ug/L	<.03
Myrex, ug/L	<.001
Parathion, ug/L	<.04
2,4-D, ug/L	<10
Silvex, ug/L	<20
Toxaphene,, ug/L	<.005
PCB-1016, ug/L	<.001
PCB-1221, ug/L	<.001
PCB-1232, ug/L	<.001
PCB-1242, ug/L	<.001
PCB-1248, ug/L	<.001
PCB-1260, ug/L	<.001
Chlorinated Hydrocarbons	
2-Chloronapthalene, ug/L	<10
1,2-Dichlorobenzene, ug/L	<10
1,3-Dichlorobenzene, ug/L	<10
1,4-Dichlorobenzene, ug/L	<10
Hexachlorobenzene, ug/L	<10
Hexachlorobutadiene, ug/L	<10
Hexachlorocyclopentadiene, ug/L	<10
Hexachloroethane, ug/L	<10
1,2,4-Trichlorobenzene, ug/L	<10
Gross Alpha, pc/L	2.2±2.3
Gross Beta, pc/L	5.7±4.2
Radium 226, pc/L	4.1±0.1
Radium 228, pc/L	0.0±1.0
Strontium 90,pc/L	<0.5

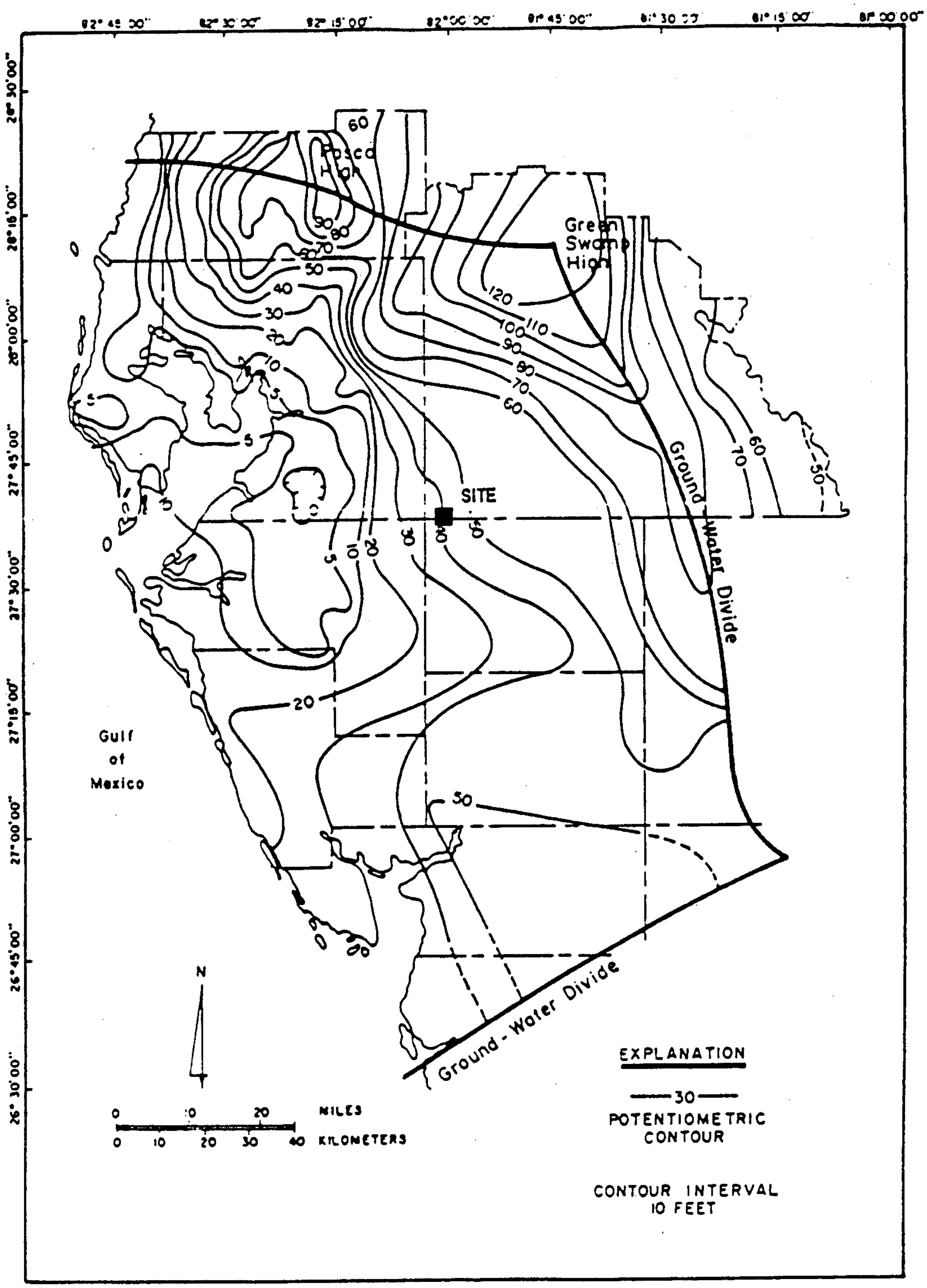


Figure 2.3.2-3 POTENTIOMETRIC SURFACE - FLORIDAN AQUIFER (MAY 1987)

Hardee Power Station

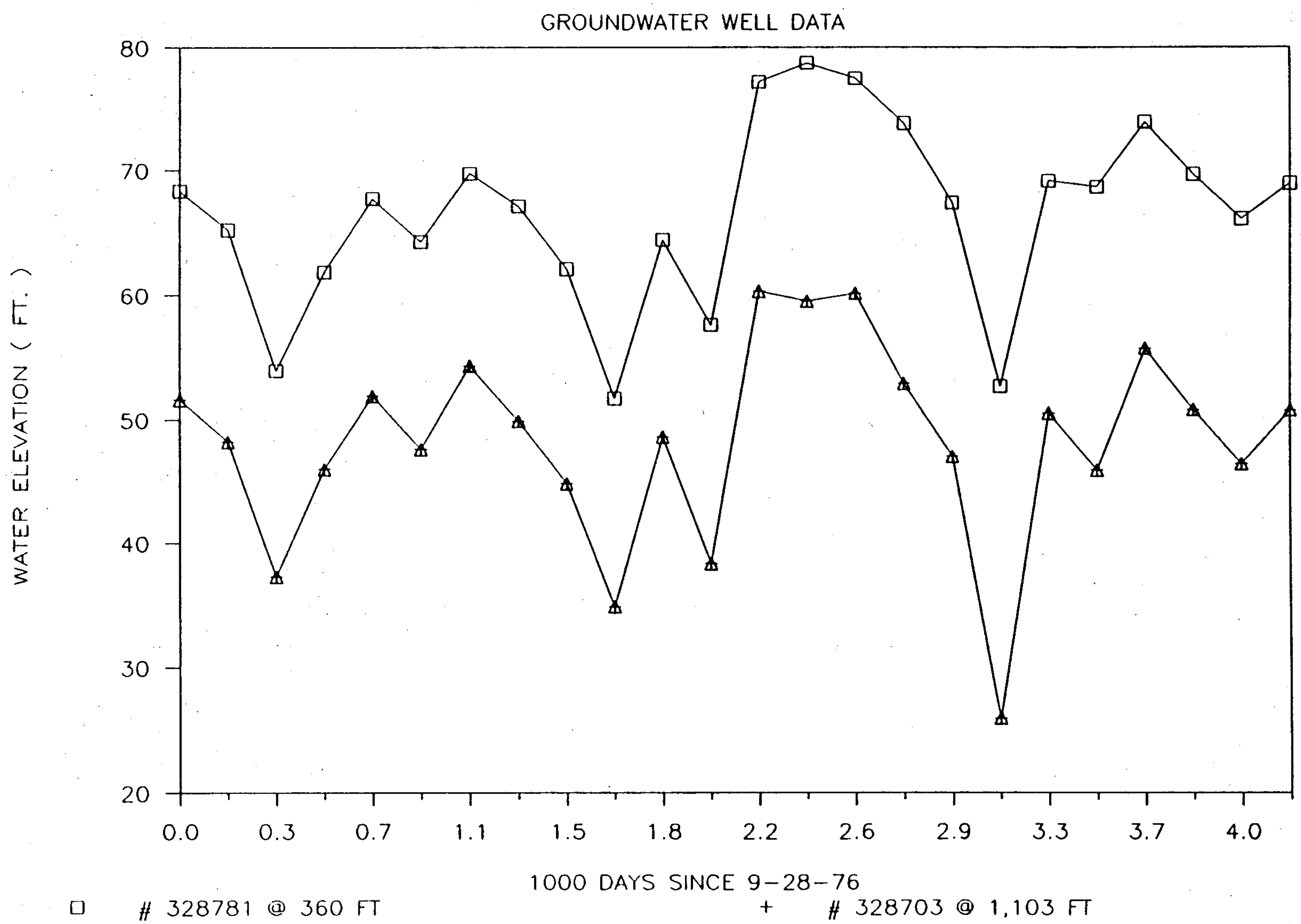


Figure 2.3.2-4 WATER LEVEL FLUCTUATIONS IN THE FLORIDAN AQUIFER FROM WELLS IN THE VICINITY OF THE HARDEE POWER STATION

SOURCE: AGRICO PERSONAL COMMUNIQUE, 1989.

Hardee Power Station

CHARACTERISTIC CONFINING UNITS

The Upper Confining Bed as described in Section 2.3.1.2 separates the Shallow Surface aquifer above from the Intermediate aquifer below. Recharge to the Intermediate aquifer through the Upper Confining Bed is classified as none to very low, perhaps ranging from 0 to 25 cm (0 to 10 inches) per year. The predominant recharge area near the site is the Lakeland Ridge in southwest Polk County.

The Lower Confining Bed as described in Section 2.3.1.2 separates the Intermediate aquifer above it from the Floridan (Carbonate) aquifer below. Recharge to the Floridan Aquifer through the Lower Confining Bed is classified as very low, ranging from 5 to 25 cm (2 to 10 inches) per year. This is in areas where the Intermediate aquifer piezometric level is high, producing a vertical gradient towards the deeper aquifer.

2.3.2.2 Karst Hydrogeology

The site area falls into the area of Central Florida Karst where cover collapse sinkholes dominate (Sinclair, et al., 1985). This area consists of cohesive sediments interlayered with discontinuous carbonate beds. A major tenet of karst development theory is that active solution enlargement of voids in carbonate rock occurs above the water table. When the site area was subjected to significant sea level changes during the Pleistocene epoch, karst activity was possible. Sea level stands at elevation (El) +45 m (+150 ft). (Okefenokee Shoreline), El +30 m (+100 ft) (Wicomico Shoreline), El + 9 m (+30 ft) (Pamlico Shoreline), and El +2 m (+8 ft) (Silver Bluff Shoreline) would presumably effect the deposits above those elevations. From the deep borings on the site, these elevations are represented by the calcareous layers in the Hawthorn formation. The Lower Carbonate Unit at El-30 m (-100 ft) is very deep and removed from any threat of current karstic activity.

All apparent sink features in the proposed plant vicinity were identified and ground-truthed. Most karst features identified are shallow and are located outside the main plant area, although some are within the cooling reservoir area (see Appendix 11.4 for exhibit and descriptions). Initial subsurface explorations conducted in the plant area though December 1988 did not reveal significant solutioning of the surfaces of the Hawthorn and surficial soils.

Topographic depressions near the site are typically 5 to 10 acres in size and are roughly circular. They are aligned according to an east-northeast fracture trend related to sinkhole activity in the past.

Based on current field operations, the effects of paleokarst features on the power plant are not expected to be significant and can be minimized with proper foundation design. The cooling reservoir is also not expected to be significantly impacted by paleokarst features. This assessment is consistent with Agrico's experience in the area. Agrico has indicated that the paleokarst features and sinkhole formation have not affected their clay settling ponds, reclamation lakes, or foundations.

2.3.3 Site Water Budget and Area Users

2.3.3.1 Site Water Budget

Components of the existing site water budget include precipitation, evaporation and evapotranspiration, runoff, and groundwater recharge. The nearest long-term climatological data collection station is located at Wauchula, Florida, approximately 14 km (9 miles) from the site.

Long-term monthly precipitation data at Wauchula for the period 1933 through 1988 were obtained from the SWFWMD and the National Oceanic and Atmospheric Administration (NOAA). The monthly data from Wauchula are given in Appendix 11.5.1. Data on long term monthly averages, maximums, and minimums is summarized in Table 2.3.3-1. The annual precipitation averages 135 cm

Table 2.3.3-1. Monthly and Annual Precipitation Averages and Extremes at Wauchula, Florida, 1933-1988

Month	Average	Maximum	Minimum
January	2.15	7.84	0.03
February	2.85	8.92	0.19
March	3.12	9.22	0.08
April	2.48	8.26	0.00
May	4.30	11.32	0.01
June	8.88	18.42	2.40
July	8.69	15.54	2.21
August	7.24	15.53	2.66
September	7.29	18.06	1.19
October	2.81	10.36	0.00
November	1.74	11.18	0.02
December	1.76	5.51	0.00
Annual	53.33	83.48	36.66

Note: All units in inches.

Sources: Southwest Florida Water Management District, 1988.
NOAA, 1988.

(53.33 inches) per year with the highest precipitation in the summer months (June, July, August, and September) and the lowest in late fall/winter (November and December); however, the entire period from October to May is subject to periods of extended and significant drought.

The estimated monthly evapotranspiration rates for the site are given in Table 2.3.3-2. Evapotranspiration estimates were prepared using published potential evapotranspiration rates for Tampa, Florida (Institute of Food and Agricultural Sciences, 1983) and an average annual plant coefficient of 70%. The estimated monthly evapotranspiration rates range from 4.6 cm (1.8 inches) per month in December to 11.2 cm (4.4 inches) per month in May.

Monthly temperature normals were also available at Wauchula for the period 1941 to 1970, and are presented in Table 2.3.3-2. Highest temperature normals occur in July and August of 27.4 and 27.6°C (81.3 and 81.6°F) and lowest in January of 16.6°C (61.8°F). The additional climatic parameters of dew point temperature, relative humidity, evaporation, and wind speed were also determined for the site area and are summarized in Table 2.3.3-2.

2.3.3.2 Area Users

There are no major municipal water users within 8 km (5 miles) of the site. The Bowling Green municipal waterworks is the closest major wellfield to the site. This wellfield is permitted for an average pumpage of less than 18.9 million liters (5 million gallons) per day. The Bowling Green wellfield is 9.7 to 11.3 km (6 to 7 miles) from the proposed site.

The only industrial users near the site are CFI and Agrico. CFI operates two deep process water make-up wells, and one drinking water well at their Hardee Complex east of the site. Agrico has four potable water wells in the vicinity. None is closer than 4 km (2.5 miles) from the plant site and all are more than 120 m (400 ft) deep.

Table 2.3.3-2. Estimated Climatic Conditions at the Hardee Power Station Site

Item	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Average
Monthly Temperature Normals[1]	Degrees F	61.8	63.1	67.1	72.1	76.6	80.2	81.3	81.6	80.2	74.7	67.4	62.7	--	72.4
Average Dew Point Temperature	Degrees F	53	54	57	60	67	72	73	73	72	66	58	54	--	63.3
Relative Humidity	%	73	72	70	66	72	76	76	75	76	74	72	73	--	73
Daily Average Wind Speed	mph	7	8	9	8	7	6	6	6	6	7	7	8	--	7
Evapotranspiration															
Potential	Inches/month	2.70	3.27	4.48	5.56	6.29	5.87	5.68	5.32	4.80	4.32	3.18	2.61	54.08	--
Estimated Actual[2]	Inches/month	1.9	2.3	3.1	3.9	4.4	4.1	4.0	3.7	3.4	3.0	2.2	1.8	37.9	--

Notes: 1. Temperature normals based on 1941-70 data from Wauchula station.
2. Actual ET based on an average annual crop coefficient of 0.7.

Sources: Institute of Food and Agricultural Sciences, U of F, 1979.
Institute of Food and Agricultural Sciences, U of F, 1983.

Approximately 46 permitted wells lie within 1.6 km (1 mile) of the site boundaries. The well construction permit listing for the four townships surrounding the site (SWFWMD, 1989) is shown in Table 2.3.3-3. The wells tap the Surficial Aquifer at depths of 6 to 9 m (20 to 31 ft), the Intermediate Aquifer is tapped at depths of 60 to 90 m (200 to 300 ft), and the Floridian aquifer at depths greater than 120 m (400 ft). Only these wells listed as "D" in Table 2.3.3-3 are potable water wells.

2.3.4 <u>Surficial Hydrology</u>

2.3.4.1 Hydrologic Characterization

PHYSICAL CHARACTERISTICS

The proposed Hardee Power Station site is in the Polk Upland physiographic region with land surface elevations ranging from 30 to 40 m (100 to 130 ft) above sea level (SWFWMD, 1988). The site is near the headwaters of Payne Creek, approximately 16 km (10 miles) from the confluence of the creek with the Peace River. This confluence is approximately 129 km (80 miles) from the mouth of the Peace River at Charlotte Harbor on the Gulf of Mexico. Payne Creek, in the site vicinity, is a meandering stream with a well defined channel under average flow conditions. Stream dimensions vary from 3 to 6 m (10 to 20 ft) wide with a maximum channel depth of approximately 1.5 m (5 ft). Beyond the channel the creek flows within a broad floodplain, as shown in Figure 2.3.4-1. Data in this figure were developed by combining on site vertical survey information in the immediate vicinity of the creek with data from 1:24000 USGS topographic maps.

Payne Creek and the Peace River to Charlotte Harbor are classified as Class III surface waters (Chapter 17-3, F.A.C.). Charlotte Harbor is classified as a Class II surface water (Chapter 17-3, F.A.C.).

The site consists of gently sloping terrain with gradients from 0% to 6% in the direction of Payne Creek (see Figure 2.3.4-2). Several wetland areas exist on or adjacent to the site with individual drainage ways to Payne

Table 2.3.3-3. Well Construction Permits Within One Mile of the Hardee Power Station

Permit No.	Town + Range	Section	Type*	Well Depth (ft)	Diameter (Inches)
384602	T33S R24E	6	I	275	4
471408	T33S R24E	6	O	21	2
472077	T33S R24E	6	O	223	2
423405	T33S R24E	6	Y	125	4
329524	T33S R24E	7	D	310	4
355801	T33S R24E	7	D	310	4
335749	T33S R24E	7	I	1205	24
473418	T33S R24E	7	O	NR	2
473419	T33S R24E	7	O	NR	2
473420	T33S R24E	7	O	NR	2
473421	T33S R24E	7	O	NR	2
328764	T33S R24E	7	T	31	6
331684	T33S R23E	1	I	125	4
471411	T33S R23E	1	O	21	2
471412	T33S R23E	1	O	21	2
471413	T33S R23E	1	O	21	2
471414	T33S R23E	1	O	21	2
471415	T33S R23E	1	O	21	2
472078	T33S R23E	1	O	238	2
472080	T33S R23E	1	O	246	2
473508	T33S R23E	1	Y	NR	2
473679	T33S R23E	1	Y	NR	6
444614	T33S R23E	2	Z	600	6
444615	T33S R23E	2	Z	600	6
324042	T33S R23E	11	D	260	4
324043	T33S R23E	11	D	260	4
412278	T32S R23E	25	Y	600	6
432020	T32S R23E	25	Y	380	6
362163	T32S R23E	25	Z	380	6
362164	T32S R23E	25	Z	600	6
432016	T32S R23E	25	Z	600	6
432017	T32S R23E	25	Z	600	6
432018	T32S R23E	25	Z	600	6
433278	T32S R23E	26	Z	600	6
444609	T32S R23E	36	Z	600	6
444610	T32S R23E	36	Z	NR	6
435892	T32S R24E	30	Y	600	6
388591	T32S R24E	30	Z	600	6
409378	T32S R24E	30	Z	600	6
409379	T32S R24E	30	Z	600	6
432018	T32S R24E	30	Z	600	6
435385	T32S R24E	30	Z	600	6
440299	T32S R24E	31	Y	600	6
440300	T32S R24E	31	Y	520	6
409380	T32S R24E	31	Z	600	6
425462	T32S R24E	31	Z	600	6

* O = observation well; I = industrial well; T = test well;
Y = plugged well; D = domestic well; Z = mine well
NR = not reported
Source: SWFWMD, 1989.

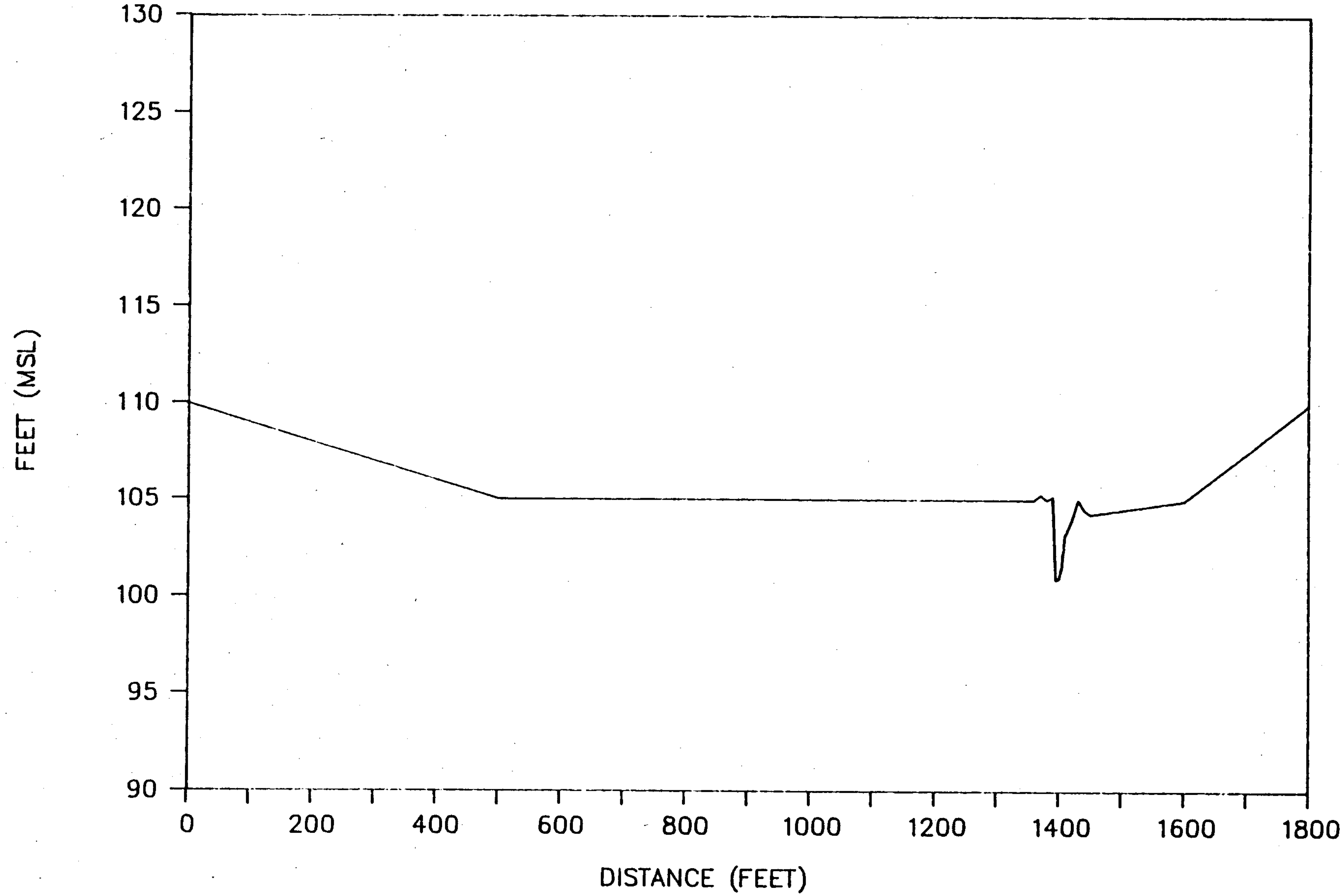


Figure 2.3.4-1 TYPICAL CROSS-SECTION OF PAYNE CREEK AND FLOOD PLAIN NEAR THE HARDEE POWER STATION (LOOKING UPSTREAM)

Hardee Power Station

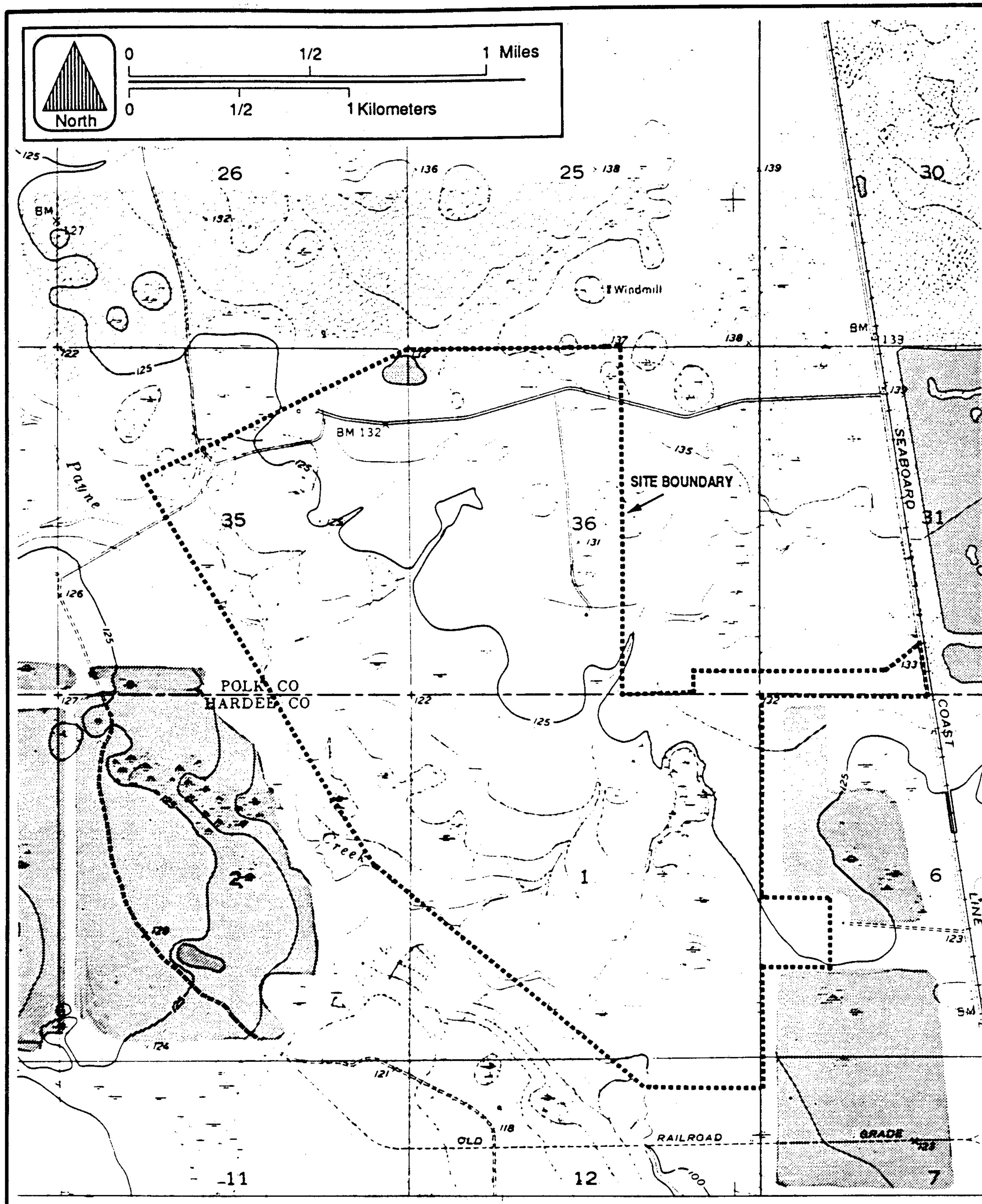


Figure 2.3.4-2 TYPOGRAPHY OF THE HARDEE POWER STATION

Hardee Power Station

Creek. Portions of the site and adjacent lands (on both sides of Payne Creek) have been or are being mined, for phosphate. After mining is completed, these areas will be reclaimed pursuant to approved reclamation plans.

HYDROLOGIC CHARACTERISTICS

The USGS has maintained a stream gauging station on Payne Creek near Bowling Green for 14 years (1964-68, 1980-present). The station (No. 02295420) is located on the U.S. 17 bridge over the creek approximately 2.4 km (1.5 miles) from the creek mouth at Peace River. This station was used to estimate the mean, maximum, and minimum average daily streamflow in Payne Creek near the Hardee Power Station site (see Table 2.3.4-1). The USGS station flows were multiplied by the ratio of drainage areas of the two locations to determine the flows at the discharge location. Average annual Payne Creek flow at the Hardee Power Station site is 22 cfs, or approximately 0.9 cfs per square mile.

The low flows in Payne Creek near the Hardee Power Station site were estimated using low flow frequency analyses of the low flows at the Payne Creek-Bowling Green U.S. Geological Survey (USGS) station (USGS, 1984), corrected to the Hardee Power Station site location using the ratio of drainage areas. The low flows for durations from 1 to 183 days and recurrence intervals from 2 to 20 years are shown in Table 2.3.4-2. Seven day low flows of 1.0 cfs or less can be expected to occur with a recurrence interval of 2 years. Thirty day low flows of less than 2.0 cfs or less can be expected also to occur with a recurrence interval of 2 years. Given the relatively small drainage area of Payne Creek at the Hardee Power Station site, regular periods of low flow routinely occur.

Flood flows in Payne Creek near the site were estimated from a technique described in USGS publication WRI 82-4012 (1982). The USGS developed a series of regression equations from long term discharge stations using the

Table 2.3.4-1. Summary of Historical Flows on Payne Creek at Bowling Green and Estimated Flows at the Hardee Power Station

	Daily Streamflow (cfs)		
Water Year	Mean	Maximum	Minimum
AT BOWLING GREEN			
1964	111	928	3.6
1965	118	2060	1.9
1966	71	892	4.3
1967	78	1310	1.2
1968	171	1920	2.0
1980	109	981	25
1981	48	276	6.4
1982	125	2500	11
1983	165	1380	27
1984	73	357	11
1985	64	635	4.4
Annual[1]	103	981	4.4
AT HARDEE POWER STATION SITE (ESTIMATED)			
1964	24	197	0.8
1965	25	438	0.4
1966	15	189	0.9
1967	17	278	0.3
1968	36	408	0.4
1980	23	208	5.3
1981	10	59	1.4
1982	27	531	2.3
1983	35	293	5.7
1984	16	76	2.3
1985	14	135	0.9
Annual[1]	22	208	0.9

Note: 1. Annual "average" for maximum and minimum streamflow values for both the Bowling Green and Hardee Power Station site stations are given as the median values for the period of record.

Table 2.3.4-2. Estimated Low Flows on Payne Creek Near the Hardee Power Station Site

Recurrance Interval (years)	Low Flow Discharge (cfs) for Various Durations (days)								
	1	3	7	14	30	60	90	120	183
2	0.7	0.8	1.0	1.2	1.7	2.8	3.8	4.9	7.6
5	0.3	0.4	0.5	0.5	0.7	1.1	1.8	2.5	3.8
10	0.3	0.3	0.3	0.4	0.4	0.6	1.2	1.9	2.5
20	0.2	0.2	0.3	0.3	0.3	0.4	0.8	1.5	1.7

Source: U.S. Geological Survey (USGS), 1984.

independent parameters drainage area, slope, and lake area in the basin. The regression equation applicable to the site area, the regression constants and exponents, and the resulting flows are given in Table 2.3.4-3 for recurrence intervals from 2 to 500 years. The peak 10-year flow at the Hardee Power Station site is estimated to be 1,810 cfs; the peak 25-year flow is estimated to be 2,530 cfs.

Streamflow and stage measurements were taken on Payne Creek as part of the monitoring program developed in support of this application (see Section 2.3.4.2). The discharge hydrograph for the monitoring period on Payne Creek near the Hardee Power Station is shown in Figure 2.3.4-3. The average daily values are presented in tabular form in the Appendix 11.5.2. During the period of site specific stream gaging (October 11, 1988 through April 13, 1989), the Payne Creek discharge varied substantially. The highest Payne Creek discharge was observed on January 25, 1989 (37.6 cfs); the lowest Payne Creek discharge was observed on April 11-13 (1.6 cfs). The Payne Creek discharge hydrograph is presented in Figure 2.3.4-3; the average daily streamflow discharge values are present in tabular form in Appendix 11.5.2.

Based on this streamflow hydrograph, there was a slow and steady decrease in the baseflow (i.e., non-storm event runoff) from October to April, with occasional short term rises due to area rainfall. The creek network drains the watershed relatively rapidly; frequent or sustained rain, such as the summer month rainfall, is required to increase this baseflow.

Streamflow measurements were taken once a month near the Hardee Power Station site from October, 1988 through April, 1989 (PC-2) and downstream of the site near Bowling Green from December, 1988 through April, 1989 (PC-4, USGS #02295420). The locations of these two stations is presented Figure 2.3.4-4. Table 2.3.4-4 gives a summary of the recorded stages and streamflows at station PC-2, near the Hardee Power Station site.

Table 2.3.4-3. Estimated Flood Flows on Payne Creek at the Hardee Power Station

Recurrance Interval (years)	Regression constant C	Regression exponents B1	B2	B3	Estimated Flood Flow (cfs)
2	93.4	0.756	0.268	-0.803	690
5	192	0.722	0.255	-0.759	1310
10	274	0.708	0.248	-0.738	1810
25	395	0.696	0.24	-0.717	2530
50	496	0.690	0.234	-0.705	3130
100	609	0.685	0.227	-0.695	3780
200	779	0.674	0.205	-0.694	4510
500	985	0.668	0.196	-0.687	5550

Source: USGS, 1982.

Notes: Drainage Area = 25.7 square miles
Slope = 5 ft/mi
Non-Contributing Lake Area = 0 percent

Regression Equation

$$QT = C\ DA^{B1}\ SL^{B2}\ (LK + 3.0)^{B3}$$

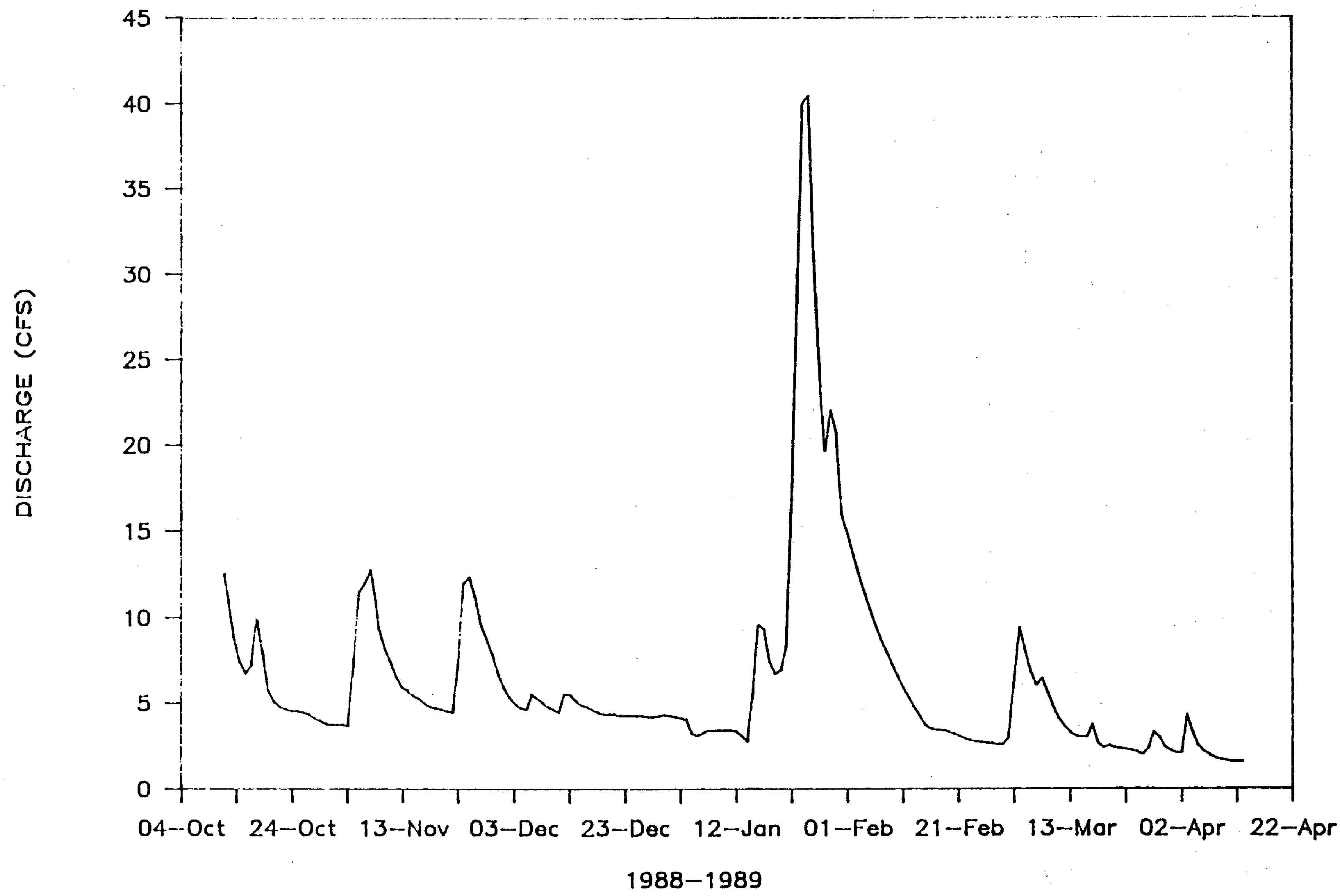


Figure 2.3.4-3 DISCHARGE HYDROGRAPH FOR PAYNE CREEK NEAR THE HARDEE POWER STATION

Hardee Power Station

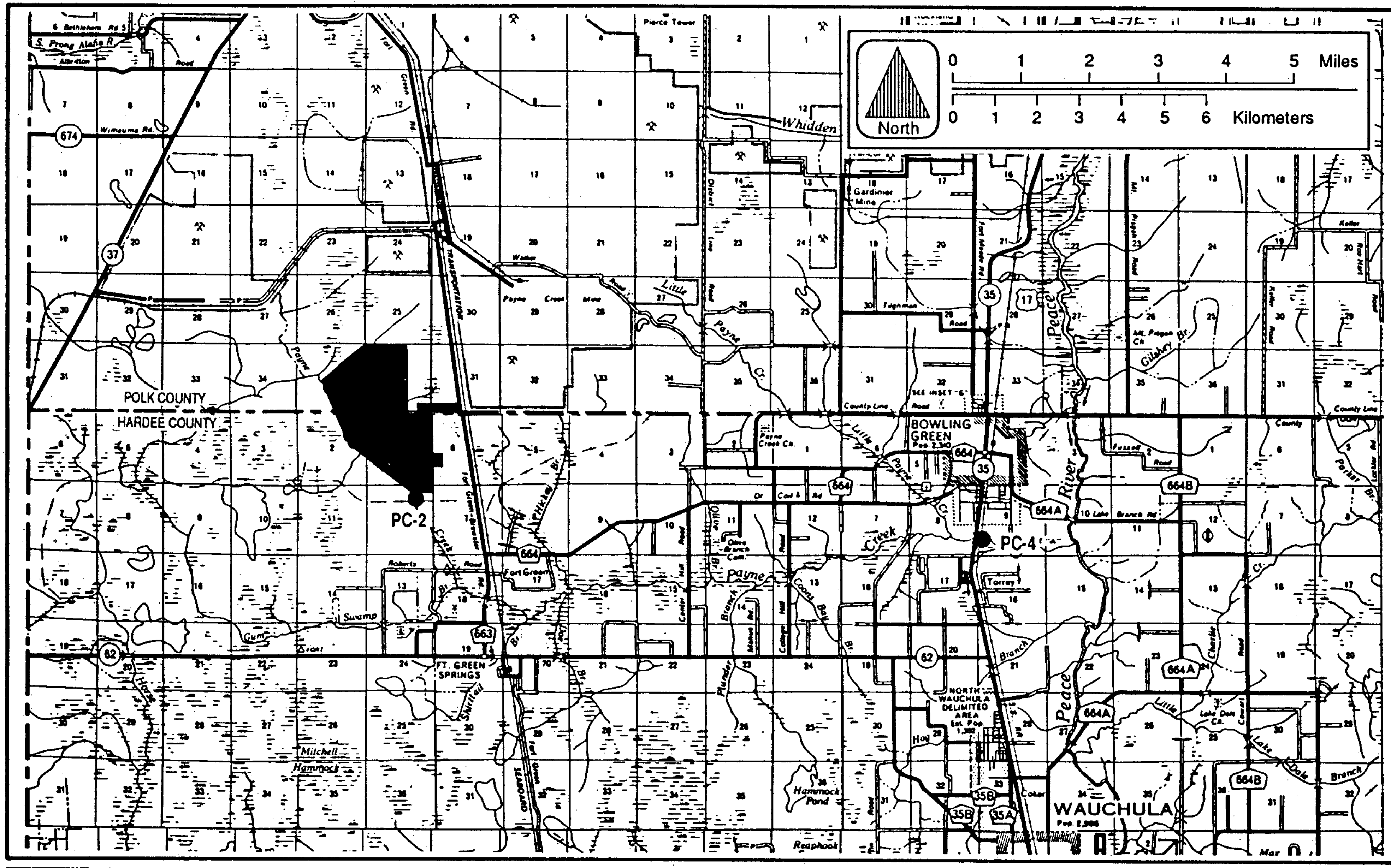


Figure 2.3.4-4 SURFACE WATER LEVELS AND STREAMFLOW MONITORING LOCATIONS

Hardee Power Station

Table 2.3.4-4. Stage and Flow Data for Payne Creek Near the Hardee Power Station Site

Station	Date	Stage (ft)	Flow (cfs)
PC-2	11-Oct-88	2.62	12.2
	08-Nov-88	2.52	11.6
	08-Dec-88	2.06	4.7
	11-Jan-89	1.76	2.3
	15-Feb-89	1.81	3.0
	15-Mar-89	1.85	4.2
	13-Apr-89	1.59	1.9

Appendix 11.5.2 provides the detailed cross-sectional velocity measurements and the stage-discharge curve for the monitoring station near the Hardee Power Station site, PC-2.

CHEMICAL CHARACTERISTICS

Prior studies of surface water quality in the site vicinity have been performed by phosphate mining companies as part of permit approval or monitoring programs for Development of Regional Impact (DRIs), National Pollution Discharge Elimination System (NPDES) permit approval programs, mining and reclamation plans and related environmental permits. Two different water quality studies were conducted in Payne Creek near the site, by Agrico and by CFI (conducted by Dames and Moore). The Agrico study consists of four annual reports for the period 1983-1986. The CFI (Dames and Moore) study encompasses the period July 1975 through January 1976. Water quality samples collected during these two studies represents data collected from four different station locations (Stations 1, 2, 3 & 4). Data from the two studies are combined and summarized in Table 2.3.4-5. These four station locations are given in Figure 2.3.4-5. The complete data set for the period is provided in Appendix 11.5.3.

For this previous data, the mean values (at any station) for five of the 46 tested parameters exceeded Chapter 17-3, F.A.C., Class III water quality standards. These parameters included: dissolved oxygen, chromium, iron, lead, and zinc. The mean dissolved oxygen concentration failed to meet Class III water quality criteria at three stations. The remaining parameters (i.e., chromium, iron, lead, and zinc) exceeded Class III water quality criteria at two stations and were based on a relatively few number of observations.

The results of monitoring conducted during October 1988 through March 1989 (i.e., field studies conducted in support of this application) are given in Tables 2.3.4-6 and 2.3.4-7. Table 2.3.4-6 presents the in situ data.

Table 2.3.4-5. Summary of Historic Payne Creek Surface Water Quality in the Vicinity of the Hardee Power Station, 1975 - 1986 (all available data) (Page 1 of 5)

Parameter/Location	Average	Maximum	Minimum	# Samples
Flow (cfs)				
Station 1	7.00	12.50	2.00	4
Station 2	- -	- -	- -	0
Station 3	- -	- -	- -	0
Station 4	55.80	105.20	10.60	4
Temperature (oF)				
Station 1	74.0	84.2	60.0	22
Station 2	72.9	85.0	59.0	8
Station 3	71.4	85.0	58.0	11
Station 4	72.1	82.0	58.0	22
Total Suspended Solids				
Station 1	5.6	10.4	3.4	12
Station 2	6.4	26.3	1.2	8
Station 3	5.1	28.3	1.0	8
Station 4	2.4	4.2	1.0	12
Total Dissolved Solids				
Station 1	273	374	188	8
Station 2	191	252	141	8
Station 3	194	284	120	11
Station 4	186	244	126	10
Dissolved Oxygen				
Station 1	1.7	4.2	0.1	22
Station 2	2.1	5.0	0.4	8
Station 3	3.2	9.5	0.1	11
Station 4	7.1	9.0	4.4	22
pH				
Station 1	7.1	7.8	6.6	16
Station 2	6.8	7.1	6.3	8
Station 3	7.0	7.2	6.5	11
Station 4	7.4	7.8	6.9	16
Specific Conductivity (umhos/cm)				
Station 1	347	577	191	8
Station 2	215	258	142	8
Station 3	288	860	156	11
Station 4	228	271	135	8
Calcium				
Station 4	25	34	15	2

Table 2.3.4-5. Summary of Historic Payne Creek Surface Water Quality in the Vicinity of the Hardee Power Station, 1975 - 1986 (all available data) (Page 2 of 5)

Parameter/Location	Average	Maximum	Minimum	# Samples
Magnesium				
Station 4	9.4	12.0	6.9	2
Sodium				
Station 4	8.1	9.0	7.1	2
Total Hardness				
Station 4	100	134	65	2
Bicarbonate Alkalinity (mg $CaCO_3$/L)				
Station 1	155	283	56	8
Station 2	61	72	50	8
Station 3	64	90	46	11
Station 4	63	98	29	8
Sulfate				
Station 1	22	68	1	4
Station 2	35	59	18	4
Station 3	32	50	17	4
Station 4	37	61	15	4
Chloride				
Station 4	15	17	13	2
Biochemical Oxygen Demand (5-day)				
Station 1	4.88	6.7	2.8	8
Station 2	1.61	4.0	0.9	8
Station 3	1.23	3.0	0.4	11
Station 4	2.46	7.1	0.8	10
Chemical Oxygen Demand				
Station 4	30	47	12	2
Fecal Strep (per 100 ml)				
Station 4	183	360	5	2
Flouride				
Station 1	1.32	1.88	0.74	16
Station 2	0.82	1.88	0.46	8
Station 3	0.94	1.91	0.56	11
Station 4	1.16	1.78	0.37	16
Silicon				
Station 1	2.22	3.30	1.20	4
Station 2	- -	- -	- -	0
Station 3	- -	- -	- -	0
Station 4	3.02	3.84	2.60	4

Table 2.3.4-5. Summary of Historic Payne Creek Surface Water Quality in the Vicinity of the Hardee Power Station, 1975 - 1986 (all available data) (Page 3 of 5)

Parameter/Location	Average	Maximum	Minimum	# Samples
Sulfide				
Station 4	0.02	0.04	0.00	2
Turbidity (NTU)				
Station 1	2.9	6.2	0.5	16
Station 2	3.6	15.0	1.0	8
Station 3	2.9	18.0	0.8	11
Station 4	2.3	10.0	0.5	18
Ammonia				
Station 1	0.16	0.51	<0.02	8
Station 2	0.29	0.90	0.03	8
Station 3	0.15	0.36	0.02	8
Station 4	0.04	0.09	0.02	8
Nitrate				
Station 1	0.90	5.90	<0.01	11
Station 2	0.15	0.36	<0.01	8
Station 3	0.33	1.25	<0.01	11
Station 4	0.18	1.00	<0.01	12
Nitrite				
Station 1	0.01	0.02	<0.01	8
Station 2	0.06	0.39	<0.01	8
Station 3	0.02	0.05	<0.01	8
Station 4	0.01	0.02	<0.01	8
Total Kjeidahl Nitrogen				
Station 1	0.79	1.14	0.37	8
Station 2	0.62	1.44	0.17	8
Station 3	0.34	0.63	0.16	8
Station 4	0.59	2.70	0.22	10
Total Nitrogen				
Station 1	2.31	12.70	0.41	12
Station 2	0.83	1.76	0.37	8
Station 3	0.71	2.65	0.23	11
Station 4	0.51	1.42	0.02	12
Total Phosphate				
Station 1	0.51	0.60	0.42	4
Station 2	- -	- -	- -	0
Station 3	0.36	0.50	0.18	3
Station 4	0.45	0.58	0.28	4
Total Phosphorus				
Station 1	0.74	1.12	0.35	8
Station 2	0.62	1.80	0.29	8
Station 3	0.45	0.72	0.15	8
Station 4	0.47	0.79	0.25	8

Table 2.3.4-5. Summary of Historic Payne Creek Surface Water Quality in the Vicinity of the Hardee Power Station, 1975 - 1986 (all available data) (Page 4 of 5)

Parameter/Location	Average	Maximum	Minimum	# Samples
Arsenic				
Station 1	0.009	0.030	<0.001	4
Station 2	0.009	0.030	<0.001	4
Station 3	0.009	0.030	<0.001	4
Station 4	0.006	0.030	<0.001	6
Barium				
Station 1	- -	- -	- -	0
Station 2	- -	- -	- -	0
Station 3	<0.01	<0.01	<0.01	3
Station 4	- -	- -	- -	0
Beryllium				
Station 1	- -	- -	- -	0
Station 2	- -	- -	- -	0
Station 3	0.24	0.69	<0.01	3
Station 4	- -	- -	- -	0
Cadmium				
Station 1	0.01	0.02	<0.005	4
Station 2	0.01	0.02	<0.005	4
Station 3	0.01	0.01	<0.005	4
Station 4	0.01	0.01	<0.002	6
Chromium				
Station 1	- -	- -	- -	0
Station 2	- -	- -	- -	0
Station 3	0.07	0.10	<0.01	3
Station 4	0.03	0.03	<0.02	2
Copper				
Station 1	- -	- -	- -	0
Station 2	- -	- -	- -	0
Station 3	0.01	0.01	<0.01	3
Station 4	0.02	0.03	<0.01	2
Iron				
Station 1	1.21	2.94	0.22	8
Station 2	1.30	5.60	0.32	8
Station 3	0.81	4.77	0.05	11
Station 4	0.33	1.01	0.10	10
Lead				
Station 1	0.02	0.05	<0.01	4
Station 2	0.02	0.05	<0.01	4
Station 3	0.07	0.20	<0.01	7
Station 4	0.02	0.05	<0.01	6

Table 2.3.4-5. Summary of Historic Payne Creek Surface Water Quality in the Vicinity of the Hardee Power Station, 1975 - 1986 (all available data) (Page 5 of 5)

Parameter/Location	Average	Maximum	Minimum	# Samples
Manganese				
Station 1	0.03	0.05	0.02	8
Station 2	0.03	0.06	0.01	8
Station 3	0.02	0.05	0.01	8
Station 4	0.02	0.05	0.01	8
Nickel				
Station 4	0.01	0.01	<0.002	2
Selenium				
Station 4	.0025	.005	<0.014	2
Zinc				
Station 1	- -	- -	- -	0
Station 2	- -	- -	- -	0
Station 3	0.04	0.05	<0.01	3
Station 4	0.07	0.10	0.04	2
Hexane Solubles				
Station 4	22	24	20	2
MBAS				
Station 4	0.13	0.25	<0.01	2
Phenols				
Station 4	0.01	0.03	0.00	2
Gross Alpha (pCi/l)				
Station 1	4.7	14.0	<0.1	8
Station 2	1.5	7.5	<0.1	8
Station 3	2.1	8.4	<0.1	11
Station 4	3.2	10.2	<0.1	8

Sources: Dames & Moore, 1976.
Agrico, 1983-86.

Note: All values mg/l unless otherwise noted.
All values are total concentrations unless noted.

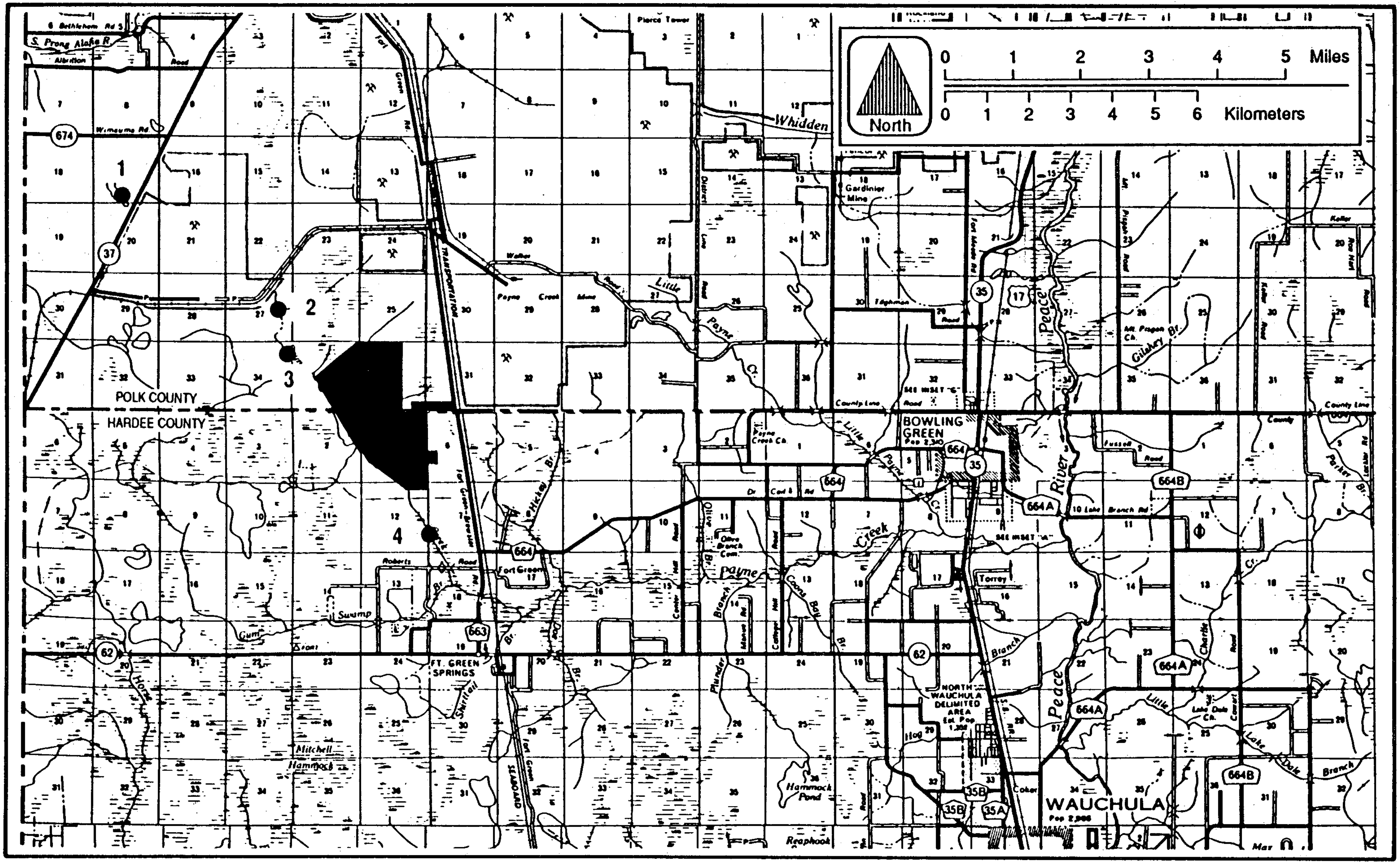


Figure 2.3.4-5 SURFACE HISTORIC WATER QUALITY MONITORING LOCATIONS FOR AGRICO AND DAMES & MOORE STUDIES (1975 - 1986)

Hardee Power Station

Table 2.3.4-6. In Situ Water Quality Parameters For Payne Creek (October 1988 through March 1989)

Station	Parameter	Minimum	Maximum	Mean	Standard Deviation
PC-1	Temperature (°C)	17.3	25.1	20.3	2.5
	pH	6.0	6.7	6.4	0.3
	Dissolved Oxygen (mg/L)	1.0	6.9	4.9	1.9
	Conductivity (umhos/cm)	148	208	183	21.2
	Secchi (ft)	N/A	>2.5	N/A	N/A
	Total Chlorine (mg/L)	0.0	<0.1	<0.1	N/A
PC-2	Temperature (°C)	16.9	25.0	19.6	2.6
	pH	6.4	7.1	6.7	0.3
	Dissolved Oxygen (mg/L)	4.1	7.7	6.6	1.2
	Conductivity (umhos/cm)	174	214	193	14.7
	Secchi (ft)	N/A	>3	N/A	N/A
	Total Chlorine (mg/L)	<0.1	<0.2	<0.1	N/A
PC-3	Temperature (°C)	17.3	25.7	20.4	2.7
	pH	6.5	7.2	6.7	0.2
	Dissolved Oxygen (mg/L)	5.5	7.0	6.4	0.5
	Conductivity (umhos/cm)	197	247	216	17.7
	Secchi (ft)	N/A	>4	N/A	N/A
	Total Chlorine (mg/L)	<0.1	<0.2	<0.1	N/A
PC-4	Temperature (°C)	18.1	24.9	20.2	2.2
	pH	6.5	7.2	6.9	0.2
	Dissolved Oxygen (mg/L)	5.7	7.9	7.3	1.6
	Conductivity (umhos/cm)	243	334	286	97.8
	Secchi (ft)	N/A	>3	N/A	N/A
	Total Chlorine (mg/L)	0.0	<0.2	<0.1	N/A

Note: N/A = Not Available or Not Applicable

Table 2.3.4-7. Summary of Water Quality Conditions in Payne Creek (PC-1, PC-2, PC-3, PC-4) October 1988 - March 1989 (Page 1 of 3)

Parameter	Average	Maximum	Minimum	Number of Samples	Class III Standard	Number of Exceedences
WATER QUALITY DATA						
Alkalinity (Bicarbonate), mg $CaCO_3$/L	56	76	36	24	20	0
Alkalinity, (Carbonate), mg $CaCO_3$/L	<0.5	<0.5	<0.5	24		0
Cyanide, mg/L	<0.004	<0.004	<0.004	24	0.005	0
Fluoride, mg/L	1.0	1.8	0.5	24	10	0
Hardness, mg equiv. $CaCO_3$/L	90.1	133.0	59.5	24		0
Methylene Blue Active Substances, mg/L	0.039	0.116	<0.025	24	0.5	0
Total Kjeldahl Nitrogen, mg/L	0.7	1.5	0.2	24		0
Ammonia Nitrogen, mg/L	0.073	0.486	<0.005	24	0.02	9
Organic Nitrogen, mg/L	0.7	1.5	0.2	24		0
Nitrate+Nitrite-Nitrogen, mg/L	0.81	3.02	0.19	24		0
Total Nitrogen, mg/L	1.53	3.68	0.63	24		0
Oil and Grease, mg/L	<5	<5	<5	24	5	0
Carbonaceous Biochemical Oxygen Demand, (5-day) mg/L	1.1	2.4	1.0	24		0
Chemical Oxygen Demand, mg/L	39	171	<10	24		0
Orthophosphorus, mg/L	0.4	0.6	0.2	24		0
Total Phosphorus, mg/L	0.46	0.70	0.31	24		0
Sulfate, mg/L	30.6	62.6	9.2	24		0
Turbidity, NTU	1.7	6.1	0.5	24	29	0
Aluminum, ug/L	117	365	32	24		0
Antimony, ug/L	<10	<10	<10	24		0
Arsenic, ug/L	<5	<5	<5	24	50	0
Beryllium, ug/L	<3	<3	<3	24	11	0
Cadmium, ug/L	<0.4	<0.5	<0.4	24	0.8	0
Calcium, mg/L	19.2	29.7	12.3	24		0
Chromium, ug/L	<10	<10	<10	24	50	0
Copper, ug/L	7	12	<6	24	30	0
Iron, ug/L	256	648	49	24	1000	0
Lead, ug/L	5.9	9.8	5.0	24	30	0
Magnesium, mg/L	10.2	14.3	7.0	24		0
Manganese, ug/L	8.0	18.0	3.0	24		0
Mercury, ug/L	0.24	0.50	<0.20	24	0.2	4
Nickel, ug/L	16	35	<12	24	100	0
Potassium. mg/L	1.3	2.6	0.1	20		0
Selenium, ug/L	<5	<5	<5	24	25	0
Silver, ug/L	<0.08	<0.08	<0.08	24	0.07	0
Sodium, mg/L	8.6	11.0	6.3	24		0
Zinc, ug/L	6.8	36.0	<5.0	24	30	1
Total Coliforms, colonies/100 ml	382	2000	1	24	2400	0
Fecal Coliforms, colonies/100 ml	94	346	1	24	800	0

Table 2.3.4-7. Summary of Water Quality Conditions in Payne Creek (PC-1, PC-2, PC-3, PC-4) October 1988 - March 1989 (Page 2 of 3)

Parameter	Average	Maximum	Minimum	Count	17-3,FAC Standard	Number of Violations
RADIATION DATA						
Alpha, Gross (pCi/L)	1.9	4.6	0.0	24	15	0
Alpha, Gross, Ct. Error +/- (pC/L)	1.7	3.0	1.1	24		0
Beta, Gross (pC/L)	2.4	6.1	0.0	24		0
Beta, Gross, Ct. Error +/- (pC/L)	1.9	3.6	1.4	24		0
Radium 226 (pC/L)	0.7	1.4	0.0	24	2.5	0
Radium 226 Ct. Error +/- (pC/L)	0.04	0.10	0.00	24		0
Radium 228 (pC/L)	0.5	1.7	0.0	24	2.5	0
Radium 228, Ct. Error (pC/L)	0.9	1.9	0.4	24		0
Strontium-90 (pC/L)	0.5	1.5	<0.5	24		0
Chlorophyll-a, mg/m^3	2.0	29.9	<1	24		0
Chloride, mg/L	13.9	16.1	11.6	4		0
Total Dissolved Solids, mg/L	149.8	199.0	125	4		0
Silica, dissolved reactive, mg/L	3.3	4.8	2.3	4		0
ORGANICS DATA (all values in ug/L)						
Phenols	<5	<5	<5	8	1	0
Aldrin	<0.003	<0.003	<0.003	8	0.003	0
Dieldrin	<0.003	<0.003	<0.003	8	0.003	0
Chlordane	<0.01	<0.01	<0.01	8	0.01	0
4,4'DDT	<0.001	<0.001	<0.001	8	0.001	0
Demeton	<0.1	<0.1	<0.1	8	0.1	0
Endrin	<0.004	<0.004	<0.004	8	0.004	0
Endosulfan	<0.003	<0.003	<0.003	8	0.003	0
Guthion	<0.01	<0.01	<0.01	8	0.01	0
Heptachlor	<0.001	<0.001	<0.001	8	0.001	0
Lindane	<0.01	<0.01	<0.01	8	0.01	0
Malathion	<0.1	<0.1	<0.1	8	0.1	0
Methoxychlor	<0.03	<0.03	<0.03	8	0.03	0
Myrex	<0.001	<0.001	<0.001	8	0.001	0
Parathion	<0.04	<0.04	<0.04	8	0.04	0
2,4-D	<10	<10	<10	8		0
Silvex	<20	<20	<20	8		0
Toxaphene	<0.005	<0.005	<0.005	8	0.005	0
PCB-1016	<0.001	<0.001	<0.001	8	0.001	0
PCB-1221	<0.001	<0.001	<0.001	8	0.001	0
PCB-1232	<0.001	<0.001	<0.001	8	0.001	0
PCB-1242	<0.001	<0.001	<0.001	8	0.001	0
PCB-1248	<0.001	<0.001	<0.001	8	0.001	0
PCB-1254	<0.001	<0.001	<0.001	8	0.001	0
PCB-1260	<0.001	<0.001	<0.001	8	0.001	0

Table 2.3.4-7. Summary of Water Quality Conditions in Payne Creek (PC-1, PC-2, PC-3, PC-4) October 1988 - March 1989 (Page 3 of 3)

Parameter	Average	Maximum	Minimum	Count	Class III
Chlorinated Hydrocarbons					
2-Chloronaphthalene	<10.0	<10.0	<10.0	8	0
1,2-Dichlorobenzene	<10.0	<10.0	<10.0	8	0
1,3-Dichlorobenzene	<10.0	<10.0	<10.0	8	0
1,4-Dichlorobenzene	<10.0	<10.0	<10.0	8	0
Hexachlorobenzene	<10.0	<10.0	<10.0	8	0
Hexachlorobutadiene	<10.0	<10.0	<10.0	8	0
Hexachlorocyclopentadiene	<10.0	<10.0	<10.0	8	0
Hexachloroethane	<10.0	<10.0	<10.0	8	0
1,2,4-Trichlorobenzene	<10.0	<10.0	<10.0	8	0

Table 2.3.4-7 presents a summary of the lab parameters and a comparison to water quality standards. The locations of the water quality sampling stations are shown in Figure 2.3.4-6. Detail water quality monitoring data is presented in Appendix 11.5.4.

In general, water quality monitored as part of the recent monitoring program is very good. Only four exceedances of the Class III mercury standard were observed and one exceedance of the Class III zinc standard was observed.

2.3.4.2 Measurement Programs

The following surface water hydrology and water quality field studies were conducted to supply the information needed for impact assessments.

Continuous Water Level Recording--A continuous water level recording station location was installed on Payne Creek adjacent to the Hardee Power Station site; this station was (PC-2) operated as part of the study for a period of 8 months. This gaging station location is shown in Figure 2.3.4-6. The station consisted Leupold and Stevens Type A Continuous Water-Level Recorders and vertically mounted PVC stilling wells. The recorders show changes in water level and water flow. The water level recorder was serviced and the charts removed each month with 100% data recovery. The charts were digitized and the data stored in computer files. The original charts were catalogued and filed as a permanent record.

In addition, the USGS maintains a gaging station on Payne Creek below the proposed site, near Bowling Green (USGS #02295420). The drainage area to this gage is approximately 313 square km (121 square miles) and includes the Hardee Power Station site. The current data from this station (i.e., for the study period) were obtained.

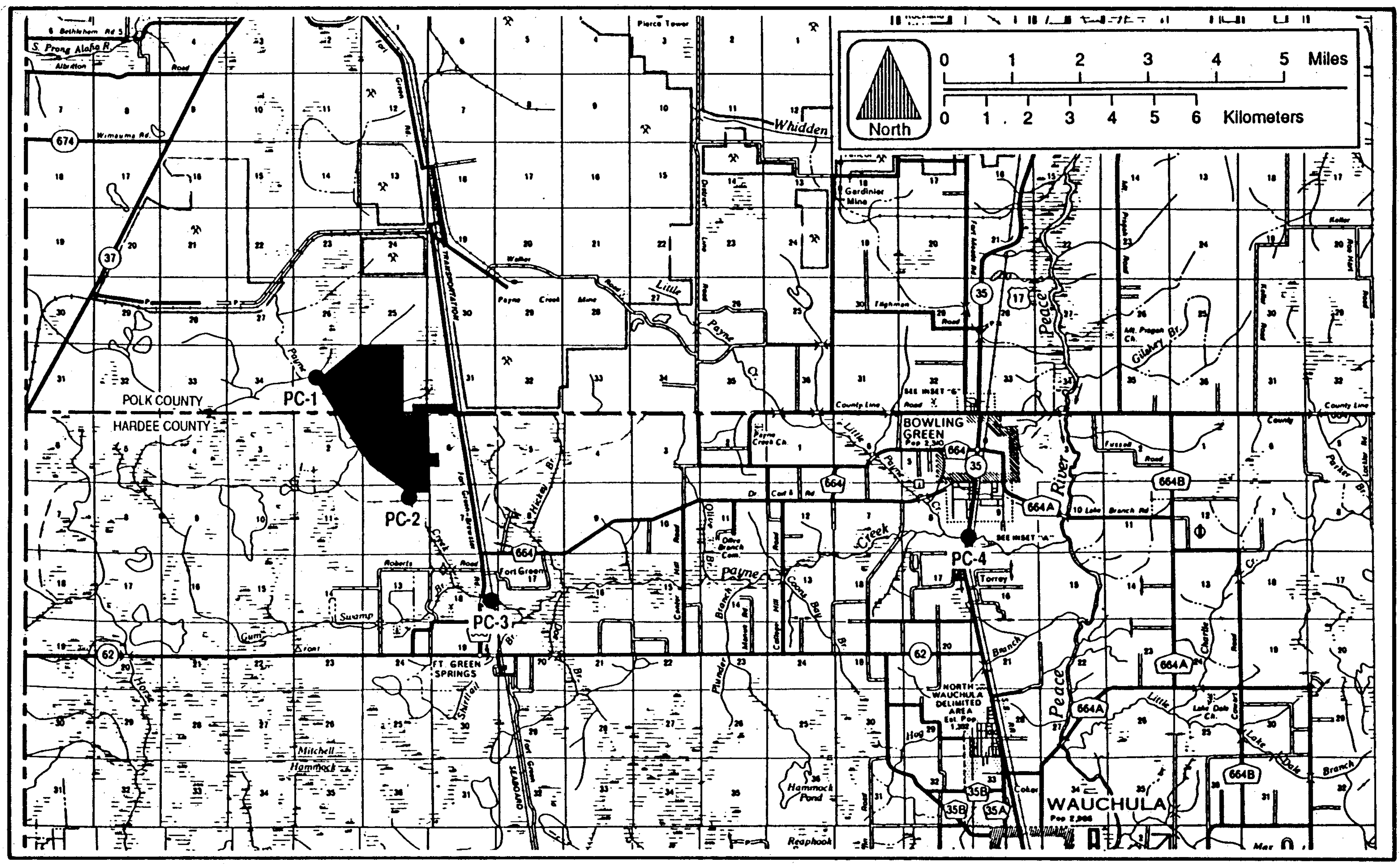


Figure 2.3.4-6 SURFACE WATER QUALITY MONITORING LOCATIONS (OCTOBER 1988 - MARCH 1989)

Hardee Power Station

Cross-section Survey--A cross-section was conducted at a representative site near the additional water level gaging stations on Payne Creek to determine river/creek morphology in the vicinity of probable points of discharge. The data was collected using a sounding rod and surveyor's level.

Water Quality Sampling--The baseline water quality monitoring program was structured to provide the necessary data base on existing water quality at the site for evaluation of impacts and mitigative measures. The locations of the water quality sampling stations are shown in Figure 2.3.4-6. Samples were collected from four stations on Payne Creek; one located upstream of the proposed Hardee Power Station site, one located adjacent to the proposed site; and two stations located downstream of the proposed Hardee Power Station site. All samples were surface grab samples.

Samples were analyzed for the parameters listed in Table 2.3.4-8. Water quality sampling for most water quality parameters (including Chapter 17-3, F.A.C. Class III water quality parameters, except organics, and other classical water quality parameters) were conducted monthly for six months at four stations. Chapter 17-3, F.A.C. Class III organics (e.g., pesticides) were sampled twice (November 1988 and February 1989). All analyses (except total dissolved solids) were done on a total or unfiltered basis.

Synoptic Streamflow Studies--Streamflow was measured at the Hardee Power Station site and USGS gaging stations once every month for the monitoring period of 8 months. The two gaging stations have been previously shown in Figure 2.3.4-6. The discharge measurements were made using either Teledyne-Gurley pygmy and Price flow meters or Marsh-McBerney flow meters in accordance with standard USGS stream gaging techniques. The measurements were coordinated with the water quality sampling efforts and completed within 2 days to ensure consistency among stations.

Table 2.3.4-8. Hardee Power Station Water Quality Monitoring Parameters

Category	Parameters
Field:	o Specific Conductance o Temperature o Dissolved Oxygen o pH o Total Chlorine o Secchi Disk (ft)
Classicals:	Alkalinity, mg/L as $CaCO_3$, Fluoride, mg/L, Total Kjeldahl Nitrogen, mg/L, Ammonia Nitrogen, mg/L, Organic Nitrogen, mg/L, Nitrate+Nitrite-Nitrogen, mg/L, Total Nitrogen, mg/L, Oil and Grease, mg/L, Carbonaceous Biochemical Oxygen Demand, mg/L, Chemical Oxygen Demand, mg/L, Orthophosphorus, mg/L, Total Phosphorus, mg/L, Sodium, mg/L, Sulfate, mg/L, Turbidity, NTU, total Coliforms, colonies/100 ml, Fecal Coliforms, colonies/100 ml, Silica, Hardness mg equiv $CaCO_3$/L, Carbonate mg $CaCO_3$/L, Bicarbonate mg $CaCO_3$/L
Metals:	Aluminum, ug/L, Antimony, ug/L, Arsenic, ug/L, Beryllium, ug/L, Cadmium, ug/L, Chromium, ug/L, Copper, ug/L, Iron, ug/L, Lead, ug/L, Mercury, ug/L, Nickel, ug/L, Selenium, ug/L, Silver, ug/L, Zinc, ug/L, Calcium, mg/L, Manganese ug/L, Mangesium mg/L, Potassium mg/L
Other:	Chlorophyll-a, mg/m^3, Cyanide, mg/L, Methylene Blue Active Substances, mg/L
Organics/Pesticides/ Herbicides:	Phenols, Aldrin, Dieldrin, Chlordane, 4,4'DDT, Demeton, Endrin, Endosulfan, Guthion, Heptachlor, Lindane, Malathion, Methoxychlor, Myrex, Parathion, 2,4-D, Silvex, Toxaphene, PCB-1016, PCB-1227, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260, and Chlorinated Hydrocarbons; 2-Chloronaphthalene, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, Hexachlorobenzene, hexachlorobutadiene, hexachlorocyclopentadiene, hexachloroethane, 1,2,4-Trichlorobenzene
Radioactivity:	Alpha, Gross (pCi/L), Alpha, Gross, Ct. Error +/- (pCi/L), Beta, Gross (pCi/L), Beta, Gross, Ct. Error +/- (pCi/L), Radium 226 (pCi/L), Radium 226 Ct. Error +/- (pCi/L), Radium 228 (pCi/L), Radium 228, Ct. Error (pCi/L), Strontium-90 (pCi/L)

2.3.5 Vegetation/Land Use

As mentioned earlier, the Hardee Power Station Site consists of actively mined and yet to be reclaimed lands, lands still to be mined and reclaimed, and lands not to be mined. The lands which are to be mined or which have been mined comprise majority of the site.

Based on field studies in 1988 and 1989, major land uses and vegetation communities onsite include mined lands improved pasture with scattered pine, forested wetland, and the Payne Creek floodplain which is a combination of forested wetland and pine flatwoods. The Florida Land Use Cover and Classification System (FLUCCS) Level III code for these communities are 161, 211, 615, and 411, respectively. There are also some scattered marshes (<0.4 ha or <1 acre each) in the northern part of the site (FLUCCS 641). Figure 2.3.5-1 shows the vegetation communities and the areas of mined land on and adjoining the site. Each community is described in detail in Section 2.3.6.1. All species observed in each community are listed in Table 2.3.5-1.

2.3.6 Ecology

2.3.6.1 Species-Environmental Relationships

AQUATIC SYSTEMS

Payne Creek and its unnamed tributaries are the only aquatic systems in the vicinity of the Hardee Power Station. Payne Creek is a relatively shallow stream situated on the western boundary of the property. Mining activity has occurred on both sides of the Payne Creek floodplain (see the following terrestrial systems discussion). The creek bottom is typically a combination of detritus, sand and silt. Figure 2.3.6-1 presents the locations of the aquatic sampling sites. The Payne Creek floodplain has been subject to hydrologic change resulting from sedimentation, ditching of its tributaries for agricultural operations, and more recently, elimination of some tributaries as a result of mining. Sedimentation in the creek bed is particularly noticeable near the site. The tree canopy is consequently young and much of the vegetation is in a shrubby successional state.

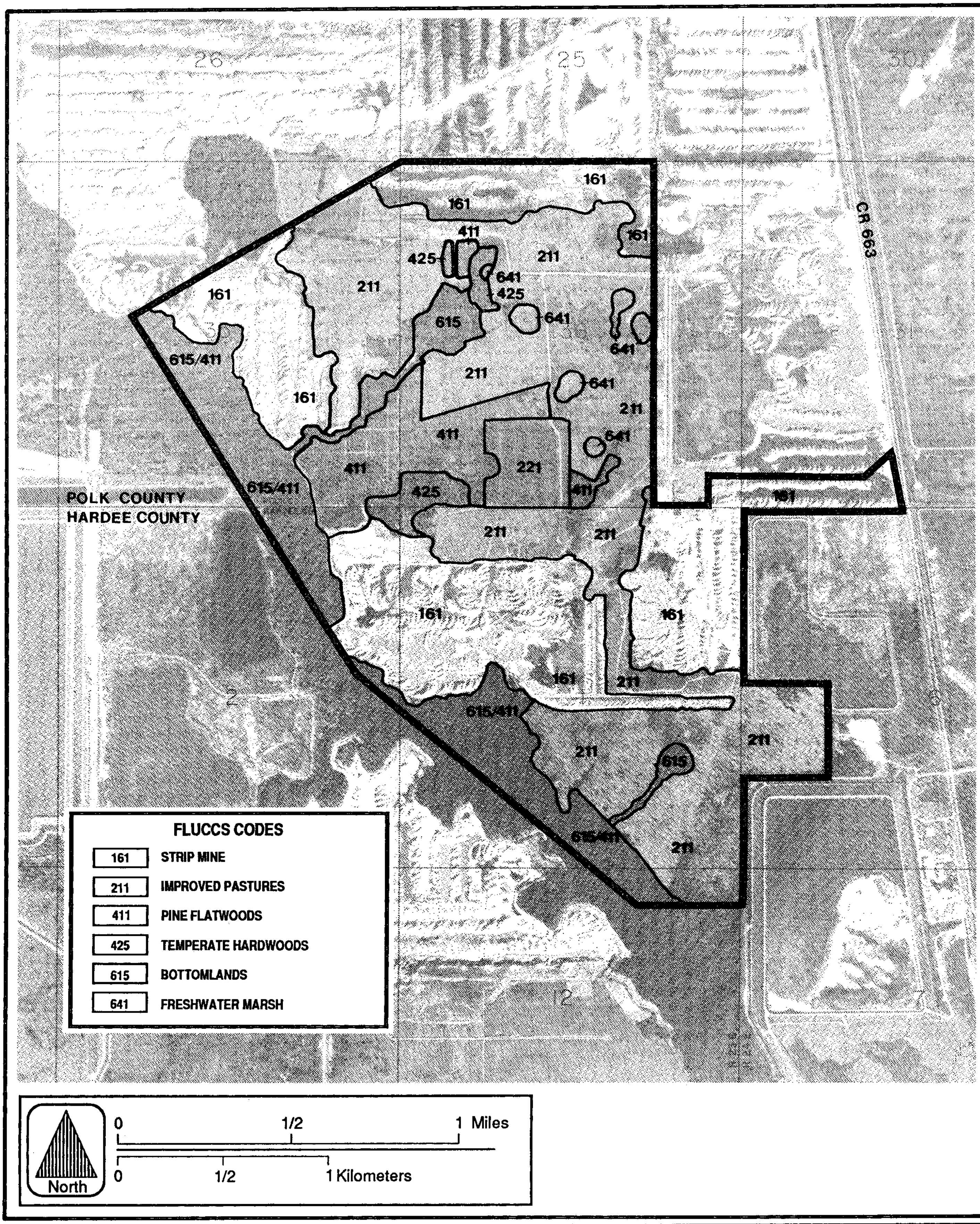


Figure 2.3.5-1 LAND USE AND VEGETATION OF PLANT SITE AND ASSOCIATED FACILITIES

Hardee Power Station

Table 2.3.5-1. Species Observed on the Hardee Power Station Site (Page 1 of 3)

Scientific Name	Common Name	Pasture	Flatwoods	Wetlands
TREES				
Acer rubrum	Red maple			x
Diospyros virginiana	Persimmon			x
Fraxinus caroliniana	Pop ash			x
Gordonia lasianthus	Loblolly bay			x
Liquidambar styraciflua	Sweetgum			x
Magnolia virginiana	Sweetbay magnolia			x
Nyssa biflora	Swamp black gum			x
Persea borbonia	Red bay			
Quercus laurifolia	Swamp laurel oak			x
Quercus nigra	Water oak			x
Quercus virginiana	Live oak	x	x	
Pinus elliottii	Slash pine	x	x	x
Pinus palustris	Longleaf pine	x	x	
Salix caroliniana	Carolina willow			x
SHRUBS				
Ampelopsis arborea	Pepper vine			x
Baccharis glomeruliflora	Stalkless groundsel bush			x
Cephalanthus occidentalis	Buttonbush			x
Gelsemium sempervirens	Yellow jessamine			x
Ilex cassine	Dahoon holly			x
Itea virginica	Virginia willow			x
Myrica cerifera	Wax myrtle		x	x
Osmanthus americana	Wild olive			x
Rhododendron viscosum	Swamp honeysuckle			x
Serenoa repens	Saw palmetto	x	x	x
Smilax auriculata	Catbrier		x	x
Smilax bona-nox	Greenbrier		x	x
Smilax laurifolia	Bamboo vine			x
Toxicodendron radicans	Poison ivy			x
Vaccinium corymbosum	Highbush blueberry			x
Viburnum obovatum	Small viburnum			x
Vitis sp.	Grape			x

Table 2.3.5-1. Species Observed on the Hardee Power Station Site (Page 2 of 3)

Scientific Name	Common Name	Pasture	Flatwoods	Wetlands
HERBACEOUS SPECIES				
Andropogon glomeratus	Bushy broomgrass	x		
Andropogon brachystachyus	Shortspike broomgrass		x	
Andropogon virginicus	Broom grass	x		
Aristida spiciformis	Bottlebrush grass		x	
Aster subulatus	Annual marsh aster	x		
Blechnum serrulatum	Swamp fern			x
Canna flaccida	Golden canna			x
Cassia nictitans var. _aspera_	Wild sensitive plant	x		
Centella asiatica	Coinwort	x		
Conyza candadensis	Horseweed	x		
Cyperus polystachyos	Texas sedge	x		
Desmodium incanum	Creeping beggarweed	x		
Desmodium triflorum	Sagotia beggarweed	x		
Diodia teres	Poor joe	x		
Digitaria ciliaris	Southern crab grass	x		
Elephantopus elatus	Florida elephant's foot	x		
Eleocharis sp.	Spikerush	x		
Encyclia tampensis	Butterfly orchid			x
Eremechloa ophiuroides	Centipede grass	x		
Eupatorium capillifolium	Dog fennel	x		
Habenaria repens	Water spider orchid			x
Hypoxis juncea	Yellow star grass		x	
Juncus scirpoides	Rush			x
Ludwigia peruviana	Primrose willow			x
Mitchella repens	Partridge berry			x
Murdannia nudiflora	Dove weed	x		
Osmunda cinnamomea	Cinnamon fern			x
Panicum anceps	Beaked panicum			x
Panicum rigidulum	Redtop panicum			x
Paspalum distichum	Knot grass	x		
Paspalum urvillei	Vasey grass	x		
Phlebodium aureum	Golden polypody			x
Sacciolepis indica	Cupscale	x		
Sesbania vesicaria	Bladderpod	x		
Saururus cernuus	Lizards-tail			x

Table 2.3.5-1. Species Observed on the Hardee Power Station Site (Page 3 of 3)

Scientific Name	Common Name	Pasture	Flatwoods	Wetlands
Tillandsia fasciculata	Wild pine			x
Tillandsia recurvata	Ball-moss	x		x
Tillandsia usneoides	Spanish moss	x	x	x
Urena lobata	Caesar weed	x		x
Woodwardia areolata	Chain fern			x
Woodwardia virginiana	Virginia chain fern			x
Xyris platylepis	Broadscale yellow-eyed-grass	x		

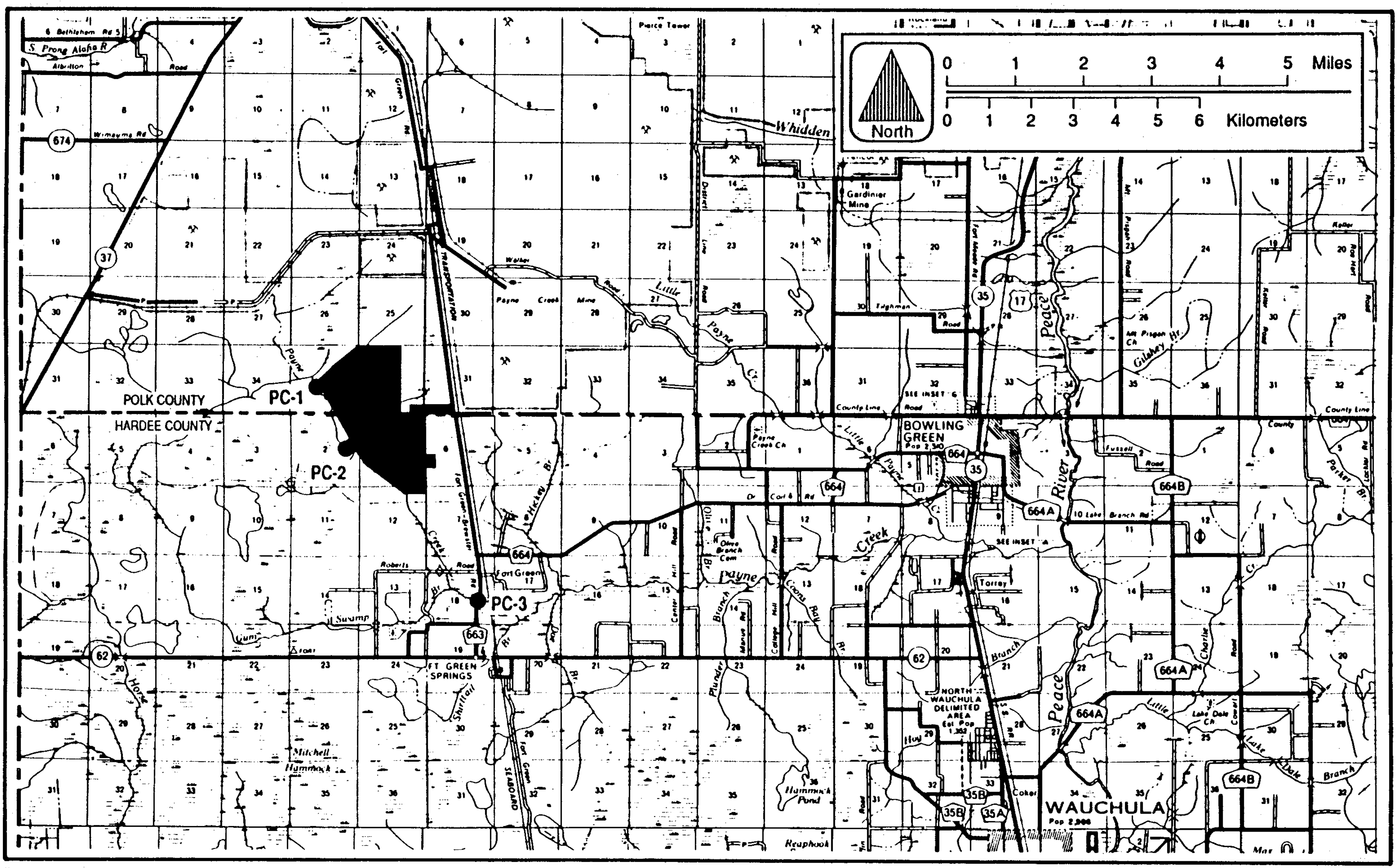


Figure 2.3.6-1 AQUATIC ECOLOGY SAMPLING STATION LOCATIONS

Hardee Power Station

FISHES

Based on the results of the icthyofaunal sampling Payne Creek is characterized as a typical, and relatively healthy stream ecosystem. From the standpoint of ichthyofaunal composition, the species captured represented the typical suite of fishes expected in a south-central peninsular Florida stream. Although large-mouth bass (Micropterus salmoides) was not found in the samples collected, it is likely to occur in the Payne Creek. The predominance of two salt-tolerant secondary freshwater species, the flagfish (Jordanella floridae), and the sailfin molly, (Poecilia latipinna), collected in October 1988, at the upstream sampling Station (PC-1) and the presence of the walking catfish (Clarias batrachus) at this station may signal proximity to drainage ditches, which traditionally host this exotic and the previous two species.

Mosquitofishes (Gambusia holbrooki), predictably, dominated the catches numerically during the October sampling. This species is ecologically tolerant and is the most abundant fish in Florida freshwaters. The brook silverside (Labidesthes sicculus) and the golden shiner (Notemigonus crysoleucas), when found in an appropriate habitat such as the upstream station, are frequently abundant. The golden topminnow (Fundulus chrysotus) and least killifish (Heterandria formosa) are characteristically common components of vegetated habitats.

Ecologically, the ichthyofauna collected in October may be broken down into three major assemblages (Table 2.3.6-1). The dominant grouping involves seven species of killifishes (families Cyprinodontidae and Poeciliidae), juveniles of four species of sunfishes (Centrarchidae), and a gar (Lepisosteidae). This assemblage characteristically occupies vegetated habitats, including areas with submergent, emergent and overhanging plants. Next in importance is an open-water group consisting of three minnows (Cyprinidae) and a silverside (Atherinidae), plus adult sunfishes. Adult centrarchids frequently assemble at the interface between vegetated habitats and open water. The third assemblage, involving two species of catfishes (Ictaluridae and Clariidae) and a darter (Percidae), is closely associated with the bottom.

Table 2.3.6-1. Fishes Collected at Three Stations in Upper Payne Creek, 6 October 1988, with Characterizations of Ecological Assemblages

Scientific Name	Common Name	Station PC-1	PC-2	PC-3
Lepisosteus platyrinchus (1)	Florida gar		1	
Notemigonus crysoleucas (2)	Golden shiner	13		4
Notropis emiliae (2)	Pugnose minnow			1
Notropis petersoni (2)	Coastal minnow	12	12	14
Noturus gyrinus (3)	Tadpole madtom	1		
Clarias batrachus (3)	Walking catfish	1		
Fundulus chrysotus (1)	Golden topminnow	7	3	6
Fundulus seminolis (1)	Seminole killifish	2		1
Jordanella floridae (1)	Flagfish	32	7	3
Lucania goodei (1)	Bluefin killifish	18	2	1
Gambusia holbrooki (1)	Mosquito fish	162	91	275
Heterandria formosa (1)	Least killifish	5		11
Poecilia latipinna (1)	Sailfin molly	69	3	9
Labidesthes sicculus (2)	Brook silverside	20	54	45
Lepomis gulosus (1,2)	Warmouth	2	1	
Lepomis macrochirus (1,2)	Bluegill	3		8
Lepomis marginatus (1,2)	Dollar sunfish	1	1	1
Lepomis microlophus (1,2)	Redear sunfish	2	3	16
Etheostoma fusiforme (3)	Swamp darter	1		3
TOTAL SPECIES		17	11	15
TOTAL INDIVIDUALS		351	178	398

Note: (1) Vegetation assemblage
(2) Open water assemblage
(3) Benthic assemblage

Sampling at middle Station (PC-2) resulted in relatively fewer fishes than at Stations PC-1 and PC-3. This trend mirrors diversity, as measured by the number of species captured. The most upstream Station (PC-1), yielded 17 species. Fifteen species were collected at downstream Station (PC-3), and 11 were found at the middle station (PC-2). Station PC-1 offered the most diverse habitats with riffles, pools and submergent vegetation; the high number of species present in this station was thus expected. Station PC-2 lacked any riffle habitat and Station PC-3 offered less divergent micro-habitats than the first two stations, but dense submergent and emergent vegetation provided good niche complexity, thereby allowing high faunal diversity.

Results of the February 1989 sampling effort (Table 2.3.6-2) are consistent with those obtained during October 1988. As was the case during October, number of species was higher at the upstream and downstream Stations (PC-1 and PC-3) than at the middle station (PC-2). During the February 1989 sampling, the total number of species was down at all three stations when compared to the October 1988 results; 11 species were collected at PC-1 (17 species during October 1988), 10 species at PC-2 (11 species during October 1988), and 12 species at PC-3 (15 species during October 1988). However, the total number of species collected from Payne Creek were 19 during both sampling periods. Based on the present qualitative effort, it was found that fish abundance was generally higher during February 1989 than October 1988. Four hundred and forty-three individuals were collected at the upstream station during February 1989 (351 specimens during October 1988), 190 individuals at the middle station (178 specimens during October 1988) and 180 individuals at the downstream station (398 specimens during October 1988).

Three species (Lepisosteus platyrinchus, C. batrachus, and J. floridae) collected in October were absent in February. The absence of L. platyrinchus, C. batrachus and J. floridae was not unexpected; the first two species were initially represented by only single individuals. According to Burgess (personal communication 1989), J. floridae may be an annual killifish (i.e., it lives for only one year), so its absence may

Table 2.3.6-2. Fishes Collected at Three Stations in Upper Payne Creek, 14 February 1989, with Characterizations of Ecological Assemblages

Scientific Name	Common Name	Station PC-1	PC-2	PC-3
Notemigonus crysoleucas (2)	Golden shiner	4		
Notropis emiliae (2)	Pugnose minnow		8	
Notropis petersoni (2)	Coastal shiner	67	38	16
Ictalurus natalis (3)	Yellow bullhead			1
Noturus gyrinus (3)	Tadpole madtom			1
Fundulus chrysotus (1)	Golden topminow	3	1	
Fundulus seminolis (1)	Seminole killifish	1		
Lucania goodei (1)	Bluefin killifish	9	5	2
Gambusia holbrooki (1)	Mosquito fish	282	69	109
Heterandria formosa (1)	Least killifish		1	6
Poecilia latipinna (1)	Sailfin molly	52	3	6
Labidesthes sicculus (2)	Brook silverside	13	63	
Elassoma evergladei (1)	Everglades pygmi sunfish			1
Lepomis gulosus (1,2)	Warmouth			3
Lepomis macrochirus (1,2)	Bluegill	5	1	2
Lepomis marginatus (1,2)	Dollar sunfish			29
Lepomis microlophus (1,2)	Redear sunfish	2		
Lepomis punctatus (1,2)	Spotted sunfish	5	1	
Etheostoma fusiforme (3)	Swamp darter			4
TOTAL SPECIES		11	10	12
TOTAL INDIVIDUALS		443	190	180

Note: (1) = Vegetation assemblage
(2) = Open water assemblage
(3) = Benthic assemblage

reflect natural mortality. New species collected in February were Ictalurus natalis, Elassoma evergladei, and Lepomis punctatus. All three species taken for the first time are typical for this type of stream and were expected to appear with additional sampling.

BENTHIC MACROINVERTEBRATES

Macroinvertebrate sampling emphasized benthic infaunal and epifaunal communities. These sampling efforts were carried out during October 1988 and February 1989, concurrent with the fish surveys. Artificial substrates were incubated for four weeks and picked up in November and March, respectively. A total of 153 macroinvertebrate taxa were collected from Payne Creek during the present study.

A total of 90 taxa collected by the artificial substrates (Appendix 11.6 Table 1). The midge family Chironomidae were the numerically dominant group of invertebrates collected on the artificial substrates in Payne Creek. This family comprised from 64 to 91% of all invertebrates collected (Table 2.3.6-3). Polypedilum was the most common genus of Chironomidae occurring on the artificial substrates, and Polypedilum convictum was the most common species at the two upstream sites, and occasionally comprised over 40% of the total fauna (PC-2 in October/November and PC-1 in February/March). Simpson and Bode (1980) state that these organisms are filter feeders and that their occurrence seems to be primarily governed by current speed and the amount of suspended material in the water. Other chironomids that were abundant at Stations PC-1 and PC-2 were the Endochironomus group, the Rheotanytarsus exiguus group, Tanytarsus spp., the Thienemanniella fusca group, and occasionally the Corynoneura taris group (Appendix 11.6, Tables 2-6). Of these, the R. exiguus group, the T. fusca group, and the C. taris group are also described as occurring in areas of moderate to high flow water containing high amounts of suspended organic matter. The T. fusca group and the C. taris group are considered to be sensitive to organic pollution. These data appear to indicate that areas near Stations PC-1 and PC-2 are relatively free of organic pollution, but may be rich in organic matter.

Table 2.3.6-3. Density, Diversity, and Number of Taxa of Macroinvertebrates Collected from Payne Creek Using Artificial Substrates During October/November 1988 and February/March 1989

	October/November 1988			February/March 1989		
	PC-1	PC-2	PC-3	PC-1	PC-2	PC-3
<u>Density</u>*	14,296	23,247	+	31,821	23,385	7,006
<u>Diversity</u>	3.62	3.14	+	2.74	3.58	4.11
<u>Number of Taxa</u>	32	39	+	34	39	38
<u>Percent Composition</u>						
Ephemeroptera	5	2	+	<1	4	8
Chironomidae	64	89	+	80	91	81
Mollusca	< 1	< 1	+	<1	2	4
Other	30	8	+	18	3	7

* Per meter square (m^2)
\+ Samples vandalized.

The hydropsychid caddisfly larvae, Cheumatopsyche sp., was also very abundant on the artificial substrates at Station PC-1. Cheumatopsyche are also filter-feeders that require current of adequate speed and substantial quantities of suspended organics. Simpsom and Bode (1980) noted that Cheumatopsyche and R. exiguus are frequently found together and are indicative of a community having an abundance of suspended foodstuffs.

Mayflies and stoneflies are generally an indicator of clean environmental conditions. Although numerically they only comprised a small portion of the fauna (between 2 and 8%), due to their large size, as compared with the smaller chironomids, they are actually quite significant in terms of the total amount of food available for fish and the total productivity of the system. Common mayflies included Stenacron interpunctatum, Stenonema exiguum, and Caenis diminuta.

Species composition at Station PC-3 was different from that of upstream sites. Chironomids again dominated the fauna, however, species that had dominated Stations PC-1 and PC-2 no longer dominated Station PC-3 and were only collected sporadically, if at all. P. convictum which overwhelmingly dominated the fauna at PC-1 and PC-2, was not collected at PC-3, although other species of Polypedilum were found. Dicrotendipes, primarily, D. simpsoni was common. Species that had not been collected at the other creek Stations (PC-1 and PC-2) were collected at PC-3, they include: Cryptotendipes nr. pseudotener, Glyptotendipes lobiferous, Kiefferulus dux, and Paralauterborniella nigrohalteralis. The slower steam flow at PC-3 may be partially responsible for this change in species composition and for the increased enrichment. The species found at Station PC-3 do not require flowing water as do those that dominate PC-1 and PC-2. Furthermore, the reduced stream flow allows deposition of suspended matter in the downstream areas. Although Station PC-3 was vandalized during the October/November sampling period, the data gap does not affect the overall characterization of Payne Creek. The February/March sampling results indicated a typical assemblage of organisms for this habitat.

Macroinvertebrate data from the artificial substrates indicate that a relatively significant change occurred in the fauna of the upstream Station PC-1 from October/November 1988 to February/March 1989. Densities more than doubled, while percent composition of chironomids increased by 16%, and percent composition of the relatively intolerant ephemeropterans (mayflies) decreased (Table 2.3.6-3). Furthermore, diversity decreased by 25%.

A total of 82 taxa were collected by Ponar sampling from Payne Creek (Appendix 11.6, Table 1). The Ponar samples from the two upstream creek stations collected more taxa than ponar samples usually contain, and many of these taxa were insects that are not commonly found in grab samples (Table 2.3.6-4). The rich infauna benthic populations observed in the upstream stations (PC-1 and PC-2) may be due to several reasons. First, much of the creek bottom in this area is covered with leaf packs which provides excellent habitat for these invertebrates. Second, the flow is moderate to swift, which keeps the area just above the substrate well oxygenated. Finally, the creek appears relatively undisturbed in the upstream areas sampled, even though mining has occurred in the vicinity of both banks.

Macroinvertebrates from the dip net samples revealed that the grass shrimp, Palaemonetes paludosus, and chironomids dominated the vegetation, leaf packs, submerged roots and sticks in the streams (Table 2.3.6-5). Cambarid crayfish were also abundant, especially at the upstream stations.

In summary, the present evaluation of the macroinvertebrate communities in Payne Creek indicates that the two upstream stations of the creek are typical of central Florida small sandy bottom streams. A considerable load of suspended organic matter is indicated by the population parameters studied using the artificial substrates (i.e., the taxonomic composition, the high total densities and the proliferation of typical suspension feeders). The epifaunal communities at the upstream station (PC-1) changed between the October/November 1988 and February/March 1989 sampling periods, more so than at any other site. The amount of suspended organic material in the water may have increased during the course of the study, as implied by

Table 2.3.6-4. Density, Diversity, and Number of Taxa of Macroinvertebrates Collected from Payne Creek by Ponar Grab Samples in October 1988 and February 1989.

	October 1988			February 1989		
	PC-1	PC-2	PC-3	PC-1	PC-2	PC-3
Density*	13,090	12,090	3,636	27,270	26,906	2,818
Diversity	3.38	4.50	2.07	4.02	4.14	3.75
Number of Taxa	35	47	11	32	35	18
Percent Composition						
Oligochaeta	28	12	61	14	6	19
Ephemeroptera	8	20	<1	3	5	1
Chironomidae	7	21	11	52	61	74
Mollusca	47	38	26	13	7	1
Other	10	9	1	18	21	5

* per meter square (m^2)

Table 2.3.6-5. Macroinvertebrates Collected in Qualitative Dip Net Samples from Payne Creek During October 1988 and February 1989 (Page 1 of 2)

Scientific Name	Common Name	October 1988			February 1989		
		PC-1	PC-2	PC-3	PC-1	PC-2	PC-3
Turbellaria	Flatworm		F	F			
Prostoma rubrum	Probiscus worm			P			
Lumbriculidae	Aquatic earthworm						P
Tubificidae	Aquatic earthworm		P	P			
Hirunidea	Aquatic earthworm						P
Batracobdella phalera	leech	P		P			
Hyalella azteca	Scud	F	C	C		F	C
Gammaridae	Scud	P					
Cambarinae	Crayfish		C	P		F	
Palaenometes paludosus	Shrimp	P	C	AA	C	C	AA
Perlidae	Stonefly		P				
Baetis sp.	Mayfly	A	F				
Callibaetis floridanus	Mayfly			F			
Pseudocloeon alachua	Mayfly						P
Caenis diminuta	Mayfly	A		P			
Stenacron interpunctatum	Mayfly	F		C			
Stenonema spp.	Mayfly		P				
S. exiguum	Mayfly				F		
Chloroterpes hubbelli	Mayfly		F				
Tricorythodes albilineatus	Mayfly				P		
Hetaerina sp.	Damselfly						F
Argia sedula	Damselfly				F	P	F
Anomalagrion hastatum	Damselfly					F	
Nehallenia sp.	Damselfly	A		P	F	P	F
Aeschnidae	Dragonfly			P			
Gomphus minutus	Dragonfly		P		P		
Hagenius brevistypus	Dragonfly				P		
Brachymesia gravida	Dragonfly	F			P	F	
Macromia sp.	Dragonfly		P			F	F
M. taeniolata	Dragonfly				F	F	
Cheumatopsyche sp.	Caddisfly	AA			AA		
Hydropsyche sp.	Caddisfly						F
Hydroptilidae	Caddisfly						
Cyrnellus sp.	Caddisfly		F				
Polycentropus sp.	Caddisfly			P		F	
Homoptera	True Bug			P			
Pelocoris sp.	True Bug			F			
Ranatra sp.	True Bug					C	F
Lepidoptera	Aquatic Carterpillar		F	P		F	F
Chrysomelidae	Weevil Beetle		F				
Dubiraphia sp.	Riffle Beetle	C					
Heterelmis vulnerata	Riffle Beetle	P				P	
Stenelmis fusca group	Riffle Beetle						
Gyrinidae	Whirligid Beetle	F					

Table 2.3.6-5. Macroinvertebrates Collected in Qualitative Dip Net from Payne Creek During October 1988 and February 1989 (Page 2 of 2)

		October 1988			February 1989		
Scientific Name	Common Name	PC-1	PC-2	PC-3	PC-1	PC-2	PC-3
Dineutus sp. (larvae)	Whirligid beetle	F					P
Haliplidae	Crawling beetle		F	C			
Helodida	Beetle			P	C	F	
Noteridae	Burrowing water beetle						F
Ceratopogonidae	Biting Midges						
Chirionomidae	midges	AA	AA	AA	AA	AA	A
Simulium sp.	Blackflies						P
Stratiomyiidae	soldier flies			F			
Tabanidae	horseflies		F				
Tipulidae	craneflies			P		P	
Laevipex floridana	eimpet		P	P			
Pseudosuccinea columella	pond & snail		P				
Planorbella scalaris	mesa rams-horn	P		P			
Pomacea paludosa	apple snail			P			P
Corbicula fluminea	asiatic clam		F		P	F	P

Notes: AA = very abundant (>20 organisms)
A = abundant (10-20)
C = common (6-10)
F = few (2-5)
P = present (1)

the increase in total densities and the dominance of a few taxa in March over those in November. The macroinvertebrate communities at this station did not change substantially between sampling periods, as indicated by only minor changes in such community parameters as densities, diversities, number of taxa, and dominance.

At the most downstream station (PC-3), the river broadens and the flow slows down considerably. This station is affected by the apparent load of suspended material from upstream tributaries. In fact, this site is quite eutrophic, and the organisms collected by Ponar grab particularly reflected this. Macroninvertebrates collected by the artificial substrates samplers at this station contained both taxa that had apparently drifted downstream from areas of higher environmental quality and taxa that were quite tolerant to enrichment and more representative of this station.

TERRESTRIAL SYSTEMS - FLORA

<u>Mined Lands</u>--Mined lands are on the north and northwestern part of the site (Figure 2.3.5-1 FLUCCS Code 161). These lands consist of bare, scarified land, spoil piles of material which has been scraped from the surface, and excavated areas which are filled with water. There is no vegetation on these lands except for the occasional ruderal species that have managed to establish on the spoil piles. Ditches and berms that border the mined areas keep runoff from draining into Payne Creek.

<u>Improved Pasture with Scattered Pine</u>--The pasture is the dominant community on the unmined portion of the site. The pasture in the southeastern corner of the site below the mined lands (Figure 2.3.5-1, FLUCCS Code 211) represents lands that will not be mined. The power block associated facilities will be built on this land. The dominant grass in the pasture is bahia grass (<u>Paspalum</u> <u>notatum</u>). The soil underlying most of the pasture is Smyrna sand, a nearly level, poorly drained soil with moderate permeability and moderate natural fertility. The southeastern corner of the pasture on site, adjacent to an intact forested tributary, is underlain by Myakka fine sand, a nearly level poorly drained soil with low natural fertility. Its permeability is rapid in the surface layer and substratum and moderate to

moderately rapid in the subsoil. The water table recedes to a depth greater than 1 m (40 inches) in very dry seasons (Robbins, et al., 1984). These soil types and the species types that are colonizing the pasture indicate that its original native vegetation was flatwoods.

Although planted grass dominates the herbaceous layer, many native species and weedy aliens are present throughout the pasture (Table 2.3.6-6). Mature slash pine (Pinus elliottii) occurs scattered throughout the area; mature longleaf pine (Pinus palustris) can be found in the southwestern and western portion of the site. The trees range in diameter from 12 to 30 cm with a mean diameter of 23 cm. Their density on the site is approximately 5 per ha (2 per acre). Most trees bear cones, but young pines were seen only in the southern border near the Payne Creek floodplain. Remnant saw palmetto (Serenoa repens) clumps surround the pine trunks. Live oak (Quercus virginiana) clumps or individual trees occur in the southern pasture which is closer to the floodplain. Spanish moss (Tillandsia usneoides) and to a lesser extent, ball moss (Tillandsia recurvata) are common epiphytes on the pasture trees.

Dog fennel (Eupatorium capillifolium) has invaded much of the improved pasture. Bluestem grass (Andropogon virginicus) is also abundant here. Centipede grass (Eremochloa ophiuroides) which may either have been planted with the bahia grass or invaded afterward is common. Many species are indicative of wet poorly drained conditions in parts of the pasture, e.g., Aster subulatus, Boltonia diffusa, and Centella asiatica. If left undisturbed, the open pasture would eventually be reclaimed by flatwoods or hardwood forest, depending upon the frequency of wildfire.

Forested Wetland--One unmined tributary (0.9 ha or 2.3 acres) occurs in the southeastern pasture (Figure 2.3.5-1, FLUCCS Code 615) of the site. The forested headwaters of this tributary has a rich flora. Water spider orchid (Habenaria repens), goldfoot fern (Phlebodium aureum), and partridge berry (Mitchella repens) were some of the herbaceous species observed in addition to the more dominant groundcover of poison ivy (Toxicodendron radicans), lizard tail (Saururus cernua), and ferns (Osmunda cinnamomea, Woodwardia

Table 2.3.6-6. Plant Species Abundance in Improved Pasture at Hardee Power Station Site (Number of Plots = 20)

	*Mean Percent Cover	Mean Percent Frequency	Importance Value
<u>Species</u>**			
<u>Paspalum notatum</u>	80.0	100.0	26.6
<u>Desmodium triflorum</u>	59.1	55.0	17.4
<u>Sacciolepis indica</u>	29.2	40.0	10.2
<u>Desmodium incanum</u>	37.5	20.0	9.1
<u>Eupatorium capillifolium</u>	29.0	30.0	8.9
<u>Centella asiatica</u>	6.0	50.0	7.4
<u>Eremochloa aphiuroides</u>	30.0	10.0	6.5
<u>Richardia scabra</u>	5.0	30.0	4.7
<u>Cyperus polystachyos</u>	3.3	20.0	3.1
<u>Diodia teres</u>	3.3	15.0	2.5
<u>Conyza canadensis</u>	4.0	10.0	2.0
<u>Murdannia nudiflora</u>	2.0	10.0	1.7

* Mean percent cover in plots where the species occurred.

Importance Value = (Relative Mean Percent Cover + Relative Mean Percent Frequency) divided by 2

** See table 2.3.5-1 for common names

spp.) The overstory consists of red maple (Acer rubrum), water oak (Quercus nigra), sweetbay magnolia (Magnolia virginiana), black gum (Nyssa biflora), and loblolly bay (Gordonia lasianthus) (Table 2.3.6-7). Red maple is dominant with an importance value of 45.7%. Average basal area of red maple trunks is 914.3 cm^2. Total basal area of the tree canopy is 210 m^2/hectare. Epiphytes are common on canopy trees in this community and buttonbush (Cephalanthus occidentalis), swamp honeysuckle (Rhododendron viscosum), and Virginia willow (Itea virginica) were abundant in the shrub stratum with importance values of 14.0, 9.5, and 17.0%, respectively. Redbay (Persea borbonia), sweetbay magnolia and water oak (Quercus nigra) were the most common saplings. South of the forested headwater area the tributary was narrow (1-3 m wide), deep in some areas, and shallow in others. Trees are intermittent in this part of the drainage. Sedges and lizard-tail (Saururus cernua) occupied treeless areas. Canna (Canna flaccida) and narrow-leaf sunflower (Helianthus angustifolia) were also observed in open areas of the tributary.

Payne Creek Floodplain--The creek has a clearly incised channel, although the channel becomes shallower and wider in some areas. Parts of the floodplain have terraced elevations with sloughs or channels behind the higher terraced areas. Near the mining operation, large areas of sand have deposited in the creek bed. The differences in elevation throughout the floodplain have resulted in very different plant communities adjacent to each other. Saw palmetto, slash pine, sweetgum and laurel oak occur at the higher elevations and pop ash (Fraxinus caroliniana), buttonbush, red maple, and other wetland species grow at the lower elevations (Figure 2.3.5-1 FLUCCS Code 411/615). High dense saw palmetto or grasses (Aristida stricta, Aristida spiciformis, Andropogon brachystachus) are between the pasture and the forested wetland. These upland areas and the wetland bordering the creek comprise the floodplain. The property south of Payne Creek and its bordering vegetation has been mined for phosphate.

The dominant tree in the upper floodplain is laurel oak with an importance value of 82.4% (Table 2.3.6-8). The average basal area of this species is 711.5 cm^2. Sweet gum (Liquidambar styriciflua) and red maple are also

Table 2.3.6-7. Plant Species* Abundance in Forested Wetland at Hardee Power Station Site (Number of plots = 4) (Page 1 of 2)

Stratum	Abundance Measurements			
TREES	Total Basal area (cm^2) per M^2	Average Basal area (cm^2)	Total Density per M^2	Importance[1] Value (%)
Acer rubrum	11886	914.3	13	45.7
Magnolia virginiana	3534	441.8	8	19.2
Quercus nigra	1001	200.2	5	9.1
Nyssa biflora	996	332.1	3	6.4
Liquidambar styraciflua	1128	1127.6	1	4.0
Gordonia lasianthus	325	162.4	2	3.5
Quercus laurifolia	260	129.9	2	3.3
Ilex cassine	834	834.3	1	3.3
Pinus elliottii	740	739.9	1	3.1
Persea borbonia	460	459.7	1	2.4
Total	52.0		.09	

SHRUB LAYER	Total Density per m^2	Frequency	Importance[2] Value (%)
Itea virginica	30	50	17.0
Cephalanthus occidentalis	15	100	14.0
Vitis spp.	12	100	12.7
Rhododendron viscosum	13	50	9.5
Magnolia virginiana	12	50	9.0
Liquidambar styriciflua	8	50	7.2
Persea borbonia	7	50	6.8
Osmanthus americana	5	25	4.1
Serenoa repens	4	25	3.6
Myrica cerifera	1	25	2.3
Quercus nigra	1	25	2.3
Ilex cassine	1	25	2.3
Smilax laurifolia	1	25	2.3
Vaccinium corymbosum	1	25	2.3
Smilax auriculata	1	25	2.3
Total	1.1		

Table 2.3.6-7. Plant Species Abundance in Forested Wetland at Hardee Power Station Site (Number of plots = 4) (Page 2 of 2)

Stratum	Abundance Measurements		
GROUND LAYER	Percent Cover per m^2 plot	Frequency	Importance Value (%)[3]
Osmunda cinnamomea	40	100	38.5
Saururus cernuus	30	75	29.2
Toxicodendron radicans	8	50	13.1
Myrica cerifera	10	25	9.6
Acer rubrum	10	25	9.6

1. Importance value of trees = (Relative Basal Area + Relative Density) divided by 2

2. Importance value of shrub layer = (Relative Density + Relative Frequency) divided by 2

3. Importance value of ground layer = (Relative Percent Cover + Relative Frequency) divided by 2

* See Table 2.3.5-1 for common names

Table 2.3.6-8. Plant Species* Abundance in Payne Creek Floodplain at Hardee Power Station Site (Number of plots = 4)

Stratum	Abundance Measurements			
TREES	Total Basal area (cm^2) per m^2	Average Basal area (cm^2)	Total Density per m^2	Importance[1] Value (%)
Quercus laurifolia	15,652	711.5	22	82.4
Liquidambar styraciflua	1,074	214.8	5	11.2
Fraxinus caroliniana	50	25.1	2	3.1
Quercus nigra	77	76.9	1	1.7
Persea borbonia	23	22.9	1	1.6
Total	42.5		.08	

SHRUBS LAYER	Total Density	Frequency	Importance[2] Value (%)
Serenoa repens	57	100	32.6
Smilax bona-nox	47	50	22.5
Baccharis glomeruliflora	13	75	14.4
Smilax auriculata	23	50	14.4
Liquidambar styraciflua	5	75	11.6
Quercus laurifolia	3	25	4.5
Total	1.5		

GROUND LAYER	Percent Cover per m^2 plot	Frequency	Importance[3] Value (%)
Panicum rigidulum	80	25	39.1
Urena lobata	50	25	29.1
Acer rubrum	10	25	15.9
Pteridium aquilinum	10	25	15.9

1. Importance value of trees = (Relative Basal Area + Relative Density) divided by 2

2. Importance value of shrub layer = (Relative Density + Relative Frequency) divided by 2

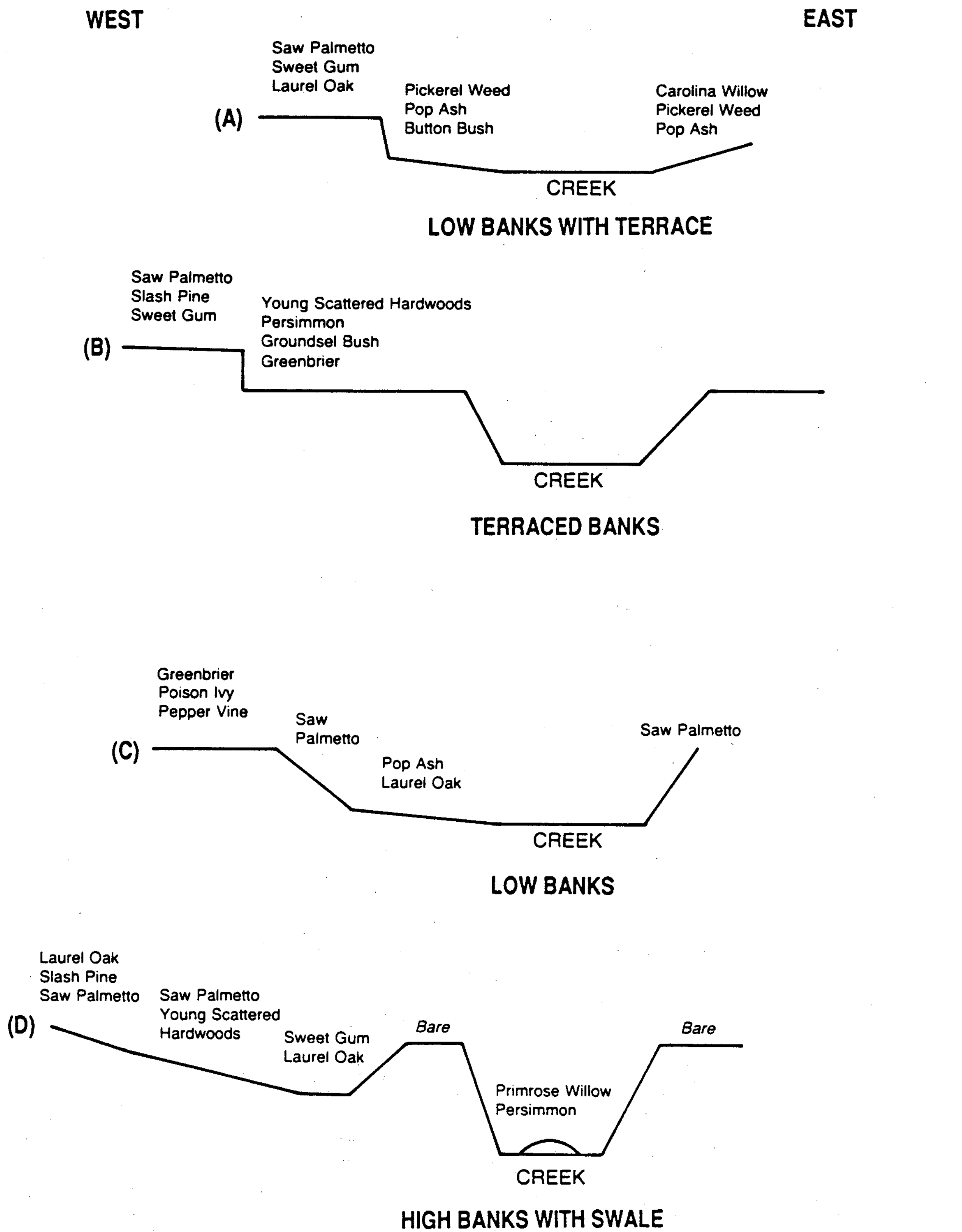
3. Importance value of ground layer = (Relative Percent Cover + Relative Frequency) divided by 2

** See Table 2.3.5-1 for common name

abundant. Total basal area of the tree canopy is 42.5 cm/m^2. Saw palmetto with an importance value of 32.6% is the most abundant shrub. Greenbrier (Smilax spp.) and groundsel tree (Baccharis glomeruliflora) are also abundant in the shrub layer. Redtop panicum (Panicum rigidulum) is a common groundcover in open areas of the floodplain. Epiphytes are common in the canopy trees and include Spanish moss, ball-moss, wild pine (Tillandsia fasciculata), and butterfly orchid (Encyclia tampensis). Red maple and sweetgum saplings are abundant in the understory and overtop the saw palmetto in many areas. This part of the floodplain is typical of flatwoods that have not burned for a long time; if fire continues to be excluded, a hardwood floodplain forest will replace much of the saw palmetto.

Species associations on the floodplain vary with slope and height as shown in a generalized depiction of these relationships (Figure 2.3.6-2). Cross-section A shows the floodplain which is characterized as low banks with a terrace. The vegetation in this type of area is comprised of pickerelweed, redtop panicum, pop ash, and buttonbush. Adjacent to this is an area approximately one meter higher with saw palmetto, sweetgum and laurel oak, festooned with yellow jessamine. In areas with terraced banks (Cross-section B) the vegetation pattern is characterized by a high shrubby area adjacent to the creek channel of grass, greenbrier, persimmon, yellow jessamine, groundselbush, grape, and wax myrtle with scattered young sweetgum, red maple and laurel oak. The few overstory trees are live oak and sweet gum. This zone is approximately 7 m (23 ft) wide. Adjacent to it the bank rises sharply 1 to 2 m (3 to 7 ft) higher to a palmetto-pine-sweetgum zone. Lichen lines on the sweetgum tree trunks about 30 cm (12 in) from the ground surface indicate occasional flooding here.

Parts of the floodplain have low banks flat (Cross-section C). They support pop ash, elm, and laurel oak. The understory is almost bare with no litter, shrubs, or groundcover. This zone is approximately 8 m (26 ft) wide and is adjacent to a 2 m (6.6 ft) wide zone of dense saw palmetto and some sweetgum trees which rises sharply to a high bank of poison ivy, greenbrier, and peppervine (Ampelopsis arborea).



(Not drawn to scale)

Figure 2.3.6-2 GENERALIZED RELATIONSHIP OF PLANT SPECIES TO PAYNE CREEK FLOODPLAIN CONFIGURATIONS

Hardee Power Station

Cross-section 2.3.6-2-D depicts the floodplain in areas with high banks and swales. Lichen lines on sweetgum and laurel oak trees in swales behind the banks are approximately 1 m (3 ft) from the ground surface indicating that flooding to that height is sufficiently frequent to keep the lichens from growing any lower. Persimmon and primrose willow are growing on a large sandbar in the center of the creek.

The upper floodplain is a vegetation zone dominated by saw palmetto, yellow jessamine, bracken fern, sweetgum and laurel oak saplings, and swamp honeysuckle. Further upland is a zone with laurel oak, slash pine, sweetgum, and very dense saw palmetto. The lichen lines extend to the base of the trees indicating little flooding in this section. Many small drainages from the upland area of the site dissect this zone. Beyond this zone to the north, the saw palmetto drops out, there is slight litter on the ground, and groundsel bush, greenbrier, young sweetgum, water oak seedlings, and caesarweed predominate.

The Payne Creek floodplain near the southeast corner of the site has a wide floodplain and the stream channel is less than 1 m (3 ft) deep. Large areas are dominated by ferns [cinnamon fern, swamp fern (Blechnum serrulatum), chain ferns], lizards-tail, and smartweed (Polygonum hydropiperoides). The most common tree is young red maple and red maple leaf litter approximately 10 cm (4 in) deep overlays the peat surface. Laurel oak, pop ash, and slash pine are also present. Moss-covered cypress knees are common, but live cypress has been historically timbered. Few shrubs were observed. The bases of the trees are above the ground exposing the roots; this could indicate peat subsidence due to a lowered water level, but the charred trunks of the older slash pine indicate a peat fire in the recent past.

Lands to be Mined--Agrico is permitted to mine the northern part of the site for phosphate. This area contains the site of the cooling reservoir for the Hardee Power Station. Much of it will have been excavated by Agrico before construction of the power plant begins. This area is predominantly pasture. It also contains an abandoned citrus orchard, logged pine plantation, and a small oak woodland. The land was originally flatwoods before citrus and pasture were planted and some remnant flatwoods areas remain.

Wetlands in this area include several isolated marshes and a central forested wetland that drains into Payne Creek. The marshes have formed in depressions in the flatwoods and are dominated by maidencane (*Panicum hemitomon*), juncus (*Juncus effusus*), and pickerelweed. One of these marshes drains into a small pond. A sawgrass (*Cladium jamaicense*) marsh borders the forested wetland.

The forested wetland has been altered by filling, logging, and other disturbances that have favored weedy vegetation in some areas. Water oak, live oak, red maple, black gum, and saw palmetto are the dominant woody species. A large isolated wetland that will not be mined lies offsite to the northwest.

TERRESTRIAL SYSTEMS - FAUNA

Lands That Have Been Mined--The region surrounding the Agrico site has been severely altered by strip mining operations. The barren spoil piles and bare ground of mined land support virtually no wildlife species. Moreover, these mined areas isolate non-mined wildlife habitat from larger habitat areas. However, the ditches, excavated ponds and settling ponds support many wading birds and waterfowl.

Lands Not to be Mined--Remnant areas of important wildlife habitats, including forested wetland along Payne Creek and improved pasture with pine and upland oak-palmetto, still remain in the southern portion of the site (Figure 2.3.5-1). The most productive of these habitats are the forested wetlands along Payne Creek. This hardwood habitat supports a greater number of observed and potentially occurring species of animals than the other identified habitats (Tables 2.3.6-9, 2.3.6-10 and 2.3.6-11).

Ubiquitous species (those species actually observed in all habitats), included the feral hog, nine-banded armadillo, downy woodpecker, and the blue jay (scientific names are listed in Tables 2.3.6-9 and 2.3.6-10). Feral hogs were abundant in all habitats and their foraging created much disturbance, particularly along forest edges.

<u>Forested Wetland</u>--Mixed species flocks of migrant and resident small insectivorous birds, including yellow-rumped warblers, blue-gray gnatcatchers, ruby crowned kinglets, tufted titmice, and palm warblers accounted for much of the avian activity in this habitat.

Common omnivorous birds included the gray catbird, mockingbird, red-bellied woodpecker, and white-eyed vireo. Northern bobwhites were observed retreating into the forest from the adjacent pasture. The Eastern phoebe was common along the forest edge. The red-shouldered hawk, a carnivore, appeared to be fairly common, while the piscivorous belted king fisher perched in the forest along Payne Creek.

Tracks were found of bobcat and river otter, in this habitat. Tracks of raccoons and deer were also observed. The burrows of crayfish, important prey of river otters and raccoons, were present in the floodplain. Centrarchid fish, another important prey of the river otter, were common in Payne Creek (see Aquatic Systems Section).

Gray squirrels occur in the forested wetlands. Amphibians including green anoles and frogs including the green tree frog, bullfrog, and southern leopard frog were observed.

<u>Flatwood Habitat</u>--Birds were much less common in this habitat than in the forested wetland. Wildlife observed in the flatwoods included the downy woodpecker, tufted titmouse, blue-gray gnatcatcher, ruby crowned kinglet,

Table 2.3.6-9. Mammal Species Observed (O) or Which Potentially Occur (P) on the Hardee Power Station Site

Common name	Scientific name	Mesic Hardwoods	Open Pine-Pasture	Upland Oak-Palmetto
Opossum	Didelphis virginiana	P	P	P
Least shrew	Cryptotis parva			
Shorttail shrew	Blarina brevicauda	P	P	P
Eastern mole	Scalopus aquaticus		P	P
Big brown bat	Eptesicus fuscus	P	P	P
Seminole bat	Lasiurus seminolus	P	P	P
Eastern yellow bat	Lasiurns intermedius	P	P	P
Evening bat	Nycticeius humeralis	P	P	P
Eastern big-eared bat	Plectotus rafinesquei		P	P
Mexican free-tailed bat	Tadarida braziliensis		P	P
Black bear	Ursus braziliensis	P		P
Raccoon	Procyon lotor	O		P
Longtail weasel	Mustela frenata	P		
Mink	Mustela vison	P		
River otter	Lutra canadensis	O		
Spotted skunk	Spilogale putorius	P		P
Striped skunk	Mephitis mephitis	P		P
Gray fox	Urocyon cinereoargenteus	P	P	P
Bobcat	Lynx rufus	O	P	P
Eastern gray squirrel	Sciurus carolinensis	O		O
Eastern fox squirrel	Sciurus niger	P		P
Southern flying squirrel	Glaucomys volans	P		
Southeastern pocket gopher	Geomys pinetis		P	P
Eastern harvest mouse	Reithrodontomys humulis		P	
Cotton mouse	Peromyscus gossypinus	P		
Florida mouse	Peromyscus floridanus		P	P
Eastern woodrat	Neotoma floridana	P	P	P
Rice rat	Oryzomys palustris	P		
Hispid cotton rat	Sigmodon hispidus		P	P
Eastern cottontail	Sylvilagus floridanus	P	P	P
Marsh rabbit	Sylvilagus palustris	P		
White-tailed deer	Odocoileus virginianus	P	P	P
Armadillo	Dasypus novemcinctus	O	O	O
Wild hog	Sus scrofa	O	O	O

Table 2.3.6-10. Birds Observed (O) or Which Potentially Occur (P) on the Hardee Power Station Site (Page 1 of 2)

Common name	Scientific name	Mesic Hardwoods	Open Pine-Pasture	Upland Oak-Palmetto	Flying Overhead	Seasonal Status*
Double-crested cormorant	Phalacrocorax auritus				O	P
White pelican	Pelecanus erythrorhynchos				O	W
Wood stork	Mycteria americana				O	R
Killdeer	Charadrius vociferus		O			RW
Red-shouldered hawk	Buteo lineatus	O	O	P		R
Red-tailed hawk	Buteo jamaicensis	P	O	P		R
American kestrel	Falco sparverius		O			RW
Black vulture	Coragypes atratus	P	P	P	O	RW
Northern bobwhite	Colinus virginianus	O	P	P		RW
Belted kingfisher	Megaceryle alcyon	O				W
Red-bellied woodpecker	Melanerpes carolinus	O	O	P		R
Downy woodpecker	Picoides pubescens	O	O	O		R
Pileated woodpecker	Dryocopus pileatus	O				R
Yellow-bellied sapsucker	Sphyrapicus varius	O		P		W
Great crested flycatcher	Myiarchus crinitus	O				S
Eastern phoebe	Sayornis phoebe	O				W
Tree swallow	Iridoprocne bicolor	O		O		R
Blue jay	Cyanocitta cristata	O	O	O		R
Tufted titmouse	Parus bicolor	O		O		R
Carolina wren	Thyrothorus ludovicianus	O		P		R
House wren	Troglodytes aedon	O	O			W
Ruby crowned kinglet	Regulus calendula	O		O		W
Blue-gray gnatcatcher	Polioptila caerulea	O		O		RW
Brown thraswer	Toxostoma rufum	O				R
Northern mockingbird	Mimus polyglottos	O	O	P		R
Gray catbird	Dumetella carolinensis	O	O			W
Loggerhead shrike	Lanius ludovicianus		O			R
White-eyed virego	Vireo griseus	O	O			R
Black-and-white warbler	Mniotila varia	O				W
Yellow-throated warbler	Dendroica dominica	O				W

Table 2.3.6-10. Birds Observed (O) or Which Potential Occur (P) on the Hardee Power Station Site (Page 2 of 2)

Common name	Scientific name	Mesic Hardwoods	Open Pine-Pasture	Upland Oak-Palmetto	Flying Overhead	Seasonal Status*
Yellow-rumped warbler	Dendroica coronata	O				W
Palm warbler	Dendroica palmarum	O	O	P		W
Common yellowthroat	Geothlypis trichas	O				R
Red-winged blackbird	Agelaius phoeniceus		O			R
Eastern meadowlark	Sturnella magna		O			R
Northern cardinal	Cardinalis cardinalis	O		O		R
Rufons-sided towhee	Pipilo erythropthalmus	O	P	P		RW
Henslows sparrow	Ammodramus henslowii		O			W

* Seasonal Status:

W = Winter resident
S = Summer resident
R = Year-round resident
RW = Resident in area but numbers augmented by wintering birds from the north.

Table 2.3.6-11. Terrestrial Reptiles and Amphibians Observed (O) or Which Potentially Occur (P) on the on the Hardee Power Station Site (Page 1 of 2)

Common name	Scientific Name	Mesic Hardwoods	Open Pine-Palmetto	Upland Oak-Palmetto
Eastern coachwhip	Masticophis flagellum	P	P	P
Florida pine snake	Pituophis melaneucus mugitus			P
Yellow rat snake	Elaphe obsoleta quadrivittata	P		P
Corn snake	Elaphe guttata guttata	P	P	P
Florida scarlet snake	Cemophora coccinea coccinea		P	P
Scarlet king snake	Lampropeltis triangulum elapsoides			P
Florida king snake	Lampropeltis getulus floridana	P		
Short-tailed snake	Stilosoma extenuatum			P
Peninsula crowned snake	Tantilla relicta	P		P
Florida cottonmouth	Agkistrodon piscivorous conanti	P		
Dusky pygmy rattlesnake	Sistrurus miliaris barbouri	P	P	
Eastern diamondback rattlesnake	Crotalus adamanteus	P	P	P
Eastern coral snake	Micrurus fulvius fulvius	P	P	P
Southern dusky salamander	Desmognathus auriculatus	P		
Slimy salamander	Plethodon glutinosus	P		
Dwarf salamander	Eurycea quadridigitata	P		
Eastern spadefoot toad	Scaphiopus holbrooki		P	P
Eastern narrowmouth toad	Gastrophyrne carolinensis	P		
Southern toad	Bufo terrestris	P	P	P
Oak toad	Bufo quericus	P	P	P
Florida box turtle	Terrepene carolina bauri	P	P	
Gopher tortoise	Gopherus polyphemus	P	P	P
Green anole	Anolis carolinensis	O		P
Southern fence lizard	Sceloperus undulatus undulatus	P		P
Ground skink	Scincella laterale	P		P
Southeastern five-lined skink	Eumeces inexpectatus	P		P
Peninsula mole skink	Eumeces egregins onocrepis		P	P
Six-line race runner	Cnemidophorus sexlineatus		P	P
Eastern glass lizard	Ophisaurus ventralis	P	P	
Island glass lizard	Ophisaurus compressus		P	P
Slender glass lizard	Ophisaurus attenuatus		P	
Worm lizard	Rhineura floridana		P	P
Florida green water snake	Nerodia cyclopian floridana	P		
Brown water snake	Nerodia taxispilota	P		
Florida water snake	Nerodia sipedon pictiventris	P		
Florida brown snake	Storeria dekayi victa	P		P
Eastern garter snake	Thamnophis sirtalis	P		
Peninsula ribbon snake	Thamnophis sauritus	P		
Pine woods snake	Rhadinaea flavilata	P		
Florida red-bellied snake	Storeria occipitomaculata	P	P	
Eastern hognose snake	Heterodon platyrhinos		P	P
Southern hognose snake	Heterodon simus		P	P
Southern ringneck snake	Diadophis punctatus	P		
Rough green snake	Opheodrys aestivus	P		
Southern black racer	Colaber constrictor priapus	P	P	P

Table 2.3.6-11. Terrestrial Reptiles and Amphibians Observed (O) or Which Potentially Occur (P) on the Hardee Power Station Site (Page 2 of 2)

Common name	Scientific Name	Mesic Hardwoods	Open Pine-Palmetto	Upland Oak-Palmetto
Barking treefrog	Hyla gratiosa	P		
Green treefrog	Hyla cinerea	O		
Squirrel treefrog	Hyla squirella	P		
Pine woods treefrog	Hyla femoralis	P		
Florida chorus frog	Psuedracris negrita verrucosa	P		
Bullfrog	Rana catesbeiana	O		
Pig frog	Rana grylio	P		
Southern leopard frog	Rana sphenocephala	O		
Florida gopher frog	Rana areolat aesopus	P		

blue jay, and cardinal. Adult and juvenile hogs, and gray squirrels were also seen.

Improved Pasture with Pine ~~Habitat~~--The most prominent birds in ~~this habitat~~ the pasture area are ~~were~~ the American kestrel, loggerhead shrike, Eastern meadowlark, and the killdeer, all of which are typical species of pasture land and/or open pine. Another grassland species observed was a granivore, the Henslow's sparrow.

Other birds observed included the red-bellied and downy woodpecker, red-tailed hawk, and the mockingbird, all of which, like the shrike and kestrel, utilized the scattered pines as perch sites. Where growths of dog-fennel provided cover, catbirds and house wrens were present. Small groups of the palm warbler, a species common in open habitats during winter, were observed foraging in the scattered pines and on the ground.

THREATENED AND ENDANGERED SPECIES - ~~FLORA AND FAUNA~~

Species designated by the U.S. Fish and Wildlife Service (USFWS) as listed or under review, listed as endangered or threatened by the Florida Game and Fresh Water Fish Commission (FGFWFC), Florida Department of Agriculture and Consumer Services (FDACS), and on the Special Plants List by the Florida Natural Areas Inventory (FNAI) were included in ~~this category.~~ the threatened or endanger species category. Sources used to identify threatened and endangered plant and animal species that could potentially occupy the unmined areas of the site included the FNAI data base, Florida Committee on Rare and Endangered Plants and Animals (FCREPA) reports, and DRI applications for the Agrico site and the CFI mine south of the Agrico site. The descriptions and flowering or fruiting seasons for plant species were reviewed and herbarium specimens were observed before a field search for the species was conducted. The following species listed as threatened on the FDA list were found on the Hardee County Power Plant site: water spider orchids and golden polypodie, both plants were in the pasture tributary. ~~and shown in Table 2.3.6-12.~~

Flora--Threatened and endangered plant species were not found on the Agrico property (which includes the area of the plant site) in February 1976 during preparation of the DRI (Agrico 1977). However, as pointed out in the DRI,

Table 2.3.6-12. Threatened and Endangered Plant Species that Could Potentially Occur on or Near Hardee Power Station Site

Scientific Name	Common Name	Status	Habitat	Source	Prob. on Site
Gymnopogon floridanus	Florida beardgrass	UR2	Pinelands	USFWS	M
Habenaria repens	Water spider orchid	T	Wetlands	FDA	P
Hartwrightia floridana	Hartwrightia	T/UR2	Marsh grassland or boggy swales Blooms Sept-Nov	FDA/USFWS	L
Phlebodium aureum	Golden polypody	T	Epiphytic in hammocks	FDA	P
Pteroglossapsis ecristata	Wild coco	T	Dry sandy pinelands Blooms in Fall	FDA/USFWS	L
Tillandsia setacea	Wild pine	T	Epiphytic in hammocks	FDA	M
Vittaria lineata	Shoestring orchid	T	Epiphytic in hammocks	FDA	M

T = threatened according to FDA
UR2 = under review for listing by FWS, but substantial evidence of biological vulnerability and/or threat is lacking.

P = present on site
L = low probability of presence
M = moderate probability of presence

FCREPA - Florida Committee on Rare and Endangered Plants and Animals

FDA - Florida Department of Agriculture and Consumer Services list published in Preservation of Native Flora of Florida Act, Section 581.185-187 F.S.

USFWS - United States Fish and Wildlife Service.

the season was not optimum for identification of such species. Several listed species were reported on the CFI mine site, south of the Agrico Payne Creek mine, in 1985 and these were considered to potentially occur on the Agrico site.

Species that could potentially occur on the site are listed in Table 2.3.6-12 and the probability of their occurrence is assessed. Detailed descriptions and the results of the search for these species follow in this section.

Florida beardgrass [Gymnopogon floridanus, (G. chapmanianus in Wunderlin 1982)]
This grass is under review (Category 2) for listing by USFWS and is on the FNAI Special Plants List. It was found on the CFI site in flatwoods. The plant flowers in the fall and would have been recognized if seen. Although it was not observed, it is listed as having a moderate probability of being present because of the large area of flatwoods and pasture in which it could have possibly occurred.

Water spider orchid (Habenaria repens)
Water spider orchid occurs in the understory of the tributary forest and is common on site along the eastern part of the Payne Creek floodplain. It was in flower when observed. It is listed only by the FDACS with a designation of threatened. Wunderlin (1982) states that it is common throughout Central Florida.

Hartwrightia (Hartwrightia floridana)
Hartwrightia is under review (Category 2) for listing by USFWS and is listed as threatened by the FDACS. It is not reported from the area by FNAI or in CFI (1985). However, Ward (1978) reported it as occurring in Hardee County and Dr. Hall (personal communication) said that it could occur in wet open areas in the region. It produces pinkish lavender florets in fall and its achenes has resinous glands. Favorable habitats were thoroughly searched for this species, but it was not found. The probability of occurrence is, therefore, listed as low.

Golden polypody (Phlebodium aureum)
Golden polypody is an epiphytic fern listed as threatened by FDACS. Wunderlin (1982) refers to this species as frequent in hammocks. Three plants were observed in the pasture tributary on fallen red maple trees.

Wild coco (Pteroglossapsis ecristata)
This orchid is listed as under review (Category 2) by USFWS and as threatened by FDA. It was reported in the Payne Creek State Park by FNAI and on the CF site (CF 1985). Wunderlin (1982) states that it is frequent on sand pine scrub and sandhills. It is a tall plant that blooms in the fall and would be conspicuous. It was not observed on the site. The probability of the plant's occurrence is listed as low.

Wild pine (Tillandsia setacea)
This epiphyte is listed as threatened by FDACS. It was observed on the CFI site (CFI 1985) in swamp forest. Wunderlin (1982) states that it is common in Central Florida except for the northernmost counties. It could have been unobserved in canopy trees in the Payne Creek floodplain and therefore it is given a moderate probability of occurrence.

Shoestring fern (Vittaria lineata)
This epiphytic fern is listed as threatened by FDACS. It is listed as frequent by Wunderlin (1982). CFI (1985) reported that it occurred in the swamp forest. It has a moderate probability of occurrence in the Payne Creek floodplain, although it was not observed.

Fauna--No federally or state listed species have been observed onsite either during the Agrico DRI studies or this study (Table 2.3.6-13). For a number of species their range includes the site and potentially suitable habitat occurs in the site area. The following describes those species whose range include the site area.

Burrowing owl (Athene cunicularia)
The burrowing owl, listed as a species of special concern by the FGFWFC, was not observed during the survey. Suitable habitat (open pine-pasture) is

Table 2.3.6-13. Threatened and Endangered Faunal Species that Occur or Could Potentially Occur on or Near Hardee Power Station Site

Scientific Name	Common Name	Status	Habitat	Source	Prob. on Site
Athene cunicularia	Burrowing owl	SSC	Open pine-pasture	FGFWFC	L
Falco sparverius paulus	Southeastern American kestrel	T UR2	Open-pine pasture	FGFWFC USFWS	M
Haliaeetus leucocephalus	Bald eagle	T E	Open pine-pasture with tall trees	FGFWFC USFWS	L
Polyboros plancus audobonii	Audubon's crested caracara	T T	Prairie's open pasture	FGFWFC USFWS	L
Mycteria americana	Wood stork	E E	Wetlands	FGFWFC USFWS	L
Felis concolor coryi	Florida panther	E E	Large habitat areas	FGFWFC USFWS	L
Mustael frenata peninsulae	Florida long-tailed weasel	UR2	Forested stream borders	USFWS	M
Gopherus polyphemus	Gopher tortoise	SSC UR2	Upland areas with abundant herbaceous ground cover	FGFWFC USFWS	L
Rana areolata	Gopher frog	SSC UR2	Associated with gopher tortoise	FGFWGC USFWS	L
Drymarchon corais couperi	Eastern indigo snake	T T	Wooded areas	USFWS FGFWFC	M
Pituophis melanoleucus mugitus	Florida pine snake	SSC UR2	Upland oak-palmetto open pine-pasture	FGFWFC USFWS	M
Stilosoma extenuatum	Short-tailed snake	T UR2	Upland oak-palmetto	FGFWFC USFWS	M

L = low probability
P = present
M = moderate probability
SSC = Species of Special Concern
T = Threatened
E = Endangered
UR2 = Under review

USFWS = U.S. Fish and Wildlife Service
FGFWFC = Florida Game and Fresh Water Fish Commission

present but the likelihood of occurrence is low because of past and present mining activities.

Southeastern American kestrel (Falco sparverius paulus)
The Southeastern American kestrel is listed as threatened by the FGFWFC, under review for listing by the USFWS but substantial evidence of vulnerability is lacking (UR2). Two subspecies of kestrels occur in Florida. Eastern American kestrel is a winter resident only, while the Southeastern American kestrel is a year-round resident occupying open pine habitats. American kestrels (Falco sparverius sparverius) were found to be fairly common in the open pine-pasture of the site, but their subspecies could not be determined.

Bald eagle (Haliaeetus leucocephalus)
The bald eagle is listed as threatened by the FGFWFC and endangered by the USFWS. The closest nest is 4.8 km (3 miles) west of the Hardee Power Station site. Some of the pines on the site may be large enough to be used for occasional roosting sites. The likelihood of occurrence is low because of the mining activity and lack of open water on site for feeding.

Audubon's crested caracara (Polyboros plancus audobonii)
The crested caracara is listed as threatened by both the FGFWFC and the USFWS. It was not observed during the survey, but has been recorded within three miles of the study site and suitable habitat onsite is present. The likelihood of occurrence for feeding is low because of mining activities.

Wood stork (Mycteria americana)
Listed as endangered by both the FGFWFC and the USFWS. Several birds were observed circling overhead during surveys. A rookery occurs several miles to the north of the site. Suitable feeding or nesting habitat does not appear to be present on the site, but is present in the immediate vicinity.

Florida panther (Felis concolor coryi)
The Florida panther is listed as endangered by both the FGFWFC and the USFWS, and was not observed during the survey. Adequate prey may be present

in the area, but habitat is presently too fragmented for panthers. However a radio-collared panther was reported located within 24 km (15 miles) of study site.

Florida long-tailed weasel (Musteal frenata peninsulae)
The long-tailed weasel is listed as UR2 by USFWS, and was not observed. However, mesic hardwood forest along creeks may provide suitable habitat.

Gopher tortoise (Gopherus polyphemas)
Listed as a species of special concern by the FGFWFC and as UR2 by USFWS, gopher tortoise burrows were observed in open flatwoods on the lands to be mined. Although the upland oak-palmetto and open pine-pasture may also provide suitable habitat, the likelihood of occurrence in most areas is low because of the mining activities which have fragmented habitats.

Gopher frog (Rana areolata)
The gopher frog is listed as a species of special concern by the FGFWFC and as UR2 by the USFWS. It was not observed, but the upland oak-palmetto and open pine-pasture may provide suitable habitat. The gopher frog is found in association with the gopher tortoise.

Eastern indigo snake (Drymarchon corais couperi)
The eastern indigo snake is listed as threatened by both the FGFWFC and the USFWS. It was observed in palmetto on lands to be mined and has been reported in other areas within 8 km (5 miles) of study site. The upland oak-palmetto and mesic hardwood forest provide suitable habitat.

Florida pine snake (Pituophis melanoleucus mugitus)
The Florida pine snake, listed as a species of special concern by the FGFWFC and as UR2 by USFWS, was not observed, but the upland oak-palmetto and open pine-pasture are suitable habitat.

Short-tailed snake (Stilosoma extenuatum)
The short-tailed snake is listed as threatened by the FGFWFC and as UR2 by

the USFWS. It was not observed during the survey, but the upland oak-palmetto may provide adequate habitat.

2.3.6.2 Pre-existing Stresses

AQUATIC SYSTEMS

Payne Creek is located in an area of extensive phosphate mining. At the time these studies were conducted, mining was taking place north and east of the study site on either side of Payne Creek. Historically, Payne Creek has been altered by ditching of its tributaries for agricultural operations, and, more recently, by the elimination of the tributaries as a result of mining.

TERRESTRIAL SYSTEMS

The greatest pre-existing stress to regional vegetation, including the site, is the result of extensive phosphate mining. Not only the vegetation, but the natural topography, soils, and hydrology are extensively altered. Wildlife habitat is disrupted and natural drainage features are modified. Active mining is occurring on site and in the vicinity of the site. Areas north and west of the site are being or have been reclaimed. Reclamation land uses consist predominantly of pasture land, lakes, and wetlands.

Agriculture is the predominant industry influencing natural vegetation and wildlife in both counties, with the exception of phosphate mining, and is likely to be the dominant industry when mining operations are complete. Cattle ranching, citrus and vegetable farming are the major agricultural enterprises (Stricker, 1988).

South and southeast of the site are productive citrus groves. These groves are south of the area where citrus was killed by 1984-1985 freezes. The foliage of the trees observed appears healthy. Foliage of natural vegetation not adjacent to phosphate mining activities was also healthy and showed no sign of disease or unusual insect herbivory.

2.3.6.3 Measurement Programs

AQUATIC ECOLOGY

The purpose of the measurement program was to collect and analyze macroinvertebrates and fish samples for estimating existing and future biological communities in Payne Creek. This information was supplemented by DRI studies conducted in the area. The sampling program was described in the environmental licensing plan of study (KBN, et al., 1988) and was approved by reviewing agencies.

Selected components of the aquatic biological system (i.e., fish and macroinvertebrates) were studied on a seasonal basis to biologically characterize the present status of Payne Creek in the vicinity of the proposed cooling reservoir discharge. The fish and macroinvertebrate communities were sampled at three stations in Payne Creek during October 1988 (wet season) and February 1989 (dry season).

Station locations in Payne Creek were selected based on preliminary design information regarding the location of the cooling reservoir outfall. Three stations were studied in Payne Creek, they were PC-1, PC-2, and PC-3. These stations were selected to encompass areas upstream, near, and downstream of the proposed cooling reservoir discharge. Figure 2.3.6-1 shows the aquatic ecology sampling stations, which coincide with the surface water stations. All biological sampling was conducted concurrent with water quality sampling. Due to variability in stream depth and current, similar areas were selected upstream and downstream, whenever possible to characterize habitats.

The following is a description of the sampling stations.

Station PC-1 is the most upstream sampling site in Payne Creek; it is located near the northern boundary of the Hardee Power Station property. This station offered the most diverse micro-habitats with riffles, pools, and submergent and overhanging vegetation present. The area sampled was shallow, less than 0.9 m (3 ft) deep, and completely covered by a tree canopy. The substrate was a mixture of sand, silt and detritus. It is important to note that Agrico mining activities were ongoing in proximity to PC-1 during the October 1988 sampling period. The area surrounding PC-1 had been mined when the February 1989 sampling effort took place.

PC-2 is located downstream from the proposed outfall of the cooling reservoir. This section of the stream is relatively undisturbed, except for a small bridge and a downstream man-made pool (possibly used as a cattle watering hole in the past). All samples were taken from locations upstream of the man-made pool. This area of the creek was about 1.2 m (4 ft) deep, the water was clear brown, and the stream bottom was covered with heavy leaf litter over sand. Station PC-2 lacked any riffle habitat.

Station PC-3 was the most downstream site of Payne Creek sampled. It is located south of the property and upstream of the CR 663 bridge. The creek in this area is very wide, slow flowing, not covered by a tree canopy, and with a depth of approximately 1.8 m (6 ft). At this point, several tributaries have joined Payne Creek giving it the above characteristics. The bottom was covered with about 0.6 m (2 ft) of black soil containing decaying matter (muck) over sand. Station PC-3 had less divergent microhabitats than the first two stations, but dense submergent and emergent vegetation provided excellent niche complexity. The following is a discussion of the October 1988 and February 1989 Payne Creek sampling efforts.

All biological samples collected were fixed and labeled in the field. The samples were then taken to the laboratory for taxonomic identification. A voucher collection of representative specimens was prepared concurrent with the taxonomic work up of samples. A macroinvertebrate reference collection was prepared and is maintained by KBN's taxonomists. The ichthyological specimens were deposited as part of the collection of the Florida Museum of Natural History in Gainesville, Florida.

The objective of fish sampling effort was to gather baseline qualitative data on the composition of the ichthyofaunal community. Thus, a seine was chosen as the most appropriate method of fish capture in Payne Creek. A 9.1

meter (m) by 1.8 m, 6 millimeter (mm) mesh flat nylon minnow seine was employed at all three stations. The net was often rolled shorter to accommodate varying stream widths at Stations PC-1 and PC-2, while the maximum length was usually used at Station PC-3. Sampling efforts varied according to the habitat complexity of individual stations; Stations PC-1 and PC-2 offered more complex microhabitats than did Station PC-3, so more hauls were made at these first two stations to ensure coverage of all available niches. Captured fish were preserved immediately in 10% formalin and returned to the laboratory for sorting, identification, and quantification.

The macroinvertebrate surveys consisted of two phases:

1. A semiquantitative (artificial substrates) and qualitative (dip nets) assessment of epifaunal species, and
2. A quantitative survey of infaunal macroinvertebrate communities.

Artificial Substrates--Epifaunal macroinvertebrates were sampled using Hester-Dendy artificial substrate samplers which were incubated in Payne Creek from October to November 1988 and February to March 1989. The samplers were incubated for four weeks; three replicates were analyzed.

Ponar Grab Samples--Infaunal communities were sampled quantitatively using a petit Ponar. Six replicate samples were taken from the natural sediment. Four replicate samples were processed. Samples of infaunal macroinvertebrates were collected from Payne Creek during October 1988 and February 1989. These data and specific discussion are included in Appendix 11.6, Tables 7-12.

Dip Net--Organisms on vegetation, sticks, logs, and other substrates ere collected qualitatively using a dip net. Organisms in dip net samples were identified to the lowest taxon readily discernible (e.g., order of family level). Samples were collected at all stations.

TERRESTRIAL ECOLOGY

Existing information was reviewed and field studies were conducted in order to determine 1) the nature of the regional and the onsite biota, 2) pre-existing environmental stresses, 3) effect of existing land uses on site biota, and 4) the potential occurrences of threatened and endangered species onsite.

Flora--Major onsite vegetation communities, defined as communities with an area of at least 2 ha (5 acres) or with significant functional value, e.g., wetlands, were delineated on aerial photographs. Dominant vegetation was identified during field surveys conducted in autumn of 1988 and early spring, 1989. Species composition and abundance in each community were sampled in representative plots. The number of replicate plots was proportional to the size of the community sampled.

Trees $\geq$ 5 cm trunk diameter were identified, counted, and the diameter recorded in 10 x 10 m plots. Shrub stems and trees <5 cm trunk diameter that were $\geq$ 1 m tall, were counted in 5 x 5 m plots. Percent cover projected by the canopy of herbaceous species and woody species that were <1 m tall were counted in 1 x 1 m plots. Smaller plots were nested in the larger plots in the communities sampled that had tree, shrub, and ground cover.

Regional vegetation was characterized through literature review, aerial photography, and road surveys. Existing environmental stress was identified through personal observation and consultation with Hardee and Polk County agricultural extension agents and the Polk County forester. Potential and/or actual occurrences of threatened and endangered species were determined by: consultation with FNAI and Dr. David Hall, curator of the Florida State Museum of Natural History herbarium; review of DRI applications, and FCREPA reports, 1978; and field surveys in likely habitats. These surveys were conducted in October and November, 1988 and in February 1989.

Fauna--Wildlife surveys were conducted on November 1 and December 28, 1988 and March 22 and 23, 1989. Mammals, birds, reptiles and amphibians were recorded as they were encountered in the field (Tables 2.3.6-9, 2.3.6-10 and 2.3.6-11). No trapping or quantitative surveys were conducted. Birds were qualitatively surveyed by walking though all habitats in the study area and recording each species seen or heard. Medium and large sized mammals were surveyed by searching for their sign (tracks, scat, foraging, trails, scrapes, etc). Direct observations of mammals were also recorded. Reptiles and amphibians were surveyed by searching under logs and other debris.

2.3.7 Meteorology and Ambient Air Quality

2.3.7.1 Meteorology

The meteorological data collected at existing monitoring stations were used to describe the local and regional climatology in the vicinity of the proposed Hardee Power Station. The closest existing meteorological station to the proposed plant with complete meteorological data is the primary National Weather Service (NWS) station located at the Tampa International Airport situated approximately 67 km (42 miles) to the west-northwest of the proposed plant site. The NWS has recorded weather observations for more than 40 years at this site, and these data are the most complete for and representative of the region surrounding the proposed project.

TEMPERATURE

The climate in the Tampa area, including the project site, is subtropical with a marine influence from the Gulf of Mexico. Temperature means and extremes for Tampa are presented in Table 2.3.7-1. The mean annual temperature is 22°C (72°F) with monthly temperatures varying from a maximum of 32.4°C (90.3°F) to a minimum of 9.7°C (49.5°F). Record extreme temperatures range from a low of -7.8°C (18°F) to a record high of 37°C (99°F). Although the sun's elevation is nearly zenith during the summertime, temperatures do not exceed 38°C (100°F). The reason can be attributed to the high relative humidities with subsequent cloud cover formation and the abundant convective-type precipitation.

Table 2.3.7-1. Temperature Means and Extremes (°F) Measured at Tampa International Airport, Tampa, Florida

Month	Temperatures*			Extremes+	
	Mean	Maximum	Minimum	Maximum	Minimum
January	59.8	70.0	49.5	84	21
February	60.7	71.0	50.4	88	24
March	66.2	76.2	56.1	91	29
April	71.5	81.9	61.1	93	40
May	77.2	87.9	67.2	98	49
June	80.9	89.5	72.3	99	53
July	82.1	90.0	74.2	97	63
August	82.3	90.3	74.2	98	67
September	80.8	88.9	72.8	96	57
October	74.4	83.7	65.1	94	40
November	66.7	76.9	56.4	90	23
December	61.3	71.6	50.9	86	18
Annual	72.0	81.4	62.5	99	18

* 30-year period of record, 1951 to 1980.

+ 39-year period of record, 1947 to 1985.

Source: NOAA, 1985.

RELATIVE HUMIDITY AND PRECIPITATION

Relative humidity, an indication of the amount of moisture in the air at a given temperature, is presented in Table 2.3.7-2 for the morning hours of 0100 and 0700 and early afternoon and evening hours of 1300 and 1900. The highest humidities are coincident with the coolest ambient temperatures, which generally occur at 0700 or near dawn. The lowest humidities coincide with the highest ambient temperatures.

Precipitation means and extremes are also presented in Table 2.3.7-2. Approximately 69% of the annual precipitation falls during the six warmest months, May through October. The mean annual precipitation is 119 cm (47 inches), but this has varied from as little as 74 cm (29 inches) to over 193 cm (76 inches) in the last 35 years. The majority of rain is in the form of short-lived convection showers.

WIND PATTERNS

The Tampa area lies entirely within the trade wind belt (i.e., below 30°N latitude) resulting in predominant winds from the east. However, because of the location of the Gulf of Mexico, moderate to strong late afternoon sea breezes occur on days in with strong land heating producing local onshore winds (i.e., wind with a westerly component). Annual and seasonal wind roses for the 5 year period from 1982 through 1986 are given in Figures 2.3.7-1 and 2.3.7-2. A summary of the average wind speeds for each season and throughout the year, including calm conditions, is presented in Table 2.3.7-3.

ATMOSPHERIC STABILITY

Atmospheric stability is a measure of the atmosphere's capability to disperse pollutants. During the daytime with strong insolation, the atmosphere can disperse pollutants very quickly for a relatively short period of time. This condition is considered as very unstable and generally occurs infrequently during the year. During the nighttime under clear skies and light wind speeds, the atmosphere is considered stable with minimal

Table 2.3.7-2. Precipitation and Diurnal Relative Humidity Measured at Tampa International Airport, Tampa, Florida

Month	Precipitation (inches)			Humidity** (%) hour (LT)			
	Mean*	Maximum+	Minimum+	0100	0700	1300	1900
January	2.17	8.02	T	84	86	59	73
February	3.04	7.95	0.21	83	85	56	69
March	3.46	12.64	0.06	82	86	55	67
April	1.82	6.59	T	82	87	51	62
May	3.38	17.64	0.17	81	86	53	62
June	5.29	13.75	1.86	84	87	60	68
July	7.35	20.59	1.65	85	88	63	73
August	7.64	18.59	2.35	87	91	64	76
September	6.23	13.98	1.28	86	91	62	75
October	2.34	7.36	0.16	85	89	57	71
November	1.87	6.12	T	85	88	57	74
December	2.14	6.66	0.07	84	87	59	74
Annual	46.73	76.57	28.89	84	88	58	70

Note: T = trace amount.

LT = Local Time

* 30-year period of record, 1951 to 1980.

+ 39-year period of record, 1947 to 1985.

** 22-year period of record, 1964 to 1985.

Source: NOAA, 1985.

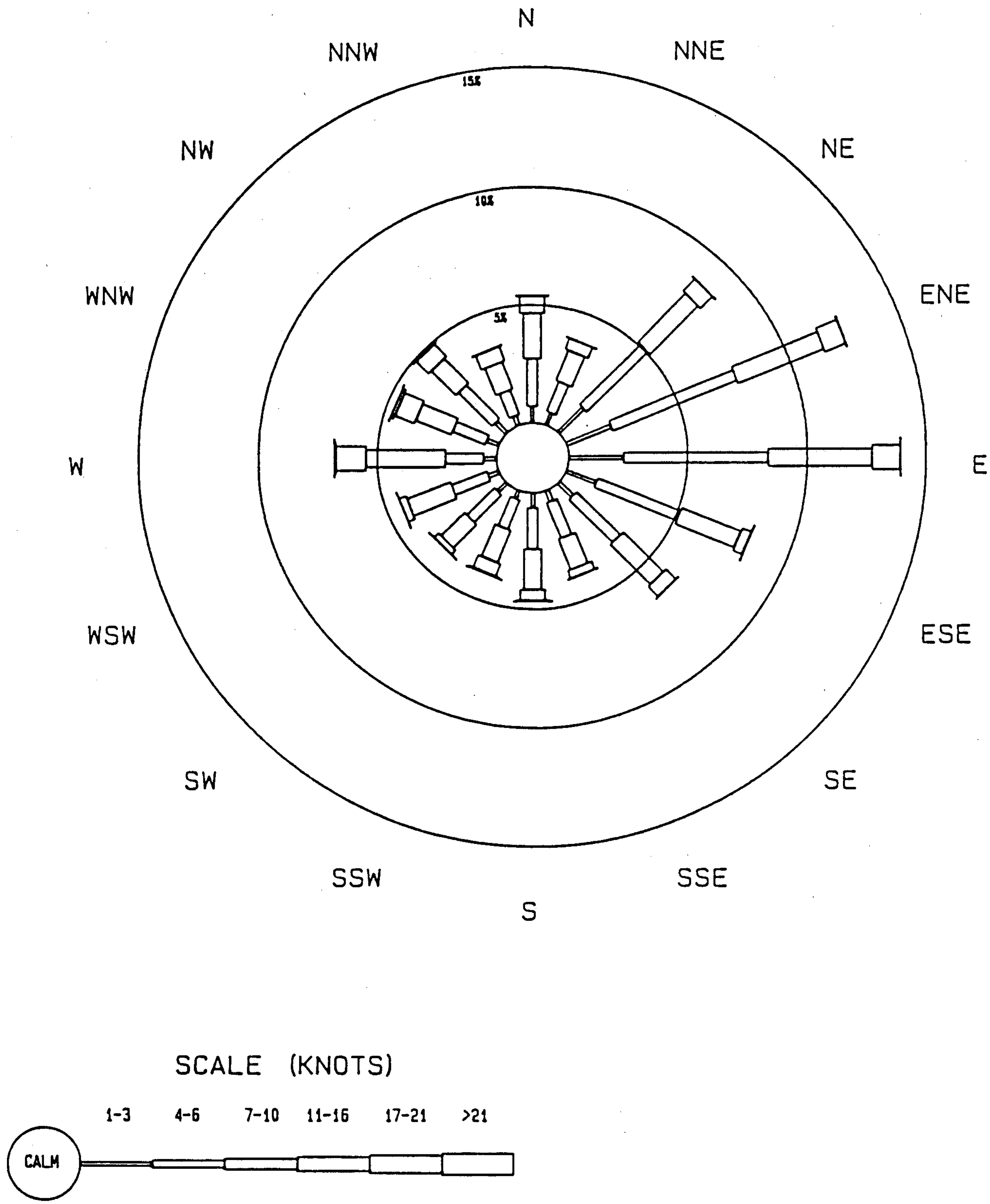


Figure 2.3.7-1 ANNUAL AVERAGE WIND FREQUENCY DISTRIBUTION (1982 THROUGH 1986) MEASURED AT THE NATIONAL WEATHER SERVICE STATION IN TAMPA, FLORIDA

Hardee Power Station

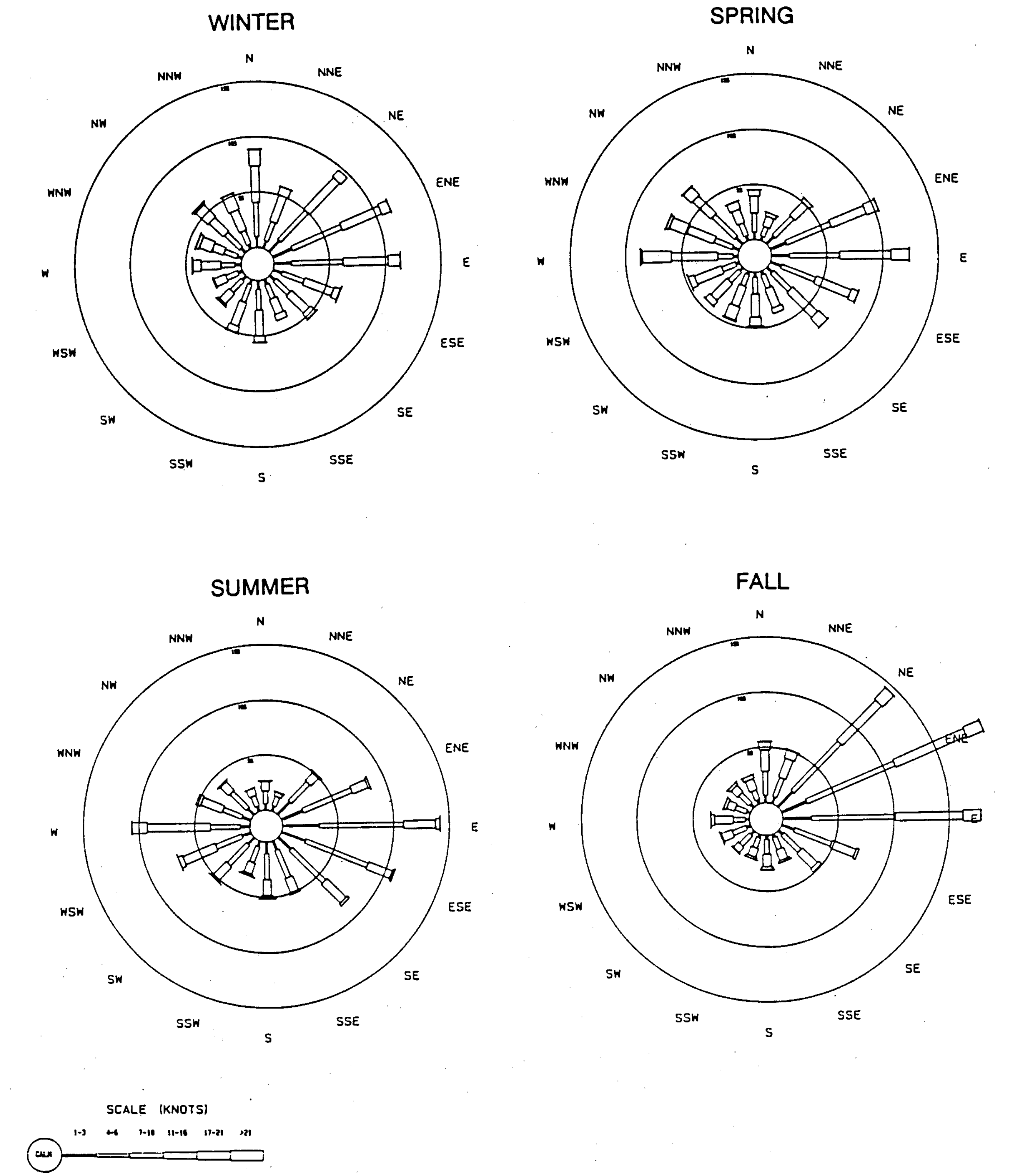


Figure 2.3.7-2 SEASONAL AVERAGE WIND FREQUENCY DISTRIBUTION (1982 THROUGH 1986) MEASURED AT THE NATIONAL WEATHER SERVICE STATION IN TAMPA, FLORIDA

Hardee Power Station

Table 2.3.7-3. Wind Direction and Speed Measured at Tampa International Airport*

Season	Average Wind Speed (mph)	Calm (%)	Prevailing Wind Direction: Direction	Prevailing Wind Direction: Average Wind Speed (mph)
Winter	7.9	6.7	East-northeast, East	7.6 7.9
Spring	8.3	6.4	East	8.4
Summer	6.4	10.2	East	6.4
Fall	7.2	7.0	East-northeast	7.7
Annual	7.5	7.6	East	7.6

* 5-year period of record, 1982 to 1986.

Source: NOAA, 1986.

potential to disperse pollutants. Under moderate to high wind speeds, pollutants are dispersed at moderate rates under neutral conditions, which are generally more prevalent throughout the year and can occur any time throughout the day.

The seasonal and annual average occurrences of atmospheric stability classes are shown in Table 2.3.7-4. Frequent and strong sea breezes cause a predominance of neutral and stable air (neutral and stable stabilities), counteracting the effect of high incidence of sunshine over Tampa.

During the summer months, unstable stability occurs nearly 40% of the time due to strong insolation, while occurring only 16% of the time in the winter months. Neutral stability occurs most frequently during the winter months due to the higher wind speeds in this season. Stable stability occurs nearly uniform throughout the year, with a maximum occurrence of approximately 47% in the fall.

MIXING HEIGHT

The mixing height is a parameter used to define the vertical height to which pollutants can disperse and, therefore, used in estimating the volume of air in which pollutants are emitted and can be dispersed. In general, the higher the mixing height, the greater the potential for pollutants to be dispersed.

The seasonal and annual average morning and afternoon mixing depths for Tampa determined using the Holzworth method are listed in Table 2.3.7-5. The highest afternoon mixing depths occur in the spring and the lowest morning depths occur in mid-winter.

SEVERE STORMS

Thunderstorms are the most frequent of severe storms, occurring an average of 87 days per year. These storms occur throughout the year, but about 88% occur from May through October.

Table 2.3.7-4. Occurrences of Atmospheric Stability Classes Determined at Tampa International Airport, Tampa, Florida*

Season	Occurrence (%) of Stability Class					
	Very Unstable	Moderately Unstable	Slightly Unstable	Neutral	Slightly Stable	Moderately Stable
Winter	0.0	3.8	12.2	42.6	16.7	24.6
Spring	0.8	10.7	17.3	29.6	15.8	25.7
Summer	3.5	17.2	17.4	17.9	15.8	28.2
Fall	0.6	9.3	16.1	26.6	18.3	29.0
Annual	1.2	10.3	15.8	29.1	16.7	26.9

* 5-year period of record, 1982 to 1986.

Source: NOAA, 1986.

Table 2.3.7-5. Morning and Afternoon Mixing Heights Determined at Tampa International Airport, Tampa, Florida*

Season	Mixing Height (m)	
	Morning	Afternoon
Winter	464	1,041
Spring	562	1,500
Summer	760	1,428
Fall	565	1,305
Annual	588	1,320

* 5-year period of record, 1982 to 1986.

Source: NOAA, 1986.

In the 80 km (50-mile) coastal strip from above Pinellas County to Tampa Bay, there is less than a 10% chance that a tropical storm will pass over the Bay area during any given year. For storms of hurricane strength [i.e., wind speeds exceeding 117 km/hr (73 mph)], the chance decreases to 1 in 16 (i.e., 6.2%) with a one percent chance that the winds will be greater than 200 km/hr (124 mph) (i.e., wind speeds of a great hurricane).

Statistics compiled by the Severe Local Storms (SELS) branch of the National Severe Storms Forecast Center (Pautz, 1969) show that 42 tornadoes were spotted within the 1° latitude by 1° longitude square centered just south of the Tampa area from 1955 to 1967. This averages approximately 2 tornadoes per year. The tornado recurrence interval for any specific point location within the 1° square was estimated by the methodology of Thom (1963) to be 740 years. Therefore, the mean recurrence interval for a tornado striking a point within this square is 740 years. The most common tornado month is June.

2.3.7.2 Ambient Air Quality

AMBIENT STANDARDS

The existing applicable National and Florida ambient air quality standards (AAQS) are presented in Table 2.3.7-6. Primary National AAQS were promulgated to protect the public health, and secondary national AAQS were promulgated to protect the public welfare from any known or anticipated adverse affects associated with the presence of pollutants in the ambient air. Areas of the country in violation of AAQS are designated as nonattainment areas, and new sources to be located in or near these areas may be subject to more stringent air permitting requirements.

Prevention of Significant Deterioration (PSD) review is used to determine whether significant air quality deterioration will result from the new or modified source located in attainment areas. Under federal PSD review requirements, all major new or modified sources of air pollutants regulated under the Clean Air Act (CAA) must be reviewed and approved by the USEPA or

Table 2.3.7-6. Federal and State of Florida Ambient Air Quality Standards (AAQS)

Pollutant	Averaging Time	AAQS (ug/m^3) Federal Primary Standard	AAQS (ug/m^3) Federal Secondary Standard	AAQS (ug/m^3) State of Florida
Particulate Matter (PM10)	Annual Arithmetic Mean	50	50	50
	24-Hour Maximum+	150	150	150
Sulfur Dioxide	Annual Arithmetic Mean	80	N/A	60
	24-Hour Maximum*	365	N/A	260
	3-Hour Maximum*	N/A	1,300	1,300
Carbon Monoxide	8-Hour Maximum*	10,000	N/A	10,000
	1-Hour Maximum*	40,000	N/A	40,000
Nitrogen Dioxide	Annual Arithmetic Mean	100	100	100
Ozone	1-Hour Maximum+	235	235	235
Lead	Calendar Quarter	1.5	1.5	1.5

Notes: N/A = Not applicable.
ug/m^3 = micrograms per cubic meter
PM10 = particulate matter with nominal diameter $\leq$10 um.

* Maximum concentration not to be exceeded more than once per year.

\+ Maximum concentration not to be exceeded more than an average of 1 calendar day per year.

Sources: 40 CFR, Parts 50 and 52.
Florida Administrative Code (FAC), Chapter 17-2.

an agency delegated with PSD review authority. In Florida, the FDER has been delegated PSD review authority by USEPA.

In promulgating the 1977 CAA Amendments, Congress specified that certain increases above an air quality "baseline concentration" level of sulfur dioxide (SO_2) and particulate matter (PM) concentrations would constitute "significant deterioration." The magnitude of the allowable increment depends on the classification of the area in which a new source (or modification) will be located or have an impact. Three classifications were designated based on criteria established in the CAA Amendments. Initially, Congress promulgated areas as Class I [international parks, national wilderness areas, and memorial parks larger than 2,024 ha (5,000 acres), and national parks larger than 2,428 ha (6,000 acres) or as Class II (all areas not designated as Class I). No Class III areas, which would be allowed greater deterioration than Class II areas, were designated. USEPA then promulgated as regulations the requirements for classifications and area designations.

On October 17, 1988, the USEPA promulgated regulations to prevent significant deterioration due to NO_x emissions and established PSD increments for NO_2 concentrations. The USEPA class designations and allowable PSD increments are presented in Table 2.3.7-7. Florida has adopted the USEPA allowable increments for PM and SO_2, but has not yet adopted the NO_2 increments.

The term "baseline concentration" evolves from federal and state PSD regulations and denotes a fictitious concentration level corresponding to specified baseline data and certain additional baseline sources. By definition in the PSD regulations, as amended August 7, 1980, baseline concentration means the ambient concentration level which exists in the baseline area at the time of the applicable baseline date. A baseline concentration is determined for each pollutant for which a baseline date is established and includes:

Table 2.3.7-7. Federal and State of Florida PSD Allowable Increments

	Allowable Increment (ug/m^3)		
Pollutant/Averaging Time	Class I	Class II	Class III
Particulate Matter (TSP)			
Annual Geometric Mean	5	19	37
24-Hour Maximum*	10	37	75
Sulfur Dioxide			
Annual Arithmetic Mean	2	20	40
24-Hour Maximum*	5	91	182
3-Hour Maximum*	25	512	700
Nitrogen Dioxide+			
Annual Arithmetic Mean	2.5	25	50

Note: TSP = total suspended particulate.

* Maximum concentration not to be exceeded more than once per year.

+ Not yet adopted by the state of Florida.

Source: 40 CFR Part 52, Section 52.21.
Florida Administrative Code, Chapter 17-2.

1. The actual emissions representative of sources in existence on the applicable baseline date; and
2. The allowable emissions of major stationary sources which commenced construction before January 6, 1975 for SO_2 and total suspended particulates (TSP) concentrations and February 8, 1988 for NO_2 concentrations, but were not in operation by the applicable baseline date.

The following emissions are not included in the baseline concentration and therefore affect PSD increment consumption:

1. Actual emissions from any major stationary source on which construction commenced after January 6, 1975 for SO_2 and TSP concentrations and February 8, 1988 for NO_2 concentrations; and
2. Actual emission increases and decreases at any stationary source occurring after the baseline date.

"Baseline date" means the earliest date after August 7, 1977 for SO_2 and TSP concentrations and February 8, 1988 for NO_2 concentrations, on which the first complete application under 40 CFR 52.21 is submitted by a major stationary source or major modification subject to the requirements of 40 CFR 52.21.

AMBIENT AIR QUALITY DATA

The FDER has approved an exemption from PSD ambient air quality monitoring for this project. The request was made in the Environmental Licensing Plan of Study (KBN, 1988) with FDER's recommendation for monitoring exemption in September 1988 (FDER, 1988) The exemption is appropriate because:

1. The site is not located near [i.e., within 10 km (6.2 miles)] any major sources of pollutant emissions;
2. Background concentrations are expected to be low and near the PSD monitoring <u>de minimis</u> impact levels; and
3. Data from existing monitors will provide conservative background concentrations because these sites are located in more industrial areas than the project site.

Because of the rural area and minimal amount of air pollution sources in Hardee County, the FDER does not operate any monitoring stations in the county. Existing air quality data were obtained from monitoring stations operated by the FDER in Polk County, which has monitoring stations closest to the proposed project site. The closest ambient air monitoring stations to the proposed project site that measure SO_2 concentrations are located in Nichols, about 25 km (16 miles) north-northwest of the site, and in Lakeland, about 50 km (31 miles) north of the site. These stations use continuous methods to measure SO_2 concentrations. TSP concentrations are measured using Hi-volume samplers at 5 locations in Polk County. These stations are located 17.5 km to 50 km (11 to 31 miles) from the proposed site. A summary of observed TSP and SO_2 concentrations measured at these stations during 1986 and 1987 is given in Table 2.3.7-8.

The TSP and SO_2 concentrations observed at these stations are within the federal and state AAQS. Because these monitors are located in urban areas, and/or in proximity [i.e., within 10 km (6.2 miles)] of major sources, the observed concentrations are considered to be higher than those expected to occur at the proposed facility site. Data from a rural monitoring network 5-6 km (3-4 miles) south of Ona, located in Hardee County, confirm this conclusion. This network was operated for Farmland Industries and consisted of one continuous SO_2 concentration for 5,649 hourly observations averaging 4 ug/m^3, with maximum 3- and 24-hour concentrations of 157 ug/m^3 and 69 ug/m respectively. Observed TSP concentrations averaged from 24 to 32 ug/m^3 over the year with maximum 24-hour concentrations ranging from 74 to 58 ug/m^3.

Table 2.3.7-8. Ambient Air Concentrations of Sulfur Dioxide (SO_2) and Total Suspended Particulate Matter (TSP) for Stations Located in Polk County

Pollutant	Location	Site Number	UTM Coordinates (km)* East	North	Year	Observations+ Number	%	Concentration (ug/m^3) 3-Hour 1st	2nd	24-Hour 1st	2nd	Annual
SO_2	Lakeland	2160-001-F01	407.5	3107.5	1987	8444	96.4	200	162	86	55	10
			(3°, 50 km)		1986	6520	74.4	267	178	81	71	13
	Nichols	3680-010-F02	399.5	3081.3	1987	8571	97.8	697	267	115	51	11
			(348°, 24.5 km)		1986	4994	57.0	203	162	38	35	7
TSP	Lakeland	2160-001-F-01	407.5	3107.5	1987	58	95.1	-	-	87	86	50
			(3°, 50 km)		1986	58	95.1	-	-	109	87	47
	Nichols	3680-010-F02	399.5	3081.3	1987	58	95.1	-	-	73	73	38
			(348°, 24.5 km)		1986	58	95.1	-	-	119	81	38
	Bartow	0180-010-0	418.4	3084.05	1987	42	68.9	-	-	74	71	40
			(27°, 29.9 km)		1986	57	93.4	-	-	70	70	37
	Mulberry	2860-003-F02	404.993	3085.497	1987	42	68.9	-	-	75	75	43
			(360°, 28 km)		1986	54	88.5	-	-	74	74	38
	Bradley	3680-011-F02	403.1	3074.8	1987	61	100.0	-	-	110	91	45
			(354°, 17.5 km)		1986	60	98.4	-	-	94	80	41

* Direction and distance from the site listed in parentheses.
\+ For TSP, based on observations every 6 days (61 per year).
Source: FDER, 1987/88.

The rural nature of the site also suggests that for other criteria pollutants, i.e., carbon monoxide (CO), ozone (O_3), NO_2 and lead (Pb), the observed concentrations are well below the AAQS. Hardee County is classified as an attainment area for all criteria pollutants.

EXISTING AIR POLLUTANT SOURCES

The proposed plant location is in a rural area with minimal amount of air pollution sources. The nearest major air pollution source is located about 12 km (7 miles) from the site in Polk County. Although phosphate rock mining and a benefication plant are located within 10 km (6.2 miles) of the site, air pollutant emissions from these sources, in the form of fugitive dusts, are not significant.

Because SO_2, NO_2, and PM concentrations were determined to be significant due to emissions from the Hardee Power Station (see Section 5-6), a detailed review was conducted to determine SO_2, NO_2 and PM emission sources located within 50 km (31 miles) of the proposed source. The FDER supplied a list of 305 facilities within a 100 km (62 miles) square centered on the proposed site. A list of major facilities that are within 50 km (31 miles) of the site and have SO_2, NO_2, or PM emissions greater than 100 tons per year (TPY) are presented in Tables 2.3.7-9 through 2.3.7-11, respectively.

BACKGROUND CONCENTRATIONS

Background concentrations are air quality concentrations due to air pollutant sources not explicitly accounted for in the air modeling analysis. Because the site is not located near any major sources of SO_2, PM, and NO_x emissions, background concentrations are expected to be low. As a result, existing monitoring data are used to estimate background concentrations. The ambient data are collected in areas that are more industrialized and have higher emission densities than the proposed site. Therefore, the estimated background concentrations are considered to be conservative (i.e., higher concentrations than actually exist at the proposed plant site).

Table 2.3.7-9. SO2 Sources (>100 TPY) Within 50 km of Proposed Hardee Power Station

Facility	UTM Coordinates (km) East	UTM Coordinates (km) North	Relative Location (km) To Proposed Site X	Relative Location (km) To Proposed Site Y	Distance From Proposed Site (km)	Direction From Proposed Site (degree)	Maximum SO2* Emissions (TPY)
Gardinier	415.3	3063.3	10.5	5.9	12.0	61	1,173
Imperial Phosphate	404.8	3069.5	0.0	12.1	12.1	0	275
Agrico Chemical Co. (S. Pierce)	407.5	3071.5	2.7	14.1	14.4	11	4,557
Mobil Oil Big Four Mine	394.7	3069.6	-10.1	12.2	15.8	320	569
U.S. Agri-Chemicals	416.0	3069.0	11.2	11.6	16.1	44	2,933
Wachula City Power Plant	418.4	3047.0	13.6	-10.4	17.1	127	180
IMC Fort Lonesome	389.5	3067.9	-15.3	10.5	18.6	304	1,547
Agrico Chemical Co. (Pierce)	403.7	3079.0	-1.1	21.6	21.6	357	417
Mobil-Electrophosphate Division+	405.6	3079.4	0.8	22.0	22.0	2	1,428
Farmland Industries	409.5	3080.1	4.7	22.7	23.2	12	2,877
IMC	396.7	3079.4	-8.1	22.0	23.4	340	10,168
IMC/Noralyn Mine Road	414.7	3080.3	9.9	22.9	24.9	23	505
C.F. Industries	408.4	3082.4	3.6	25.0	25.3	8	8,443
Kaplan Industries	418.3	3079.3	13.5	21.9	25.7	32	385
American Orange Corp.	429.8	3047.3	25.0	-10.1	27.0	112	198
Conserv. Chemicals	398.7	3084.2	-6.1	26.8	27.5	347	1,597
Royster Co.	406.8	3085.1	2.0	27.7	27.8	4	1,231
Mobil Chemical Co./Nichols	398.4	3085.3	-6.4	27.9	28.6	347	899
IMC/Praire	402.9	3087.0	-1.9	29.6	29.7	356	137
W.R. Grace & Co.	409.8	3086.7	5.0	29.3	29.7	10	8,171
U.S. Agri-Chemicals	413.2	3086.3	8.4	28.9	30.1	16	1,575
FPL Manatee	367.3	3054.2	-37.5	-3.2	37.6	265	85,305
Tricil Recovery Services	422.7	3091.9	17.9	34.5	38.9	27	240
Consolidated Minerals	393.8	3096.3	-11.0	38.9	40.4	344	3,302
Teco Big Bend	361.9	3075.0	-42.9	17.6	46.4	292	364,554
Citrus World	441.0	3087.3	36.2	29.9	47.0	50	597
Columbus Company	361.9	3077.8	-42.9	20.4	47.5	295	167
Gardinier	363.4	3082.4	-41.4	25.0	48.4	301	5,181
Lakeland City Power	409.0	3106.2	4.2	48.8	49.0	5	4,014
Lakeland City Power	409.2	3106.2	4.4	48.8	49.0	5	30,176
Adams Packing	421.7	3104.2	16.9	46.8	49.8	20	172
						Total	542,973

* Maximum facility emissions from APIS, or other available information on facility.

Table 2.3.7-10. NO2 Sources (>100 TPY) Within 50 km of Proposed Hardee Power Station

Facility	UTM Coordinates (km) East	UTM Coordinates (km) North	Relative Location (km) To Proposed Site X	Relative Location (km) To Proposed Site Y	Distance From Proposed Site (km)	Direction From Proposed Site (degree)	Maximum NO2* Emissions (TPY)
Gardinier	415.3	3063.3	10.5	5.9	12.0	61	176
Agrico Chemical	407.5	3071.5	2.7	14.1	14.4	11	139
Mobil Oil Big Four Mine	394.7	3069.6	-10.1	12.2	15.8	320	156
U.S. Agri-Chemicals	416.0	3069.0	11.2	11.6	16.1	316	131
IMC Fort Lonesome	389.5	3067.9	-15.3	10.5	18.6	304	610
Farmland Industries	409.5	3080.1	4.7	22.7	23.2	12	226
IMC	396.7	3079.4	-8.1	22.0	23.4	340	322
Kaplan Industries	418.3	3079.3	13.5	21.9	25.7	32	100
Mobil Chemical Co./Nichols	398.4	3085.3	-6.4	27.9	28.6	347	134
W.R. Grace & Co.	409.8	3086.7	5.0	29.3	29.7	10	528
FPL Manatee	367.3	3054.2	-37.5	-3.2	37.6	265	28,233
Consolidated Minerals	393.8	3096.3	-11.0	38.9	40.4	344	534
Sherex Polymers	410.7	3098.9	5.9	41.5	41.9	352	617
Juice Bowl Products	409.4	3099.9	4.6	42.5	42.7	354	109
Owens-Illinois	406.0	3102.3	1.2	44.9	44.9	358	391
Teco Big Bend	361.9	3075.0	-42.9	17.6	46.4	292	82,624
Citrus World	441.0	3087.3	36.2	29.9	47.0	50	1,382
Gardinier	363.4	3082.4	-41.4	25.0	48.4	301	466
Lakeland City Power	409.0	3106.2	4.2	48.8	49.0	5	3,978
						Total	120,856

* Maximum facility emissions from APIS, or other available information on facility.

Table 2.3.7-11. PM Sources (>100 TPY) Within 50 km of Proposed Hardee Power Station

Facility	UTM Coordinates (km) East	UTM Coordinates (km) North	Relative Location (km) To Proposed Site X	Relative Location (km) To Proposed Site Y	Distance From Proposed Site (km)	Direction From Proposed Site (degree)	Maximum PM * Emissions (TPY)
Gardinier	415.3	3063.3	10.5	5.9	12.0	61	132
Imperial Phosphates	404.8	3069.5	0.0	12.1	12.1	0	162
Agrico Chemical	407.5	3071.5	2.7	14.1	14.4	11	1,692
Mobil Oil Big Four Mine	394.7	3069.6	-10.1	12.2	15.8	320	263
U.S. Agri-Chemicals	416.0	3069.0	11.2	11.6	16.1	316	871
Biochemical Energy, LTD	418.3	3048.0	13.5	-9.4	16.5	125	281
IMC Fort Lonesome	389.5	3067.9	-15.3	10.5	18.6	304	679
IMC	398.2	3075.7	-6.6	18.3	19.5	340	168
Agrico Chemical	403.7	3079.0	-1.1	21.6	21.6	357	631
C&M Products	405.5	3079.1	0.7	21.7	21.7	358	162
Mobil-Electrophos Division	405.6	3079.4	0.8	22.0	22.0	358	555
Farmland Industries	409.5	3080.1	4.7	22.7	23.2	12	977
IMC	396.7	3079.4	-8.1	22.0	23.4	340	162
IMC	414.7	3080.3	9.9	22.9	24.9	337	1,018
C.F. Industries	408.4	3082.4	3.6	25.0	25.3	352	788
IMC/ Uranium Recovery	408.4	3082.8	3.6	25.4	25.7	8	831
American Orange Corp.	429.8	3047.3	25.0	-10.1	27.0	112	180
Conserv Chemical	398.7	3084.2	-6.1	26.8	27.5	13	1,620
Royster	406.8	3085.1	2.0	27.7	27.8	4	210
Mobil Chemical Co./Nichols	398.4	3085.3	-6.4	27.9	28.6	347	433
W.R. Grace & Co.	409.8	3086.7	5.0	29.3	29.7	10	636
Ridge Pallets	418.6	3084.1	13.8	26.7	30.1	27	180
U.S. Agri-Chemicals	413.2	3086.3	8.4	28.9	30.1	16	182
Allsun Products	413.5	3093.8	8.7	36.4	37.4	13	317
FPL Manatee	367.3	3054.2	-37.5	-3.2	37.6	265	6,672
Consolidated Minerals	393.8	3096.3	-11.0	38.9	40.4	344	740
Pavers, Inc.	414.0	3098.2	9.2	40.8	41.8	347	114
Rinker Cencon Corp.	412.4	3099.0	7.6	41.6	42.3	350	159
Quikrete	412.8	3099.0	8.0	41.6	42.4	349	253
Landia Chemical	403.7	3101.8	-1.1	44.4	44.4	1	2,313
Kraft Citrus	399.0	3101.8	-5.8	44.4	44.8	353	108
Owens-Illinois	406.0	3102.3	1.2	44.9	44.9	358	102
Jahna Concrete, Inc.	450.0	3052.2	45.2	-5.2	45.5	97	139
Teco Big Bend	361.9	3075.0	-42.9	17.6	46.4	292	7,699
Agrico Chemical Co.	362.1	3076.1	-42.7	18.7	46.6	66	184
Macasphalt	451.1	3050.0	46.3	-7.4	46.9	99	165
Citrus World	441.0	3087.3	36.2	29.9	47.0	50	166
FPL Avon Park	451.4	3050.5	46.6	-6.9	47.1	98	212
Gardinier	363.4	3082.4	-41.4	25.0	48.4	301	863
Lakeland City Power	409.0	3106.2	4.2	48.8	49.0	5	14,705
Coca Cola Citrus	421.6	3103.7	16.8	46.3	49.3	20	334
Adams Packing Association	421.7	3104.2	16.9	46.8	49.8	20	129
						Total	23,591

* Maximum facility emissions from APIS, or other available information on facility.

For SO_2 concentrations, data collected at the monitoring stations in Nichols and Lakeland were reviewed and used in estimating background concentrations. The nearest station to the proposed site is located in Nichols, approximately 24.5 km (15 miles) to the north-northwest. During 1987, the second highest 3- and 24-hour and annual average concentrations were 267, 51, and 11 ug/m^3, respectively. These concentrations were assumed to represent background concentrations.

There are no stations within 50 km (31 miles) of the proposed site location that measure NO_2 concentrations. The nearest station to the proposed site is located in Ybor City, Hillsborough County, approximately 60 km (37 miles) to the west-northwest. This station is in a highly urbanized area and has a significant impact from vehicular traffic. During 1987, this station (No. 4360-052-G01) measured an annual average concentration of 45 ug/m^3, based on 69 percent data capture. This concentration was used to represent a conservative estimate of the background concentration.

TSP concentration data collected at the monitoring station in Bradley were used in estimating background PM10 concentrations. These values were the second highest 24-hour and annual average concentrations of 91 and 45 ug/m^3, respectively. The data from this station were selected because this is the closest station to the project site with TSP concentrations. It should be noted that the AAQS for particulate matter is based on PM with a nominal diameter of 10 microns (u) or less (PM10). TSP concentrations include particles with diameters of approximately 30 u or less. Therefore, the use of TSP concentrations to estimate PM10 background concentrations will provide an additional conservative factor in determining compliance with AAQS.

2.3.7.3 Measurement Programs

Since the Hardee Power Station project was exempted by FDER from ambient air quality monitoring, all information (i.e., meteorology and air quality data) were compiled from off-site monitoring stations maintained and operated by cooperating governmental agencies. Ambient air quality data were obtained from the FDER and which operate a total of 7 monitoring stations in Polk

County. No significant changes in these programs are anticipated after plant operation has begun.

Meteorological data were obtained from the NWS surface stations in Tampa and upper air station in Ruskin. These data were obtained for a 5-year period from 1982 through 1986 from which the joint frequency of wind direction, wind speed, and atmospheric stability and a 5-year average of mixing heights were developed. Since 1965, the wind sensors have been located 6.7 m (22 ft) above grade. Regular surface observations are taken just before each hour, 7 days per week. Upper-air soundings are conducted twice per day at 0700 and 1900 Eastern Standard Time.

2.3.8 Noise

2.3.8.1 Background

The proposed facility is located in an isolated, undeveloped area of open-pit phosphate mining. The unmined topography of woodland/grassland area is predominately flat with the exception of overburden spoil mounds that range in length from a few to hundreds of meters. Directly east of the proposed site are two retention ponds enclosed by a levee system approximately 10 m (32 ft) in height. Most of the phosphate mining area is undeveloped with the closest residential receptor a little more than a mile to the south of the proposed facility. Neither Polk nor Hardee Counties have noise ordinances for receiving lands.

2.3.8.2 Noise Measurement Procedures

The continuous ambient noise monitoring was performed using slow response mode to obtain A-weighted sound levels. A windscreen was used since all measurements were taken outside. The microphone was positioned so that a random incidence response, as specified by the American National Standard Institute (ANSI), was achieved. A continuous record of the sound level meter output data was made on the strip chart during all monitoring. This not only produced a continuous hard copy output of the Model 2230, but also provided a quality control check of the sound level meters operation during monitoring. Hourly sound pressure level (SPL) data were collected at each location and consisted of three noise parameters.

Leq - The sound pressure level averaged over the measurement period; this parameter is as the continuous steady sound pressure level which would have the same total acoustic energy as the real fluctuating noise over the same time period.

Max - The maximum sound pressure level for the sampling period.

Min - The minimum sound pressure level for the sampling period.

Monitoring was conducted using the sound level meter mounted on a tripod at a height of 1.2 m (4 ft) above grade. An output cable connected the sound level meter with the strip chart recorder. The strip chart recorder was located away from the sound level meter so that time marks and comments could be recorded without disturbing or influencing the sound level measurement process. Local wind speed and temperature were measured by a handheld anemometer and thermometer during the monitoring period. Field notes were recorded during monitoring and included the local meteorological parameters and major noise sources.

A comprehensive baseline noise analysis survey to assess the existing ambient noise levels in the area of the proposed facility was conducted from the 8th through the 10th of February, 1989. SPL data were collected at six different locations (Figure 2.3.8-1) using ANSI measurement techniques. The noise monitoring equipment used during the survey included:

Continuous Noise Monitoring Equipment

Bruel & Kjaer Type 2230 Precision Integrating Sound Level Meter
Bruel & Kjaer Type 2639 Microphone Preamplifier
Bruel & Kjaer Type 4155 Prepolarized Condenser Microphone
Primeline Model 6723 Two-Pen Portable Strip Chart Recorder
Windscreen, Tripod and Various Cables

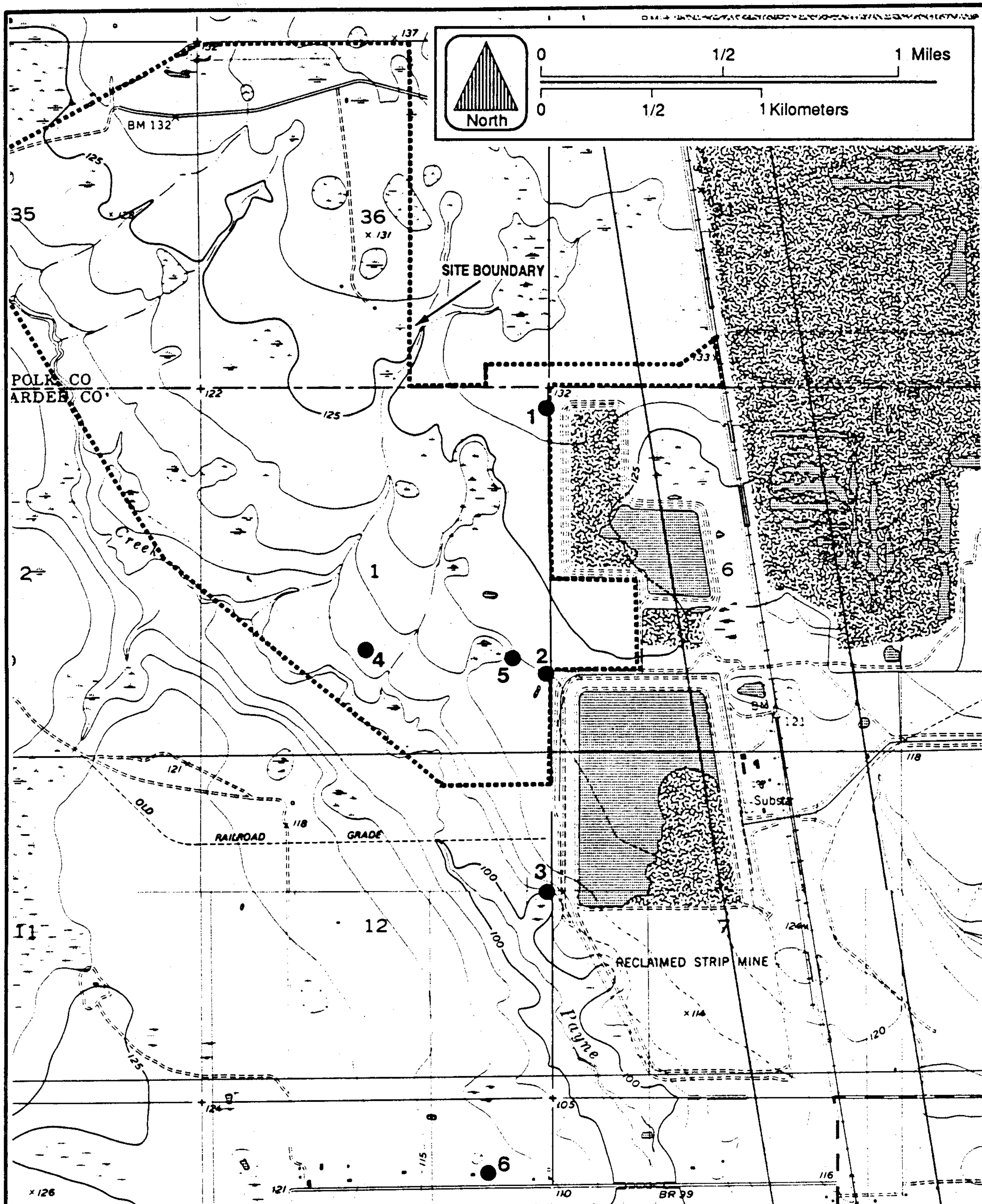


Figure 2.3.8-1 NOISE MONITORING LOCATIONS

Hardee Power Station

Sound Level Meter Calibration Unit

Bruel & Kjaer Type 4230 Sound Level Calibrator, 94 decibels (dB) @ 1000 hertz (Hz).

The B & K Type 2230 sound level meter complies with "Type I - Precision" requirements set forth by ANSI S1.4 for sound level meters. The sound level meter was recently purchased and is under manufacturer's original calibration. The specifications for this equipment are presented in Appendix 11.7.

The six monitoring locations represent sites that are: 1) at the proposed property boundaries relative to human populations (Sites 1, 2 and 3); 2) at maximum noise impact area (next to proposed facility location, Sites 4 and 5); and 3) at the closest residential receptors relative to the facility (Site 6). Site 1 is located at the extreme northwest corner of Section 6, Range 24 East/Township 33 South. Site 2 is just off the access road at the northwest corner of CFI's South Pond. This site is the closest monitoring site to a commercial receptor, CFI's Hardee Plant, about 900 m (3,000 ft) to the east-southeast. Site 3 is located at the southwest corner of CFI's South Pond. Site 4 is located in Section 1, Range 23 East/Township 33 South at the western corner of the property line. Site 5 is situated approximately 60 m (200 ft) west of the fence line that runs from the southwest corner of CFI's North Pond. Site 6 is located approximately 2,400 m (7,800 ft) due south of the proposed plant site on the north side of Roberts Road. The homes on Roberts Road are the closest non-commercial (residential) receptors to the plant site.

Ambient SPLs were measured at various times during the day and night time for 60 consecutive minutes at each of the six sites. The Leq (equivalent sound pressure level averaged for 60 minutes) as well as the maximum and minimum SPLs during each monitoring episode were recorded and are presented in Table 2.3.8-1. The average minimum, maximum and Leq SPL for each site was calculated. The SPL averages are calculated using the

Table 2.3.8-1. Ambient Sound Pressure Level Data for the Hardee Power Station Site

SITE NO.	DATE/TIME	WIND SPEED(mph)	AIR TEMP(F)	MIC ANGLE(deg)		SOUND PRESSURE LEVELS MIN	MAX	Leq	COMMENTS
1	2/09/89--1702	5	64	278		32.5	60.9	43.0	Airplane & birds
	2/10/89--1425	4	74	278		29.9	76.2	51.9	Airplane (2)
					Ave.	31.4	73.3	49.4	
2	2/09/89--1425	4	72	268		37.2	69.8	44.9	None
	2/09/89--2345	4	52	268		34.5	54.3	40.7	None
					Ave.	36.1	66.9	43.3	
3	2/09/89--1541	1	72	258		28.0	56.5	42.8	Airplane & birds
	2/10/89--0935	7	52	258		35.3	63.0	40.8	Jet & airplane (3)
					Ave.	33.0	60.9	41.9	
4	2/10/89--1100	2	64	130		50.2	62.3	60.9	Dragline operations
	2/10/89--1204	2	71	130		35.3	60.3	45.3	Dragline operations
					Ave.	47.3	61.4	58.0	
5	2/09/89--2225	1	52	282		32.8	65.2	41.4	Airplane (2)
	2/10/89--1315	4	74	282		34.4	57.7	42.1	Jet
					Ave.	33.7	57.7	41.8	
6	2/10/89--0808	6	48	004		37.3	74.0	49.0	Car (2) & truck (3)

following formula:

$$\text{Average SPL} = 10 \text{ Log} \frac{\sum_{i=1}^{N} 10^{(SPL_i/10)}}{N}$$

where: SPL_i = sound pressure level in data set

Also included in Table 2.3.8-1 are the wind speed, temperature, microphone direction and comments during the monitoring program. The SPL data were analyzed and reported in "A weighted" decibels (dBA). The higher the decibel value, the louder the sound.

2.3.8.3 Existing Ambient Sound Pressure Level Conditions

The ambient Leq SPLs in the area of the proposed facility ranged from a low of 40.7 dBA at Site 2 to a high of 60.9 dBA at Site 4. The minimum ambient values varied from 29.9 dBA to 50.2 at Sites 1 and 4, respectively. Sound sources in the proposed area included dragline mining operations, aircraft traffic, vehicular traffic at the residential area (Site 6) and various types of songbirds. The intensity of these various noise sources can vary significantly both spatially and temporally.

The major on-site noise sources currently are the drag-line cranes and to a lesser degree, drag-line operations support equipment (bulldozers, trucks, etc.). These sources will move in direction and distance, relative to the proposed facility, as the mining operations continue to follow the phosphate-bearing seams.

2.3.9 Other Environmental Features

The previous section described the environmental features of the Hardee Power Station site.

REFERENCES - Chapter 2

Agrico Chemical Company. 1977. Application for Development Approval for the Extension of Ft. Green and Payne Creek Mines Extension into Hardee County.

Agrico Chemical Company. 1983. Fort Green Reclamation Project, First Annual Report.

Agrico Chemical Company. 1984. Fort Green Reclamation Project, Second Annual Report.

Agrico Chemical Company. 1985. Fort Green Reclamation Project, Third Annual Report.

Agrico Chemical Company. 1986. Fort Green Reclamation Project, Fourth Annual Report.

Agrico Chemical Company. 1989. Personal Communique.

Allen, D. Telephone conversation between D. Allen, Bartow Water Dept., and J. Smolinski, Stone & Webster. January 1989.

Applied Technology and Management, Inc. 1989.

Applin, P.L. and Applin, E.R. 1965. The Comanche Series and Associated Rocks in Subsurface Florida. USGS Professional Paper 447.

Barr, G.L. 1987. Potentiometric Surface-Upper Floridan Aquifer in Florida-May 1985. Florida Bureau of Geology. VOL. MS, NO. 119.

Barr, G.L. and Lewelling, B.R. 1986. Potentiometric Surface of the Upper Floridan Aquifer, West-Central. USGS Open File Report 86-409W.

Bartow Realty. Telephone conversation between representative of Bartow Realty and J. Smolinski of Stone & Webster. January 1989.

Bechtold, W.A. and Knight, H.A. 1982. Florida's Forests. Resource Bulletin SE-62. Southeastern Forest Experiment Station. Asheville, North Carolina.

Bergendahl, M.H. 1956. Stratigraphy of Parts of DeSoto and Hardee Counties, Florida. USGS WRI-78-34.

Berner, L. and Pescador, M. 1987. The Mayflies of Florida. Univ. Presses of Florida, Gainesville, Florida. 415 p.

Borchers, Ron. Chief of Current Planning for Polk County. Memorandum of January 20, 1989.

Bouono, A., et al. 1979. Generalized Thickness of the Confining Bed Overlying the Flo. USGS WRI 79-1171.

Brinkhurst, R.O. 1986. Guide to the Freshwater Aquatic Microdrile Oligochaetes of North America. Canadian Special Pub. Fish. and Aquatic Sci. 84. Dept. Fisheries and Oceans, Ottawa. 259 p.

Brooks, H.K. 1981. Geologic Map of Florida. Florida Coop Extension Service, University of Florida, Gainesville, Florida.

Brown, H.P. 1972. Aquatic Dryopoid Beetles (Coleoptera) of the United States. Biota of Freshwater Ecosys., Identification. Manual No. 6. USEPA. 87 p.

Bryan, M. Telephone conversation between M. Bryan, Bowling Green Municipal Offices, and J. Smolinski, Stone & Webster. January 1989.

Buono, A. and Rutledge, A.T. 1979. Configuration of Top of Floridan Aquifer, SWFWMD and Adjacent Areas. USGS WRI 78-34.

Burch, J.B. 1973. Freshwater Unionacean Clams (Mollusca:Pelecypoda) of North America. Biota of Freshwater Ecosystems Identification Manual No. 11. USEPA. 176 p.

CF Industries. 1985. Appendix IV. Development of Regional Impact. Central Florida Planning Council.

Campbell, K.M. 1986. Florida Bureau of Geology. Geology of Polk County, Florida. VOL. OFR, NO. 13.

Causey, L.V. and Leve, G.W. 1976. Florida Bureau of Geology. Thickness of the Potable-Water Zone in the Floridan Aquifer. VOL. MS, NO. 74.

Central Florida Regional Planning Council (CFRPC). Comprehensive Regional Plan. July 1987.

Central Florida Regional Planning Council. 1988. Population of Region 7 by County and City 1980 - and Estimates/Projections to 2000. (Computer produced Table).

Colson, J. Telephone conversation between J. Colson, Polk County Water & Sewer Dept., and J. Smolinski, Stone & Webster. January 1989.

Corral, M.A. 1983. Distribution of Selected Chemical Constituents in Water Floridan Aquifer. USGS WRI Report 83-4041.

Corral, M.R. and Wolansky, R.M. 1984. Generalized Thickness and Configuration Top Intermediate Aquifer. USGS WRI Report 84-4018.

Crow, Lawrence W., Jr. Letter from Sheriff Crow to J. Smolinski, Stone & Webster. February 3, 1989.

Dames & Moore. 1976. Application for Development Approval: CF Mining Corporation Hardee Phosphate Complex, A Development of Regional Impact, Volumes One and Two.

Dames and Moore. 1979. Hydrology of the South Rockland Area and Vicinity - Polk and Hardee Counties, Florida. Report to Agri-Chemicals, Division of U.S. Steel Corp.

Davis, Joe. Telephone conversation between J. Davis, Hardee County Board of Realtors, and J. Smolinski, Stone & Webster. January 1989.

Department of Community Affairs (DCA). 1988. Mapping and Monitoring of Agricultural Lands Project 1984-1987 County Data. 2571 Executive Center Circle East. Tallahassee, Florida 32301.

Department of Natural Resources, Division of Recreation and Parks, "Florida State Parks Guide," brochure. Undated. (Received from DNR 1988.)

Department of Natural Resources. 1987. Division of Recreation and Parks. Outdoor Recreation in Florida - February 1987.

Duerr, A.D., et al. 1987. Hydrogeology of the Intermediate Aquifer System. SWFWMD. USGS WRI 87.

Economic Development Council of Polk County, Inc. (EDC). Undated. (Booklet of social and economic characteristics - untitled.)

Fitzpatrick, J.F., Jr. 1983. How to Know the Freshwater Crustacea. The Pictured Key Nature Ser. Wm. C. Brown Co. Pub., Dubuque, Iowa. 227 p.

Florida Department of Environmental Regulation. 1987. Comparison of Air Quality Data with the National Ambient Air Quality Standards, ALLSUM Report, Bureau of Air Quality Management.

Florida Department of Environmental Regulation. 1988b. Comparison of Air Quality Data with the National Ambient Air Quality Standards, ALLSUM report, Bureau of Air Quality Management.

Florida Department of Environmental Regulation. 1988. Comments for Seminole Electric Cooperative's Plan of Study PA 89-25. Interoffice memorandum to Buck Oven from Jim McDonald. September 23, 1988.

Florida Department of Labor & Employment Security, Bureau of Labor Market Information. 1988. SDA Profiles, Labor Market Information.

Florida Natural Area Inventory (FNAI). 1988. Special Plants List. Tallahassee, Florida.

Gieger, Doug. Telephone conversation between D. Gieger, Polk County Public Safety Dept., and J. Smolinski, Stone & Webster. January 1989.

Gilboy, A.E. 1985. Hydrogeology of the Southwest Florida Water Management District. SWFWMD Technical Report 85-01.

Gunter, Bill. Telephone conversation between B. Gunter, Bartow & Ft. Meade Fire Departments., and J. Smolinski, Stone & Webster. January 1989.

Hall, David, Ph.D. Telephone conversation between Dr. D. Hall, Curator of Herbarium at Florida Museum of Natural History, Gainesville, Florida, and Robin Hart, KBN Engineering and Applied Sciences, Inc. January, 1989.

Hall, R.B. 1983. General Geology and Stratigraphy S. Extension of Phosphate District. Central Florida Phosphate District, Field Trip Guidebook.

Hammett, K.M. 1985. Low Flow Frequency Analysis for Streams in West-Central Florida. USGS WRI Report 84-4299.

Hampson, P.S. 1984. Wetlands in Florida. Florida Bureau of Geology. VOL. MS, NO. 109.

Hardee County Comprehensive Plan. (Electric Utility Element).

Hardee County Comprehensive Plan. (Land Use Plan).

Healy, H.G. 1975. Terraces and Shorelines of Florida. Florida Bureau of Geology. VOL. MS, NO. 71.

Healy, H.G. and Hunn, J.D. 1984. Occ of Beds of Low Hydraulic Conductivity in Surficial Deposits Florida. USGS WRI Report 84-4210.

Hearn, W.H. 1979. Identification Manual of the Freshwater Clams of Florida. Dept. Environmental Reg. Technical Series 4(8). 83 p.

Heine, George. Telephone conversation between G. Heine, Wauchula Municipal Offices, and J. Smolinski, Stone & Webster. January 1989.

Hendry, C.W. and Lavender, J.A. 1959. Florida Bureau of Geology. Information Circular. Final Report on an Inventory of Flowing Artesian Wells in Florida. VOL. IC, NO. 21.

Hodge, M. Telephone conversation between M. Hodge, Polk County Water Dept., and J. Smolinski, Stone & Webster. January 1989.

Hutchinson, C.B. 1978. Appraisal of Shallow Groundwater Res in Upper Peace & Alafia River. USGS WRI 77-124.

Institute of Food and Agricultural Sciences, 1979. Florida Daily Temperature Normals, Circular 464. University of Florida, Gainesville, Florida.

Institute of Food and Agricultural Sciences, 1983. Potential Evapotranspiration Probabilities and Distributions in Florida. Agricultural Engineering Extension Mimeo Report 83-13. University of Florida, Gainesville, Florida.

Johannsen, O.A. 1969. Aquatic Diptera. Entomological Reprint Specialist, Los Angeles. Four parts, paged separately.

Johnson, R.A. 1986. Index Map of Shallow Stratigraphic Core Tests on File. Florida Bureau of Geology. VOL. MS, NO. 111.

Johnson, R.A. 1986. Shallow Stratigraphic Core Tests on File. Florida Bureau of Geology. VOL. IC, NO. 103.

Johnston, R.H., et al. 1981. Potentiometric Surface of Tertiary Limestone Aquifer System, SE US. USGS Open File Report 81-486.

Jones, Capt. Harold. Telephone conversation between Capt. Jones, Hardee County Fire & EMS Dept., and J. Smolinski, Stone & Webster. January 1989.

KBN Engineering and Applied Sciences, Inc. 1988a. SECI Combined Cycle Project, Environmental Licensing Plan of Study. Prepared for Seminole Electric Cooperative, Inc., August 1988.

King, K.C. and Wright. 1979. Revision of the Tampa Formation, West-Central Florida. Gulf Coast Association of Geological Societies, Transactions.

Klemm, D.J. 1985. A Guide to the Freshwater Annelida (Polychaeta, Naidid and Tubificid Oligochaeta, and Hirudinea) of North America. Kendall/Hunt, Dubuque, Iowa. 198 p.

Lane, E. 1986. Karst in Florida. Florida Bureau of Geology. VOL. SP, NO. 29.

Lawton, Lt. M.L. Bartow Sheriff's Department. Letter to J. Smolinski, Stone & Webster. February 1989.

Lewelling, B.R. 1987. Potentiometric Surface of Intermediate Aquifer System, West-Central. USGS Open File Report 87-705.

Lewelling, B.R. 1987. Potentiometric Surface of the Upper Floridan Aquifer, West-Central. USGS Open File Report 87-451.

Lewis, P. Telephone conversation between P. Lewis, Polk County Solid Waste Dept., and J. Smolinski, Stone & Webster. January 1989.

MacNeil, F.S. 1950. Pleistocene Shore Lines in Florida and Georgia. USGS Prof. Paper 221F.

Maddox, Lt. J. Telephone conversation between Lt. J. Maddox, Hardee County Sheriff's Dept., and J. Smolinski, Stone & Webster. January 1989.

Martin, Gerald C. Zoning Administrator of Polk County. Letter of January 24, 1989.

Menke, C.G., et al. 1961. Water Resources of Hillsborough County, Florida. Florida Bureau of Geology. VOL. RI, NO. 25.

Merritt, R.W., and Cummins, K.W., Eds. 1978. An Introduction to the Aquatic Insects of North America. Kendall/Hunt Pub. Co., Dubuque, Iowa. 441 p.

Messer, L. Telephone conversation between L. Messer, Ft. Meade Municipal Offices, and J. Smolinski, Stone & Webster. January 1989.

Miller, J.A. 1979. Potential Subsurface Zones for Liquid-Waste Storage in Florida. Florida Bureau of Geology. VOL. MS, NO. 94.

Miller, J.A. 1982. Thickness of Upper Permeable Zone of Tertiary LS Aquifer, SE US. USGS Open File Report 81-1179.

Miller, J.A. 1986. Hydrogeologic Framework of Floridan Aquifer System in Florida, Georgia, South Carolina, Alabama. USGS Professional Paper 1403-B.

Moore, D.L., et al. 1986. Design and Establishment of Background Ground-Water Quality Monitor. SWFWMD.

Morin, Sgt. Dan. Telephone conversation between Sgt. Dan Morin, Wauchula Police Department, and J. Smolinski, Stone & Webster. January 1989.

Mulberry Fire Chief. Telephone conversation between Mulberry Fire Chief, Mulberry Fire Dept., and J. Smolinski, Stone & Webster. January 1989.

National Oceanic and Atmospheric Administration. 1985. Local Climatological Data, Annual Summary with Comparative Data, Tampa Florida.

National Oceanic and Atmospheric Administration. 1986. WBAN Hourly Surface Observations and Mixing Height Data, 1982 to 1986, Tampa, Florida.

National Oceanic and Atmospheric Administration. 1988. Climatic Data for Florida.

Needham, J.G., and Westfall, M.J., Jr. 1954. A Manual of the Dragonflies of North America (Anisoptera). University of California Press, Berkeley, California. 615 p.

Pautz, M.E. 1969. Weather Bureau, Office of Meteorological Operations, Weather Analysis and Prediction Division. Severe Local Storm Occurrences 1955-1967. September.

Pearson, Sgt. Clark. Telephone conversation between Sgt. Clark Pearson, Hardee County Sheriff's Dept., and J. Smolinski, Stone & Webster. January 1989.

Peek, H.M. 1958. Groundwater Resources of Manatee County, Florida. Florida Bureau of Geology. VOL. RI , NO. 18.

Pennak, R. W. 1978. Fresh-water Invertebrates of the United States, 2nd ed. John Wiley & Sons, New York. 803 pp.

Polk County Soil Conservation Service. 1988. Unpublished.

Robbins, J.M., et al. 1984. Soil Survey of Hardee County, Florida. United States Department of Agriculture and Soil Conservation Service.

Robertson, A.F. and Mills, L.R. 1974. Ground-Water Withdrawals in Upper Peace and Upper Alafia River Basin. Florida Bureau of Geology. VOL. MS , NO. 67.

Rosenau, J.C., et al. 1977. Springs of Florida. Florida Bureau of Geology/DER. VOL. BUL, NO. 31.

Rutter, B. 1987. Revised Key to Tanytarsus Larvae of Florida. Unpublished. Taxonomic Key. 3 p.

Ryder, P.A. 1985. Hydrology of the Floridan Aquifer System in West-Central Florida. USGS Professional Paper 1403-F.

Scott, T.M. 1988. The Lithostratigraphy of the Hawthorn Group (Miocene) of Florida. Florida Bureau of Geology. VOL. B, NO. 59.

SEGS Ad Hoc Committee. 1986. Hydrogeological Units of Florida. Florida Bureau of Geology. VOL. SP , NO. 28.

Simpson, K.W., and Bode, K.W. 1980. Common Larvae of Chironomidae (Diptera) from New York State Streams and Rivers. New York State Museum, Bull. No. 439. State Educ. Dept., Albany, 105 p.

Sinclair, W.C. and Stewart, J.W. 1985. Sinkhole Type, Development and Distribution in Florida. Florida Bureau of Geology. VOL. MS, NO. 110.

Sinclair, W.C., et al. 1985. Types, Features,and Occ of Sinkholes in Karst of West-Central Florida. USGS WRI 85-4126.

Southwest Florida Water Management District. 1988. Regional Rainfall Database. Brooksville, Florida.

Stewart, H.G. 1966. Ground-Water Study of Polk County. Florida Bureau of Geology. VOL. RI , NO. 44.

Stewart, J.W. 1980. Areas of Natural Recharge to the Floridan Aquifer in Florida. Florida Bureau of Geology. VOL. MS , NO. 98.

Stricker, R. Telephone conversation between R. Stricker, Polk County Agricultural Extension Agent, and Robin Hart, KBN Engineering. November 1988.

Stringfield, V.T. 1936. Artesian Water in the Florida Peninsula. USGS WSP 773-C.

Sutcliffe, H. 1975. Appraisal of the Water Resources of Charlotte County, Florida. Florida Bureau of Geology. VOL. RI, NO. 78.

SWFWMD. 1987. Aquifer Characteristics Within the Southwest Florida Water Management District. SWFWMD, Brooksville, Florida.

Thom, H.C.S. 1983. Tornado Probabilities. "Monthly Weather Review," October-December, 1963.

Thompson, F.G. 1984. The Freshwater Snails of Florida. University Presses of Florida. University of Florida Press. Gainesville, Florida. 94 p.

U.S. Bureau of the Census. 1980. Census of Population. Characteristics of the Population, Number of Inhabitants: Florida, Document #PC80-1-All Fla. February 1982.

U.S. Bureau of the Census. 1983. County and City Data Book. G.P.O. 1984.

U.S. Bureau of the Census. 1988. County and City Data Book. G.P.O.

U.S. Geological Survey. 1982. Water-Resources Investigations Report 82-4012.

U.S. Geological Survey, 1984. Low-Flow Frequency Analyses for Streams in West-Central Florida. U.S. Geological Survey, Water-Resources Investigations Report 84-4299.

University of Florida. 1987. Bureau of Economic and Business Research. Florida Statistical Abstract, 21st Edition. The University Presses of Florida, Gainesville, Florida. 1987.

University of Florida. 1987. College of Business Administration, Bureau of Economic and Business Research. 1987 Florida Statistical Abstract. University Presses of Florida.

University of Florida. 1988. Bureau of Economic and Business Research. Population Estimates and Projections by Age, Sex and Race for Florida and its Counties, 1987-2000. Bulletin No. 85-86. June.

Vernon, R.O. 1951. Geology of Citrus and Levy Counties, Florida. Florida Bureau of Geology. VOL. BUL, NO. 33.

Vernon, R.O. and Puri, H.S. 1964. Geologic Map of Florida. Florida Bureau of Geology. VOL. MS , NO. 18.

Vickery, J.W. Telephone conversation between J.W. Vickery, Zolfo Springs Police Dept., and J. Smolinski, Stone & Webster. January 1989.

Ward, D. 1978. Plants. Volume Five. Florida Committee for Rare and Endangered Species. University Presses of Florida.

Webb, L. Telephone conversation between L. Webb, Bradley Fire Department, and J. Smolinski, Stone & Webster. January 1989.

White, W.A. 1970. Geomorphology of the Florida Peninsula. Florida Bureau of Geology. VOL. BUL, NO. 51.

Wiederholm, T., Ed. 1983. Chironomidae of the Holarctic Region. Part 1. Larvae. Entomologica Scandinavic Supplement No. 19. 457 p.

Wiederholm, T., Ed. 1986. Chironomidae of the Holarctic Region. Part 2. Pupae. Entomologica Scandinavic Supplement No. 28. 482 p.

Wiggins, G.B. 1977. Larvae of the North American Caddisfly Genera (Trichoptera). University of Toronto Press, Toronto. 401 p.

Wilson, W.E. 1977. Groundwater Resources of DeSoto and Hardee Counties, Florida. Florida Bureau of Geology. VOL. RI , NO. 83.

Wolansky, R.M. and Garbade, J.M. 1981. Generalized Thickness of the Floridan Aquifer, SWFWMD. USGS Open File Report 80-1288.

Wolansky, R.M., et al. 1979. Generalized Thickness of Surficial Deposits Above Confining Bed. USGS Open File Report 79-1071.

Wood, D. 1988. Official Lists of Endangered and Potentially Endangered Fauna and Flora in Florida. Florida Game and Fresh Water Fish Commission. Tallahassee, Florida.

Woodard, H.J. 1964. Preliminary Report on Geology and Groundwater Res Hardee and DeSoto Counties. Florida Board of Conservation, Division of Water Resources & Cons.

Wunderlin, R.P. 1982. Guide to the Vascular Plants of Central Florida. A University of South Florida Book. University Presses of Florida. Tampa, Florida.

Zolfo Springs Municipal Office. Telephone conversation between Zolfo Springs Municipal Office and J. Smolinski, Stone & Webster. January 1989.